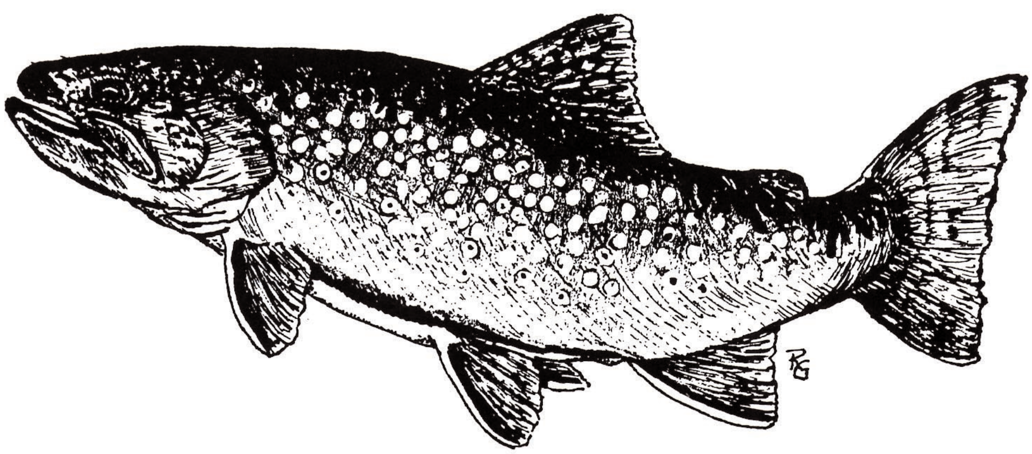
Ontario

Brook Trout Stocking: An Annotated Bibliography and Literature Review with an Emphasis on Ontario Waters



Brook Trout Stocking: An Annotated Bibliography and Literature Review with an Emphasis on Ontario Waters

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Cover drawing by Ruth E. Grant, Brockville, Ontario.

Preface

This bibliography and literature review is the first in a set of reference documents developed in conjunction with a review of fish stocking policies and guidelines in the Province of Ontario. It has been prepared to summarize information pertaining to the current state of knowledge regarding brook trout stocking in a form which can readily be utilized by field staff and stocking proponents.

Material cited in this bibliography includes material published in scientific journals, magazines and periodicals as well as "gray" literature such as file reports from Ministry of Natural Resources (MNR) field offices. Unpublished literature was obtained by soliciting information (i.e., unpublished data and file reports) from field biologists from across Ontario. Most published information was obtained from a literature search from the MNR corporate library in Peterborough. Twenty-one major fisheries journals were reviewed as part of this exercise. These included Aquaculture (1972-1998), California Fish and Game (1917-1999), Copeia (1913-1999), Environmental Biology of Fishes (1976-1999), Fishery Bulletin (1963-1999), Fisheries Management (1975-1984), Journal of Freshwater Ecology (1981-1999), New York Fish and Game Journal (1954-1985), North American Journal of Fisheries Management (1981-1999 inclusive), Journal of the Fisheries Research Board of Canada/Canadian Journal of Fisheries and Aquatic Sciences (1950-1999 inclusive), Progressive Fish Culturist (1940-1999), and Transactions of the American Fisheries Society (1929-1999 inclusive). Searches were also made of other publications including Proceedings of the Annual Meeting of the Southeastern Association of Fish and Wildlife Agencies, Proceedings of the Annual Meeting of the Western Association of Fish and Wildlife Agencies, Transactions of the Annual North American Fish and Wildlife Conference, Transactions of the Annual Midwest Fish and Wildlife Conference, United States Department of the Interior Fisheries Technical Papers, FAO Fisheries Technical Papers and Circulars, and reports published under the Canadian Technical Report Series of Fisheries and Aquatic Sciences. Some material was obtained by a search on the Fish and Fisheries Worldwide database (1971-present) via the Internet.

Information from over 370 sources has been assembled. Abstracts from published papers have been included wherever possible. In cases where abstracts were not available, an attempt has been made to extract pertinent material from the document to provide a synopsis of the findings. In some cases, I was unable to obtain a copy of the document but have simply included the citation.

(i)

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History of Brook Trout Stocking in Ontario

Brook trout (*Salvelinus fontinalis*) has traditionally been one of the most popular sport fish among anglers and one of the most commonly stocked species in the Province of Ontario. With the exception of the Great Lakes, brook trout are stocked throughout Ontario.

Brook trout was among the first fish species to be artificially propagated in Ontario (as early as 1857). Samuel Wilmot's Newcastle hatchery is usually credited as being the first station to rear a number of different salmonids including brook trout. There were other early brook trout culture efforts in the private sector. It is known that, by 1870, a facility at Galt, Ontario, carried a brood stock of approximately 10,000 brook trout as well as fry and fingerlings (MacCrimmon et al. 1974). Other private facilities, situated at Alton, Hillsburg and Redickville, also reared between 60-70,000 brook trout annually. Records of early stocking activities from these facilities are poorly documented however.

In 1900, one of the first expressed interests in brook trout was documented through a request to take 10,000 brook trout from local streams in the Toronto area to be deposited in private ponds to provide angling for a price of 40 cents per pound of fish caught. This request was denied.

One of the earliest recorded brook trout stocking efforts involved a transfer of fish. In 1902, an application was received from the Board of Trade of Rat Portage, Ontario, for brook trout to be placed in waters in vicinity of that town. Approximately 100 brook trout were subsequently captured from the Nipigon River and transported west by the Canadian Pacific Railway (CPR). Several fish died during transport but the remainder, averaging approximately 2 pounds in weight, were apparently stocked in good condition.

By 1912, reports of the Ontario Fish and Game Commission lamented the disappearance of the forest from logging activities in the Ottawa River basin and the Haliburton-Hastings area which impaired brook trout habitat and necessitated the implementation of stocking programs.

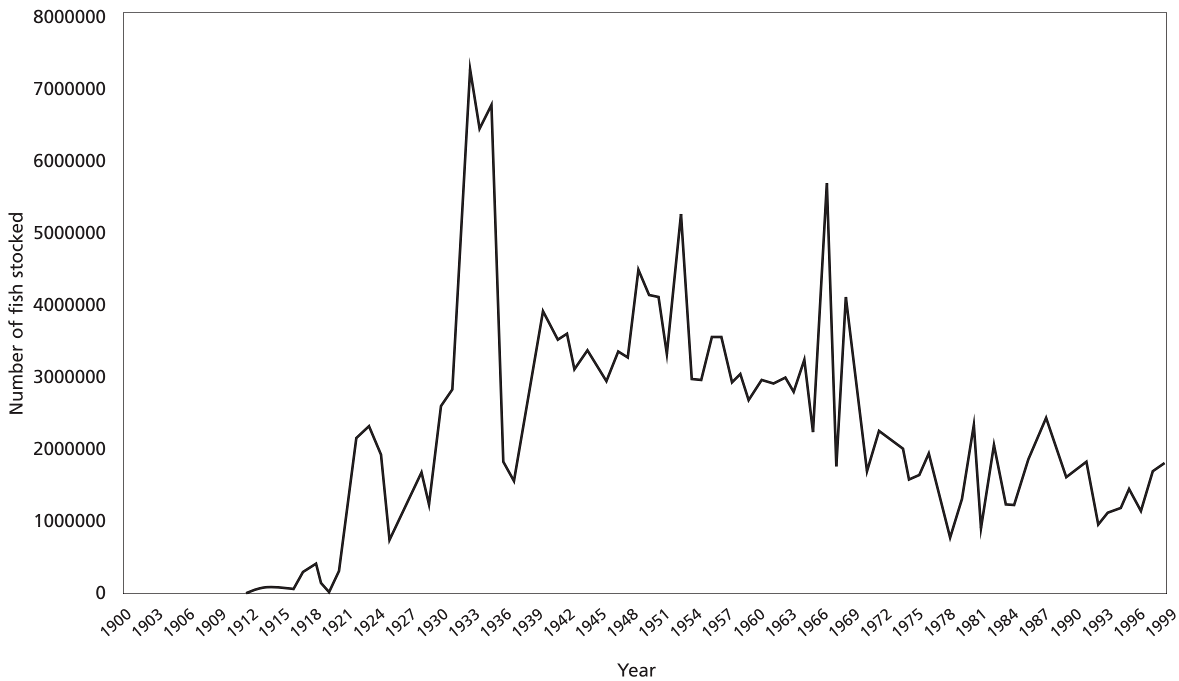
Between 1918-1920, the first major plantings (> 200,000 fish) of brook trout were recorded from the Mount Pleasant and, to a lesser extent, the Normandale provincial fish hatcheries. Most of the waters stocked were streams in southwestern Ontario.

Early stocking efforts largely involved the release of fry but, by the1930s, more emphasis was being placed on the culture and distribution of fingerling and larger brook trout. Brook trout stocking peaked in the 1930s when 7.2 million fish were released in 1933 (see Appendix 1 and Figure 1). Since 1970, brook trout stocking programs in the public waters of Ontario have ranged between one and two million fish annually. Over the past century, almost 205 million brook trout have been stocked in Ontario waters.

There are currently three strains of brook trout in the provincial fish culture system (OMNR 1996b). There are the Hills Lake domestic strain (HLHL), the Lake Nipigon wild strain (LN) and a hybrid of the two (LNHL). The Hills Lake strain has resulted from approximately 20 generations of domestication at the Hill's Lake Fish Culture Station near Englehart, Ontario. It is believed to have originated in Pennsylvania. The Nipigon strain originates from a native population from Lake Nipigon, Ontario.

Several brook trout variants have been cultured and stocked over the years. Albino brook trout yearlings were raised and stocked in 1963, 1964, 1965 and 1967. Captive breeding programs for Aurora trout commenced in 1958 (Snucins and Gunn 1994). The first plantings of Aurora trout occurred in 1964 (582 fry and 682 yearlings). The following year, 4,000 fingerlings Aurora trout were stocked. These fish culture efforts are believed to have saved the Aurora trout from extinction. Currently, several thousand Aurora trout are reared and stocked annually in an attempt to rehabilitate and restore naturally self-sustaining populations.

Figure 1. Brook trout stocking (all life stages combined) in Ontario waters, 1900-1999.



Currently, brook trout brood stock is retained at three provincial fish culture stations. Lake Nipigon brood stock is maintained at the Hill's Lake and Dorion stations while the Hill's Lake brood stock is maintained at the Hill's Lake and Tarentorus stations. In addition to these facilities, brook trout are also reared at other stations in the proximity of where the fish will ultimately be stocked. Transfers of eyed eggs or fry are made form one of these three stations to other facilities (e.g., White Lake, North Bay and Chatsworth fish culture stations) for rearing until the time the fish are stocked.

In 1999, a total of 1,709,024 brook trout were planted in Ontario waters (Table 1). This represents almost 20% of all the fish stocked in the province.

Table 1. Brook trout stocking in Ontario waters by the Ontario Ministry of Natural Resources in 1999.

Region	MNR District	Number fish stocked
Southcentral	Algonquin Park	10,749
	Bancroft	154,652
	Kemptville	11,000
	Midhurst	29,264
	Pembroke	97,245
	Peterborough	11,106
Northeastern	Chapleau	30,500
	Cochrane	13,000
	Hearst	190,500
	Kirkland Lake	363,885
	North Bay	73,705
	Sault Ste. Marie	44,842
	Sudbury	64,848
	Timmins	250,500
	Wawa	81,471
Northwestern	Dryden	22,300
	Fort Frances	7,000
	Kenora	2,800
	Nipigon	38,657
	Sioux Lookout	8,000
	Thunder Bay	203,000
Total		1,709,024

Source: Fish Culture Section, Ontario Ministry of Natural Resources, Peterborough.

Synthesis of Selected Literature

This section will attempt to summarize and highlight several selected stocking related topics under the following categories:

1. Survival of stocked brook trout
2. Contributions of stocked brook trout to the fishery
3. Factors influencing stocking success
4. Potential impacts of stocked brook trout
5. Best management practices for brook trout stocking
6. Guidelines for stocking private ponds
7. Stocking assessment

Survival of Stocked Brook Trout

Stocking success is usually measured in terms of either post-stocking survival or contribution to the creel. Several studies from various North American waters have reported on post-stocking survival rates for brook trout (Appendix 2). The majority of these results, particularly for those in Ontario, are based on assessment netting projects conducted at some point after the actual stocking event. Unfortunately, because of the diversity of different methods for determining post-release survival and the varying times from release, direct comparisons among waters are difficult (Table 1).

Table 1. A summary of post-stocking survival rates for brook trout reported from various North American jurisdictions.

	Reported Survival Rates	
Life Stage Stocked	Streams	Lakes
Fry	3.6-19.7% (N=2)	0.0-9.2% (N=9)
Fingerlings	0.0-45.6% (N=20)	7.7-77.0% (N=5)
Yearlings	0.0% (N=5)	0.0-50.8% (N=47)
Catchables	4.4-92.0%	-

From the available literature, most use of younger life stages (e.g., fry and fingerlings) have involved stocking in streams while the use of yearling fish has been confined largely to lakes. In Ontario, current brook trout stocking practices primarily involve the use of yearling (15-16 month old fish) fish and stocked waters are most frequently lakes. Releases of young fish (e.g., fry) or legal-sized fish (e.g., catchables) is a relatively uncommon practice in Ontario.

Despite small sample sizes in some cases (e.g., yearling trout stocked in streams) and the inability to make direct comparisons among the data reported, two general observations are obvious (i) Post-stocking survival rates of hatchery-reared brook trout are quite low, and (ii) survival rates vary greatly among waterbodies. There are obviously a great number of factors involved which ultimately influence the survival of stocked fish (see subsequent section) but it appears that there are pronounced differences between lakes and streams. It would also appear that the greatest mortality occurs shortly after the stocking event. Latta (1963) found that the greatest natural losses of hatchery-reared brook trout occurred during the first summer after planting and that natural mortality was much greater during the summer than during the winter period.

Contributions of Stocked Trout to the Fishery

Brook trout are known to be very vulnerable to angling and provide immediate, but relatively short term, returns to a recreational fishery. In many instances, stocked brook trout provide the basis for popular winter ice fisheries. Havey and Locke (1980) reported near total exploitation early in the ice fishing season from 5,400 age 1+ brook trout planted the previous fall. They estimated that 92% of the catch was taken in the first six days of the winter ice fishing season.

Surprisingly, there are relatively few reports on the contribution of stocked brook trout to the recreational fishery (Appendix 3). Once again, direct comparisons are difficult as a result of varying creel survey techniques, length of time from stocking, and situation under which fish were stocked.

Generally, returns of stocked fish to the fishery improve as the age and size of fish increases (Table 2). Needham (1959) summarized results of several stocking projects involving large-sized trout and reported an average recovery rate (to the recreational fishery) of 34.5%. Although returns from plantings of yearling brook trout have been as high as 79% (Hunt 1979), they are most commonly less than 10% of the number planted in Ontario waters.

Table 2. A summary of contributions of stocked brook trout to the recreational fishery as reported from various jurisdictions.

	Returns (% of number stocked)	
Life Stage Stocked	Streams	Lakes
Fry	-	-
Fingerlings	0.07-28.0% (N=7)	4.3-25.6% (N=2)
Yearlings	14.1-19.6% (N=2)	0.5-79.0% (N=13)
Catchables	5.0-43.0% (N=7)	64.0-76.6% (N=2)

Factors Influencing Stocking Success

There are many factors which can influence the success of a particular stocking project (Table 3). Basically these factors may be categorized into those which involve the stocking technique (i.e., stocking rate, age/size of fish, transportation methods, etc.), habitat in the receiving waterbody (i.e., physical and chemical parameters), and environmental factors (i.e., predation, competition, winter severity, etc.)

Table 3. A summary of potential factors which can influence the success of a brook trout stocking project.

Factor	Reference(s)
Poor habitat and/or water quality	Anonymous (Undated, 1986a,), Buck (1969), Fraser (1972), Bernier (1978), Gowing (1978), Kerr (1979), Dextrase (1986), Deyne and Arnett (1987c), Ball (1988)
Age and size of fish when stocked	Hazzard and Shetter (1938), Shetter (1939, 1947, 1950), Anonymous (1953), Mullan (1956), Carline et al. (1976), Fraser (1978b, 1988a), Johnson (1978), Brady (1983), Dupont and Bernier (1984)
Domesticated behavior	Vincent (1960), Flick and Webster (1964, 1976), Mason et al. (1967), Moyle (1969), Flick (1971), Hunt (1979), Kerr (1979), Fraser (1980), Wiley et al. (1993)
Genetic strain	Greene (1951), Green (1964), Flick and Webster (1976), Keller and Plosila (1981), Dupont and Bernier (1984)
Stocking technique	White (1930), Surber and Aikens (1932), Hoover and Johnson (1937), Shetter and Hazzard (1940), Shetter (1947), Cooper (1952), Walden (1956), Brady (1991)
Stocking season	Trembley (1941), Williamson and Schneberger (1942), Shetter (1947), Hale (1952b), Anonymous (1953, 1963 1971b), Christenson et al. (1954), Needham (1959), Alexander and Shetter (1961, 1967), DeRoche (1963), von Rosen (1972), Guthrie et al. (1973), Fraser (1976), Fitch (1977), Kerr (1979), Cresswell (1981)
Stress from handling and transport	Patrick (1959b, 1960), Fraser (1968a), Cheshire and Day (1969), Fraser and Beamish (1969) Piper et al. (1982), Liimatainen (1988), McDonald et al. (1993)
Winter severity	Fraser (1978b), Pardue (1979), Franzin and Harbicht (1985).
Diet conversion/starvation	Armitage (1958), Miller (1958), Kerr (1979), Ersbak and Haase (1983), LaChance and Magnan (1990)
Fish health and disease	Thorpe et al. (1944), Goede (1986), Alexander et al. (1990)
Intraspecific competition	Miller (1957), Saunders and Smith (1961), Olver (1969), Carline et al. (1976), Fitch (1977), LaRoche and Pardue (1978), Dextrase (1986), LaChance and Magnan (1990a), Coultes (1992), Hartleb and Moring (1994), Armstrong and Davis (1998)
Interspecific competition	Anonymous (1990i), Clark (1959), Fraser (1972), Kerr (1979), Borgeson (1980), Dupont and Bernier (1984), LaChance and Magnan (1990),Vermont Department of Fish and Wildlife (1993)
Predation	White (1924, 1930), Wales (1946), Latta (1963), Alexander and Shetter (1967), Carline et al. (1976), Fraser (1976), Johnson (1978), Kerr (1979), Keller and Plosila (1981), Dupont and Bernier (1984), Fisher (1986), Deyne and Arnett (1987a), Fraser and Rumsey (1988), Shelley and Matkowski (1989), Vermont Department of Fish and Wildlife (1993), Alberta Ministry of the Environment (1994), Belfry (1997)
Post-stocking movements	Cobb (1933), Hazzard and Shetter (1938), Smith (1941), Trembley (1943), Shetter (1944), Cooper (1952), Hale (1952b), Kuehn and Schumacher (1957), Newell (1957), Smith (1944, 1967), Anonymous (1965), Brynildson (1967), Helfrich and Kendall (1982), Cone and Krueger (1988), Alexander et al. (1990), Van Offelen et al. (1993), Josephson and Youngs (1996)

Habitat and Water Quality - Brook trout are relatively stringent in their habitat requirements (Table 4). Two of the most key water quality parameters are water temperature and dissolved oxygen.

Table 4. General habitat requirements of brook trout.

Parameter	Requirement
Lake size	• Generally less than 50 ha
Lake bathymetry	• Littoral:surface area of 30-80%
Water depth	• Minimum of 4.5 m
	• Maximum of 15-20 m.
Morphoedaphi index (MEI)	• Usually <2
Total dissolved solids	• < 50 mg L^{-1}
Water temperatures	• < 20º C
Dissolved oxygen	• ≥ 5.0 mg L^{-1} PH > 6.0
Water clarity	• Optimum @ 0-30 JTU
Groundwater	• Springs and upwellings sought as thermal refuges and spawning areas.
Stream size	• Usually small, headwater streams
	• Presence of pools for older trout
Water velocity	• Slow to moderate
Cover and structure	• Overhead cover and underwater structure (e.g., logs) sought
Aquatic vegetation	• Water cress used by juveniles

Elevated water temperatures, usually in mid-late summer, often restrict brook trout from many waters. Similarly, oxygen depletions, which most commonly occur in mid summer or late winter, can prove anoxic to brook trout. Brook trout are also susceptible to pH depressions during the spring runoff. Siegler (1948) did report, however, that trout stocked under optimal conditions do have the capability to adapt to less than suitable levels of dissolved oxygen and temperature.

Age and Size of Fish Stocked – The size of fish planted has been attributed to the success or failure of several brook trout stocking projects (Anonymous 1953, Carline et al. 1976, Brady 1983, Dupont and Bernier 1984, Fraser 1988a). Generally, larger-sized trout display better survival and higher angler returns (Mullan 1956). Johnson (1978) reported substantial mortality if fish were stocked at sizes of 100/lb. or smaller.

Fall fingerlings seem to be best suited for waters where there is little or no competition and where there is an abundance of groundwater to minimize ice cover (Shetter 1947). In other situations (Shetter 1939, 1950, Fraser 1988a), fall fingerlings have repeatedly demonstrated poor survival and low returns to the fishery. Fraser (1978b) found that spring yearlings consistently outperformed fall fingerlings in a set of Algonquin Park lakes.

The practice of stocking large, catchable-sized brook trout has been shown to provide improved angling but only for a relatively short (i.e., 2-3 weeks) period of time (Hazzard and Shetter 1938).

Domesticated Behaviour – The influence of artificial rearing on the physiology and behaviour of hatchery-reared brook trout has been identified as a factor influencing survival once fish are stocked in the wild. Behaviour associated with their rearing environment includes lack of fear for predators (Vincent 1960, Flick 1971), absence of any concealment response (Vincent 1960, Flick 1971, Wiley et al. 1993), higher vulnerability to angling (Hunt 1979), reduced adaptability to changes in water chemistry (Vincent 1960), inefficient foraging (Wiley et al. 1993), greater tendency to emigrate (Armitage 1958, Cone and Krueger 1988) and overall poorer survival (Flick and Webster 1964). Tyler (1964) found that eggs from domesticated female brook trout had significantly higher mortality than eggs from wild trout. Fraser (1989) also speculated that during the long period of domestication in the hatchery environment, domestic strains of brook trout may have lost their ability to locate and utilize suitable spawning areas.

Genetic Strain – Several researchers have concluded that genetic strain is important in determining growth, survival and longevity. Recent advances in molecular biology have enabled managers to distinguish different strains of brook trout and use this information to preserve the genetic integrity and biodiversity of wild stocks. Domestic strains usually display faster growth but poorer stamina (Green 1964), reduced lifespan and lower survival (Flick and Webster 1976, OMNR 1999b). In many cases, hybrid strains survive longer and grow better than parent stocks (Keller and Plosila 1981, Ihssen et al. 1982, Fraser 1986). There is also evidence to show that domesticated brook trout are more vulnerable to angling and provide only a short term fishery while wild strains can sustain a fishery throughout the entire season (Greene 1951, Flick 1971).

Stocking Technique – Stocking technique includes the frequency and timing of stocking activities, the density at which fish are planted and the means by which they are released.

Brook trout have been planted during all seasons of the year but, except for put-and-take fisheries which are stocked throughout the fishing season, most stocking occurs in the spring, fall or winter. There have been numerous reports of the advantages of planting brook trout in the spring. Generally, spring stocking results in higher angler recovery of stocked fish (Anonymous 1953, Needham and Sumner 1941). In the Pawcatuck River, Rhode Island, Guthrie et al. (1973) found that returns from trout stocked in the spring were three times greater than those released in the fall. Similarly, Fraser (1976) found that recoveries of spring-planted brook trout were significantly higher (mean 39.7%) than winter (mean 15.7%) and autumn (mean 7.7%) planted trout. Shetter (1947) concluded that spring releases of adult or sub-adult brook trout was more desirable, in terms of survival and return to the fishery, than fall stocking fish of a similar size. In a study involving fall and spring planted brook trout in two Wisconsin streams, Christenson et al. (1954) found that returns to the angler from spring stocked brook trout outnumbered those from fall stocked fish by as much as 9:1. There is also considerable evidence to indicate that the best returns for artificial fisheries are plants made before and during the fishing season (Hale 1952b, Fitch 1977, Cresswell 1981).

Generally, reported results of fall stocking programs involving brook trout are poor (Anonymous 1963, Cresswell 1981) and that overwinter survival is low (Needham 1959, Alexander and Shetter 1961, 1967) . Alexander and Shetter (1961) planted 300 brook trout in East Lake, Michigan, in October but recorded significant mortality shortly after their release. DeRoche (1963) reported that 84% of fall stocked brook trout in Branch Brook, Maine, died between

October and April. Christenson et al. (1954) concluded that fall stocking should not occur in streams. Contrary to many studies, Trembley (1941) reported that, in Spring Creek, Pennsylvania, returns from fall versus spring plantings were similar (49.4% vs 54.1% respectively).

Relatively fewer incidences of winter brook trout plantings have been reported but there is evidence that trout stocked through the ice may suffer high mortalities perhaps as the result of low air and water temperatures (vonRosen 1972, Johnson 1978). Kerr (1979) reported that recovery rates of brook trout stocked in Oakley lake, Ontario, during the late winter were considerably lower than five other nearby lakes which were planted in the spring. Both brook and rainbow trout planted in December were found to be in inferior condition when compared to spring-planted fish which were angled the following fishing season in the Deerskin River, Wisconsin (Williamson and Schneberger 1942).

Stocking densities vary widely (Table 5). Many Ontario lakes are planted at rates of approximately 100-150 yearling trout per surface hectare of lake. There are many exceptions however and several researchers have recognized that many waters were being overstocked. At excessive stocking rates intraspecific competition increases, growth is reduced and mortality increases (Gowing 1974, Fraser 1978). Dupont and Bernier (1984) concluded that survival was inversely related to the stocking rate and recommended that stocking rates be reduced to 35-50 yearling fish/lake area (in hectares) between 0 and 6 meters in depth. Borgeson (1980) concluded that "sparse" stockings of brook trout (40-50 fingerlings per surface acre) resulted in the best survival and growth. In a comparative study of returns of trout stocked in Pigeon River lakes, Michigan, at three densities (194 fish/ha; 396 fish/ha; and 1,336 fish/ha), it was found that the best growth and production was achieved by the lowest stocking density (Anonymous 1973).

Ideally, stocking rates should be based on the natural productivity of the waterbody and the anticipated mortality of stocked fish. For brook trout the natural productivity of the waterbody is usually related to the proportion of littoral area in a lake.

Table 5. Brook trout stocking rates utilized by selected North American jurisdictions.

Waterbody	Stocking Density	Reference(s)
Alberta waters	• 75-100 fingerlings/ha	Alberta Ministry of the Environment (1994)
Colorado waters	• catchable stocking in lakes calculated by the formula: (surface area in acres) (fishing pressure factor from 0-1)(habitat suitability factor from 0-1)	Seaman (1966)
Michigan waters	• 2-25 (5-7") yearlings per acre in large, oligotrophic, multispecies lakes • 25 (5-7") yearlings per acre in multispecies two-story lakes • 50-150 (3-4") fingerlings per acre in single species trout lakes • 50-150 (5-7") yearlings per acre in large fertile trout streams • 100-200 (3-4") fingerlings per acre in small-moderate sized streams with light competition	Michigan Department of Natural Resources (1987)

Continued……

Table 5 (cont'd)

Waterbody	Stocking Density	Reference(s)
Michigan waters (cont'd)	• 150-300 fingerlings per acre in large fertile trout streams • 100-200 fingerlings per acre in small-moderate trout streams of average fertility	
Minnesota waters	• 150-200 fingerlings (10-100/lb)/acre • 100-250 yearlings (<10/lb)/acre	Johnson (1978), Minnesota Department of Natural Resources (1982)\
New York waters	• 30√MEI fingerlings/acre • 15√MEI yearlings/acre	New York Department of Environmental Conservation (1979)
Ohio lakes (3)	• 50 fish/ha (best growth) • 100 fish/ha • 500 fish/ha (worst growth)	Momot (1970)
Ohio waters	• 75 catchables/acre (waters ≤ 40 acres) • 50 catchables/acre (waters 41-80 acres) • 25 catchables/acre (waters > 80 acres) minimum of 500 fish; maximum of 4,000 fish for any stocking project.	Ohio Department of Natural Resources (Undated)
Ontario waters	• (Littoral area in acres)(150 yearlings if TDS > 100 ppm or 100 yearlings if TDS< 100 ppm) (Fishing pressure factor) where angling pressure is light (0-10 days/acre/year) the factor is 0.5; where pressure is medium (10-20 days/acre/year) the factor is 1.0; and where pressure is heavy (> 20 days/hectare/years) the factor is 1.5	Ontario Department of Lands and Forests (1970)
Pennsylvania waters	• 475 catchables/acre in high yield streams • 75-425 fish/acre in high yield waters • 75 fish/acre in low yield waters • 75-625 fish/acre in lakes	Pennsylvania Fish and Boat Commission (1997)
Québec waters	<u>Low competition</u> • 100 fish/ha in oligotrophic lakes • 200 fish/ha in mesotrophic lakes • 60/m x # km of stream (maximum of 1200/km) <u>Moderate competition</u> • 60 fish/ha in oligotrophic lakes • 125/ha in mesotrophic lakes • 40/m x #km of stream	Québec Ministère du Loisir de la Chasse et de la Pêche (1988)
Saskatchewan waters	• 100 fingerlings/ha	Saskatchewan Department of Environment and Resource Management (1999)
Vermont waters	• < 20 lbs/acre (lakes) • < 200 trout/mile (streams) • 30√MEI for fingerlings • 15√MEI for yearlings	Vermont Department of Fish and Wildlife (1993)

The frequency of stocking varies according to the objective of the individual stocking program. In artificial fisheries, stocking may occur several times during the season. For introductions or rehabilitation stocking projects, it may be desirable to stock on an annual basis for several years. Much of the brook trout stocking done in Ontario is on a put-grow-take basis to maintain local fishing opportunities. Many of these small, relatively unproductive waters are stocked on an annual or alternate year basis. Johnson (1964) concluded that, in waters having average growth and survival of planted fish, restocking should occur in alternate years. Eipper (1961) recommended that New York ponds required stocking every other year to provide adequate fishing.

Several techniques have been used to release fish into the recipient waterbody in an effort to avoid predators and distribute fish to maximize return to the greatest number of anglers. In streams two basic methods have been employed: “scatter” planting where small numbers of fish are distributed amongst many locations and “spot” planting where the entire allocation of fish is released at one site. The benefits of one technique over the other is unclear. In some cases, “scatter” planting is believed to be the best stocking method (White 1930, Surber and Aikens 1932, Hoover and Johnson 1937). In several Michigan streams, Shetter and Hazzard (1940) concluded that as many anglers benefited from “spot” plantings as those released by wider distribution. Similar conclusions were reached by Cooper (1952) in the Pigeon River, Michigan.

In the lake environment, the basic release techniques involve planting fish in shallow near-shore areas or in offshore in deeper, open water. Walden (1956) recommended that brook trout be planted in littoral areas of lakes where protective cover could readily be sought. Brady (1991) found no difference is survival from brook trout planted in mid lake (over open water) compared with littoral releases.

Handling and Transport Stress –Stress associated with handling and transporting hatchery-reared brook trout can cause immediate or delayed mortality (Piper et al. 1982) although brook trout may be one of the most least sensitive salmonid to transport stress (McDonald et al. 1993).

A variety of methods, including truck, backpack, fixed-wing aircraft, and helicopter, have been used to transport hatchery-reared brook trout to their stocking site. Air drops of fish from a fixed wing aircraft were discontinued in Ontario several years ago after some evidence of mortality (Patrick 1959b, Fraser 1968a, Chesire and Day 1969). Helicopters are now utilized to stock many remote lakes in Ontario.

Several causes of stress during transport have been identified. Depressed pH of transport water has been reported by Patrick (1960) and Liimatainen (1988). Liimatainen (1988) suggested the addition of sodium bicarbonate in an attempt to neutralize acidic transport water. Oxygenation of transport water is a common practice but elevated levels of dissolved oxygen (due to oxygenation rather than aeration) have been found to be moderately stressful to brook trout (McDonald et al. 1993). Temperature differential between transport water and water of the receiving waterbody has traditionally been a concern which is usually addressed by tempering (gradual mixing) the two waters. Brett (1941) reported that gradually raising water temperatures over a 15 minute period had no effect on the ultimate lethal temperature. Finally, Fraser and Beamish (1969) reported elevated levels of lactic acid in fish loaded and transported at increased densities of fish.

Winter Severity – Winter severity, in terms of cold conditions, heavy ice formation and deep snow, has been noted to influence overwinter survival of stocked brook trout (Fraser 1978b, Pardue 1979, Franzin and Harbicht 1985).

Diet Conversion and Starvation – Brook trout are highly opportunistic feeders which select food organisms based on their abundance and availability (Table 6). Insects are often the most important component of the diet although Fraser (1981) reported good growth of brook trout in waters containing only cyprinids and sticklebacks.

Table 6. Food items of stocked brook trout.

Food Item	Reference(s)
Aquatic Insects	Anonymous (1973, 1984b, 1986c, 1990g), White (1924), Needham and Sumner (1941), Gowing (1974), Powell (1977), LaRoche and Pardue (1978), Kerr (1979), Fraser (1976, 1978a, 1980), Bradbury (1981), Stankiewicz (1981), Dextrase (1986), Loftus and Brady (1987)
Terrestrial Insects	Anonymous (1984b, 1984d), Fraser (1976, 1980), Powell (1977), Dextrase (1986)
Snails	Loftus and Brady (1987)
Crayfish	Anonymous (1973, 1990g), Momot (1970), Gowing (1974), Fraser (1978), Kerr (1979), Duckworth (1980), Read (1981), Stankiewicz (1981), Tynela and Jones (1983), Van Leeuwen (1985), Loftus and Brady (1987), Anonymous (1990g),
Leeches	Anonymous (1984d, 1986c), Fraser (1976, 1978a, 1980), Powell (1977), Kerr (1979), Stankiewicz (1981), Dextrase (1986), Loftus and Brady (1987)
Freshwater Shrimp	Anonymous (1986c), Carline et al. (1976), Bradbury (1981), Loftus and Brady (1987)
Fish	
Cyprinids	Bradbury (1981), Read (1981), Stankiewicz (1981), Dextrase (1986), Anonymous (1987, 1990f, 1990g), Tynela and Jones (1993)
Darters	Anonymous (1984c, 1990f), Powell (1977), Stankiewicz (1981)
Brook stickleback	Anonymous (1986b, 1986c), Carline et al. (1976), Powell (1977), Dextrase (1986), Loftus and Brady (1987)
Pumpkinseed	Fraser (1980)
Mudminnow	Carline et al. (1976)
Fathead minnow	Powell (1977), Loftus and Brady (1987)
Northern redbelly dace	Loftus and Brady (1987)
Creek chub	Loftus and Brady (1987)
Yellow perch	Fraser (1980)

Continued ....

Table 6 (cont'd)

Food Item	Reference(s)
Brook trout	Powell (1977)
Sculpins	Van Leeuwen (1985)
Fish eggs	Loftus and Brady (1987)
Frogs and toads	Loftus and Brady (1987)
Salamanders	Loftus and Brady (1987)
Misc. (spruce needles, woody debris)	LaRoche and Pardue (1978), Kerr (1979), Loftus and Brady (1987)

Hatchery-reared brook trout are generally less selective in food choice than wild brook trout. Despite their diverse diet, there is evidence to suggest that brook trout may have difficulty adjusting to their new environment with respect to obtaining sufficient food (Ersbak and Haase 1983). Nutritional deprivation leads to a decline in body condition as stores of metabolites are exhausted (Miller 1957). This situation intensifies when there is competition with other fish for food sources.

Fish Health and Disease - Despite precautions taken at fish culture stations, there is always the possibility of releasing either diseased or carrier hatchery-reared fish into the wild. The potential consequences include reduced performance of the stocked fish, direct mortality, increased sensitivity to stressors, and establishing a reservoir of infection.

There have been instances were diseased fish were stocked into natural waterbodies with no obvious consequences (Alison 1961, Brousseau 1985) but, as a general rule, precautionary measures should be instituted to ensure risks are minimized.

Intraspecific Competition - There are many instances which demonstrate poor returns from supplemental brook trout plantings which have been attributed to intraspecific competition for food and space (Saunders and Smith 1961, LaRoche and Pardue, 1978). In such interactions resident trout have the competitive advantage.

Lachance and Magnan (1990a) found that recovery, per cent of increment in weight, and yield of planted brook trout was inversely correlated with the relative abundance of native brook trout. Fitch (1977) believed that stocking hatchery-reared brook trout over a wild, self-sustaining population resulted in increased mortality of stocked fish and a decrease in the catch of wild fish. Olver (1969) concluded that the presence of a naturally reproducing, native brook trout population in Kerwin Lake, Ontario, was responsible for the poor survival of stocked brook trout. Armstrong and Davis (1998) reached similar conclusions in a set of northeastern Ontario lakes. Based on negligible survival of planted brook trout in five southwestern Ontario streams, Coultes (1992) recommended that supplemental stocking activities be discontinued.

In at least two instances where supplemental brook trout stocking has been discontinued, the natural production of wild trout increased and sustained the local fishery (Smith Undated, Dunlop and Brady 1995)

Interspecific Competition – In addition to a negative association with resident brook trout, interspecific competition is probably one of the most significant factors influencing the success of a brook trout stocking project. Hatchery-reared brook trout do not compete well with many fish species (Table 7).

Table 7. Competitors of hatchery-reared brook trout.

Fish Species	Reference(s)
Bullheads	Hartleb and Moring (1994)
Cyprinids	Anonymous (1993a)
Lake Whitefish	Anonymous (1983)
Pumpkinseed	Thomas (1993a), Dosser (1996)
Rock Bass	Belfry (1997)
Round Whitefish	Donald (1987)
Smallmouth Bass	Deyne (1990), Dosser (1996), MacKay (Undated$_a$)
Walleye	Van Leeuwen (1985)
White Sucker	Anonymous (1983, 1993a), Atkinson (1978), Marks (1979), Bradbury (1980), Fraser (1981), Miller (1982), Deyne and Arnett (1987), Deyne (1990), Lachance and Magnan (1990a, 1990b), Thomas (1993b), Dosser (1996)
Yellow Perch	Anonymous (1983), Zilliox and Pfeiffer (1956), Hughson and Stassen (1971), Fraser (1978a), Kerr and Taylor (1981), Deyne (1990), Flick and Webster (1992), Thomas (1993c), Alberta Ministry of the Environment (1994), Belfry (1995, 1996), Dosser (1996)
Other Salmonids	White (1930), Curtis (1951), Miller (1957), Needham (1959), Donald (1987), Fraser (1972, 1988a), Lachance and Magnan (1990), Thomas (1993a), Isley and Kempton (2000)

Hartleb and Moring (1994) concluded that stocking brook trout into waters containing other dietary competitors, such as perch, pumpkinseed and bullheads, may limit the survival and growth of brook trout. In an Algonquin Park study, Fraser (1978a) found that planted brook trout could not compete successfully with yellow perch for food. He concluded that survival and growth of stocked brook trout was maximized in waters with the least complex fish community.

Suckers are often present in many stocked brook trout waters. Lachance and Magnan (1990) reported that recovery and yield of stocked brook trout was inversely correlated with the occurrence of white sucker. They suggested a niche shift in brook trout when living with white sucker. Conversely, neither Dextrase (1986) or Kerr (1979) were able to demonstrate any relationship between the abundance of white suckers with the survival or growth of stocked brook trout. Longnose suckers did not have an obvious influence on brook trout populations in Canadian Mountain national parks (Donald 1987).

Predation – Predation of stocked fish is another important factor to consider when determining the appropriate stocking strategy. There are a wide variety of predators which are known to prey on stocked brook trout (Table 8). Fraser (1974) was so concerned about predation by loons, that he experimented with training brook trout to avoid these avian predators.

Table 8. Predators of stocked brook trout.

Predator	Reference(s)
Fish	
American eel	Fraser (1972)
Brook trout	White (1924, 1930), Wales (1946), Fraser (1976), Fisher (1986)
Brown trout	Needham and Sumner (1941)
Creek chub	White (1924)
Lake trout	Fisher (1986)
Northern pike	Alberta Ministry of the Environment (1994)
Rainbow trout	Fraser (1988a)
Rock bass	White (1924)
Splake	Fraser (1976)
Walleye	Wright and Sopuck (1979)
Birds	
Common loon	Fraser (1972, 1974), Fraser and Rumsey (1988), Matkowski (1989)
Great blue heron	Fraser (1972), Matkowski (1989)
Kingfisher	Fraser (1972)
Merganser	Fraser (1972)
Osprey	Fraser (1972)
Mammals	
Mink	Fraser (1972)
Otter	Fraser (1972)

Post-Stocking Movements – Hatchery-reared brook trout often display significant movements after their release in both stream and lake environments.

Upstream movements have been recorded in the Pine River, Michigan, (Hazzard and Shetter 1938) and in smaller coldwater streams (Cobb 1933). Conversely, downstream movements have been reported in the Beaverkill River, New York (Anonymous 1965), Big Stoney Creek, Virginia (Helfrich and Kendall, 1982), Salmon Trout River, Michigan (Smith 1941), four southeastern Minnesota streams (Kuehn and Schumacher 1957), and five other Michigan streams (Shetter 1944). In the Split Rock River, Minnesota, Hale (1952b) found that, although some fish moved both upstream and downstream, most stocked brook trout remained near the stocking site.

Movements out of lakes have also been reported. Smith (1967) found that a large proportion of brook trout stocked in Crecy Lake, New Brunswick, migrated out the lake outlet. Yearlings, particularly those maturing seemed to be most prone to leave and movements were associated with the greatest water discharge from the lake. Josephson and Youngs (1996) also noted that the greatest emigration out of several Adirondack lakes during the spring coincided with peak runoff. Other movements of brook trout from the lake environment have been recorded during the fall and were associated with the spawning season (Alexander et al. 1990, Josephson and Youngs 1996).

There may be a number of variables involved with movements of stocked brook trout. Brynildson (1967) believed that movements were associated with both the age of fish and the season they were stocked. He reported little movement of fingerlings stocked in the summer and early fall, upstream movement of yearling fish planted in the winter and downstream movements of yearlings planted in the spring. There is some evidence to indicate that movements may be temperature related. Cooper (1952) reported that at water temperatures below 50º F (10º C) there were downstream movements of stocked brook trout while there was little movement if temperature of the receiving water was greater than 50º F. Finally, there is some evidence to suggest that movements of stocked fish may be related to their genetic background (Cone and Krueger 1988, Van Offelen et al. 1993).

Potential Impacts of Stocked Brook Trout

In addition to factors which may influence the success of a brook trout stocking project, fisheries managers should also consider potential impacts of stocking brook trout on other aquatic biota (Table 9). For projects involving the introduction of a fish species, including brook trout, an environmental assessment, which includes an evaluation of the potential impacts, must be completed.

Table 9. Potential impacts of brook trout stocking.

Potential Impact	Reference(s)
Competition for resources	LaRoche and Pardue (1978), LaRoche (1979), Loftus and Brady (1986), Marnell (1986), Hill (1990), Indiana Department of Natural Resources (1999), Kerr and Grant (2000)
Predation on resident biota	Nilsson (1972), Marnell (1986), Evans (1989), Schofield et al. (1989), Kerr and Grant (2000)
Introduction of parasites	Marnell (1986)

Continued............

Table 9 (cont'd)

Potential Impact	Reference(s)
Hybridization	Krueger and Menzel (1979), Marnell (1986), Hill (1990), McCracken et al. (1993), Indiana Department of Natural Resources (1999), Kerr and Grant (2000)
Transmission of disease	Goede (1986)
Increased fishing pressure/harvest on wild brook trout	Hazzard and Shetter (1938), LaRoche and Pardue (1978), Loftus and Brady (1986)
Impairment of natural reproduction by resident brook trout	Hazzard and Shetter (1938), Dunlop and Brady (1995)
Competition (displacement) with resident brook trout	Oehmcke and Radonski (1969), Pardue (1979), Marnell (1986), MacKay (Undated$_a$)

Best Management Practices for Brook Trout Stocking

Brook trout stocking practices vary considerably but several practices can be identified which are believed to optimize the likelihood of stocking success. These may be summarized as follows:

Stocking Objective – It is important to identify the objective of the fish-stocking project and determine quantifiable measures to evaluate success. For example if the goal is to provide enhanced angling opportunities stocking should achieve some pre-determined level of fishing pressure, angling success or harvest.

Supplemental Stocking – As a general rule, stocking should not occur in waters containing a viable resident population where natural reproduction occurs. Intraspecific competition can lower survival and growth of stocked fish and hatchery-reared trout can dilute the native gene pool. A viable population may be loosely defined as one having at least 25-30% native (unmarked) fish in the population. Waters should be inventoried and evaluated for natural reproduction before they are stocked.

Waterbody characteristics – The stocked waterbody should have physical and chemical parameters which meet or exceed the habitat requirements for various life stages of brook trout. Water temperature and dissolved oxygen are particularly important in this regard and water quality monitoring should be completed in mid-late summer (i.e. August) and late winter (i.e., March) to make this determination. If the objective is to establish a naturally reproducing population, suitable spawning habitat and nursery areas should be available. To prevent any emigration, lakes should have a small outlet or no outlet at all. Unstocked lakes should be inventoried before fish stocking is considered. Every effort should be made to ensure that the resident fish community is compatible with brook trout. Waters having complex fish communities, including those with spiny-rayed predators, should not be stocked.

Strain of Fish – The most appropriate strain will depend on the stocking objective. Wild or hybrid strains should be used wherever possible particularly where the goal is to introduce or establish a self-sustaining population. Where the provision of an immediate or relatively short-term fishery is desired, domestic strains may be more appropriate.

Disease Considerations – Fish should be free of any serious disease agents at the time of stocking. Stocking proponents should not knowingly stock fish with emergency disease agents such as infectious hematopoietic necrosis (IHN) virus, viral hemorrhagic septicemia (VHS) and the causative agent of proliferative kidney disease. Stocking fish infected with a certifiable disease (e.g., infectious pancreatic necrosis (IPN) virus, *Renibacterium salmoninarum*, *Aeromonas salmonicida*, and *Yersinia ruckeri*) will depend on the seriousness of the disease outbreak. In no instance would fish, displaying a clinical disease (i.e., fish dying and pathogen detected) be stocked.

Age/Size of Fish to Stock – For put-and-take stocking where the intent is to provide artificial fisheries, the size of fish should be maximized. In situations where the objective is to provide a put-grow-and-take fishery and where competition with other fish species is minimal, large fingerlings (i.e., 40/kg) or yearlings may be used. For projects involving introductions or rehabilitation and where competition with other species is minimal, fry or smaller fingerlings (i.e., 50-100/kg) may be appropriate.

Marking – Fish should be marked if post-stocking assessment is planned. The most appropriate mark will be based on cost effectiveness and the size of fish being stocked.

Stocking Rate – Stocking rate should represent the optimal density to maximize growth and survival. There is considerable evidence that many brook trout waters in Ontario are currently being overstocked. An initiative should be undertaken to develop a new provincial stocking rate based on the size and life stage of fish being stocked as well as the parameters of the recipient waterbody. In the interim, stocking rates should continue to be based on earlier guidelines (Ontario Department of Lands and Forests 1970).

Stocking Frequency – The frequency which waters are stocked will depend on the objective of the stocking project. It is recommended that stocking be conducted annually for put-and-take stocking programs. In some cases where it is necessary to maintain artificial fisheries, it may be desirable to have repeated stocking through the season. For all other types of stocking, including put-grow-take stocking, it is recommended that stocking be done on an alternate year basis.

Time of Stocking – As a general rule, brook trout stocking should be conducted in the spring when air temperatures are cool and lake and stream water temperatures more closely match those of the hatchery environment. It is preferable to stock brook trout before lake temperatures exceed 18º C (65º F).

Transporting Fish to Stocking Site – All precautions should be taken to ensure that stress associated with handling, loading, transporting and releasing fish are minimized. The most appropriate transporting technique should be used so that the duration of the trip is as short as possible. Attention should ensure optimal loading densities (e.g., 20-40 kg/100 L) are not exceeded, oxygenation and aeration occurs as required, and temperature differential between hatchery, transport and recipient waterbody water temperatures are minimized. Some consideration should be given to the addition of salt (i.e., 10 gm each of $NaHCO_3$ and $CaCL_2$ per 100 L of water) particularly for longer trips.

Release Sites – Efforts should be undertaken to ensure that fish are well distributed and released as quickly as possible. Wind exposed shorelines and areas dominated by predators should be avoided. Areas having good natural cover and in proximity to groundwater sources should be selected if known.

Stocking Technique – Time and effort should be taken to ensure that fish are released in a manner which will maximize their chance of survival. Fish should be dispersed in the littoral zone where there is little chance of predation and when water temperatures are suitable. Trout should be released over deeper water if littoral predators are present.

Guidelines for Stocking Private Ponds

Brook trout are a popular species for landowners who have private ponds and many trout are purchased from the private sector for that purpose. Several publications have reviewed factors to be considered when constructing and stocking a private pond with brook trout (see Brown and Thoreson 1958, Brumsted 1960, and Ryder undated). Some of the more common considerations may be summarized as follows:

- Ponds suitable for brook trout should have both shallow areas and deep (minimum of 3-4 meters) water. There should be shaded banks and ideally a groundwater source (e.g., spring).
- The pond should have cool water temperatures (< 20-22º C) and sufficient dissolved oxygen (> 5 mg L^{-1}) throughout the year.
- Stock only one age/size of fish in a new pond. If the pond is devoid of fish, fry may be planted.
- Suggested stocking rates are 1,000 fry per surface acre or 300 fingerlings per surface acre. It is better to understock than to overstock.
- Don’t mix fish species (e.g., rainbow trout and brook trout) in the same pond.
- It may be necessary to control (remove) coarse fish. Never introduce minnows as a food source.
- Fish should be stocked in the spring before water temperatures warm beyond 18º C (65º F). Avoid midsummer stocking in hot weather.

Stocking Assessment

Stocking assessment programs can be initiated to evaluate a number of parameters including factors influencing stocking success, impacts of stocked fish on resident biota, sociological aspects of stocking programs, evaluation of new/different stocking strategies, cost:effectiveness of the program and returns of stocked fish to the recreational fishery.

Most assessment programs are designed to evaluate the success of stocking either in terms of post-stocking survival or returns to the fishery. In Ontario, post-stocking survival has been evaluated primarily by netting projects. In the 1970s and 1980s these projects involved the removal technique of sampling using gill nets of a variety of small mesh sizes. These projects were usually based on three consecutive nights (in early fall) of netting whereby the brook trout population size could be estimated and compared to the number of fish stocked the previous spring. Many of the assessment projects reported took place in northeastern Ontario (Bernier 1975, 1978, Kerr 1979, 1980, Duckworth 1980, Kerr and Taylor 1981, Read 1981, Stankiewicz 1981, Stanfield 1982, Dupont and Bernier 1984, Brown 1985, Van Leeuwen 1985, and Mulgrew 1986).

More recently, efforts have been initiated to develop a new sampling protocol for evaluating the status of brook trout populations in lakes (Algonquin Fisheries Assessment Unit 2000, Stott 1999). This technique is an adaptation of the spring littoral index netting (SLIN) protocol and involves the use of small mesh gill nets. Sampling is conducted in early summer by randomly selecting shoreline netting sites and setting nets perpendicular to shore for only a short time (e.g., 30 minutes) before they are lifted.

Assessment programs designed to assess returns to the fishery have traditionally involved routine creel census programs and the volunteer participation of anglers by maintaining angler diaries and catch sampling. It has been suggested that stocking success in these cases be evaluated in terms of angling quality (i.e., catch-per-unit-of-effort (CUE > 0.35) or by the returns of planted fish (i.e., > 20% of the number planted) (Armstrong and Davis 1998). In the case of catchable-sized fish, it is usually realistic to expect a return to the angler of > 50% of the number planted.

Based on a review of the assessment data which has been reported, there is an obvious need for some standardization of sampling protocol and methods of reporting results.

Annotated Bibliography

ADELMAN, H. M. and J. L. BINGHAM. 1955. Winter survival of hatchery-reared and native brook trout. Progressive Fish Culturist 17 : 177-180.

The purpose of this study was to compare the effect of winter months upon the rate of survival of both hatchery-raised trout and native trout. The procedure was to plant brook trout of both types of rearing into two streams with screened off areas so that the fish could not radically change their location. Monthly population determinations were made by utilization of a 240 volt direct current electroshocker. The two sites chosen for study were sections of Hunt Creek, Montmorency County, and Slagle Creek, Wexford County, Michigan.

The areas that were utilized produced widely disparate results. In Hunt Creek, the final shocking revealed that the natives were surviving at a rate of 59 per cent and the hatchery fish at a rate of 28 per cent, whereas at Slagle Creek the figures were 37 per cent for the natives and 64 per cent for the hatchery trout.

The widely disparate results presented here support one main conclusion. When survival is studied in controlled areas with monthly population determinations, there is no evidence for increased rates of survival as a function of origin of the fish studied. There seems to be little or no difference between hatchery-reared brook trout and native brook trout in their ability to survive the winter months.

ALBERTA MINISTRY OF THE ENVIRONMENT. 1994. Fish stocking program policy and fish stocking process. Natural Resources Service, Fisheries and Wildlife Management Division, Edmonton, Alberta.

This policy deals with the stocking of reservoirs, lakes, ponds and streams in Alberta. Fish stocking has an important role to assist natural reproduction in some cases and to maintain fish populations in others. It should not be used as a replacement for natural reproduction. Policy statements pertaining to the stocking of brook trout include:

- Brook trout should not be stocked in waterbodies that have northern pike.
- Stocking trout in waterbodies with perch may be justified depending on the size of perch populations however stocking should be discontinued when the perch begin to have a measurable impact on the trout fishery.
- To protect bull trout populations from competition with brook trout, stocking of brook trout is not recommended where bull trout occur.
- Generally, trout are stocked only in lakes where there is no natural reproduction to create “put-grow-take” fishing opportunities.
- The decision to stock or not to stock a stream should be based primarily on the ability and potential of a resident trout population to sustain a fishery.
- Brook trout should be considered for lakes where there is poor spawning potential for bull, cutthroat, rainbow or golden trout and/or a risk of some winterkill because brook trout have special adaptations for such conditions. However, if there is poor spawning potential for even brook trout the lake should not be stocked unless there are overriding reasons to the contrary.
- The initial and subsequent stocking rates should depend on the potential sustained fish yield and, as a rule, should be from 75 to 100 fingerlings per hectare.

ALEXANDER, G. R. 1975. Growth, survival, production and diet of hatchery-reared rainbow trout and brook trout stocked in East Fish Lake under different stock densities, cropping regimes and competition levels. Fisheries Research Report No. 1828, Michigan Department of Natural Resources, Ann Arbor, Michigan. 24 p.

ALEXANDER, G. R. and D. S. SHETTER. 1961. Seasonal mortality and growth of hatchery-reared brook and rainbow trout in East Fish Lake, Michigan. Michigan Academy of Science Arts and Letters 46 : 317-330

The present study considers seasonal mortality and growth between October, 1958 and September, 1959, of hatchery-reared brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) released in East Fish Lake, Montmorency County.

Hatchery-reared brook and rainbow trout of identical length and age (I) were used so that survival and growth of the two species could be compared. On October 14, 1958, 300 brook and 300 rainbow trout ranging in total length from 8.5 to 9.5 inches (average 8.9) were marked by removal of the left pelvic fin and planted in East Fish Lake. Population estimates and growth data were obtained from these populations of trout during the following periods: October14-November 6; November 6-12; December 29-January 9; February 26-March 11; April 20-22; and the winter of 1959-60.

Data suggest that rainbow trout suffered little mortality between planting and early January whereas brook trout population estimates suggest a mortality of about 163 fish between November 9 and January 2 (or a total of 176 out of 300 since the date of planting). Rainbow trout were caught by anglers at a much slower rate than brook trout. The instantaneous rate of mortality of brook trout was greatest during the first 4 weeks of the trout season but nearly all of this was fishing mortality (82 trout caught). Thus two-thirds of the brook trout planted had died before the fishing season opened. Anglers caught 88 of 103 (85%) of the brook trout available at the opening of the trout season but this was only 29% of the number planted at the beginning of the study.

Both the natural and fishing mortality rates of rainbow trout were very different from those of brook trout. It was estimated that only 8 rainbow trout died between planting and the opening of the trout season. Anglers caught 197 of 292 (67%) of the rainbow trout available at the opening of the season or 65% of the number planted. The catch of rainbow trout was distributed throughout the entire season, whereas 93% of the total brook trout catch was made during the first four weeks of the fishing season.

ALEXANDER, G. R. and D. S. SHETTER. 1969. Trout production and angling success from matched plantings of brook trout and rainbow trout in East Fish Lake, Michigan. Journal of Wildlife Management 33 : 682-692.

We studied survival, growth, exploitation and production from five consecutive matched plantings of brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) (8.5-9.5 inches long) in East Fish Lake, Montmorency County, Michigan, 1958-1962. Stocked fish were given varying fin clips for later recognition. Population numbers at several intervals between introductions were determined by Petersen type estimates. Angler exploitation was tabulated from a complete creel census. Rainbow trout survival was about 98 per cent from stocking in October to the following fishing season in April, whereas brook trout survival averaged only 49 per cent. About one-third of brook trout deaths occurred between 15 October and the date of ice formation (approximately 15 December). Brook trout stayed in shallow water along shore more than did rainbow trout.

Anglers caught 86 per cent of the stocked rainbow trout but only 39 per cent of the brook trout. For each pound of trout stocked, anglers caught 3.59 pounds of rainbow trout but only 0.76 pounds of brook trout. In addition to the better return on a poundage basis, rainbow trout provided a fishery throughout the angling season whereas nearly all brook trout were caught during the first 10 days.

The brook trout grew well (average increment 0.9 lb/year) but the rainbow trout averaged a 1.3 lb. increment per year. Possibly a greater poundage return on rainbow trout would accrue if the beginning of the angling season could be delayed to take advantage of the early summer growing season.

ALEXANDER, G. R., H. GOWING, and A. J. NUHFER. 1990. Population characteristics of Assinica and Temiscamie strains of brook trout. Fisheries Research Report No. 1966, Michigan Department of Natural Resources, Ann Arbor, Michigan.

Matched numbers of Assinica and Temiscamie strains of brook trout (*Salvelinus fontinalis*) were stocked as fall fingerlings into two Michigan lakes. Survival, growth, movement, sex ratio and maturity were determined for each strain to age V. Aside from a post-stocking mortality of Assinica fish, which was believed due primarily to a furunculosis infection contracted in the hatchery, there was little evidence of consistent or significant differences in the survival of either strain to age VG. Long term incremental increases in length were not significantly different among strains although Assinica tended to be significantly longer than Temiscamie at younger ages. Assinica were from 8 to 18% heavier than Temiscamie of the same length depending on the lake. There were no significant differences between the growth rates of the sexes. Sex ratios became progressively more weighted toward females each year due to higher mortality rates for males of both strains. A majority of both strains matured at age I and both were fully mature at age II. There was no appreciable difference among strains in vulnerability to capture by angling. Emigration rates for both strains within a lake were quite similar. Depending on the year, 40 to 90% of the populations attempted downstream movement out of the lakes during each spawning period which could seriously deplete populations in lakes without fish barriers. Both Assincia and Temiscamie strains appear about equally suited for Michigan trout lake management.

ALGONQUIN FISHERIES ASSESSMENT UNIT. 2000. Brook trout index netting. Draft manual, Ontario Ministry of Natural Resources, Whitney, Ontario. 30 p.

The brook trout index method outlined here is an adaptation of the lake trout spring littoral index netting (SLIN) program. It is intended to be a low mortality netting program which can be carried out with a minimum investment of training and equipment. It has been designed with the objectives of providing an unbiased index of abundance as well as some information relating to the community structure of brook trout populations.

The method involves setting small mesh gill nets at randomly selected sites for a duration of 1/2 hour. The nets consist of three panels (46 m in length) of a single mesh size. The mesh sizes used are 38 mm (1.5"), 51 mm (2.0") and 64 mm (2.5"). A single net would therefore consist of three panels of one of these mesh sizes. The nets are set in depth strata of 2-6 m and 6-10 m and are oriented perpendicular to shore. The netting program is designed to be conducted in mid summer preferably after thermal stratification.

ALLISON, L. N. 1961. The fate of kidney disease among hatchery trout stocked in natural waters. Progressive Fish Culturist 23(2) : 76-78.

Kidney disease is a bacterial infection of salmonid fishes that has been reported from hatcheries located in widely scattered areas of the United States. Mortality from the disease may be high. In the literature, no information could be found concerning the fate of infected hatchery trout when stocked in lakes or streams or whether the disease was transmitted from these fish to other trout inhabiting natural waters. The work described here was designed to investigate these questions.

Brook trout from the infected groups held at the Oden and Marquette hatcheries were stocked in 25 lakes during the fall of 1955 and 1956. In all, 164 trout were collected from natural waters and examined for kidney disease. There were no instances in which the disease was transmitted from stocked fish to fish already in the waters. No mortalities of trout were reported from any of the lakes or streams which were stocked with brook trout infected with kidney disease, although some of the waters were regularly visited by personnel of the Department of Conservation. Therefore, it appears unlikely that the stocking of infected brook trout in lakes and streams can result in a widespread mortality due to kidney disease.

AMANN, E. 1989.Investigations of two high mountain lakes stocked with brook trout (*Salvelinus fontinalis*) in Montafon Valley (Vorarlberg). Ostgerreichs Fischerei 42(4) : 96-103. (In German with English summary).

ANDREWS, P. S. 1977. Effects of three varying stocking rates on trout production and resultant fisheries. Maine Department of Inland Fish and Game. 31 p.

ANONYMOUS. 1953. Trout planting. Fisheries Division Pamphlet No. 10, Michigan Department of Conservation. 5 p.

This pamphlet summarize results of projects designed to evaluate the success of trout plantings of various sized fish at differing times of the year. Stocking of small (fingerling) trout at any season of the year added little to the angler’s catch in streams having suitable conditions for natural reproduction. In smaller lakes and streams having a lack of spawning habitat, annual plantings of fingerling trout in the fall was an economical and generally satisfactory method of maintaining trout fishing. In trout lakes having adequate spawning grounds, stocking is unnecessary and probably harmful.

In order to learn the value of stocking trout reared to legal size (7 inches or larger) Michigan conducted 68 experiments between 1937-45. The main results may be summarized as follows:

- Six times more brook trout, four times more rainbow trout and twice as many brown trout were recovered by the anglers from early spring and open season plantings as were recaptured from comparable fall releases;
- Fall planted trout did not “spread out” over the stream appreciably more than those planted in the spring and open season and were generally caught close to where they were released;
- The significant effect of plantings on the catch lasted about two weeks for brook and rainbow trout and about four weeks for brown trout;
- Plantings of rainbow trout and brook trout gave noticeably higher returns to the fishermen than did equal numbers of brown trout. Brook trout and rainbow trout planted in 1949 were recovered at the rate of 40 and 45% respectively; brown trout recaptures amounted to only 25.6%;
- Legal-sized brook, brown and rainbow trout, planted in streams subjected to heavy fishing pressure, contributed to the catch for a relatively short period of time.

ANONYMOUS. 1957. Evaluation of the trout fishery in Maxwell Pond. p. 18-20 *In* 1957-58 Summary of Conservation Officer Projects. Department of Lands and Forests, Southwestern Region.

Maxwell pond is stocked for put-and-take fishing with both brook trout and Kamloops trout. The number of fish reportedly taken between May 22 and June 15, 1957 were 16 Kamloops trout and 21 speckled trout. Fishing was considered good. A few of the speckled trout measured 12 inches but the average was 8-9 inches. It was quite noticeable that suckers have again infested the pond. I would suggest that the pond be drained and poisoned. The pond was restocked and closed to fishing on June 24, 1957.

ANONYMOUS. 1959. Success and failure with speckled trout plantings. p. 8 *In* A Guide to Angling in Algonquin Provincial Park. Ontario Department of Lands and Forests.

In the beginning it was thought that extensive plantings would restore depleted fisheries. Hundreds of thousands of speckled trout were planted in dozens of Algonquin Park lakes. The results were, to say the least, disappointing. During the period when plantings were made and immediately afterwards, there was no appreciable improvement in speckled trout fishing. Since 1946, plantings have been largely confined to lakes where environmental conditions suggested a better chance of survival. Larger fish were also used. Plantings of speckled trout in small lakes of less than 50 acres, where no game fish previously existed, have been particularly successful. Each year a few more of these lakes are stocked after they have first been surveyed as to their suitability for plantings. In lakes where there is good creel census coverage, these fish are marked so that the success of the plantings may be determined. This marking is most often done by clipping off the adipose, the small fatty fin on the back near the tail.

ANONYMOUS. 1963. Fishery investigations of the Pawcatuck River drainage. Progress Report, Project F-20-R-4, State of Rhode Island. Wakefield, Rhode Island.

Field work was completed on 17 streams and 7 ponds in the Pawcatuck River drainage. Analysis and interpretation of data is incomplete but will be presented in the final report. A tagging program was carried out to evaluate the success of the trout program in the watershed. From the 11,350 trout tagged, voluntary returns totaled 3,594 or 31.7%. Returns were higher for rainbow trout (37.1%) than either brook trout (29.5%) or brown trout (27.2%). Rainbow trout and brown trout sustained fishing pressure over a longer period of time. Returns from the fall stocking were poor (12.1%).

ANONYMOUS. 1965. Fish planting formula studies. Interim Report, Project No. F-9-R-12, New York Department of Environmental Conservation, Albany, New York.

A creel census was conducted on the Willowemoc Creek during the 1964 trout season to determine how closely the catch rate compared with the 1964 rate predicted by the fish planting formula. The prediction for 1964 was within 14.6% of the actual census estimate, an agreement considered excellent in the face of the number of variables which exist in a trout stream fishery.

In order to produce the desired catch rate for 1964, twice as many fish were stocked than in 1963. It appears that doubling the stocking rates only serves to increase the catch rate of the more capable anglers since the number of successful trips remained constant in 1963 and 1964 (4745 and 4744 successful trips). A limited number of two year old brown trout were stocked, and as in the previous year, they were extremely catchable. Their estimated annual return was 82%.

It was noted in both years of census that trout stocked in April had lower returns than those stocked in May. There is considerable evidence that these fish migrated downstream from the census area, since an estimated 6% return of April stocked trout were recorded in the Beaverkill River creel census during 1964.

ANONYMOUS. 1968. Studies on planted brook trout and limnological conditions in unfished lakes. Fisheries Division Job Completion Report , Project F-30-R-1, Michigan Department of Natural Resources, Ann Arbor, Michigan.

This project was designed to investigate the population dynamics of brook trout stocked at different densities in lakes closed to fishing; determine the seasonal diet of trout in six lakes; and to measure the crayfish resources in three lakes and the extent of their utilization by trout.

Brook trout (*Salvelinus fontinalis*) were stocked in six lakes at a rate of 50 per acre (North Twin and Hemlock), 100 per acre (South Twin and Lost), and 500 per acre (West Lost and Ford) in November 1965.

Growth rates of brook trout were density dependent with best growth occurring at a stocking rate of 50 fish per acre and slowest growth at densities of 500 fish per acre. High condition values were associated with fast growth and poor condition values with slow growth.

ANONYMOUS. 1970$_a$. Comparative angling contributions provided by wild, hybrid and domestic strains of brook trout in Black Pond. Job Progress Report, Project F-22-R-11, New York State Department of Environmental Conservation, Albany, New York.

A study of the comparative angling contributions provided by wild, wild x domestic and domestic strains of brook trout in Black Pond (reclaimed 76 acre Adirondack pond), begun in 1967, was continued. Fall fingerlings, 2000 each of the same strains as stocked in 1967, were stocked in the fall of 1968. Respective estimates of 1968-69 over-winter survival of fish of 1968 and 1967 plants were: 25.45% and 95.31% wild, 42.65 and 45.09% cross and 17.25 and 42.85% domestic (based on fall 1968 population estimates).

Interview data from the 1969 angler survey were expanded to catch estimates of 229 and 82 wild, 500 and 33 cross 1+ and 2+ fish, respectively, and 282 age 1+ domestics. Wild strain fish of age 2+ provided most of the initial 1969 fishery. The remainder of the 1969 fishery was sustained by 1+ fish, domestic fish in the earlier part and cross and wild strains in the middle and later parts, respectively. Respective estimates of summer natural mortality (based on spring population estimates) for 1+ and 2+ study fish were 0.00% and 7.38% wild, 29.66% and 0.00% cross and 14.78% and 33.33% domestic. Fall population estimates were: 259 wild, 69 cross and 7 domestic 1+ fish and 31 wild 2+ fish. Average total lengths (inches) of 1+ study fish during spring and fall netting were 5.07 and 8.90 wild; 5.66 and 10.27, cross; 7.01 and 11.27, domestic. Average total lengths of 2+ fish during spring netting were 12.39, wild; 13.17, cross; 12.53, domestic. The only 2+ fish caught during fall netting were wild strain fish which averaged 14.46 inches total length. The wild strain seems to have the best potential for longevity under existing natural and angling conditions, however, the bulk of the fishery was sustained by 1+ cross fish.

ANONYMOUS, 1970$_b$. Studies of mixed species of trout planted in unfished lakes. Progress Report, Project F-30-R-4, Michigan Department of Natural Resources, Ann Arbor, Michigan.

Plantings of brook trout and rainbow trout of similar sizes were made in East Fish Lake each October for several years (1958-1969). Cropping of the population was limited to trout needed to monitor the mean volume of food per stomach and the composition of the diet. Mark and recapture population estimates were carried out to determine trout survival. Trout growth rate and benthic invertebrate populations were monitored.

In general, survival and growth rates of rainbow trout have been reduced considerably during this study. Increasing the planting rate of rainbow trout from 19 to 38 per acre, plus lowering the annual kill by eliminating angler harvest, and/or competition from suckers, have resulted in the change. Average volume of food per trout stomach was much reduced. Brook trout were stocked at the rate of 19 per acre every year. Their survival, growth and mean stomach content have changed little during the duration of the study.

Standing crop of invertebrate benthos has been monitored periodically during this study. These data show little change in total numbers of organisms present. Further analysis may show a change in species composition of the benthic community.

ANONYMOUS. 1971_a. Hatchery performance of wild and hybrid strains of brook trout. Progress Report, Project F-22-R-12, New York State Department of Environmental Conservation, Albany, New York.

Survival and growth data were compiled for nine experimental strains of brook trout propagated during 1970. Survival from egg to feeding stage was 62.1-88.5% for wild strains, 59.1% and 63.4% for a domestic strain and 7.5-46.4% for wild x domestic strains. Survival from feeding to fall fingerling stage was 94.3% for the domestic strains. Survival from feeding to fall fingerling stage was 94.3 for the domestic strain, 75.4-92.7% for wild x domestic strains and 72.7-83.1% for wild strains.

Growth rates were highest for the domestic strain, intermediate for wild x domestic strains and lowest for wild strains. Numbers of fingerlings per pound at the end of September were 17 domestic strain, 28-49 for wild x domestic strains and 95-118 for wild strains. Average total lengths of wild, wild x domestic and domestic strains at fall stocking were 3.1, 4.1 and 5.4 inches respectively. It is recommended that hatchery performance data be compiled for experimental brook trout to be propagated in 1971.

ANONYMOUS. 1971_b. Comparative angling contributions provided by wild, hybrid, and domestic strains of brook trout in Black Pond. Job Progress Report, Project F-22-R-12, New York State Department of Environmental Conservation, Albany, New York.

A study of the comparative angling contributions provided by wild, wild x domestic and domestic strains of brook trout (*Salvelinus fontinalis*) in Black Pond (reclaimed 76 acre Adirondack pond) begun in 1967 was continued. Fingerlings, 1500 of each of the same domestic and hybrid strains as stocked in 1967 and 1968, but from a different hatchery were stocked in October 1969. Lot mates, 1500 of each strain, were stocked in poor condition which biased their winter carry over relative to the winter hybrid increment. Fall plant domestics showed a superior relative winter carry over to their winter stocked lot mates and both plants of hybrids. Interview data from the 1970 angler survey were expanded to catch estimates of 263 fall plant domestics, 152 winter plant domestics, 190 fall plant hybrids, 310 winter plant hybrids (all age 1+), 4 age 2+ domestics, 37 age 2+ hybrids, 128 age 2+ and 4 age 3+ wild strain fish. Age 2+ wild strain fish provided most of the fishery during the first period after ice out. Yearling fish sustained the fishery for the rest of the season, fall stocked domestics predominated in periods 4-6, winter stocked hybrids in the 7^{th} period and fall stocked hybrids for the remaining two periods.

ANONYMOUS. 1972$_a$. The field performance of a wild strain of brook trout in a small naturally producing brook trout pond. Job Progress Report, Project F-22-R-13, New York State Department of Environmental Conservation.

A study of the field performance of Horn Lake strain brook trout (a New York wild strain of *Salvelinus fontinalis*) was begun in Long Pond (a 13 acre Adirondack pond) in 1970. The pond was reclaimed in 1970 and stocked with 1750 fin clipped fall fingerling brook trout the same year. Most data were collected during spring and fall trap netting in 1971.

An estimated 73% of the brook trout survived to ice-out in 1971. The fish averaged 81 mm in total length in the fall of 1970, 147 mm in the spring of 1971 and 256 mm in the fall of 1971. At the same time average weights were 16 gm, 32 gm, and 186 gm respectively. During fall netting, 36 mature males and no mature females were noted among the 176 different fish handled.

One year was not enough time to finish the study and continued study of these fish in Long Pond is recommended.

ANONYMOUS. 1972$_b$. Comparative angling contributions provided by wild, hybrid and domestic strains of brook trout in Black Pond. Final Report, Project F-22-R-13, New York State Department of Environmental Conservation.

In 1970, Black Pond (a 76 acre Adirondack pond) was reclaimed and stocked with 1500 marked fall fingerling brook trout (*Salvelinus fontinalis*) of each of the following strains: Crown Point (New York domestic), Horn Lake (New York wild), Temaskamie (Canadian wild) Temiscamie x Crown Point (hybrid). The comparative 1971 fishery performance of these trout was determined primarily from data collected from a creel survey. Hybrids were dominant in the total catch by numbers and pounds caught. Temiscamies were second in numbers and pounds caught. Domestics were third and Horn Lake strain brook trout last in numbers and pounds caught. On a seasonal average, the domestics were largest in length and weight and Temiscamies were smallest. Hybrids were second in length and third in weight and Horn Lake strain brook trout were third in length and second in average weight. On an overall basis the hybrids appear to have been the prime contributor to the 1971 Black Pond fishery

ANONYMOUS. 1972$_c$. Evaluation of experimental wild strain brook trout planted in Little Cedar Pond. Progress Report, Project F-22-R-13, New York State Department of Environmental Conservation.

Yearling, wild strain brook trout exhibited the best overwinter growth while landlocked salmon exhibited the best summer growth. First year survival was higher for fall fingerling rainbow trout than for spring fingerling brook trout.

ANONYMOUS. 1973. Survival and growth of hatchery trout stocked at different densities in Pigeon River lakes. Quality of diet of brook trout in relation to growth and survival. Final Report, Project F-30-R-7, Michigan Department of Natural Resources, Ann Arbor, Michigan.

In the fall of 1965, populations of age-0 and age-1 brook trout were established at three different densities in six Pigeon River lakes as follows: (1) low density lakes, 194 fish per hectare; (2) intermediate density lakes, 396 fish per hectare; and (3) high density lakes, 1,335 fish per hectare. There was a direct relationship between total trout density at the outset and the natural mortality rate (q) of the 1965 year class during the first winter after stocking. For the 1964 year class, high densities (125-857 fish per hectare) at the outset of the first summer were associated with high natural mortality rates during the summer. Growth in length of the 1965 year class was highest with low density lakes, intermediate in the lakes of intermediate density and lowest with high density lakes. Brook trout stocked at a mean length of 142 mm in November 1965 attained a length of 245 mm in September 1966 after one growing season in the low density lakes, 218 mm in the intermediate density lakes and 225 mm in the high density lakes. Highest growth rates (g) were achieved in the low density lakes and lowest in the high density lakes. There was an inverse relationship between trout density at the outset of the study and growth rates of the 1965 and 1964 year classes during the first year. The 1965 and 1964 year classes showed negative growth rates during the first winter in the high density lakes.

The best ratio of standing crop, at the outset, to total production, was observed in the low density lakes. However, total production was less than two times the initial standing crop. As a guide for future management, satisfactory growth of individual fish will require low stocking rates as determined here and in other studies.

ANONYMOUS. 1977$_a$. Effect of three varying stocking rates on trout production and resultant fisheries. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 31 p.

ANONYMOUS. 1977$_b$. Brook trout stocking assessment on Emerson lake, Rose Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 8 p.

Five gill nets were set over a two night period (July 16-18, 1977) to evaluate the success of brook trout stocking in Emerson Lake. A total of 61 hatchery-reared brook trout and 3 white sucker were captured. Trout ranged from 16.0-27.5 cm in total length.

ANONYMOUS. 1983. Salmonid stocking assessment on Helenbar Lake, Hembruff Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 5 p.

Helenbar Lake was stocked with brook trout in 1970, 1972 and 1974. Five gill nets were set overnight (July 7-8, 1983) to determine the status of the brook trout fishery. The catch consisted of one brook trout, 571 white suckers, 886 lake whitefish and 9 dace. This lake is extremely good brook trout habitat but currently the brook trout fishery is non-existent. It would appear that the lake whitefish and white suckers have overcrowded the brook trout. Consideration should be given to reclaiming this lake.

ANONYMOUS. 1984$_a$. Brook trout stocking assessment in Millichamp Lake, 1984. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 4 p.

Millichamp Lake was reclaimed in November 1960 in order to eliminate a large population of yellow perch that was competing with the resident brook trout population. Re-introduction of brook trout began in 1962. Although yellow perch did not become re-established, pumpkinseeds were accidentally introduced to the lake and appear to be thriving. Stocking assessment, consisting of seine and gill netting, was conducted in 1984. Three standard gangs of gill nets were fished for a total of 65.0 hours. Sixteen brook trout and 1 brown bullhead were captured in the nets. The trout ranged in size from 50.0 gm (16.9 cm total length) to 1,375 gm (46.0 cm total length). No fin clips were present on any of the captured fish. Angling pressure on Millichamp Lake is believed to be heavy. Subsequent plantings of brook trout should continue to be done every two or three years and periodic creel surveys must be carried out to determine the success of the stocking program. Due to some late summer dissolved oxygen depressions, numbers of fish planted into Millichamp Lake should reflect the small area of suitable summer habitat available. Fall spawning checks should be made to determine the extent of natural reproduction within Millichamp Lake.

ANONYMOUS. 1984$_b$ 1984 stocking assessment on Quirke Lake, Bouck and Buckles Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 11 p.

Quirke Lake was stocked with 34,240 unmarked brook trout yearlings in 1982. Eight gill nets, with mesh sizes ranging from 1-2.5 inches, were set overnight (July 8-10) to evaluate this planting. The catch consisted of 10 brook trout, 106 white suckers, 12 lake whitefish, 145 rock bass, 2 brown bullhead, 58 lake herring, and 7 smelt. Captured brook trout ranged from 12.6-46.4 cm in total length and from 18-1150 gm in weight. Based on the yearling size of some brook trout which were captured, it would appear that there is some natural reproduction occurring.

ANONYMOUS. 1984$_c$. 1984 stocking assessment on Blue Sky Lake, Sagard Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 6 p.

Blue Sky Lake was stocked with 2,000 unmarked brook trout yearlings in 1983. Four overnight gill net sets were made from August 27-28, 1984 to evaluate the success of this planting. The catch consisted of 3 lake trout, 34 longnose sucker, 110 chub and 26 dace. Based on the absence of brook trout in the catch, it is recommended that this lake not be stocked with brook trout in the future.

ANONYMOUS. 1984$_d$. 1984 stocking assessment on Gibby Lake, Winkler Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 6 p.

Gibby Lake was stocked with 500 unmarked brook trout in 1983. Four gill nets were set overnight (June 28-29, 1984) to determine the success of this planting. The catch consisted of 18 brook trout (all age-2) and 5 dace. Brook trout ranged from 31.2-41.1 cm in total length and from 380-1040 gm in weight. Stomach contents included fish, terrestrial insects and leeches. Based on the good survival and growth it is recommended that Gibby Lake be continue to be stocked on a high priority basis.

ANONYMOUS. 1984$_e$. 1984 stocking assessment on Corbold Lake, Montgomery Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 1 p.

Corbold Lake was stocked with 8,000 unmarked yearlings in 1983. Four short gill net sets (July 26-27, 1984) were used to evaluate the success of this planting. The catch consisted of 288 white suckers, 72 lake herring, 6 trout-perch, 21 chub and 31 dace. On the basis that no brook trout were captured, we would not recommend restocking this lake.

ANONYMOUS. 1985. Brook trout survival netting on Lake #30, Guilfoyle Township. File Report, Ontario Ministry of Natural Resources, Kapuskasing, Ontario. 5 p.

Lake #30, in Guilfoyle Township, was stocked in 1983 with 1,000 yearling brook trout, in 1984 with 600 two year old brook trout, and again in 1985 with 1,000 yearling brook trout. Survival netting was conducted on July 17, 1985 to determine stocking success and growth rates. A total of 61 m of monofilament netting was used with a total catch of 2 brook trout. Total angling effort consisted of two anglers fishing 2.5 hours producing one brook trout approximately 12 cm in length. It is recommended that brook trout continue to be planted and efforts be made to monitor stocking success.

ANONYMOUS. 1986$_a$. Summary evaluation of twelve stocked lakes. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 2 p.

This project was designed to assess the condition and growth rates of hatchery fish in stocked waters with limited assessment data. Multifilament gill nets were set in eight brook trout lakes. Survival of planted brook trout in Clayton Lake, Donut Lake, Laurier Lake and Luck Lake is good and stocking should be continued in these waters. There were no fish sampled from Round Lake in this assessment and it is recommended that additional assessment be conducted. Limburner Lake, which produced a good brook trout fishery in the 1970s and early 1980s, should be planted with brook trout in 1987. The shallow water of Ink Lake probably results in high water temperatures which are fatal to brook trout. The introduction of rainbow trout should be considered for Ink Lake.

ANONYMOUS. 1986$_b$. Salmonid stocking assessment on Bernard Lake, Montgomery Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 7 p.

Bernard Lake was stocked with unclipped brook trout in 1983 (1,500 fish) and in 1985 (1,000 fish). Two gill nets were set overnight (August 21-22, 1986) to evaluate these plantings. A total of 32 brook trout, 9 lake herring, 189 white suckers, 40 golden shiners, 9 common shiners and 48 lake chub were captured. Captured brook trout ranged from 20.6 - 55.8 cm in total length and from 0.10-2.25 kg in weight. Stocked brook trout showed good growth and survival but evidence of natural reproduction could not be determined because stocked fish were not clipped.

ANONYMOUS. 1986$_c$. Salmonid stocking assessment on Rodge Lake, Jogues Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 11 p.

Rodge Lake (79.8 ha) was stocked with brook trout in 1983 (3,000 fingerlings), 1984 (3,000 fingerlings), and 1986 (2,000 fingerlings). Four overnight gill nets (August 18-19, 1986) were used to evaluate these plantings. Eighty-three (83) brook trout were captured. Brook trout ranged from 16.7-53.5 cm in total length and from 40-2,000 gm in weight. Brook trout are apparently surviving very well. Growth and reproduction was difficult to determine because stocked trout were not marked (e.g., fin clipped). It is recommended that stocking be discontinued in 1987 and 1988 and a further assessment be conducted in the fall of 1988 to determine if natural reproduction is occurring.

ANONYMOUS. 1987. Brook trout reproduction assessment on Lake #2, Lewis Township. File Report, Ontario Ministry of Natural Resources, Blind River, Ontario. 6 p.

Lake #2 was reclaimed in 1979 and was assessed in 1981 with only brook trout being captured. Brook trout were stocked regularly in Lake #2 between 1983-87 (1500 in 1983, 1400 in 1984, 1200 in 1986 and 500 in 1987). One night of gill netting using 200 foot gangs of green monofilament net produced a catch of 2 brook trout, 5 white suckers and 1 cyprinid. The brook trout that were caught seemed to have a normal growth rate but abnormal gonad development. Both fish were probably sterile. More intensive netting should be done to determine brook trout survival and whether more nuisance species have re-established themselves in the lake.

ANONYMOUS. 1990$_a$. Brook trout stocking assessment in Rice Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 3 p.

Rice Lake is a two hectare lake located in Gill Township, District of Cochrane, Ontario. A stocking assessment was carried out on this lake on August 22, 1990 to determine the success of previous brook trout stockings. The standard lake survey gill nets were set in two different locations for a total effort of 8 hours. No brook trout were captured during these sets. White sucker was the only species captured. Numerous perch were observed throughout the day's activities.

ANONYMOUS. 1990$_b$. 1990 brook trout stocking assessment on Gagnon Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Gagnon Lake is a nine hectare lake located in Arnott Township, Ontario. A stocking assessment was carried out on the lake on August, 1990 to determine the success of previous stockings. A standard lake survey gill net was set in the lake for two hours and one brook trout was captured. The capture of a single large brook trout indicates that brook trout can survive in the lake but it seems that the population is low. The trout contained amphipods in its stomach.

ANONYMOUS. 1990$_c$. 1990 brook trout stocking assessment on Bittern Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Bittern lake is a seven hectare lake located in Township 238 of the Hearst District. A stocking assessment project was carried out on August 21, 1990 to determine the success of previous stockings. A standard lake survey gill net was set in the lake in two different locations for a total effort of 18 hours. Six brook trout, ranging in size from 29.4-34.3 cm fork length, were captured. It appears that brook trout in Bittern Lake are surviving the stocking and doing well.

ANONYMOUS. 1990$_d$. 1990 brook trout stocking assessment on Old Squaw Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Old Squaw Lake is a 4.5 hectare lake located in Township 238 of the Hearst District. A stocking assessment project was carried out on August 20, 1990 to determine the success of previous stockings. A standard lake survey gill net was set in four different locations for a total effort of 24 hours. Only one brook trout, measuring 34.3 cm fork length and weighing 680 gm, was captured.

ANONYMOUS. 1990$_e$. 1990 brook trout stocking assessment on Scaup Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Scaup Lake is a 30 hectare lake located in Rogers Township, Ontario. A stocking assessment was carried out on the lake on August 27, 1990 to determine the success of previous stockings. A standard lake survey gill net was set across the southern basin of the lake for two hours. Three brook trout and three splake were captured. It appears that the brook trout and splake in Scaup Lake are surviving and doing well.

ANONYMOUS. 1990$_f$. 1990 brook trout stocking assessment on Pointing Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Pointing Lake is a 12 hectare lake located in Frost Township, Ontario. A stocking assessment was carried out on the lake on August 29-30, 1990 to determine the success of previous stockings. A standard lake survey gill net was set in the lake in three different locations for total effort of 20 hours. Four brook trout, ranging from 47.1-54.6 cm in fork length and 1700-3150 gm in weight, were captured. It appears that the brook trout in Pointing Lake are surviving although the populations seems to consist of a few large adults. Minnows are abundant in the lake and one brook trout had both darters and minnows in its stomach.

ANONYMOUS. 1990$_g$. 1990 brook trout stocking assessment on Canary Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Canary Lake is a 4.2 hectare lake located in Rogers Township, Ontario. A stocking assessment was carried out on the lake on August 23, 1990 to determine the success of previous stockings. A standard lake survey gillnet, consisting of 8 panels with mesh sizes of 5”, 3”, 4”, 2”, 3.5”, 1.5”, 4.5”, and 2.5”, were set in the lake for two hours. Two brook trout, ranging in size from 39.4-48.2 cm in fork length and 900-1200 gm in weight, were captured. The capture of two healthy mature brook trout indicates that the trout are surviving the stockings. The trout stomachs contained cyprinids, chironomid larvae and crayfish.

ANONYMOUS. 1990$_h$. 1990 brook trout stocking assessment on Evelyn Lake. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 2 p.

Evelyn Lake is a 30 hectare lake located in Arnott Township, Ontario. A stocking assessment was carried out on the lake on August 28, 1990 to determine the success of previous stockings. A standard lake survey gill net was set across the main basin of the lake for two hours and thirty-one brook trout, ranging in size from 18.1-28.5 cm in fork length and 80-1400 grams in weight, were captured. It appears that the brook trout in Evelyn Lake are surviving the stocking and doing well.

ANONYMOUS. 1990$_i$. Summary report for 1990 brook trout (*Salvelinus fontinalis*) stocking assessment of Tasso Lake. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario.

Gill netting surveys were conducted in Tasso Lake, Finlayson Township, from July 17 to July 24, 1990 in an effort to determine abundance indices for stocked and natural brook trout (*Salvelinus fontinalis*) populations. Tasso Lake had been stocked with 1,500 brook trout in 1987 and 2,000 brook trout in 1989. A total of 30 gill nets were set for 66.76 hours resulting in a total catch of 1 lake trout (*Salvelinus namaycush*), 161 yellow perch (*Perca flavescens*), 97 white suckers (*Catastomus commersoni*), and 14 other incidental fish. No brook trout were caught. Catch-per-unit-effort (fish per 100 net hours) ranged from 241.16 for yellow perch to 1.50 for lake trout. Angler returns appear to be low. If anglers have not been successful in catching brook trout during the last few years, then the low CUE for brook trout may be due to competition or predation by incidental fish species.

ANONYMOUS. 1993$_a$. 1993 Fall Lake brook trout stocking assessment. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 3 p.

A stocking assessment project was carried out on Fall Lake, Dorion Township , on July 22 and 23, 1993. The objective of the project was to qualitatively assess the survival of stocked brook trout, while a second objective was to try to determine if natural reproduction was occurring in the lake.

Fall Lake is stocked regularly (often annually) with yearling brook trout to provide a put-grow- and-take fishery. Road access to the lake is available from the Tower road and the lake is fished heavily at times. Fall Lake has been closed to winter fishing since January 1989 to provide better summer angling.

Small mesh monofilament gill nets (mesh sizes ranging from 1.0 to 2.5 inches) were set in Fall Lake in July 1993 to capture brook trout. A total of thirteen brook trout were captured over the two days. They ranged in size from 122 to 313 mm in total length. One and two year old brook trout were present in Fall Lake which corresponds to ages of brook trout stocked in 1993 and 1992. The aging results do not support (but also do not eliminate) the possibility that natural reproduction is occurring in Fall Lake. It is unknown why older brook trout were not collected in the sample. Winterkill, heavy fishing mortality or some other cause may be responsible.

Fall Lake, as indicated by the netting results, seems to have a large healthy population of white suckers. Northern redbelly dace, finescale dace, and bluntnose minnows were also present in the minnow traps which were set. Competition between these species and brook trout no doubt reduce the potential yield of brook trout from Fall Lake.

ANONYMOUS. 1993$_b$. 1993 Bigger Lake brook trout assessment. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 2 p.

Between 1986 and 1992, Bigger Lake was stocked three times with 3,000 brook trout fry. Gill netting and angling was carried out in August 1993 to determine if natural reproduction was occurring. The target was to obtain aging structures (otoliths and pectoral fin rays) from at least ten brook trout. A total of six brook trout were obtained from Bigger Lake. These fish ranged in age from 3+ to 5+. If no natural reproduction was occurring in Bigger Lake than only brook trout from the 1992, 1988 and possibly 1986 year classes should have been caught. Five of the six fish were from the 1990 and 1989 year classes during which no stocking occurred. This provides a strong indication that natural reproduction of brook trout is occurring in Bigger Lake.

ANONYMOUS. 1993$_c$. 1993 brook trout stocking assessment on Hilma Lake. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 3 p.

Gill netting of Hilma Lake was carried out on August 17, 1993 to determine if natural reproduction of brook trout was occurring. The lake had been stocked with 6,000 brook trout fry in 1985 and with 2,000 yearlings in 1992. The target was to obtain aging structures (otoliths or pectoral fin rays) from at least 10 brook trout. A total of 12 brook trout samples, including one young-of-the-year caught in a minnow trap, were collected .

If no natural reproduction was occurring in Hilma Lake than only brook trout from the 1991 year class (stocked as yearlings in 1992) should have been present. Seven of the twelve fish captured were from year classes other than 1991 during which years no MNR stocking occurred. This provides a strong indication that natural reproduction of brook trout is occurring in Hilma Lake. The observance and capture of brook trout fry in the small tributary flowing into Hilma Lake also provides an indication of natural reproduction.

ANONYMOUS. 1996. Summary of the 1996 index netting program on stocked brook trout lakes. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 3 p.

Four lakes (Wilbur, Poorhouse, Finger and Surprise) were assessed during the summer of 1996 to evaluate marked (fin clipped) brook trout which had been stocked in 1995. The assessment was conducted between July 15 and August 22, 1996. Two monofilament gill nets, with mesh sizes ranging from 2.5-6.4 cm, were used. Nets were set perpendicular to shore for a period of 30 minutes.

Wilbur Lake was stocked with 1,500 yearling brook trout (167 fish ha^{-1}) in 1995. A total of 20 brook trout were captured. Nineteen of these fish were fin clipped. Fish ranged from 150-1350 gm in weight. Poorhouse Lake was stocked with 2,000 yearling brook trout (76 fish ha^{-1}) in 1995. Twenty-one brook trout were captured. Only two of these fish had fin clips. Fish ranged from 197-1450 gm in weight. Finger Lake was stocked with 500 yearling brook trout (140 fish ha^{-1}). No brook trout were captured during the assessment program. Surprise Lake was stocked with 1,000 yearling brook trout (36.4 fish ha^{-1}) in 1995. Eighteen brook trout were captured in the nets. Five of these fish had fin clips. Captured trout ranged from 160-620 gm in weight.

ANONYMOUS. 1999. Preliminary results of a 1998-99 winter survey of stocked brook trout lakes in the Thunder Bay district. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 2 p.

This project was conducted to estimate the level of use and fishing success of lake stocked with brook trout fry in the Thunder Bay district. Thunder Bay is the only MNR district which stocks brook trout fry extensively. This represented the first extensive survey of stocked brook trout lakes. The project involved the use of a small fixed wing aircraft to count anglers of 59 different lakes on a weekly basis. Stocking lists and angler diaries were also provided to volunteer anglers to record their fishing activities. Although many lakes were being fished, the overall fishing effort was low. The overall catch rate was low to moderate but sporadic and inconsistent between lakes. Several lakes have been identified for further assessment in 1999.

ARMITAGE, G. 1958. Speckled trout planting experiments. p. 52-55 *In* Conservation Officer Projects, Ontario Department of Lands and Forests, Southwestern Region.

The purpose of these projects was to try and determine what becomes of hatchery stocked speckled trout that are placed in streams. The lower portion (1.5 miles from the outlet) of a stream in King Township was poisoned with Rotenone on April 13, 1957. Fourteen legal sized brook trout were recovered. On April 16, 1957 217 marked speckled trout, approximately 6 inches in length, were placed in the stream. On April 23, 1957 a second poisoning was carried out approximately two miles upstream of the outlet. Ten native trout and 25 marked trout were recovered. On May 3, 1957 a third poisoning was carried out on the complete stream and tributaries and 6 native trout and 4 marked speckled trout were recovered. On November 28, 1957 200 marked speckled trout were placed in the stream at different points. On April 22, 1958 a fourth poisoning was carried our with 6 marked trout and 0 native trout being recovered.

A stream in Tay Township was stocked in 1956 with 5,000 yearling trout and on May 5, 1957 100 marked trout were placed in the stream. The stream was poisoned on May 7, 1957 with 301 resident and 53 marked speckled trout being recovered. The stream was poisoned again on August 3, 1957 with 123 speckled trout being recovered. The stream was restocked with 200 marked trout on November 28, 1957 and poisoned again on April 30, 1958. Forty-two marked speckled trout and 38 unmarked trout were recovered.

This project has shown that hatchery fish do not adjust themselves to the streams they are placed in if an outlet is available to them. More trout would probably have been recovered if we had been able to get to the bottom of the deep holes. I feel that a barrier should be placed across the stream for a few days immediately after stocking so that the fish could re-distribute themselves throughout the stream and adjust themselves to the feed available.

ARMSTRONG, K. B. and P. H. DAVIS. 1998. Angler returns of stocked brook trout strains from small lakes in northeastern Ontario. File Report, Ontario Ministry of Natural Resources, Kirkland Lake, Ontario.

This study was initiated to evaluate the success of the brook trout stocking program in northeastern Ontario. All stocked lakes were within a 100 km radius of Kirkland Lake. Four strains including wild (LN),domestic (HL), hybrid (HL x LN), and splake (KL x HL) were stocked for two consecutive years (1991 and 1992). Fish were stocked based on the provincial stocking rate. Lakes were closed to fishing from 1991 to 1994. In 1993 angling was allowed for two weekends in March and one weekend in May. Randomized creel surveys were used to evaluate angler returns. Intensive gill netting was done immediately after the angling period to capture any remaining fish.

Overall there was high variability within treatments for the various response variables. The maximum catch-per-unit-effort (CUE) for any one lake was 3.82. Catch-per-unit-effort seemed to be a good indicator of population density. We recommend establishing a CUE > 0.35 as a measure of success. Stocked populations produced yields far in excess of natural populations. The maximum yield observed from any lake was 41.2 kg/ha. Five of the twelve study lakes which had never been stocked previously had highest survival and returns. We recommend establishing angler recovery of planted fish to exceed 20% of those planted. High angling effort occurred over a very short period. Brook trout populations in small lakes are susceptible to high exploitation.

ATKINSON, D. G. 1968. Panagapka Lake reclamation project. File Report, Ontario Department of Lands and Forests, Kirkland Lake, Ontario. 9 p.

A reclamation project was carried out on Panagapka Lake, Clifford Township, on October 3, 1968 using Pro-Noxfish as the fish toxicant. The area of the lake is 52.7 acres and it contains 782.5 acre feet of water. The required amount of toxicant was 275 gallons costing $5.75 per gallon for a total cost of $1,580.25. This project was in cooperation with the Parks Branch in the Swastika District who supplied four men, provisions and pump rental. The lake will be stocked with 2 year old brook trout in early spring of 1969 to provide a fishery for the park visitors. The main coarse fish in the lake was common white suckers (*Catastomus commersoni*).

AXON, J. R. and E. W. CARROLL. 1989. Evaluation of brook trout introductions into a headwater stream in eastern Kentucky. Fisheries Bulletin No. 86, Kentucky Department of Fish and Wildlife Resources.

A natural population of brook trout was successfully established at Bad Branch after stocking 3-4 inch fingerlings at a rate of about 200 fish per mile in 1980 and 1981. The standing stock of brook trout above the falls was 153 fish per mile and 31 pounds per acre in 1982. The population density remained good despite the severe drought conditions in 1983 and 1985-87. Bad Branch had higher population densities of brook trout in 1986 and 1987 when compared to densities of brook trout in other streams in Kentucky. Natural reproduction occurred each year from 1982-1987. Brook trout survived to at least age 3+ at Bad Branch; the largest fish captured was 13.8 inches long. Brook trout began to exceed 10 inches in length at age 2+ which is the minimum length limit for brook trout on several streams in Kentucky. The results of this study have led the Kentucky Department of Fish and Wildlife Resources to develop natural populations of brook trout in other suitable streams.

BAEDER, H. A., P. I. TACK, and A. S. HAZZARD. 1945. A comparison of the palatability of hatchery-reared and wild brook trout. Transactions of the American Fisheries Society 75 : 181-185.

Objective organoleptic tests scoring for aroma, flavor, texture, and moisture were made for eight samples of wild brook trout (*Salvelinus fontinalis*) from two streams and for seven samples of hatchery reared brook trout from two rearing stations. Samples were obtained during May, June, July, and August, were cooked separately by the same method and identified by the judges by code number. Average scores of six judges showed all samples acceptable but values for wild fish from both streams were significantly higher than for hatchery-reared trout. The color of the flesh and the overall appearance of the wild trout were also more attractive. The possibility of improving the eating quality of hatchery trout through better nutrition was suggested.

BALL, H. 1988. Brook trout stocking assessment, Thunder Bay District. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario.

The 1986 brook trout stocking assessment program involved six lakes situated within the Thunder Bay district of the Ontario Ministry of Natural Resources. Three lakes (Marks, Waller, and Golding) were stocked at three year intervals at densities ranging from 179-310 fry per hectare. The remaining three lakes (Head, Little Head, and Karilla) were stocked at two year intervals at densities ranging from 160-440 fry per hectare.

In late August and September 1986, temperature did not appear to limit brook trout habitat however oxygen was limiting in Waller, Marks and Golding lakes. In August 1985, 87.8% of the total volume of Morrison Lake was not suitable for brook trout. Temperature and oxygen levels in mid summer and winter may have a greater impact in limiting brook trout success especially in small shallow lakes.

Recovery rates (0.9% to 5.6%) of brook trout were low compared to those in Algonquin Park lakes (1.1 to 13.2%). In this study creel census was not conducted, therefore recovery rates are probably substantially higher than those indicated. The high rate of recovery of brook trout in Morrison Lake in 1986 compared to 1985 may indicate that gill net effort did not adequately represent actual brook trout abundance.

Length and age distribution did not reflect stocking intervals. It appears that aging tissues did not adequately describe the actual age structure of the population. There were large discrepancies between ages derived by scales, fin rays and otoliths, and the accuracy of age assessment (needed to assess brook trout stocking success) was hindered by false checking and difficulties in assessing the first and last annulus. Problems with age assessment of brook trout in stocked lakes suggests that Thunder Bay district should not continue a stocking assessment program until fry are marked and planted in a small group of representative lakes. Batch marking using a tetracycline dip would help assess stocking success and validate the assessed ages. Marking should help identify the problems with each of the aging tissues and help determine which tissue provides the most accurate age.

An intensive creel should be done as part of the assessment or lakes should be declared as sanctuaries during the assessment. Without an estimated of the total number of brook trout removed by anglers it is impossible to derive an accurate recovery rate. In Morrison Lake, poor recoveries of brook trout in 1985 compared to 1986 indicate four nights of gill netting is not adequate for assessing the status of brook trout populations in small lakes. Assessment should be conducted over a longer period of time (thaw to freeze) to be able to observe changes in oxygen and temperature over the summer and to properly assess the status of the brook trout population. Oxygen and temperature profiles should also be conducted in each lake in the winter to determine whether brook trout populations are susceptible to winter kill.

BELFRY, S. 1996. 1995 stocking assessment of Antoine Lake. File Report, Ontario Ministry of Natural Resources, North Bay, Ontario. 6 p.

Antoine Lake is a small (3.4 ha) headwater lake which has been stocked with brook trout almost every year between 1956 and 1994. In recent years the lake has been stocked with 500 yearling trout (147 fish ha^{-1}). A brief assessment was carried out on June 6, 1995 in an effort to determine survival and growth of the stocked trout and to decide whether stocking should be continued. The assessment consisted of 4-one hour gill net sets using monofilament gill net with mesh sizes ranging from 2.5-6.4 cm. A total of 1 brook trout, 6 white suckers, 13 golden shiners and 30 yellow perch were captured. The only brook trout caught measured 25.3 cm (fork length) and weighed 185 grams. It bore a left ventral (LV) fin clip indicating that it had been stocked in 1994.

The poor catch of brook trout and the low utilization of this lake by anglers suggests poor survival of the stocked trout. This is not surprising considering the high perch population. Since perch were not reported in the 1969 lake survey, they were probably introduced to the lake since that time via an anglers bait bucket. Continuing to stock this lake with yearlings on a put-and-delayed-take basis will at best provide a poor fishery. Stocking the lake with larger trout (i.e., excess brood stock) on a put-and-take basis would probably provide better results, but larger trout are seldom available. This lake should be dropped off the stocking list unless excess trout are available.

BELFRY, S. 1997. 1996 stocking assessment on Long (Turcotte) Lake. File Report, Ontario Ministry of Natural Resources, North Bay, Ontario. 15 p.

Long Lake has been stocked with brook trout most years since 1961. Most recently the lake has been stocked with between 1-3,000 yearling brook trout on an annual basis. From August 6-8, 1996, an assessment of the brook trout population was carried out on Long Lake to determine the survival and growth of the stocked brook trout and to determine if the trout were reproducing successfully. In addition, some information was gathered in an effort to determine if the lake would be suitable for the introduction of lake trout. The purpose was to determine if the current stocking practices should be continued or modified.

Assessment consisted of four overnight gill net sets. Monofilament nets with mesh sizes of 2.5-6.4 cm, were used. In total, 12 brook trout, 1 lake trout, 184 rock bass and 27 creek chub were caught. Of the eleven brook trout which were examined for fin clips, 7 had a right pectoral clip (probably stocked in the spring of 1996 as yearlings), 2 had a left pectoral clip (stocked in 1995) and 2 had no apparent fin clip (origin uncertain). Natural reproduction would seem to be either poor or non existent. Since no pre-1995 stocked fish were caught and only 2 trout from the 1995 stocking were captured, it suggests poor survival due to high natural and/or angling mortality. Since fishing pressure is very low, high angling mortality is unlikely, leaving the probability of high natural mortality. The most obvious cause for high natural mortality in this lake is competition and predation from the abundant rock bass population. The lake trout captured was believed to have been a fish which was stocked unintentionally probably because it was mixed in with a load of brook trout.

It appears that brook trout stocking is creating a fishery but not a very good one. This is probably due to competition with the resident rock bass population. Stocking splake would probably result in an improve fishery. Further consideration should also be given to stocking lake trout or smallmouth bass.

BELFRY, S. 1998. 1997 stocking assessment on Fork Lake. File Report, Ontario Ministry of Natural Resources, North Bay, Ontario. 7 p.

Fork Lake was first stocked with brook trout in 1953 and has been stocked every 1-3 years since that time. In recent years the lake has been stocked with 1,000 yearlings on an alternate year basis. A stocking assessment was conducted on Fork Lake on October 16, 1997. The purpose was to determine if the present stocking regime was appropriate and to determine if natural reproduction of brook trout was occurring. Four short gill net (monofilament with mesh sizes ranging from 2.5-6.4 cm) sets were made. A total of 5 brook trout, 12 white suckers, 13 common shiners and 1 pumpkinseed were captured. The size of the trout, uniformity of lengths, and lack of small trout seen in the catch suggest that the trout captured are all the result of the 1996 stocking event and that natural reproduction is not occurring. It is recommended that we continue with the present stocking regime (1000 yearlings every other year). If the trout captured were from the 1996 plant, growth was good, a reasonable fishery was created and there is not a lot of trout remaining to prey on or compete with the next stocked year class. We should continue to use clipped fish for stocking in order to reassess if natural reproduction is occurring.

BELFRY, S. 1999. Brook trout stocking assessment and spawning survey, Ducharme Lake. File Report, Ontario Ministry of Natural Resources, North Bay, Ontario. 7 p.

Ducharme Lake has been stocked with brook trout since 1953. The stocking regime over the past decade has been to plant 2,000 yearling fish (112 fish ha^{-1}) on an alternate year basis (e.g., 1992, 1994, 1996, 1998). Stocking assessment was conducted on November 3, 1998. Two small mesh (2.5-6.4 cm) gill nets were set for a total of 3.8 hours in mid day. A total of 24 brook trout and 1 lake trout were captured. Eighteen of the 23 brook trout were adipose fin clipped indicating that they had been stocked in the spring of 1998 as yearlings. The five unclipped brook trout captured indicates that some natural reproduction is occurring. The mean length of 27.1 cm for fall yearlings indicates rapid growth and the 42% maturity at age 1+ represents early maturity (especially for females). The one lake trout captured is believed to the result of an accidental stocking. The present stocking regime appears to be working however it is recommended to stock approximately 1,500 brook trout each year to increase fishing opportunities. It is also recommended to improve brook trout spawning habitat and consider regulation changes to prevent the introduction of non-native fish species.

BERKA, R. 1986. The transport of live fish: A review. European Inland Fisheries Advisory Commission (EIFAC) Technical Paper 48, Food and Agriculture Organization of the United Nations, Rome Italy.

The basic principles of fish transport and the main factors affecting it (fish species, oxygen content, fish metabolism products, etc.) are evaluated on the basis of an analysis of the pertinent literature. For the two basic fish transport systems, closed and open, the transport units are described and the densities of transported fish per unit volume under actual conditions are tabulated for guidance. The survey is complemented by the description of the existing methods for the chemical treatment of the environment inside the transport systems; and for the treatment of the fish transported such as fish anaesthetics, chemical water conditioning and antibacterial treatment.

BERNIER, M.-F. 1975. Hatchery assessment of brook trout yearlings. File Report, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 12 p.

This project was initiated in the summer of 1974. The objectives were to assess the returns of hatchery planted brook trout and to develop a standard method of assessing brook trout stocking. Each lake was stocked on an alternate year basis at the same rate (e.g., fifty yearlings per acre of water between zero and twenty feet). Monofilament gill nets of mesh sizes of 3.8-6.4 cm were selected. Each lake was netted for at least three nights. It is intended to net each lake twice before drawing any conclusions.

BERNIER, M.-F. 1978. Hatchery assessment of brook trout yearlings, 1974-1977. File Report, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 39 p.

The results of a four-year hatchery assessment program on brook trout lakes are presented. The number of hatchery brook trout recovered increased each year since the inception of the study. Only in 1977 was the average catch-per-unit-of-effort (CUE) higher than one fish per 100 feet of net. It was found that the CUE for lakes entirely maintained by hatchery fish did not differ significantly from lakes where natural populations also existed. The stocked fish exhibited a good growth rate for the two-month period from stocking time to assessment. Population estimates were calculated for eight lakes. It was found that almost 90% of the fish were removed by our netting techniques. The average survival rate was estimated at 6.9%. The techniques used for the assessment are discussed in an attempt to derive a methodology for future assessment.

BONNER, F. C. 1974. Evaluation of catchable trout stocking program in Delaware. Delaware Division of Fish and Wildlife. Dover, Delaware. 12 p.

BORGESON, D. P. 1980. Salmonid stocking. p. 34-38 *In* Proceedings of the First Annual Workshop “Practical Fisheries Management: More with Less in the 1980s”. July 14-16, 1980, Cazenovia College, Cazenovia, New York.

Approximately 100 lakes are kept free of competing species through chemical reclamation and rough fish barriers. They are stocked annually with trout fingerlings, usually brook trout. Sparse stocking (40-50 fingerlings per acre) gives best survival and growth. One hundred fish per acre is a more common stocking rate. Lakes produce 10-30 pounds per acre per year.

Some keys to good management with respect to stocking include:

- Avoid catch per unit effort as a management goal.
- Competition, not predation, is the key controlling factor in salmonid stocking success.
- Trout should be stocked to take advantage of highs in food availability.
- Wild trout strains generally succeed better in wild conditions.
- Stock the size that produces the desired results cheapest.
- Use regulations to maximize benefits produced from trout stocking.
- Stock sparsely. Trout growth and survival will increase to accommodate the reduced stocking rate.

BORGESON, D. P. 1987. Fish stocking guidelines (revised 1987). Fisheries Management Report No. 11, Michigan Department of Natural Resources, Lansing, Michigan 32 p.

Brook trout fingerlings may be utilized in a manner similar to brown trout for production stocking to maintain resident stream trout populations where a demonstrated lack of natural recruitment exists. Stream planting of yearling brook trout is approvable only for experimental projects. Yearling brook trout are at or near the legal size of 7 inches when planted in the Upper Peninsula, and planting yearling brook, which are particularly vulnerable to angling invites return to put-and-take fishing, which is against policy. Generally, the use of brook trout should be restricted to plants in newly rehabilitated streams (soft-water streams) or to coldwater streams where summer temperatures rarely exceed 70º F.

Wild brook trout originating from the Assinica and Temescamie strains (Québec) have shown considerable promise in research studies in New York, in the Pigeon River research lakes and in our management application. Growth of the wild fish and of crosses between Assinca strain and domestic broodstock has been markedly faster than brook trout heretofore used as planting stock. The Québec trout are slow to mature (age III-IV for females), long-lived and are more vulnerable to angling than our usual brook trout. To realize their growth potential they should be stocked sparsely (around 50 per acre).

Expanded use of Québec strains and its hybrids has already occurred and is expected to continue. These new strains have had a dramatic impact on our brook trout lake program but Great Lakes plants of these strains (in bays and island areas) also offer possibilities.

BRADBURY, G. 1980. 1980 assessment of brook trout and rainbow trout populations in Frost Centre put-and-delayed-take lakes. File Report, Ontario Ministry of Natural Resources, Leslie M. Frost Centre, Dorset, Ontario. 16 p.

The Leslie M. Frost Centre's brook trout and rainbow trout lakes provide fisheries on a put-and-delayed-take basis. The objectives of the 1980 assessment program were to determine the success of hatchery plantings, the relative abundance of year classes, growth rates of planted trout and factors which may be affecting trout survival.

Based on the 1980 assessment netting, brook trout are most abundant in Nehemiah Lake although a healthier population is indicated in Black Cat Lake by the capture of three year classes between one and six years of age. The most recently stocked brook trout were the most abundant year class caught in all lakes. It does not appear that brook trout survive past their second winter after stocking in the lakes assessed, except in Black Cat where they have survived up to five years after stocking. Growth was comparable for all lakes except Silver Buck. Reasons for this poor growth may perhaps be explained by the fact that the lake supports a large population of white suckers and it is possible that they are overly successful competitors for space and food against brook trout.

It is recommended that brook trout continue to be stocked at two year intervals and that the removal of white suckers from Silver Buck and Silver Doe lakes be considered.

BRADBURY, G. 1981. 1981 assessment of brook trout and rainbow trout populations in Frost Centre put-and-delayed-take lakes. File Report, Ontario Ministry of Natural Resources, Leslie M. Frost Natural Resources Centre, Dorset, Ontario. 17 p.

The purpose of the 1981 program was to assess the status of brook and rainbow trout populations in Frost Centre put-and-delayed-take lakes by determining the success of hatchery plantings, the relative abundance of year classes, growth rates of planted trout and factors affecting trout survival. Assessment was conducted by a two person crew using two monofilament gill nets comprised on random mesh sizes ranging from 3.9-12.7 cm mesh. Nets were set and lifted during the day.

Brook trout were most abundant in Ronald Lake followed by Lost and Shoelace. As in 1980, all brook trout netted were the last year class stocked (age II in Lost and Ronald and age IV in Shoelace). Highest brook trout catch rates were obtained on lakes stocked most recently. All brook trout from Ronald and Lost lakes exhibited normal growth but showed extremely good growth. Four-year-old brook trout from Shoelace Lake in 1981 had a mean weight close to the mean weight of six-year-old brook trout from Black

Cat Lake in 1980. The Shoelace Lake trout fed on abundant supplies of freshwater shrimp and backswimmers. There were no competing fish species in any of the 1981 brook trout assessment lakes.

It is recommended to continue stocking brook trout at two-year intervals in all Frost Centre stocked lakes until provincial guidelines are developed or until these plantings cease to be successful.

BRADY, C. 1983. Meach Lakes 1982 creel census. File Report, Haliburton-Hastings Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Bancroft, Ontario. 23 p.

This report summarizes creel survey information for the Meach Lakes during 1982. In Meach Lake, an estimated 617 trout were caught. Thirteen per cent of these were released. Trout caught from open water tended to be larger than those taken through the ice. Fifty per cent of the brook trout belong to the 1979 year class were assumed to be of hatchery origin even though they were unclipped and therefore not recognizable (3,000 marked yearlings were planted in 1980). The contribution to the Meach Lake winter brook trout fishery was 34% hatchery-reared trout (0.33 kg ha^{-1}) and 66% wild trout (0.64 kg ha^{-1}). For the open water fishery, hatchery-reared trout accounted for only 12% of the catch (0.25 kg ha^{-1}).

In Little Meach Lake, the presence of unmarked hatchery fish of the 1979 year class precludes making direct estimates of hatchery and native fish contributions to the fishery. However, by arbitrarily assigning a value of 50% it can be estimated that the winter fishery was comprised of 50% hatchery-reared brook trout (1.03 kg ha^{-1}) and 50% native trout (1.03 kg ha^{-1}). Hatchery-reared trout accounted for only 17% of the open water catch (0.55 kg ha^{-1}) however.

The 1981 planting of domestic stock yearling trout was the oldest group of identifiable hatchery fish in the lakes. An estimated 14.5% of the planting or 434 fish have been removed by anglers. This harvest represents a return of 438 grams per kilogram planted. The dramatic difference noted in the first year harvest of the 1981 planting of yearling domestic trout compared to the 1982 stocking of Nipigon trout may be attributable to the difference in size of individual fish at time of planting. The small size of the Nipigon trout may have reduced their catchability and/or their survival. Future creel census work will indicate which factor may have been responsible for the extremely low first year returns. If their catchability but not their survivorship was reduced, this group of fish should begin to show up in creels during the 1983 open water season.

BRADY, C. 1991. Comparison of midlake versus nearshore stocking of yearling brook trout (*Salvelinus fontinalis*). Haliburton-Hastings Fisheries Assessment Unit Report, Ontario Ministry of Natural Resources, Bancroft, Ontario. 9 p.

We compared two procedures for planting yearling brook trout in a small oligotrophic lake. In each of four consecutive years, equal numbers of fish were planted in: (1) a single large group in the middle of the lake over deep water; and (2) in small groups spread around the perimeter of the lake in the nearshore area. Recapture data from anglers creels and trapnetting revealed no differences in survival between the two groups. The limited available data on growth also did not indicate differences. Changes to the current Algonquin Region stocking procedure of planting the entire lot of brook trout in the center of the lake are not indicated.

BRITISH COLUMBIA MINISTRY OF FISHERIES. 1993. Policy for stocking fish in British Columbia waters. Policy and Procedural Manual, Victoria, British Columbia.

It is the policy of this Ministry to give first priority in the fisheries program to the protection, maintenance and enhancement of wild indigenous fish stocks, and that hatchery-reared or exotic species or races will be released only where there is a previous history of stocking or where wild stocks or listed rare species will not be compromised as a result.

British Columbia's hatchery program in unique in North America as it utilizes wild and semi-wild broodstocks rather than domesticated or exotic strains for 95% of the production. Brook charr, an exotic species in British Columbia, is the one exception. The first recorded brook charr stocking in British Columbia was in 1908. The hatchery program has pioneered the use of non-reproductive fish. All of the brook charr production has been sterilized since 1997.

Stocking rates are determined by regional fisheries biologist based loosely on a carrying capacity model. Brook charr are predominantly stocked as yearlings at sizes of approximately 6 gm per fish.

BRETT, J. R. 1941. Tempering versus acclimation in the planting of speckled trout. Transactions of the American Fisheries Society 70 : 397-403.

The acclimation of speckled trout (*Salvelinus fontinalis*) by keeping them in tanks at temperatures from 13º to 22º C (55.4º to 71.6º F) for a period of 12 hours raised the lethal temperature from 24º C (75.2º F) to 26º C (78.8º F). The lethal temperature was assumed to be that temperature at which 50% of the fish die within a period of 14 hours (Hathaway's method). Tempering speckled trout by gradually raising the temperature over a period of 15 minutes to that of the experimental tanks had no effect on the lethal temperature.

BROUSSEAU, C. S. 1985. Survival and growth of stocked brook trout infected with furunculosis. File Report, Ontario Ministry of Natural Resources, Cochrane, Ontario. 11 p.

This note describes the survival and growth of furunculosis infected brook trout (*Salvelinus fontinalis*) stocked in three northeastern Ontario lakes. In January 1984, 11-month-old brook trout were stocked into small, pothole type put-grow-and-take lakes (Nelson, Bear and Lake #59). All lakes had been previously stocked with brook trout but very few of these fish remained. The fish had a furunculosis infection rate of about 10%. They averaged 5.4 gm each. Stocking occurred through the ice with the water temperature of the lakes and hatchery vehicle at 4º C. Air temperatures were less than –20º C.

In August 1984, population estimates were made using catch-removal methods. Randomly placed variable meshed monofilament gill nets were set for approximately 24 hours for a minimum of three sampling periods. The survival of brook trout was low in Nelson Lake (7.7%) and Lake #59 (5.3%) but was exceptionally high in Bear Lake (63.2%). The first two lakes had survival rates similar to other lakes in northern Ontario stocked with uncontaminated brook trout. Growth of the planted fish was similar in Bear Lake and Lake #59 but was considerably less in Nelson Lake.

The results of this study support the decision to stock brook trout infected with furunculosis into closed environments as opposed to the destruction of the stock. In this manner, recreational benefits can be derived from the fish to offset the costs of raising them. Future studies of this nature should contain matched plantings of both diseased and disease-free fish in order to determine the fate of the diseased fish.

BROWN, C. J. D. and N. THORESON. 1958. Ranch ponds in Montana: Their construction and management. Bulletin 544, Montana Agricultural Experiment Station, Montana State College, Bozeman, Montana. 23 p.

The pond building program in Montana began in 1936 under the Resettlement Administration and other federal programs. More than 100 ponds were constructed in this area during the 3 ensuing years. Since that time, the number of ponds within the state has increased to about 50,000. More than 3/4 of these were constructed solely for stock water purposes and most of the others for either irrigation or the control of erosion and floods. Less than 100 ponds are known to have been built specifically for fish production although possibly more than 1,000 have been stocked with fish at one time or another. The results from those plantings have not been encouraging since fewer than 250 ponds are known to have produced fish populations suitable for fishing.

In Montana, most ponds deep enough to support fish are suitable for trout. In a number of successful trout ponds the midsummer surface temperatures exceed levels tolerable to trout but the lower waters remain cold enough to provide a suitable place for these fish. Rainbow trout (*Salmo gairdneri*) and brook trout (*Salvelinus fontinalis*) are known to be adapted to Montana ranch pond condition. They should not be planted together in the same pond, however. In new ponds devoid of fish, the planting of fry (soon after hatching) is usually very successful and is most economical. However, fry may not be available as the ice leaves the ponds in the spring when conditions are most favorable for planting. Brook trout may be as large as 2-3 inches at that time. Fingerlings of 1?-3 inches in total length should be stocked at a rate of 250-1,000 per surface acre depending upon food conditions. It is much better to understock than to overstock and more conservative numbers are best suited for untried ponds. Growth of the fish planted in ponds is extremely variable depending upon temperature, food conditions, etc. As soon as fish reach a useable size (6-7 inches) the pond should be fished. Ordinarily, good fishing will be enjoyed for 2 or 3 years depending upon the fishing pressure.

BROWN, W. P. 1985. 1984 Caribou Lake brook trout stocking assessment. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 16 p.

Caribou Lake has been stocked with two-year-old brook trout annually from 1961-1977 and with yearling brook trout from 1977-1984. This stocking program is conducted to provide put-and-delayed take angling opportunities. The stocking rate was based on stocking 225 yearlings @ 30 gm each per hectare of littoral zone. This formula produced a stocking rate of 4,815 yearling trout. The actual stocking rate has normally been between 500-1000 two-year-old fish and approximately 2,000 yearling fish.

Assessment netting was conducted from July 19-21, 1984. The assessment project was based on the removal method with a minimum of three consecutive gill net night catches. Two gill nets were set on three successive nights. Each gill net consisted of four panels, 15.2 m in length, with mesh sizes of 2.5, 3.8, 5.1 and 6.4 cm..

A total of only 3 brook trout were caught during the three nights of netting. All three fish were from the 1984 planting. Other species captured included 59 white sucker, 81 yellow perch, 5 pumpkinseed, 1 redbelly dace, 477 golden shiner and 4 rock bass. It is recommended that brook trout stocking be discontinued and that the lake be investigated for the possibility of establishing a smallmouth bass fishery.

BRUMSTED, H. B. 1960. Stocking farm fish ponds. Cornell Extension Bulletin 1046, New York State College of Agriculture. 4 p.

Increasing numbers of rural landowners who have a pond or who plan to build one consider stocking fish.

Increasing numbers of ponds in which summer water temperatures in the deepest part of the pond do not exceed 74º C are being stocked with brook (speckled) trout or rainbow trout. Both trout species, stocked in the fall as 5 inch or 6 inch fingerlings will increase in length by the following spring and be 10 inches long and 8 ounces in weight the first fall after stocking. At the end of the second year length averages 12.8 inches in length and 14 ounces in weight. Natural reproduction of trout in farm ponds is rare. This fact, together with a high natural death rate averaging 60% each year, determine the simple management scheme of fishing heavily 2 or 3 years then restocking. Brook trout are more easily caught than rainbows and some fishermen claim have superior flavor. Stock trout alone. Add no other fish and do not stock them if other fish are already present.

BRYNILDSON, O. M. 1967. Dispersal of stocked trout in five Wisconsin streams. Research Report No. 26, Wisconsin Conservation Department. Madison, Wisconsin. 9 p.

Brook trout stocked as fingerlings during early summer and during the fall remained near the stocking sites or tended to disperse a short distance above the stocking sites by the following spring. Yearling brook trout released in winter were concentrated 3 to 4 miles above the stocking site the following spring. Yearling brook trout released in March were distributed in a one mile section below the stocking site within 10 days after release.

Brown trout stocked as fingerlings during early summer and during the fall remained near the stocking sites or dispersed upstream from the stocking sits by the following spring. Yearling brown trout released during January were distributed above and below the stocking sites but were concentrated at the stocking sites the following April. Out of six stocks of yearling brown trout released during March, four had greater dispersal downstream than upstream from the area of release and two had greater dispersal upstream than downstream a week to a month after release.

Various strains of rainbow trout stocked as fingerlings during early summer and during the fall remained near the stocking sites the following spring. Yearling fall hatched rainbow trout released in March were concentrated at the stocking sites and had only limited dispersal upstream and downstream from the stocking sites 3 to 4 weeks after release.

BRYNILDSON, O. M. and L. M. CHRISTENSON. 1961. Survival, yield, growth and coefficient of condition of hatchery-reared trout stocked in Wisconsin waters. Wisconsin Department of Natural Resources Publication No. 226, Madison, Wisconsin.

BUCK, E. 1969. Returns of hatchery-reared brook trout in Little Round Lake, Oso Township, Tweed District. File Report, Ontario Department of Lands and Forests, Tweed, Ontario. 5 p.

Little Round Lake is a 19.2 acre lake which has been an extremely popular angling water for the past twenty years. Summer and winter oxygen profiles reveal a serious shortage of oxygen in the lower strata. It is assumed that the Lake never experiences a full spring or fall turnover due to high hills surrounding the Lake, which inhibit wind-wave action.

The lake was poisoned in 1962 by means of toxaphene. Brook trout were re-introduced in the year following treatment with a current annual stocking rate of 2,000 yearlings (104 fish/acre). Since the reclamation in 1962 common white sucker, various minnows and yellow perch have returned to the lake.

Little Round Lake was stocked through the ice on Friday, March 28, 1969 with 2,000 brook trout yearlings. All fish had been marked by removal of the left ventral fin. A total of 901 brook trout were recorded to have been captured between March 28 and May 12, 1969. Anglers reported an additional 299 fish. This represents a total of 1,200 trout or 60% of the planted stock. Further trout catches during June, July, August, September, January and February must also be anticipated. A total return of between 75-80% of the hatchery fish planted is therefore anticipated despite the fact that yellow perch have become re-established.

On the strength of the foregoing it is recommended that the present stocking rate of 100 yearlings per acre per year be extended. It is also recommended to restock this lake in early June.

CALHOUN, A. 1966. Habitat considerations for catchable trout. *In* Proceedings of the 46th Annual Conference of the Western Association of State Game and Fish Commissioners, Butte, Montana.

There is great diversity of habitat among the 500 California lakes and streams stocked with catchable-sized trout. An operating policy is utilized for stocking catchable trout. Catchable-sized trout shall not be stocked in streams when water temperatures reach 75° F. It appears that such temperatures will continue to occur regularly or when stream flows drop below 10 cubic feet per second except that suitable streams with flows between 2 and 10 cubic feet per second may be planted if water temperature do not exceed 70° F and other conditions are satisfactory. Catchable-sized trout shall not be stocked in streams until water temperatures attain 45° F or higher most afternoons. Catchable-sized trout shall not be stocked in lakes and reservoirs after surface water temperatures reach 78° F and it appears that such temperatures will continue to occur regularly. Catchable sized trout shall not be stocked in lakes and reservoirs until water temperatures attain 42° F or higher most afternoons.

CARLINE, R. F. and O. M. BRYNILDSON. 1972. Effects of the Floy anchor tag on the growth and survival of brook trout (*Salvelinus fontinalis*). Journal of the Fisheries Research Board of Canada 29 : 458-460.

We conducted two field trials to determine the effects of the gun-injected Floy anchor tag (FD-67) on growth and survival of 10 month old domesticated brook trout (*Salvelinus fontinalis*) in a 0.7 ha pond. Trials ran from October to the following June. In 1968 we stocked 106 tagged trout and 1005 controls, and in 1969, 300 tagged trout and 500 controls. We removed different fins from each group to determine tag loss. In both trials we sampled the trout twice through the ice and twice during open water. The tags retarded growth of the trout from October to January; differences in growth rates between tagged and controls were 18% and 28% for the 1968 and 1969 trials, respectively. After January both groups grew at similar rates. The tags did not affect survival and tag losses were 5.7% and 2.0% for the two trials.

CARLINE, R. F., O. M. BRYNILDSON, and M. O. JOHNSON. 1976. Growth and survival of trout stocked in a northern Wisconsin spring pond. Fisheries Research Report 85, Wisconsin Department of Natural Resources. 21 p.

The purpose of this study was to determine growth and survival of June and fall stocked trout in Sportsman Lake, a 0.7 ha spring pond in Shawano County. We stocked different numbers and sizes of trout to determine which combinations would provide reasonably high survival and fast growth from time of release to the following spring. We made five fall stocks and two June stocks of domesticated brook trout

(*Salvelinus fontinalis*). In one of the fall stocks we included wild brook trout and in another, domesticated rainbow trout (*Salmo gairdneri*).

Survival of fall-stocked trout to the following spring ranged from 48 to 77% and was directly related to the mean size of trout when released. All fall-stocked trout grew overwinter and their average weight ranged from 53 to 110 gm in the spring. Growth rates were inversely related to trout density. We hypothesized that trout growth rates were a function of food density and levels of trout predation on the benthos. Changes in trout biomass from fall to the following spring varied from –25 to +35%; biomass changes depended upon growth and survival. When the pond was stocked with more than 100 kg/ha of trout the overwinter change in biomass was negative. Results suggested when trout weighing more than 50 gm each were stocked in fall at stocking rates less than 100 kg/ha, overwinter growth rates and survival would be high and biomass would increase.

Survival to spring of fingerling brook trout stocked in June 1972 and 1973 was 40 and 17%, respectively. Low survival of the 1973 stock was due in part to illegal winter fishing. In spring, the 1972 stock averaged 69 gm each and the 1973 stock averaged 97 gm. Differences in growth rates were related to trout densities. Biomass of the 1972 stock increased from 20 kg/ha in June to 81 kg/ha the following April; the 1973 stock increased from 21 to 48 kg/ha over the same period.

Costs of June stocks were about $137/ha and costs of fall stocks ranged from $265 to $392/ha when trout were valued at $3.30/kg. Based on overwinter changes in biomass of trout and relative costs of stocking, June fingerlings provided satisfactory populations in spring at the lowest cost. In spring, values of June stocked trout ranged from $160 to $265/ha and values of fall stocked trout ranged from $255 to $365/ha. Differences between values of fish in spring and production costs were high for June stocks and for 65 gm trout stocked at moderate rates in fall. However, production costs of June stocks were about half those of fall stocks.

Brook and rainbow trout fed upon the same benthic invertebrates, though at somewhat different rates. Forage fish were abundant in the pond but were not heavily utilized by trout. Whenever Daphnia were available (especially those 1 mm and larger), brook and rainbow trout consumed them in large numbers.

Detailed management recommendations include: (1) size of trout to stock in spring ponds, (2) stocking rates, (3) desirability of fish barriers and their design, (4) utilization of potential pond productivity through multi-species management, and (5) introduction of forage species for improved growth rates of trout.

CHARLTON, W. H. 1960. 1960 fish plantings and creel census for Esker Lakes park. Fisheries File Report, Ontario Department of Lands and Forests, Swastika District. 4 p.

In Lake Panagapka, Swastika District, the planting of 2,200 two-year-old brook trout (50 per acre) resulted in a recovery of 23%. The following year some 6,000 two to four year old brook trout (140 per acre) provided a return of 38% to anglers. The fishing pressure on this lake decreased from 60 angling hours per acre in 1959 to 35 hours per acre in 1960.

CHESHIRE, W. F. 1969. Use of scuba divers for underwater observations on aerial fish drops. File Report, Ontario Department of Lands and Forests, Tweed, Ontario.

The writer has taken part in two diving operations designed to make underwater observations on fish dropped from aircraft. Experience from these dives has revealed that operations involving underwater observations on aerial fish drops have their own characteristic problems which differ to some extent from those related to other types of diving. This report describes the problems encountered and recommends a procedure for dealing with them. The procedure outlined in this report is designed for water depths of 20 feet. For greater water depths, a tentative procedure would have to be designed and tested in the field.

CHESHIRE, W. F. and F. S. DAY. 1969. Underwater observations on aircraft planting of large brook trout in the Tweed District. Resource Management Report, Ontario Department of Lands and Forests. 6 p.

Underwater observations of air-dropped brook trout, 8 to the pound in size, indicated mortality rates as high as 25% could result from this method of planting. The effect of air dropping other sizes of brook trout into small deep lakes should be re-examined to determine how deep they may sink before they recover. Factors to consider are (1) the possibility of experiencing oxygen deficiency before they recover; (2) the effect of deep water pressure on stunned brook trout; and (3) the possibility of smother in ooze before they recover from an air drop.

CHOATE, J. 1964. Use of tetracycline drugs to mark advanced fry and fingerling brook trout (*Salvelinus fontinalis*). Transactions of the American Fisheries Society 93 : 309-311.

This experiment provides preliminary data on dosage levels and short-term longevity of the mark in brook trout fed with tetracycline additives in the initial weeks of feeding. These tests indicate that usable marks can be produced on brook trout fingerlings that have just started to feed. Administration of oxytetracycline hydrochloride in a liver diet at levels of 4 grams per kilogram of body weight produced recognizable marks after 4-7 days of feeding.

No attempt was made at field testing. However it is evident that examination of a sample of fingerlings would require a darkened chamber and probably the use of an anesthetic if the fish were to be returned to the water. The effect of prolonged exposure to light was not investigated but it is known that light deactivates tetracycline. The filtering effect of several inches of water might have some bearing on this.

CHRISTENSON, L., V. HACKER, and O. M. BRYNILDSON. 1954. Does fall trout stocking pay? Wisconsin Conservation Bulletin 19(1) : 15-17.

Studies involving brook and brown trout were made to determine the return to the angler of fall and spring planted fish. The two streams selected for brook trout studies were Tank Creek and the North Branch of the Trempealeau River, both in Jackson County. Brook trout six to eight inches long were stocked in both streams. Fish from each group were marked by removal of a fin for recognition.

On Tank Creek, the ratio of observed returns to the angler of fall and spring planted brook trout was 1:9; that is with equal numbers planted in both fall and spring, only one fall planted brook trout was caught by anglers for every nine spring planted fish. Electro-shocking operations on Tank Creek during the first week demonstrated that for each fall planted fish there were 12 spring planted brook trout available to the angler.

On the North Branch of the Trempealeau River the results were considerably different. In the anglers catches examined, the ratio of fall planted to spring planted fish was 1:3.l. During the course of electro-shocking operations, one fall planted brook trout was recovered for every four spring planted brook trout.

It is apparent that differences in overwinter survival do exist between streams. Regardless of this difference the fact remains that at least three times as many spring planted brook trout were caught by anglers as were fall planted fish during the course of observations. On the basis of the evidence presented here, it certainly appears that as a general rule fall stocking of six to eight inch trout does not pay.

CLARK, H. W. 1959. Trout production at Harrington Pond. p. 4-5 *In* Conservation Officers Project, Ontario Department of Lands and Forests, Southwestern Region.

Harrington pond is stocked to provide angling opportunities. Anglers where checked during early May and records were kept of the number of fishermen and the number and size of Kamloops and speckled trout which were caught. On May 1, 1958 seventy-three anglers caught 32 Kamloops trout (average size of 10.5 inches) and 13 speckled trout (average size 10 inches). On May 1, 1959, fifty-three fishermen caught 7 Kamloops trout (average size of 8.75 inches) and 18 speckled trout (average size of 9.5 inches). I am satisfied that trout fishing in this pond will remain poor unless a coarse fish removal program is again carried out.

CLARK, R. D., Jr. and R. A. MARTIN. 1986. Minimizing cost of transporting fish from hatcheries to public fishing waters. Fisheries Research Report No. 1939, Michigan Department of Natural Resources, Ann Arbor, Michigan.

We developed and tested a computer system to help plan the transport of fish from hatcheries to public fishing waters. The objective of the system was to help manage the information needed for planning and to use that information to produce minimum cost schedules for loading and transporting fish. We divided the problem into two parts, hatchery assignment and truck assignment. Under hatchery assignment, we used linear programming to assign planting sites to the nearest hatcheries. Under truck assignment we developed an original algorithm to define planting trips and to assign the best type of truck for each trip. Our algorithm was able to define individual truck trips in which more than one site was planted or more than one species or size of fish was planted. Trucks were assigned according to their loading capacities, operating costs, unloading characteristics and physical availability. The computer system has been used to help plan fish transportation by Michigan Department of Natural Resources since 1980. A number of problems were encountered in applying the system but they were not insurmountable. We think the computer system generated more efficient transportation schedules than manual planning methods but we could not demonstrate this in a field test because confounding variables could not be controlled. However we used the computer system to reschedule transportation for a group of fish that had been planted before the system was developed and found the computer generated schedule could have accomplished the same fish plant 23% cheaper than the schedule actually used. If the distribution of fish production was shifted so that fish were reared closer to their planting locations, transportation costs could have been reduced 35%. The transportation system also allows managers to incorporate transportation costs into other management decisions such as locating new hatcheries or evaluating the need for new trucks. The key to the future success of the computer system will be to keep adapting and refining it as new problems are identified and solved and new technologies allow for improved performance.

COBB, E. W. 1933. Results of trout tagging to determine migrations and results from plants made. Transactions of the American Fisheries Society 63 : 308-318.

Brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) were tagged before release in order to get an idea as to the results of the previous season's plantings. The total number of streams stocked with tagged trout and on which records were kept was thirty-five.

Taking, as an example, ten streams in which were planted 4,429 tagged brook trout and 4,250 tagged brown trout, we found that of the entire lot 2,713 or 31 per cent were taken. The percentage of the total plant of brown trout caught was about two-thirds as great as the percentage of brook trout. Of the entire catch, 75.5 per cent were caught in the section where planted, 6.5 per cent had moved upstream, 14.5 per cent had moved downstream and 3.5 per cent had moved into tributaries.

A comparison of the movements of brook and brown trout in four streams in which both species had been planted shows the following results. Taken in the section in which planted, brook trout 79.7 per cent and brown trout 66.5 per cent. Upstream, brook trout 6.9 per cent and brown trout 6.8 per cent. Downstream, brook trout 9.1 per cent and brown trout 26.6 per cent. In tributaries, brook trout 4.3 per cent and brown trout 0.1 per cent. This tends to prove the correctness of our idea that our brown trout should be planted where a run downstream will place them in a good body of water other than in a polluted stream. It also tends to show that the brown trout has no great tendency to go to the smaller and colder waters above, which are in many instances inhabited by brook trout and utilized by them as a breeding ground.

COMMONWEALTH OF MASSACHUSETTS. 1984. Managers guide for put-and-take trout fishing in private waters. Division of Fish and Wildlife, Westboro, Massachusetts.

CONE, R. S. 1987. Population estimation and performance comparisons of two brook trout strains stocked into Adirondack ponds. M. Sc. thesis, Cornell University, Ithaca, New York. 91 p.

CONE, R. S. and C. C. KRUEGER. 1986. Biases in population estimation of hatchery-reared wild strains of brook trout. American Fisheries Society Annual Meeting No. 116 : 57 (Abstract only).

CONE, R. S. and C. C. KRUEGER. 1988. Comparison of survival, emigration, habitat use, marking mortality, and growth between two strains of brook trout in Adirondack ponds. North American Journal of Fisheries Management 8 : 497-504.

Performances of age-0 Assinica and Temiscamie strain brook trout (*Salvelinus fontinalis*) were compared in 1985 and 1986, 2-3 months after the fish had been stocked into two drainable ponds located in the Adirondack Mountains of New York. Overall recovery did not differ significantly between strains in three trials when both pond and inlet habitats were considered. Assinica fish emigrated at higher rates in all three trials than Temiscamie fish. In both 1986 trials, approximately 50% of the recovered Assinica brook trout were in the inlet stream, but less than 25% of the recovered Temiscamie brook trout had emigrated upstream. These differences in emigration may indicate habitat preferences of these strains or density dependent displacement. The Temiscamie strain had higher marking mortality than the Assinica strains; thus the Assinica strain appeared to be more resistant to the stress of handling. Temiscamie brook trout had significantly higher instantaneous growth rates after stocking than the Assinica strain. The Temiscamie strain, with faster growth and less emigration may be best suited for population restoration or "put-grow-and-take" fisheries. In contrast, the Assinica strain, being resistant to handling stress, may be better suited for catch-and-release fisheries, aquaculture, or put-and-take fisheries.

COOPER, E. L. 1952. Returns from plantings of legal-sized brook, brown, and rainbow trout in the Pigeon River, Ostego County, Michigan. Transactions of the American Fisheries Society 82 : 265-280.

A complete census of fishing on 4.8 miles of the Pigeon River, together with population estimates made at the end of the open season, made possible an accurate evaluation of the yield and survival of open season plantings of hatchery trout. Fishing intensity in this research area for 3 years averaged 2,414 daily trips per year, which was equivalent to 278 hours of fishing effort per acre per year. Sections in which hatchery fish were planted attracted about three times as much fishing as did the unplanted sections.

Fishing quality, measured by the catch per hour per fishing trip, was generally poor for native fish, averaging less than 1 fish for 5 hours of effort. Hatchery fish made up about 70 per cent of the total catch for the 3 years.

Planting trout from a live crate a few at a time (scatter planting) did not prove to be advantageous over the practice of liberating large number of fish in one hole (spot planting). Trout that had been scatter planted did not contribute to the catch for a longer period of time and produced fewer successful fishing trips, fewer total fish returned to anglers, and slightly fewer anglers sharing in the total catch. However, the practice of making several plantings on different dates, a few fish at a time, permitted more individual anglers to share in the catch.

Although 4,500 legal sized trout were planted each year, about half of the fishing trips were unsuccessful. Limiting the daily catch to 5 trout instead of 15 did very little to reduce the percentage of unsuccessful anglers. Further reduction to 2 fish per day lowered the unsuccessful fishing trips to 36 per cent.

Plantings of rainbow trout and brook trout gave much higher returns to the fishermen than did equal numbers of brown trout. Rainbow trout also survived over winter as well as did brown trout, although in both species the survival was less than 10 per cent. Overwinter survival of brook trout was less than 3 per cent. Fin clipped trout were recovered by fishermen more readily than those which were jaw tagged. This difference was especially apparent during the first week following planting.

Rainbow trout and brook trout, planted when water temperatures were below 50°F exhibited an immediate downstream movement. Fish planted when water temperatures were above 50°F showed very little movement.

Legal sized brook, brown and rainbow trout planted in a stream subjected to heavy fishing pressure, contributed to the catch for a relatively short time. Brook trout were exploited most readily; only 4 per cent of the recoveries were taken after 40 days of liberty. For brown trout and rainbow trout, these values were 26 per cent and 22 per cent, respectively.

Planting large numbers of hatchery fish (up to 431 trout per mile) apparently had no effect upon the catch of wild fish in the stream. Although the catch-per-hour of the planted trout increased greatly at the same time of planting, the corresponding weekly data on catch- per-hour of the wild trout showed no similar increase.

COOPER, E. L. 1959. Trout stocking as an aid to fish management. Bulletin 663, Pennsylvania State University, University Park, Pennsylvania.

Artificial propagation and stocking of brook, brown and rainbow trout is one of the oldest and best known tools of fish management in the United States. Sufficient information about the technology of fish culture and the ecology of natural trout populations is now available to assure satisfactory management of this resource. An accurate appraisal of the desires of the angling public has seldom been made. Opinions as to the type of trout management wanted range from one extreme of "no stocking: fish for fun only" to the other of "completely artificial propagation put-and-take fishing."

The emphasis and publicity accorded propagation and stocking has often belittled the greater contribution of natural trout populations in furnishing both recreation and fish in the creel. The low survival rates of both hatchery and native trout, although consistent with the high reproductive potential of these fishes, usually are sufficiently high to allow a large exploitation of the residual population by anglers without danger of depletion of the fish stocks.

Regulation of fishing historically has been considered an important part of trout management. Many regulations, such as a minimum size, daily bag, or closed season, either are too liberal to afford much protection to native populations or have little application to modern put-and-take stocking programs. Differences in catchability among trout species make it difficult to manage this resource by means of blanket type regulations.

Further advances in managing trout resources are more likely to occur when fishery biologists clearly recognize the essential differences between native trout populations and domesticated hatchery trout. It is unlikely that fish which have been selected for numerous generations to perform in a superior manner under hatchery conditions will maintain characteristics of behavior, physiology and anatomy which will enable them to survive in a natural environment at the same rate as wild fish. Based on a large number of trials by different investigators the best returns from planted trout are likely to occur:

- When trout of any size are stocked in suitable lakes, ponds or streams where there is little or no competition from fish already present in the waters, or
- When catchable-sized trout are stocked in streams where and when heavy fishing pressure is exerted promptly after stocking.

COOPER, E. L. 1961. Growth of wild and hatchery strains of brook trout. Transactions of the American Fisheries Society 90(4) : 424-438.

Various growth characteristics of the brook trout (*Salvelinus fontinalis*) were investigated by comparing the performance of three wild populations with five hatchery groups. Wild populations attained a total length at the end of two years of about six inches, which was less than half the size of the hatchery trout in the same period. Differences in weight between wild fish and hatchery fish for the same period were of the order of 10 times. Unfavorable temperature and lack of food were chief causes of slow growth of wild populations. Among the hatchery groups, inbreeding caused a decrease in growth. Randomly bred groups were very similar in size at all times up to 20 months of age. Growth rates of brook trout decline rapidly with increase in length or weight. Total length does not increase exponentially over long time periods, but growth in length more closely approximates a linear series with time. Different mathematical models were applied to growth data from the hatchery groups. The Walford-Ford concept was not applicable because the predicted ultimate sizes of the group were unrealistic. The concept of Parker and Larkin appeared to describe adequately the growth curves obtained and was useful in measuring differences due to genetic factors. Weight-length curves were similar for fish of different strains grown under similar environmental conditions. Inbred groups had markedly different weight-length curves from those of randomly bred groups. A modification of LeCren's relative condition factor, derived from the weight-length data of the hatchery groups of brook trout is proposed. It compares the observed weight of a fish with the weight expected to promote the optimum rate of growth of the species

COPE, L. and L.-A. BOWMAN. 1990. 1990 stocking assessment report with a comparison of short net sets versus overnight sets. File Report, Ontario Ministry of Natural Resources, Leslie M. Frost Centre, Dorset, Ontario. 14 p. + appendices.

The objective of this fish stocking assessment project was to determine stocking success or failure as well as determine the potential for future stocking projects. This particular project also included a comparison between traditional overnight gill net sets to the newly accepted method of short, half-hour day sets. The study area included eight lakes (Ranger, Mouse, Three Island, Little Margaret, Nehemiah, Blackcat, Rabbit and Little Avery) within the Leslie M. Frost natural resources management area.

Although daytime sets did not catch as many fish, the catch-per-unit-effort (CUE) was greater for the short day sets than for the overnight set. The mortality was approximately 97% for overnight catches. Mortality was always greater in overnight net sets.

COULTES, D. 1992. A stocking assessment of four marked year classes of brook trout on five coldwater streams in the Wingham District, Summer 1990. File report, Ontario Ministry of Natural Resources, Wingham, Ontario. 21 p

The Wingham District of the Ontario Ministry of Natural Resources completed a brook trout (*Salvelinus fontinalis*) stocking assessment of four marked year classes on five coldwater streams from July 17 to August 2, 1990. Fifteen stations were sampled on the five watercourses: Dickies, Belmore, Alps, Otter and Blind Lake creeks.

Stocked brook trout survival was exceptionally low with no fin clipped fish sampled in the 15 stations. Standing stock of stocked brook trout streams was also low ranging from 0.02-0.17 brook trout m^{-2} or 0.47-3.6 gm m^{-2} of brook trout. In comparison, unstocked brook trout streams had higher densities of brook trout ranging from 0.15-0.33 brook trout m^{-2}. It is obvious that the current brook trout stocking program is not increasing brook trout production in local streams.

Habitat use was markedly different for young-of-the-year (YOY) and 1+ aged brook trout. YOY brook trout utilized areas of slow flow habitats associated with aquatic vegetation and detritus, as well as slightly faster flowing riffles associated with rubble substrate. Yearling and adult brook trout utilized deeper areas associated with good instream and overhead cover as well as in undercuts associated with average flow rates. In both cases spring activity was present.

Instream habitat in each stream was above average but quality habitat was low in all streams. Limiting factors to production were determined to be lack of habitat for yearlings and adults, lack of winter habitat and poor stream morphology. Heavy silt and sand bedloads also had harmful effects on the brook trout populations and were found to be high in stations sampled with few brook trout. All five streams would benefit from stream rehabilitation work directed at scouring the streambed, creating a 1:1 pool:riffle ratio and by providing better quality instream and overhead cover.

CRESSWELL, R. C. 1981. Post stocking movements and recapture of hatchery-reared trout released in flowing waters - A review. Journal of Fish Biology 18 : 429-442.

The success of stocking with hatchery-reared trout has been the subject of varied investigations for the past half century. Percentage returns are summarized and literature on the post-stocking movements of hatchery-reared trout is reviewed. Factors effecting the post-stocking movements are considered, special attention being paid to studies on industrial rivers. Highest returns are obtained from stocking with trout of a size suitable for angling, made during or shortly before the angling season. The majority of stocked brown trout (*Salmo trutta*) tend to remain close to the area of stocking, but brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) show greater movement, usually in a downstream direction. Greater dispersion of all species occurs if they have overwintered or in small upstream stretches of river.

CURTIS, B. 1951. Yield of hatchery trout in California lakes. California Fish and Game 37(2) : 197-215.

This paper brings together information obtained over 10 years from hatchery trout yield experiments on nine California lakes of which six are considered of primary and three of secondary importance. Most of these lakes have no or insufficient natural spawning. It is emphasized that lakes produce very different results from streams. Figures are given for the yield in each lake: number of fish caught as a percentage of the number planted. Stocking intensity and fishing pressure are also given. The results of the different projects vary widely. From fingerling plants, three large lakes (800 acres and up) produced low yields in comparison with three small lakes (33 to 68 acres). Average yield from the former was 1% with a range of 0.2 to 1.5; from the latter 8.7% with a range of 2.7 to 25.3. In all combined fingerling plants averaged a yield of 5.4%. Extraordinary improvement in yield from fingerling plants occurred in one 47 acre lake when a population of three planted trout species plus resident lake trout was eliminated and replaced by one species. Plants of catchable trout in seven lake experiments in which areas ranged from 10 to 800 acres gave an average yield of 44.9% with a range of 27.4 to 71.6. It is suggested that the arithmetic average yields of 5.4% from fingerlings and 44.9% from catchable trout take too little account of the variations in the reliability of the figures from which they are formed and of the non quantitative factors involved. Knowledge and consideration of these lead to the proposal that the figures which best interpret the results obtained in these experiments are: yield from fingerling plants (in lakes under 80 acres) 4%; yield from plants of catchable fish 50%.

DANZMANN, R. G., P. E. IHSSEN, and P. D. N. HEBERT. 1991. Genetic discrimination of wild and hatchery populations of brook charr (*Salvelinus fontinalis*) in Ontario using mitochondrial DNA analysis. Journal of Fish Biology 39(Supplement A) : 69-77.

Two brood stocks of brook charr (*Salvelinus fontinalis*) are currently maintained by the Ontario Ministry of Natural Resources. The Nipigon brood stock originated from Lake Nipigon, in north-central Ontario, while the Hills Lake stock is believed to have been produced by hybridizing several strains (including charr from a Pennsylvania hatchery as well as charr from Ontario) in the past. The mitochondrial DNA (mtDNA) variability of these brood stocks was characterized using 51 hexanucleotide restriction enzymes. Eleven restriction enzymes, Acc I, Asn I, Ban I, Ban II, Hind III, NCO I, Nde I, Nhe I, Nsi I, Pst I, and Sph I, were polymorphic between the two brood stocks. Eight hatchery mtDNA haplotypes were detected showing a maximum of 0.41% sequence divergence. Seven haplotypes are present in the Hills Lake strain and two in the Nipigon strain. These mtDNA haplotypes are useful markers to determine the degree of reproductive success between planted and native fish. In one comparison in southern Ontario, less than 20% of the wild fish sampled from the headwater regions of a small drainage entering Lake Erie could have resulted from random introgression with hatchery fish planted further downstream because most of these fish possessed a unique Acc I cut site. This is one of the few examples in stock analysis studies where such a high degree of genetic discrimination is evident between hatchery and native fish.

DeROCHE, S. E. 1963. Why stock trout streams? Maine Fish and Game, Spring 1963 : B-25-27.

Brook trout are still bountiful in Maine's many miles of trout streams. How do numbers of trout in streams that have been stocked for years compare with streams that have never been stocked? After four years of study, we divided the 177 streams into two groups and here is what we found. Eleven miles of streams stocked consecutively for three years or more yielded only 270 trout per mile. Four and one-half miles of streams not stocked for three years or more yielded 1,054 trout per mile!

Stocking legal trout in streams provides little fishing for the future. In streams where a suitable natural trout population exists, stocking can be harmful to wild trout by creating overpopulated conditions with resulting competition for food and space.

When streams are removed from the stocking list it is usually for one of four reasons:

- An adequate population of natural trout may be present.
- The stream may be very small with light fishing pressure.
- The stream may have warmwater and a large population of rough fish.
- The stream may be of the quick run-off kind.

DEXTRASE, A. J. 1986. Brook trout stocking assessment in Northcentral Region. File Report, Ontario Ministry of Natural Resources, Thunder Bay, Ontario. 28 p.

A total of 151 brook trout (*Salvelinus fontinalis*) were recovered from six lakes surveyed in August 1985 for a stocking assessment program. Growth rates of the Lake Nipigon strain of brook trout planted in the study lakes were comparable to those from other strains planted in Ontario. Recovery rates of planted brook trout were low, ranging from 0.03 to 2.60%. Although white suckers (*Catastomus commersoni*) were present in four of the six lakes, their presence did not appear to influence the success of brook trout plants. Unfavorable temperature and oxygen levels appeared to affect brook trout survival in two of the lakes. Native brook trout were present in three of the lakes. This confounded interpretation of data concerning planted fish. In addition, one year old brook trout were not vulnerable to the gill nets used in this study.

DEYNE, G. 1990. Fish stocking guidelines, Algonquin Region. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 11 p.

These new guidelines attempt to further refine stocking decisions with respect to the suitability of waters. Criteria for stocking salmonids are based on the percentage of natural recruitment, available habitat (temperature and oxygen profiles) and resident fish communities.

Brook trout should not be stocked in waters which have natural recruitment from resident brook trout stocks. Instead of requiring all brook trout to be clipped and subsequently all waterbodies assessed, stocking criteria for brook trout was based on evidence of natural recruitment, including observations of spawning activity. Poor success of stocked brook trout in the presence of native populations is the primary reason for not stocking over native populations.

Suitable brook trout habitat is considered to be waters in which greater than 10% of the lake by volume is 3 mg L^{-1} and <18º C or where the top half of the thermocline is > 3 mg L^{-1} of dissolved oxygen. The selection of 18º C was based on a preferred temperature of 16º C and a maximum temperature for self-sustaining populations of 19º C. The lower limit for dissolved oxygen is much more arbitrary given a range of 2-4 mg L^{-1}. Although there may be special circumstances when late March oxygen concentrations will be unusually low, it is quite likely that winter oxygen problems will be reflected by unacceptable late summer conditions.

In terms of the resident fish community it is not recommended that brook trout be stocked in waters having strong populations of yellow perch, smallmouth bass and white sucker.

DEYNE, G. and G. ARNETT. 1987$_a$. Tea Lake inventory and assessment. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 15 p.

Tea Lake has been stocked repeatedly with brook trout since 1944. The most recent stocking was in May of 1987 when 4,995 brook trout fingerlings were released. A fisheries assessment of Tea Lake was carried out from September 22-23, 1987. A monofilament gill net, with mesh sizes ranging from 2.5 to 7.6 cm, was set overnight in the lake. The netting assessment of Tea Lake yielded a total of 1 lake trout, 4 brook trout, 61 creek chub and 73 white sucker. Brook trout catch rates (CUE) was low and the fish had relatively low condition factors. The capture of only one small, young brook trout (considering the spring 1987 stocking) was disappointing and may be a direct result of interspecific competition. The present three year rational stocking program for Tea Lake appears to be maintaining the small brook trout population. Consideration should be given to reducing the present stocking rate, as this waterbody is incapable of supporting such large introductions. This would most likely result in better growth and survival of planted stock.

DEYNE, G. and G. ARNETT. 1987$_b$. Kuwasda Lake inventory and assessment. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 11 p.

Kuwasda Lake supports a small brook trout population and a large common shiner and white sucker population. The lake has been repeatedly stocked with brook trout since 1948. The most recent stockings were conducted in 1984 and 1986. A fisheries assessment was carried out from September 8-9, 1987. One gill net, comprised of monofilament mesh ranging from 2.5-7.6 cm, was set overnight. The assessment yielded a total of 5 brook trout, 43 white sucker, 79 common shiner and 1 creek chub. Brook trout comprised 3.9% of the catch by number and 34.4% by weight. Although the brook trout catch rate (CUE) was low, the size frequency distribution suggests three cohorts were present in the catch. Based on condition factor, brook trout showed a good growth rate. The fishery appears to be maintained principally by the present stocking program. The three year rotational brook trout stocking program appears to be satisfying stocking objectives by increasing angling opportunities and supplementing a fishery in which harvest mortality likely exceeds natural recruitment. Future studies should emphasize quantifying the harvest as pre-netting harvest mortality may be partially responsible for the low brook trout catch rate.

DEYNE, G. and G. ARNETT. 1987$_c$. Simpson Lake brook trout stocking assessment. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 6 p.

Simpson Lake is a small (8.3 ha) lake which was stocked with brook trout on five occasions between 1956 and 1966. Two overnight gill net sets in the 1970s failed to produce any brook trout. In September 1987 additional netting was conducted to determine the status of the brook trout stock. One gang of monofilament gill net, with mesh sizes ranging from 2.5-7.6 cm, was set overnight and produced a catch of 369 northern redbelly dace.

Early attempts to establish a brook trout population appear to have failed. Lake summer water temperatures and a severe oxygen depletion starting in the metalimnion severely restricts brook trout habitat. Simpson Lake could support a put-and-take rainbow trout fishery, however its relative isolation may not maximize the number of angling opportunities for the expenditure incurred.

DEYNE, G. and G. ARNETT. 1987$_d$. Sunrise Lake brook trout stocking assessment. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 11 p.

Surprise Lake is a small (27.6 ha) lake which has been stocked repeatedly with young brook trout since 1945. In recent years it has been stocked with between 1,900 and 2,400 yearling brook trout (69-87 fish ha^{-1}) on a 2-3 year rotational basis. A fisheries assessment was conducted from September 10-11, 1987. Assessment gear consisted of one wire mesh minnow trap and one monofilament gill net (mesh sizes ranging from 2.5-7.6 cm) which were both set overnight. The catch was comprised of 7 brook trout, 47 white sucker, 16 creek chub and 1 golden shiner. Brook trout ranged in fork length from 27.2 to 43.3 cm and weighed from 300 to 1250 grams. Common white suckers accounted for 65.3% of the catch by number and 39.9% by weight. Brook trout catch rates were low. The failure to capture any young-of-the-year or small brook trout suggests that natural recruitment is low. The fork length class frequency distribution shows two distinct age classes. The observed cohorts represent the May 1985 and 1983 stocking of 1,900 and 2,400 fingerling brook trout, respectively.

Surprise Lake supports a small but healthy brook trout population illustrating exceptional growth characteristics. This can be attributed to the presence of ideal habitat, good water quality and the presence of a good forage base. The present fishery appears to be maintained entirely by the three-year rotational stocking program. Although brook trout spawning substrate of excellent quality exists, evidence of natural recruitment was not found. Future consideration may be given to the introduction of clipped brook trout to assess natural recruitment. Although no creel data is available, pre-netting harvest may be responsible for the low brook trout catch rate. Surprise Lake appears to receive recreational fishing activity year-round. Access is most easily gained over private land. At the present time, a user-landowner conflict exists and may be reason to limit stocking frequency and number.

DONALD, D. B. 1987. Assessment of the outcome of eight decades of trout stocking in the Mountain National Parks, Canada. North American Journal of Fisheries Management 7 : 545-553.

The majority of the 1,464 lakes in the Canadian mountain national parks (22,376 km^2) were devoid of fish prior to the 20th century, and those lakes that supported fish populations were usually dominated by either mountain whitefish (*Prosopium williamsoni*) or longnose suckers (*Catastomus catastomus*). From the early 1900s to 1980, about 305 lakes were stocked with either cutthroat trout (*Salmo clarki*), rainbow trout (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), or a combination of these. Results from fisheries surveys conducted primarily in the 1970s and 1980s indicated that, for lakes originally barren of fish, the probability of either rainbow or cutthroat trout (referred to as *Salmo*) species or brook trout becoming established was directly related to the size of the lake outlet. When *Salmo* and brook trout were stocked into lakes that were suitable habitats for both, brook trout displaced *Salmo* from lakes with small outlets but not from lakes with large outlets. When mountain whitefish, longnose suckers, and lake trout (*Salvelinus namaycush*) were present in mountain lakes, they prevented colonization by or restricted the population size of *Salmo*. Mountain whitefish and lake trout had a similar effect on brook trout, but *Salmo* and longnose suckers had no obvious effect on populations of brook trout.

DOSSER, S. 1996. Stocking asssessment of six brook trout lakes in the Bracebridge area, 1992. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 15 p.

The stocking of hatchery-reared fish is an integral component of the Bracebridge Area fisheries management plan. The frequency of brook trout stocking is every 2-3 years and the usual stocking rate is 225 fish ha^{-1}. Stocking assessment was conducted on six lakes in 1992. The lakes were stocked with brook trout during the spring of 1991. All fish were the progeny of the Lake Nipigon x Hills Lake strain and all fish were marked with a right pectoral (RP) fin clip to allow for the determination of recovery rates. Assessment netting was conducted from July through to the end of August, 1992. Monofilament gill nets 61 m in length and having mesh sizes ranging from 2.5 to 6.4 cm were utilized. All nets were set between 1600 and 2200 hours and left to fish for 30 minutes.

Planted brook trout were recovered from only two (Limburner and Sunrise) of the six study lakes. These two lakes have relatively simple fish communities with only one competitor (pumpkinseed). These two lakes were also planted with the largest trout and at a relatively high density. Conversely, Bluepaint Lake having a simple fish community, the highest stocking density, and relative large fish, produced no returns of stocked brook trout.

It is recommended that MNR continue to stock brook trout in Limburner and Sunrise lake at the density of 225 fish ha^{-1}. Brook trout stocking should be discontinued in Bigwind and Livingstone lakes due to the presence of strong populations of competitor species including yellow perch, white sucker, pumpkinseed and smallmouth bass. Brook trout stocking should also be discontinued in Troutspawn Lake because of the presence of a strong natural population. Brook trout stocking should be discontinued in Bluepaint Lake. This lake has received six plantings of brook trout from 1980 to 1991 but is yielding no returns of hatchery-reared fish.

DUCKWORTH, G. A. 1980. Brook trout stocking assessment study, Siderock Lake. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 21 p.

The brook trout stocking program in the Temagami District is responsible for the maintenance of put-and-take or put-and-delayed-take fisheries in a total of 39 small lakes and streams. To provide a more intensive assessment of one of our brook trout lakes, a netting project was designed for Siderock Lake. The objectives of the project were to determine survival of stocked fish, assess growth response of planted brook trout and to re-evaluate the stocking rate for the lake.

The lake was netted for three consecutive nights (July 7, 8, and 9, 1980) with one multifilament gill net 122 m long consisting of 76 m of 6.4 cm mesh and 45.7 m of 5.1 cm mesh; and another monofilament gill net 61 m long consisting of 30.5 m of 6.7 cm mesh, 15.2 m of 5.1 cm mesh and 15.2 m of 3.8 cm mesh. The netting project occurred 14 months after the fish had been stocked.

In total 33 brook trout, 15 common white sucker and 3 burbot were caught. The netting was quite efficient in removing 91.6% of the estimated brook trout population. The standing crop was estimated to be 0.439 kg/ha. The survival rate was estimated to be 1.7%. While not being exceptional, the survival rate of stocked brook trout in Siderock Lake is good compared to other stocked brook trout lakes in the northeastern region.

It is recommended that the stocking rate be reduced to 1,000 fish and then re-netted to compare the success of the two stocking rates. The brook trout stocking assessment program should also be expanded to other lakes when fishing success information is unavailable. A similar assessment should be conducted on Herbert Lake in August of 1981 to test the replicability of our results on another lake.

DUNLOP, W. I. And C. J. BRADY. 1995. What happens when you stop stocking? Responses of a native lake trout (*Salvelinus namaycush*) fishery and a native brook trout (*Salvelinus fontinalis*) fishery to cessation of supplemental stocking. p. 135 *In* Abstracts from the 15th International Symposium of the North American Lake Management Society, Toronto, Ontario. (Abstract Only)

Traditionally, fish stocking in Ontario has been undertaken for a variety of fisheries management purposes including rehabilitation of degraded stocks, range extension, put-grow-and-take fisheries, and supplemental stocking over natural populations. Recent studies have shown that supplemental stocking of hatchery fish into lakes with native populations can have a number of adverse effects. Despite this, there is still a perception that supplemental stocking is necessary to maintain acceptable angler success rates and harvest. We present winter creel survey data from two southcentral Ontario lakes where stocking has been discontinued. Lake Rosseau is a large (6295 ha) oligotrophic lake trout lake, located in the District Municipality of Muskoka. It was stocked with lake trout from 1942 until 1990. The Meach lakes are two small (72 ha total) interconnected natural brook trout lakes located in the Haliburton Highlands. The lakes were stocked with yearling brook trout from 1961 to 1986. Since stocking ceased, both trout populations have exhibited strong incoming year classes of young fish possibly due to reduced competition or predation from stocked yearlings. On Lake Rosseau angling success rates (CPUE) are double, and total catch of lake trout is higher than during the period of stocking. On the Meach lakes, after an initial decline, both angler success (CPUE) and total catch of brook trout is equal to or better than before stocking ceased. We expect harvest rates (HPUE), harvest and yield to increase also, as the strong incoming year classes are fully recruited to the fisheries.

DUPEE, B. S. and E. W. SPURR. 1980. A two year study of the factors affecting the survival of hatchery-reared brook trout (*Salvelinus fontinalis*) in streams. Job Report, Project F-42-R-5, New Hampshire Fish and Game Department, Concord, New Hampshire. 17 p.

A two year study (1978 and 1979) addressing the survival of brook trout fingerlings was undertaken on streams selected from departmental stocking records. Streams were grouped into similar types and stocked with high, intermediate and low numbers of fingerlings during the month of May. Recoveries took place during August-September of both years. Fingerlings released during the second year of the study were marked with tetracycline to facilitate the separation of hatchery from wild fish. Mean lengths, mean conditions factors (k) and mean weight of gut contents were calculated from recovered fish. Data were also collected on stream temperatures and stream conductivities.

Results indicated that survival of brook trout fingerlings ranged from 0.0% to 23.6% over a 10-12 week period and are thus in general agreement with survival values reported in the literature. Survival was not found to be related to stream type, weight of gut contents, water temperature at stocking or recovery, elevated summer water temperatures, stream conductivity or growth of fingerlings. The mean condition factor was significantly greater for wild fingerlings collected in 1979 than that of either hatchery fish recovered in 1979 or the pooled fingerling sample collected in 1978. Total fingerling captures were highly correlated within streams between years. A strong relation was also noted between total fingerling captures and fish diversity as measured by the Shannon-Weaver Diversity Index.

It is recommended that fingerling stocking in streams be curtailed as a wasteful practice. If, in some cases, this form of stocking must be continued then fish diversities for each stream should be computed as an indicator of potential fingerling survival.

DUPONT, A. G. and M.-F. BERNIER. 1984. Brook trout hatchery survival assessment (1978-1981) on nine selected lakes within the Sault Ste. Marie District. Draft File Report, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 54 p.

The results of a four year (1978-1981) hatchery brook trout stocking assessment program within the Sault Ste. Marie district are presented. There were no apparent differences in survival rates between 1978 and 1979, wild and domestic brook trout (i.e., mean wild survival rates vs. domestic were 7.35% and 8.08% of initial stocks respectively). Weight gained per day was greater for domestic trout in 1978 and 1979 than the wild trout. Results indicate that stocking rates in 1978 and 1979 were too high as a 33% reduction in stocking rates in 1980 and 1981 yielded 30% more brook trout available to anglers with an apparent increase in survival rates. Regression results indicated that apparently as species abundance, diversity and community complexity increased in the surveyed lakes, survival and growth rates declined. In addition, regression analysis of population estimates on the CUE for hatchery brook trout after one night of netting revealed that reliable population estimates and their confidence intervals can be calculated thus reducing the time needed to assess a stocked lake and reduce sample mortality.

EIPPER, A. W. 1961. Vital statistics of trout populations in New York farm ponds. Canadian Fish Culturist 29 : 13-14.

The data reported here are principally those obtained from 167 pond inventories conducted in the period 1952-1958. Natural mortality of spring fingerlings during the first season following stocking in farm ponds was extremely variable and fall fingerlings gave much more dependable results, particularly in ponds where holdover fish from an earlier plant were made.

Standing crop reached a maximum when the trout were age I+. In ponds stocked with 600 fall fingerlings per acre this maximum averages 110 pounds per acre but varies widely with the large variations in natural mortality rates among individual ponds. In the course of the investigation, ponds were encountered which contained standing crops as high as 240 pounds of trout per acre (age I+). The data indicate conclusively that New York farm ponds must be restocked with trout every other year to provide adequate fishing.

EISERMAN, F. 1966. The use of catchables in relation to habitat. *In* Proceedings of the 46th annual Conference of Western Association of State Game and Fish Commissioners, Butte, Montana.

In Wyoming, we currently stock a number of lakes and reservoirs which periodically have kills during the winter or summer or both. These lakes or reservoirs are stocked at a rate which generally results in a catch of approximately five-tenths trout per hour and generally 50% or more of the trout are taken in a single season. Another catchable trout stocking situation which we consider justifiable is in those waters that are low in basic fertility, easily accessible and having sufficient numbers of people to harvest trout over and above an annual increment of growth and to some degree over natural reproduction. Our stocking rates for situations such as these depend primarily on fishing pressure and rates vary from 150 to 300 trout per surface area.

In Wyoming catchable-sized trout are generally not stocked in :

- easily accessible lakes and reservoirs that are fertile enough to produce 8-10 inch trout at an age of 10 months from a 3-4 inch fingerling;
- high elevation lakes having light fishing pressure;
- streams, lakes or reservoirs recently chemically treated;
- streams classified as blue ribbon waters and in any stream having sufficient natural reproduction and an annual increment of growth to satisfy current fishing demands;
- streams having poor or no natural reproduction but where the annual increment of growth is sufficient to provide a satisfactory fishery from stocking fingerlings and sub-catchables. In these waters, fishing pressure is generally light; and
- small reservoirs of 10 acres or less, available to the public and rich in basic productivity.

ELLIOT, W. P. 1975. Returns of stocked yearling brook, brown and rainbow trout from six two story ponds, 1971-74. File Report, New York State Department of Environmental Conservation. 23 p.

ERSBAK, K. and B. L. HAASE. 1983. Nutritional deprivation after stocking as a possible mechanism leading to mortality in stream stocked brook trout. North American Journal of Fisheries Management 3 : 142-151.

The low survival rate of hatchery brook trout (*Salvelinus fontinalis*) stocked in the wild may be due to their inability to obtain sufficient food for survival. A comparative analysis of the diet of catchable sized resident brown trout (*Salmo trutta*) and stocked brook trout was carried out on McMichael Creek, Monroe County, Pennsylvania to determine if there is a differential success in feeding which might affect mortality.

Three hundred resident brown trout and stocked brook trout were collected over a two year period (1979-1980). The number of organisms in the stomach and the total volume of its contents was determined for each fish. Overall condition was checked prior to stocking and following capture of the trout.

The condition of hatchery trout declined steadily following their release into the wild. The rate of this decline generally increased for those stocks with high, average condition factors prior to stocking. Resident trout maintained a stable overall condition throughout the study period. Wild brown trout were twice as successful in feeding as domestic brook trout but few differences occurred in types of prey consumed by the two species of trout. Both species of trout exhibited great diversity in their forage selection. The resident population, however, indicated a greater flexibility in switching to alternate food items as they became available for consumption.

EVANS, R. A. 1989. Response of limnetic insect populations of two acidic, fishless lakes to liming and brook trout (*Salvelinus fontinalis*). Canadian Journal of Fisheries and Aquatic Sciences 46 : 342-351.

Seasonal population density estimates of limnetic insects in two Adirondack (New York) lakes were obtained from horizontal and vertical net tows and benthic sweep net samples over a 3 year period; 1 year while the lakes were acidic and fishless, and two years following addition of calcium carbonate $CaCo_3$ and the introduction of brook trout (*Salvelinus fontinalis*). Before treatment, the limnetic insect assemblages in the study lakes resembled those reported from acidic and/or fishless lakes in Sweden and Canada. Maximum densities of dominant taxa were: Notonectidae 1.5 m^{-3}; Corixidae 1.1 m^{-3}, *Graphoderus* (Dytiscidae) larvae 0.27 m^{-3}; and *Chaoborus americanus* 400 m^{-3}. Within three months after treatment, all limnetic populations were near or below the detection limit (0.01 m^{-3}). Limnetic densities of notonectids, corixids, *and C. americanus* were significantly lower (Mann-Whitney U-tests) and benthic densities of Hemiptera and Coleoptera tended to be lower (sign tests) the summer after treatment than the previous summer. Calculated trout predation levels on Hemiptera and *C. americanus* and evidence from the literature, strongly suggest that predation was the major cause of reduced limnetic insect populations. The rapid reduction or elimination of these populations indicates considerable instability of the predator-prey relationships of acidic lakes which have been recently limed and stocked with fish.

FIELDS, R. D., L. CLAGGETT, E. AVERY and D. P. PHILIPP. 1997. Application of genetic analysis to management of native brook trout in Wisconsin. p. 384 *In* Proceedings of the 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin. (Abstract Only)

Until now, little was known about the genetics of wild brook trout in Wisconsin, including regional genetic differences, the history and influence of past stocking practices, and the impacts of severely limited habitat. Recent genetic analysis of selected brook trout populations is to be used in reconstructing the history of populations and in making future management recommendations. The applications of the data will include: identification of regional management zones; stocking policy; and the identification of putative heritage populations for use in reintroducing wild trout into appropriate habitats. Genetic analysis included one hatchery broodstock and seventeen wild populations (with no history of stocking). Populations represented every major watershed and ecoregion of the state. Samples were analyzed using both allozymes and mitochondrial DNA. Results indicate that the currently used hatchery population possesses a distinctive protein allele, potentially useful in future studies of stocking impacts. Low variability within some wild populations indicates they have undergone severe reductions in population size due to habitat decline. There is also significant variability among larger, wild populations with some regional stock structuring. To protect the existing genetic diversity of wild populations, regional management should separate the distinctive populations in northwest Wisconsin from those in the southwest “driftless” area and in the central and eastern portions of the state. Populations in southeast Wisconsin appear to be small, relict populations in very limited habitat. Source populations for re-introductions should be from streams in close proximity with little historical or genetic evidence of past stocking.

FISHER, J. R. 1986. Redrock Lake: A review of the fisheries and management history, 1936-1985. Algonquin Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Whitney, Ontario.

In Redrock Lake, planting of 22,000 speckled trout and 9,000 splake were carried out between 1954 and 1957 and resulted in the capture of 62 splake and no speckled trout by a relatively intense sport fishery. Further plantings of splake and speckled trout were carried out from 1962 to 1967 when research was carried out on Redrock Lake. The research was primarily to assess the effectiveness of planting hatchery-reared fish in a number of small Precambrian lakes. The lakes were placed into broad categories based on the complexity of the resident fish community. Redrock Lake was categorized as having the most complex fish community in the set of study lakes.

The results of J. M. Fraser’s study indicated that recoveries were highest (9-30%) in a lake which minnows and brook stickleback were the only other fish. Recoveries were lowest (< 0.5%) in Redrock Lake which had a complex fish community that included native speckled and lake trout. The low survival was attributed to the low fertility of the waters and the competition with, or predation by, resident fish species. In one instance, when the opening of angling in Redrock Lake coincided closely with a planting of yearling speckled trout, appreciable numbers of the fingerlings were found in the stomachs of both native speckled and native lake trout.

FITCH, L. A. 1977. Trout stocking in streams: A review. Fisheries Management Report No. 24, Alberta Department of Recreation, Parks and Wildlife, Edmonton, Alberta. 24 p.

This report reviews information on the practice of trout stocking in streams. Based on the literature review, acceptable survival and yield of stocked trout are achieved when the following conditions are met:

- Without exception the carry over of hatchery trout to subsequent fishing seasons is very low except in a few situations where the habitat characteristics are favorable, winter conditions were mild and there was little competition with resident trout. The poor carry-over of hatchery trout makes the practice of stocking sub-catchables highly questionable. Larger trout have better survival over the angling period and this results in better yield.
- Most studies indicated that the best yields of hatchery trout were achieved when the trout were stocked either prior to or during the angling season. To maximize harvest, trout must be stocked coincident with the angling season and greatest angling pressure.
- The best yields of stocked trout are exhibited when angler use is high. Among the matters than require consideration are acceptable angler density, trout holding capacity of the stream and the level of stocking at which returns begin to diminish.
- Imposing hatchery trout on a self-sustaining resident population results in increased mortality of stocked trout and a decrease in the catch of wild trout. Because wild trout sustain the fishery in such situations there is a net decline in the harvest of trout.

The decision to stock or not to stock should be based primarily on the ability and potential of a resident trout population to sustain a fishery. If it is unable to do so due to some environmental inadequacy then stocking should be considered. However, if the stream will support trout throughout the year and has the potential for maintaining a self-sustaining population, pending the correction of environmental limitation, the funds would be best spent improving trout habitat.

FLICK, W. A. 1971. New trout for old waters. The Conservationist 25(6) : 18-21.

The genetic makeup that governs various traits is complex and selection may improve the characteristics desired but other less obvious ones may also be involved and lost in the selection process. Studies by the New York State College of Agriculture at Cornell University were initiated to compare hatchery stocks of brook trout with wild strains from New York State and Canada.

It is evident that real differences exist among various strains of trout. Domestic strains of trout were not only less wary than wild stocks but also were found to utilize the upper portion of a water column when studied in the hatchery. Domestic strain trout have been selected for rapid hatchery growth and the success of this program is evident when wild and domestic strain trout of the same length are laid together. Various strains of brook trout reared under identical conditions showed differences with regard to vulnerability to angling. With relatively light fishing it was possible to catch approximately 50% of the domestic group as compared to under 20% of the wild strains.

FLICK, W. A. and D. A. WEBSTER. 1962. Problems in sampling wild and domestic stocks of brook trout. Transactions of the American Fisheries Society 91 : 140-144.

In the spring of 1959 two wild stocks and a domesticated stock of brook trout were planted as fingerlings in Bear Pond in the northern Adirondack Mountains of New York. A resident population of brook trout of domesticated parentage was also present. Differences in behavior between the four groups affected the catch by angling and trap netting. During the summer of 1960 when all four groups were approximately the same length, over 30 per cent of the domesticated stocks were taken by fly fishing, while during the same period only 12 per cent of the two wild stocks were recovered. The stocked domestic group was found to be much more vulnerable to trap netting than the other groups. During the first 24 hours of netting, 46 per cent of the trout estimated at large from this stock were recovered. At the end of three weeks of trapnetting, 84 per cent of the stocked domestic, 64 per cent of the resident domestic, 66 per cent of the Long Pond Stream wild and 44 per cent of the Honnedaga Lake wild brook trout were recovered. Gill netting was not found to be selective for any of the four groups.

FLICK, W. A. and D. A. WEBSTER. 1964. Comparative first year survival and production in wild and domestic strains of brook trout. Transactions of the American Fisheries Society 93 : 58-69.

Brook trout (*Salvelinus fontinalis*) from three wild populations were compared with domesticated hatchery strains with respect to growth, survival and production in semi natural environments (drainable ponds). Eggs from all strains were hatched and reared in the hatchery and planted as spring or fall fingerlings. Over summer survival consistently favored wild strains (65 to 76 per cent compared with 43 to 53 per cent survival for domestic strains). Over-winter survivals were not different although the effect may have been masked by other overriding factors in the test waters. Domestic strains maintained the initial size advantages held at planting. Larger size at planting was due to faster growth rate during hatchery existence. Net production based on recovery weight less stocking weight was similar for wild and domestic groups during the over summer period (higher survivals in wild strains balanced by size advantage of domestic) but domestic groups generally showed lower production or net losses in the overwinter period.

FLICK, W. A. and D. A. WEBSTER. 1976. Production of wild, domestic and interstrain hybrids of brook trout (*Salvelinus fontinalis*) in natural ponds. Journal of the Fisheries Research Board of Canada 33 : 1525-1539.

Hatchery-reared wild and domestic strains of brook trout (*Salvelinus fontinalis*) were released in natural lakes and survival and growth estimated at semiannual intervals throughout the life spawn. Angling was restricted. Four experiments with two year classes involved three different Adirondack Mountain (New York) wild strains and two domestic strains, a fifth experiment included two wild strains from James Bay, Quebec and a hybrid between one of these (Assinica Lake) and a New York domestic strain. Wild and hybrid strains consistently exhibited greater longevity (5-7 years) compared with domestic (few recovered after 3 years). Climax sizes were not much different, except the domestic x Assinica hybrid that was substantially larger than either of the two parents. Gross production and yield to angling of any given strain cohort was correlated ($r = 0.93$) and lifespan gross production was 50% greater for wild and hybrid groups per unit fish stocked. Biomass stocked per recruit was much larger for domestic strains and taking this into account, the ratio of gross production to weight stocked was about 6 times greater. Increased costs of rearing nondomesticated strains, if any, must be taken into consideration in an economic evaluation, but use of wild and/or hybrid strains of trout offers significant benefits under management conditions of these experiments.

FLICK, W. A. and D. W. WEBSTER. 1992. Standing crops of brook trout in Adirondack waters before and after removal of non-trout species. North American Journal of Fisheries Management 12 : 783-796.

Ponds and lakes in the Aidrondack Mountain region of New York state that contain brook trout (*Salvelinus fontinalis*) are generally infertile and trout production is low when brook trout have to compete with non-trout species. Standing crop estimates for seven waters with mixed species associations ranged from 50 to 100 lb/acre; suckers (*Catastomus* spp.) were a major component of each assemblage. Brook trout standing crops were under 1 lb/acre in all but one water and were particularly low where yellow perch (*Perca flavescens*) were present. Following reclamation, during which major competing species were removed, brook trout were restocked. Subsequent estimates of brook trout standing crops ranged from 5 to 16 lb/acre and good trout fishing prevailed where previously there had been little or none.

FLURI, D. and S. BELFRY. 1998. 1996 stocking assessment on Turtle Lake. File Report, Ontario Ministry of Natural Resources, North Bay, Ontario. 8 p.

Turtle Lake (5.4 ha) was first stocked with brook trout in 1949. The most recent stocking regime was based on stocking 500 yearling fish (93 fish ha^{-1}) on an alternate year basis. A stocking assessment was conducted on Turtle Lake on October 23, 1996. The purpose was to determine if the present stocking regime was appropriate and to determine if natural reproduction of brook trout was occurring. Three short gill net (monofilament with mesh sizes ranging from 2.5-6.4 cm) sets produced a total catch of 5 brook trout and 1 white sucker. All brook trout were fin clipped (left pectoral). Although the netting effort and catch were low, the results suggest that natural reproduction is not occurring. The mean fork length of 35.9 cm at age 2+ indicates a very rapid growth rate. There appears to be a more than adequate food supply for the number of trout stocked presently. It is recommended to increase the stocking rate from 500 to 700 trout every other year.

FOYE, R. E. 1953. Survival and growth of trout in several reclaimed ponds in Maine. File report, Maine Department of Inland Fish and Game. 15 p.

FRANZIN, W. G. and S. M. HARBICHT. 1985. An evaluation of the relative success of naturalized brook charr (*Salvelinus fontinalis*) populations in South Duck River and Cowan Creek, Duck Mountain Region, Manitoba. Canadian Technical Report of Fisheries and Aquatic Sciences 1370 : 21 p.

The naturalized populations of brook charr (*Salvelinus fontinalis*) in Cowan Creek and South Duck River, Manitoba, showed markedly different densities. The streams are geologically similar but the hydrological regime of Cowan Creek has been modified by beaver activity within the study area. The diets of the two populations were similar and the streams provided abundant invertebrate food resources. Cowan Creek fish, at lower density, grew faster and had a greater mean size than South Duck River fish. The differences in the two populations appeared to correlate with differences in winter conditions and beaver activity on the streams. The development of solidly frozen reaches of Cowan Creek with subsequent overflowing of its waters sometimes out of the stream channel could have had significant effects on the suitability of much of the stream for overwinter survival, limiting brook charr mainly to beaver ponds during winter. This ice condition was not common on most of South Duck River. Consequent effects on spawning and incubation success could explain the differences in density between the streams, as well as growth and size differences. Although both populations are marginally successful, successive cold dry winters could result in extirpation of either or both of them.

FRASER, J. M. 1962. Brook trout lake and the role of hatchery fish. Fisheries Research Information Paper 22, Ontario Department of Lands and Forests. 33 p.

The purpose of this paper is to review various studies that have been carried out on brook trout (*Salvelinus fontinalis*) populations inhabiting lake environments. The purpose of stocking hatchery fish is to provide additional angling where the demand for angling exceeds the amount of fish supplied by natural reproduction. If additional angling is required it can be provided in two ways with hatchery stock. The most direct and most expensive way is to grow the fish to angling size in the hatchery and plant them in the lake for anglers to catch. It is evident that not every catchable-sized trout that is planted will not be caught. Even under fairly intensive fishing pressure, we expect to plant three catchable trout for each one we expect to be caught. The second way of using hatchery stock is to plant smaller fish in lakes which are physically and chemically stable and are relatively free of predatory or highly competitive species of fish. The main considerations in the calculations of stocking rates are the productive capacity of the water concerned and the expected mortality from natural causes. Yield or harvest depends on the size of the standing crop or biomass and the fishing intensity exerted on it. Investigators have recorded a wide range of harvest from brook trout lakes including low yield situations (0.5-2.0 lbs/acre), moderate yield situations (10.3-21 lbs./acre, and high yield situations (22-71 lbs./acre). The cost of raising one pound of brook trout in Ontario hatcheries is approximately $2.50 giving a value of $0.25 for the larger sized yearling.

In attempting to assess the significance of the factors influencing brook trout production, a major difficulty has been the unknown degree of interrelationship and its effects. In particular there is a need to study the factors which determine the productivity of various types of lakes for brook trout, determine mortality rates and define each natural mortality factor, and investigate and develop techniques for the improvement of both habitat and fish.

FRASER, J. M. 1968$_a$. Differential recovery of brook trout planted by hand and by air drop. Transactions of the American Fisheries Society 97 : 32-36.

Air-dropped brook trout yearlings experienced a lower survival than trout planted by hand. It appears that the mortality is in some manner associated with the air drop since hand planted fish which had been transported by air did not experience this lower survival.

FRASER, J. M. 1968$_b$. Effect of air planting on domestic brook trout. Progressive Fish Culturist 30 : 141-143.

This experiment tested the hypothesis that air drops kills hatchery trout planted in this manner. Sixteen month old brook trout averaging 16.6 per pound were anesthetized with tricaine methanesulfonate and fin clipped to permit identification of the trout from the various drops after recovery from the pond. Handling and transportation simulated the routine methods in use at the hatchery. A total of 1,793 brook trout in lots of approximately 300 each was dropped in six runs from a De Havilland Otter aircraft flying at 85 miles per hour over the pond. Three drops were released from a height of 400 feet and three from 200 feet. Ninety-six per cent of the 1,793 brook trout that had been dropped into the hatchery pond survived the fall and were alive at the end of the 18 day observation period. These results show conclusively that the air drop did not kill the yearling brook trout used in these tests. No appreciable mortality occurred at the time of the drop nor within a subsequent period of 18 days. Heights of 200 and 400 feet are safe for dropping fish.

FRASER, J. M. 1972. Recovery of planted brook trout, splake, and rainbow trout from selected Ontario lakes. Journal of the Fisheries Research Board of Canada 29 : 129-142.

Recoveries of hatchery-reared brook trout (*Salvelinus fontinalis*), splake (*Salvelinus namaycush* x *S. fontinalis*), and rainbow trout (*Salmo gairdneri*) planted in lakes having different resident fishes, were highest (9-30%) in a lake in which minnows and the brook stickleback were the only other fishes. Recoveries by angling and gill netting were considerably lower (2-15%) in two lakes containing the white sucker and minnows, and still lower (0.5-5%) in two lakes containing spiny rated species as well. Recoveries were lowest (<0.5%) in a lake having a complex fish community that included native brook and lake trout. Planted splake and rainbow trout generally yielded higher returns, in weight, than brook trout in comparable situations.

The low survival of planted fish was apparently due to the low fertility of the waters and to competition with, or predation by, resident fish species. Predation by fish eating birds and mammals may also have had an effect.

The weight of the catch of salmonids exceeded the weight planted in only one lake. Here, the mean yield of planted salmonids was 8.4 kg/ha per year in comparison with 2.6 to <0.5 kg/ha per year in the five other study lakes.

FRASER, J. M. 1974. An attempt to train hatchery-reared brook trout to avoid predation by the common loon. Transactions of the American Fisheries Society 103 : 815-818.

Hatchery-reared yearling brook trout (*Salvelinus fontinalis*) were trained in 1970 and 1972 to avoid an electrified plastic model loon moving through the water in a hatchery raceway. Immediately after the training programs, the trout were released together with untrained trout in a 23 ha lake which accommodated 2-3 common loons and other potential predators. Intensive gill netting 10-12 weeks after planting indicated about 16% survival of trained trout compared to about 18% untrained trout. The training received by the trout apparently had little survival value in the wild. The low survival rates by all groups suggested a high level of predation.

FRASER, J. M. 1976. Assessment of winter planting of hatchery-reared brook trout in small Precambrian lakes. Journal of the Fisheries Research Board of Canada 33 : 1794-1797.

Distinctively marked 8 month old brook trout (*Salvelinus fontinalis*) were planted in autumn, 14 month old trout in winter, and 16 month old trout in spring in 10 experiments conducted in five small Ontario lakes in 1970-73. Comparative recoveries were assessed by examining the anglers catch and by intensive sampling with gillnets 1 month following the spring planting. Recovery of spring-planted trout (mean 39.7%) was significantly higher ($P < 0.01$) than for winter (15.7%) and autumn planted trout (7.7%). Although there was evidence in one lake of predation on winter-planted trout by large brook trout and splake (*Salvelinus fontinalis* x *S. namaycush*), the factors generally responsible for the large losses of winter and fall planted trout have not been identified.

FRASER, J. M. 1978$_a$. The effect of competition with yellow perch on the survival and growth of planted brook trout, splake and rainbow trout in a small Ontario lake. Transactions of the American Fisheries Society 107 : 505-517.

Matched plantings of hatchery-reared yearling brook trout (*Salvelinus fontinalis*) and splake (*Salvelinus namaycush x S. fontinalis*) or brook trout and rainbow trout (*Salmo gairdneri*) were made in Little Minnow Lake for 6 years prior to and 6 years following the introduction of yellow perch (*Perca flavescens*). The mean return for each kilogram of fish planted was 3.3, 6.8, and 6.1 kg, respectively, for brook trout, splake, and rainbow trout in pre-perch years but after yellow perch became established the mean returns were 0.4, 0.9, and 0.8 kg, respectively, all less than the weight planted.

The 1967, 1969, and 1972 year classes of yellow perch successively dominated the fish community and yellow perch biomass fluctuated between 20 and 30 kg/hectare. The establishment of yellow perch resulted in a drastic change in the food habits of the planted salmonids and a reduction in their growth rates in excess of 50%. The evidence strongly indicates that planted salmonids could not compete successfully with yellow perch for the food supply.

FRASER, J. M. 1978$_b$. Comparative recoveries of planted yearling and fall fingerling brook trout from Ontario lakes. Journal of the Fisheries Research Board of Canada 35 : 391-396.

Yearling and fall fingerling brook trout (*Salvelinus fontinalis*) were planted in two lakes with few or no resident fish species and in three lakes with resident populations. The comparative recoveries of the two size groups of trout planted were assessed by creel census and/or intensive gillnetting. Recoveries of planted yearling brook trout were greater from lakes supporting few or no resident fish species (15.9-35.9%) and less in lakes supporting suckers, minnows, and sticklebacks (5.9-14.8%). Experience was similar with fall fingerlings planted in the same set of lakes thought comparative recoveries were less. Lakes with few fish competitors yielded 3.5-4.8 kg of trout for each kilogram of fall fingerlings planted compared with 2.9-3.0 kg for each kilogram of yearlings planted. The returns of trout from lakes also supporting resident species were only 0.3-0.8 kg for each kilogram of yearlings or fall fingerlings planted.

FRASER, J. M. 1980. Survival, growth and food habits of brook trout and F_1 splake planted in Precambrian Shield lakes. Transactions of the American Fisheries Society 109 : 491-501.

The performance of planted brook trout (*Salvelinus fontinalis*) and F_1 splake (*Salvelinus namaycush* x *S. fontinalis*) were studied in four Precambrian Shield lakes. Splake survived better than brook trout in three lakes; mean gill net recoveries were 15.3, 13.2, and 8.5% of plantings of splake compared to 2.9, 1.2, and 7.2% for brook trout. The fourth lake showed a mean recovery rate of 28% for both splake and brook trout. Most brook trout were caught in the year of planting or the year following whereas the splake recoveries were spread over 6-7 years. Each kilogram of planted yearling splake yielded 2.5-7.1 kg among lakes; each kilogram of yearling brook trout planted yielded 0.2-1.3 kg. Brook trout and splake planted in the same lake grew at approximately the same rate in the year following planting. There were, however, differences in the growth rate of both brook trout and splake among lakes and for splake the differences were maintained for an additional 5-6 years. Diet of both species differed among the lakes but brook trout fed more on aquatic insects and fish while small splake utilized Entomostraca (chiefly Cladocera) and larger splake preyed heavily on Malacostraca (chiefly crayfish) and fish (chiefly yellow perch, *Perca flavescens*).

FRASER, J. M. 1981. Comparative survival and growth of planted wild, hybrid and domestic strains of brook trout (*Salvelinus fontinalis*) in Ontario lakes. Canadian Journal of Fisheries and Aquatic Sciences 38 : 1672-1684.

Matched plantings of domestic strain and interstrain hybrid (or wild strain) brook trout (*Salvelinus fontinalis*) were made annually in nine small Precambrian Shield lakes during 1973-77. Recoveries of planted fish were made by gillnetting and/or angling during 1974-80. In six study lakes, hybrids (and wild strains) were recovered at rates two to four times greater than the domestic strain; in three lakes recoveries were similar. Most domestic strain trout were caught in the year following planting whereas recoveries of hybrids and wild strains were spread over 3-4 years. Each kilogram of hybrid (or wild) planted yielded 5.6 kg (1.2-12.3); each kilogram of domestic strain planted yield 0.8 kg (0.2-2.1). Lakes containing only minnows and sticklebacks yielded the highest returns of brook trout; lakes containing competitive species yielded low returns. Rapid growth of brook trout occurred in lakes containing only minnows and sticklebacks; slowest growth was noted in lakes supporting white suckers (*Catastomus commersoni*). Domestic strain brook trout and the matched hybrid grew at approximately the same rate within a lake and in seven of nine lakes ate the same food. The performance of the Nipigon x domestic hybrid qualifies it for consideration as a replacement for the domestic brook trout presently planted in Ontario lakes.

FRASER, J. M. 1983. The performances of two wild and two hybrid strains of brook trout planted in an infertile, acidic lake. Ontario Fisheries Technical Report Series No. 7, Ontario Ministry of Natural Resources, Toronto, Ontario. 7 p.

Survival, growth and food habits of four strains of brook trout (*Salvelinus fontinalis*) planted simultaneously as fall fingerlings in Crystal Lake, Algonquin Park, Ontario, were remarkably similar. Crystal Lake is acidic (pH = 5.3), poorly buffered (alkalinity 0.18 mg L^{-1} as $CaCO_3$), and relatively infertile (total dissolved solids 17 mg L^{-1}). All four strains grew rapidly, reaching 800 g in weight at age 3 and 1100-1200 g at age 4. Survival over the two years following planting ranged from 7.7-18.8%. The 7705 fall fingerlings, which collectively weighed 26 kg at planting, were reduced in two years to an estimated 95 fish weighing 447 kg ha^{-1} – a standing stock of 12.3 kg ha^{-1}. The reduction in numbers was due chiefly to natural mortality, although some illegal angling was reported for this sanctuary lake.

FRASER, J. M. 1986. Experimental plantings of wild and domesticated strain of speckled trout. Unpublished Manuscript, Fisheries Research Section, Ontario Ministry of Natural Resources, Maple, Ontario. 4 p.

In September, 1953, 2,000 marked brook trout (age 1+) were planted in a small barren lake, Sheila Lake, in the Geraldton District. The stock included four lots (Hill's Lake (domestic), Lake Nipigon F_2, and two interstrain hybrids) of 500 fish each. Gill nets, with mesh sizes ranging from 1.5 to 4.0 inches, were used to assess survival and growth. Progeny resulting from the two reciprocal crosses grew better in the hatchery and were released at a large size than the Nipigon F_2 fish. Their survival was almost double that of the parent stocks and their size advantage at planting was maintained during their period in the lake.

FRASER, J. M. 1988$_a$. Comparative recoveries of hatchery-reared Nipigon brook trout strain (LNDN) and hybrid F_1 splake (HLLM) planted in five Algonquin lake parks. Unpublished manuscript, Fisheries Research Section, Ontario Ministry of Natural Resources, Maple, Ontario. 13 p.

Plantings of LNDN brook trout were matched with plantings of similar aged F_1 splake in five study lakes. Brook trout grew slowly in the hatchery and, consequently, splake were about three times larger at time of planting. Brook trout planted as fall fingerlings in three lakes survived poorly, compared to planted splake. In two of these lakes, naturalized brook trout apparently competed with the planted fish. Yearling brook trout and splake were matched in two lakes and mean recovery by angling was 5-10 times greater for splake. Several age groups of carryover splake and rainbow trout extant in these lakes probably preyed on the planted salmonids. The overall results suggest that the Nipigon brook trout are too small at time of planting to effectively compete. They should be planted only in lakes offering minimal competition.

FRASER, J.M. 1988$_b$. High yields from spring plantings of fingerling brook trout and splake in a small Precambrian Shield lake. Unpublished Manuscript, Fisheries Research Section, Ontario Ministry of Natural Resources, Maple, Ontario. 13 p.

FRASER, J. M. 1989. Establishment of reproducing populations of brook trout after stocking of interstrain hybrids in Precambrian Shield lakes. North American Journal of Fisheries Management 9 : 352-363.

Planted interstrain hybrid and wild strain brook trout (*Salvelinus fontinalis*) established self-propagating populations in four Precambrian Shield lakes in which earlier plantings of a domestic strain had failed to reproduce successfully. The purpose of this study was to document successful reproduction by interstrain hybrid and wild brook trout and to suggest reasons why the domestic strain failed to reproduce. Nearly all brook trout were marked before stocking so that planted fish could be distinguished from lake-reared fish in gill net catches. The tentative conclusion is that during its long period of domestication (more than 20 generations), the domestic strain had lost much of its ability to locate and use suitable spawning areas. A secondary factor was the poor survival to maturity of the domestic strain relative to the hybrid and wild strains.

FRASER, J. M. and F. W. H. BEAMISH. 1969. Blood lactic acid concentration in brook trout (*Salvelinus fontinalis*) planted by air drop. Transactions of the American Fisheries Society 98 : 263-267.

The level of lactic acid in the blood of brook trout increased significantly after planting by air drop but remained well below levels associated with fatigue deaths in other species. Blood lactic acid level was highest among trout which had been loaded more heavily for transport.

FRASER, J. M. and C. RUMSEY. 1988. Comparative survival and growth of F_1 wild and F_3 generations of the same strain of hatchery-reared brook trout (*Salvelinus fontinalis*) planted in two small lakes. Ontario Fisheries Technical Report Series No. 28, Ontario Ministry of Natural Resources, Toronto, Ontario. 9 p.

Survival and growth of hatchery-reared first generation (F_1 wild) brook trout (*Salvelinus fontinalis*), progeny of wild Dickson Lake parents, were compared with the third hatchery-spawned and reared generation (F_3) of the same strain by recaptures of matched plantings of fall fingerlings stocked in two study lakes in 1981, 1982, and 1983. In one lake there was minimal competition from resident fish species, the matched plantings were recovered in equal proportion. In the lake which supported a resident brook trout population, survival of the F_3 plantings was significantly lower than that of the F_1 wild plantings. The poorer performance of the F_3 fish could not be attributed to genetic changes nor to differential conditioning by the hatchery environment. It is possible however that embryonic development of the F_3 fish differed from that of the F_1 fish owing to a potential difference in composition of the egg yolk. Female parents of the F_1 wild fish ate natural foods in the lake, whereas parents of F_3 fish were maintained on an artificial diet. There were no essential differences in growth between F_1 wild and F_3 fish in either study lake. In one study lake, a drastic decreased in survival of the final (1983) matched plantings was probably due to predation by a pair of loons that nested (successfully) on the lake in 1984 and 1985.

FRY, F. E. J. 1939. Report on planting of yearling speckled trout in Algonquin south in 1939. Ontario Fisheries Research Laboratory Report. 2 p.

GAGE, J. F. 1952_a. A creel census report for Eugenia hydro pond. File Report, Ontario Department of Lands and Forests, Lake Huron District, Hespeler, Ontario.

Twelve anglers were asked to cooperate by keeping a seasonal record of their catch of speckled trout. Nine personal records were returned of which only eight were in sufficient detail for use. Eight anglers fishing a total of 1,468 hours of 317 trips caught 943 speckled trout. On the average, each angler caught 2.3 trout per trip or 0.6 trout per hour. Artificial lures were used almost exclusively. A total of 466 trout were reportedly released. As the anglers set their own length limits, it does not necessarily follow that the released fish were sub-legal. Approximately 43% of the total catch were hatchery-reared speckled trout while 80% of the total catch were 12 inches in length or less.

GAGE, J. F. 1952_b. Survival of hatchery trout. File Report, Ontario Department of Lands and Forests, Lake Huron District, Hespeler, Ontario.

Creel census studies in the Huron district indicate a good survival and contribution to angling in ponds and lakes. In streams, however, there appears to be very little carry-over from one year to the next.

In Williams Lake and Bell's Lake, where spawning facilities are poor – both lakes having almost 100% marl bottoms, the natural hatch is very poor. Hatchery fish make up a large percentage of the catch in both these waters. In the Sydenham River spawning facilities are excellent and the natural hatch is very good. Hatchery-reared fish are in evidence in numbers only immediately after planting. The following year when they should be better than legal size, they are almost entirely absent from the fisherman's creel. It must be admitted, however, that in the case of the Sydenham at least, very few large natural speckled trout are caught by the angler. In Eugenia Pond, hatchery-reared fish have been caught by anglers weighing better than 2 pounds in weight. Comparing hatchery-reared trout with natural trout at Eugenia, it was found that the hatchery fish grew faster. Reports submitted by anglers revealed that the hatchery fish accepted a varied type of live baits and flies, while natural trout were more choosy in their diet and were taken mostly by fly fishermen.

GAGE, J. F. 1960. A report on the stocking of two year old speckled trout. File Report, Ontario Department of Lands and Forests, North Bay, Ontario.4 p.

The stocking of five non-trout ponds in the North Bay district with 1,900 two year old fish (9"-11") was followed up with a creel census on the opening weekend. Two ponds were ice covered on the opening day but recoveries on the other three were 17%, 50% and 87% at a rate of 0.3-2.0 fish per hour.

GALBRAITH, M., Jr. 1959$_a$. Returns to anglers during 1953-55 from fall plantings of hatchery brook trout of different sizes on three lakes in Marquette County, Michigan. Fisheries Research Report No. 1581, Michigan Department of Conservation. 25 p.

GALBRAITH, M., Jr. 1959$_b$. Returns to anglers during 1956-58 from fall plantings of hatchery brook trout of different sizes in three lakes in Marquette County, Michigan. Fisheries Research Report No. 1582, Michigan Department of Conservation. 18 p.

GIBBARD, H. J. Undated. Cochrane District fisheries management project #4 – Fish stocking rate. File Report, Ontario Department of Lands and Forests, Cochrane, Ontario.

The objective of this experiment was to test the validity of the speckled trout stocking rate as used in this district. Of secondary consideration were the various other factors which affect the quality (catch-effort) of fishing. Before the second year of the project (1961) it became obvious that the latter set of factors were more important than the stocking rate.

Two lakes were chosen for this experiment which were close together and as near as possible to being alike. Unfortunately, they were very small. In 1960, the larger of the two (5.0 acres) was stocked with 1,250 fin clipped two year old speckled trout (250 fish/acre), this being a rate chosen by the local club. The smaller lake (3.0 acres) was stocked with 360 two year old marked trout (120 fish/acre), a rate consistent with the district stocking rates for such a lake with the expected fishing pressure. A man was stationed at the lakes to take a complete creel census of each lake. The whole procedure was repeated in 1961 except that a barometer reading was taken three times daily.

The creel census from both years showed that fishing commenced too soon after stocking which proved only that tame fish can be caught. The catch-per-effort varied more on each lake from day to day than it did between the two lakes. This indicated factors outside the lakes as being more important that stocking rates. Catch-per-effort and per cent returns were compared between the lakes each year and between the first and second years. At the end of the second year of the project, the barometric pressure reading were compared statistically with the daily catch-per-effort. This showed no correlation between a daily average barometric pressure and the daily catch-per-effort. However, the project was not originally designed to test the significance of the various aspects of barometric pressure and their effect on catch-per-effort. For this reason, the author feels that the effect of barometric pressure should not be entirely discounted at this time.

GLOSS, S. P., C. L. SCHOFIELD AND R. L. SPATEHOLTS. 1987. Conditions for re-establishment of brook trout (*Salvelinus fontinalis*) populations in acidic lakes following base addition. Lake and Reservoir Management 3 : 412-420.

Some lakes with an historical record of fish populations have undergone acidification and fish no longer exist in these systems. Toxicity data suggest that the inability of fish to survive in these acidic environments is due to increased concentrations of hydrogen ions (H+) and aluminum (Al+++) in the water column. To re-establish fish populations in lakes of this kind it is necessary to (1) determine that fish are no longer present, (2) demonstrate that fish either cannot or have limited potential to survive in the systems, and (3) change the water quality and demonstrate increased survival of fish under differing chemical conditions. We examined two acidic lakes (Woods Lake, pH ~ 5.0 and Cranberry Pond, pH ~ 4.8) for the first two conditions by conducting fisheries surveys and in situ bioassays using fingerling (age 0) brook trout (*Salvelinus fontinalis*). Woods Lake was also stocked with brook trout in the fall of 1984 and overwinter survival of two age classes determined. Emigration from the lake accounted for a relatively small percentage of the approximately 90% mortality in these stocked fish over winter. Neither acclimation procedures or experimental selection of brook trout for acid tolerance improved survival. Prior to, during, and after calcium carbonate addition to the lakes in the early summer of 1985 an extensive series of in situ bioassays was conducted that showed significantly improved survival of both age 0 and 1 brook trout after liming. Interactive effects of temperature, pH, and aluminum levels were evident during these experiments. No detrimental effects of liming on fish survival were observed.

GLOSS, S. P., C. L. SCHOLFIELD, R. L. SPATEHOLTS and B. A. PLONSKI. 1989. Survival, growth, reproduction and diet of brook trout (*Salvelinus fontinalis*) stocked into lakes after liming to mitigate acidity. Canadian Journal of Fisheries and Aquatic Sciences 46 : 277-286.

Brook trout (*Salvelinus fontinalis*) were stocked into two previously acidic (pH 4.5-5.2) Adirondack Mountain lakes, Woods Lake and Cranberry Pond, following liming in June, 1985. Age 0+ Temiscamie x domestic hybrid brook trout were stocked at 200 ha^{-1} with one-half of the fish selected for presumed acid tolerance. Age 1+ Temiscamie strain brook trout were also stocked at 50 ha^{-1}. Liming increased pH to well above 7 and alkalinity to over 200 $\mu eq\ L^{-1}$. Growth and condition of stocked fish were good while water quality conditions remained suitable. However, in Cranberry Pond which reacidified 6 months after liming, both growth and survival declined dramatically. Much of the population loss was due to emigration. Annual survival in Woods Lake averaged 35% and 25% for the age 0+ and 1+ fish, respectively. Initially, large invertebrates made up most of the diet for stocked fish. These taxa were replaced by zooplankton within a few months. Limited natural reproduction was associated with low velocity groundwater inflows and high acidity in tributary streams. Fry emergence from artificial spawning substrates placed in Woods Lake peaked well after snowmelt inflows which produced toxic conditions in littoral areas.

GOEDE, R. W. 1986. Management considerations in stocking of diseased or carrier fish. p. 349-355 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management. Fish Culture and Fisheries Management Sections, American Fisheries Society, Bethesda, Maryland.

The specialized and increasingly proficient fish cultural operations are periodically besieged by a variety of disease problems. These problems are often infectious in nature and are capable of inducing losses that range from minor annoyances to catastrophic devastation which essentially eliminates entire stocks of fish. Often, the population is showing no losses but contains many individuals which have latent infections with serious pathogens, that is carrier fish.

Some of the problems associated with stocking diseased fish include direct mortality, establishing a reservoir of infection , increased sensitivity to stressors and reduced performance. Reduced performance has been shown in a population of brook trout which contained a high percentage of positive carriers of infectious pancreatic necrosis virus upon release from the hatchery. After two and half years, the carrier fish were smaller by five and eight per cent in two separate comparisons.

The basic framework of sound biological information and methods exist at this point in time to provide some rationale relative to decisions concerning disposition of diseased hatchery stocks. It should now be possible to assign levels of concern with respect to receiving waters and pathogens to present proper recommendations to administration. Trained fish health specialists should be in place in active and advisory capacities to aid in initiation of quality control programs. Quality of fish reared and planted should be quantifiable and incorporated in the body of records. Similar health or quality assessment should be incorporated in field programs evaluating success of free-ranging stocks.

GOWING, H. 1968. Studies on planted brook trout and limnological conditions in unfished lakes. Michigan Department of Conservation. Ann Arbor, Michigan. 3 p.

GOWING, H. 1974. Survival, growth, diet and production of hatchery trout stocked in six pothole lakes in Michigan. Fisheries Research Report 1816, Michigan Department of Natural Resources 30 p.

In the fall of 1965, populations of age-0 and age-1 brook trout were established at three different densities in six Pigeon River lakes as follows: (1) low density lakes, 194 fish per hectare; (2) intermediate density lakes, 396 fish per hectare; and (3) high density lakes, 1,335 fish per hectare. There was a direct relationship between total trout density at the outset and the natural mortality rate (q) of the 1965 year class during the first winter after stocking. For the 1964 year class, high densities (125 to 857 fish per hectare) at the outset of the first summer were associated with high natural mortality rates during the summer. Growth in length of the 1965 year class was highest in low density lakes, intermediate in the lakes of intermediate density, and lowest in high density lakes. Brook trout stocked at a mean length of 142 mm in November 1965 attained a length of 245 mm in September 1966 after one growing season in the low density lakes, 218 mm in the intermediate density lakes, and 173 mm in the high density lakes. Highest growth rates (g) were achieved in the low density lakes and lowest in the high density lakes. There was an inverse relationship between trout density at the outset of the study and growth rates (g) of the 1965 and 1964 year classes during the first year. The 1965 and 1964 year classes showed negative growth rates (g) during the first winter in the high density lakes.

Based on the total volume of food observed in the stomachs of trout sampled over a two year period, insects made the largest contribution to the diet of trout in all lakes except in West Lost. Crayfish were predominant in trout from West Lost Lake. In three of the lakes containing crayfish, this food type ranked second. Fish, other than trout, ranked second in two of three lakes containing fish. Cladocerans made the third largest contribution in four of the six lakes.

The largest standing crop of the 1965 year class occurred in the fall, after the first summer. Maximum standing crops of the 1964 year class was established at the outset. Maximum production of trout flesh in the six lakes, grouped in three pairs, was achieved after the first summer. Production attained in the low density and the intermediate density lakes during this period was similar (11.0 and 10.6 kg/ha), whereas it was about two times greater in the high density lakes. The largest average production (46 kg/ha) was generated in the high density lakes during the 23 months; the low density lakes produced about 19 kg/ha; and the lakes of intermediate density produced 15 kg/ha. Greater production in the high density lakes was achieved primarily by the large population of slow growing fish. The 1965 year class contributed about 77% of the total production in the low density lakes, 83% in the intermediate density lakes, and 93% in the high density lakes.

The best ratio of standing crop at the outset to total production was observed in the low density lakes. However, total production was less than two times the initial standing crop. As a guide for future management, satisfactory growth of individual fish will require low stocking rates, as determined here and in other studies.

GOWING, H. 1978. Survival, growth and production of domestic and Assincia strain brook trout in four Michigan lakes. Fisheries Research Report No. 1862, Michigan Department of Natural Resources, Ann Arbor, Michigan. 19 p.

In the fall of 1973, matched plantings of domestic and Assincia strain brook trout fingerlings of the 1973 year class were stocked in three small oligotrophic lakes and one shallow flowage. Stocking rate was 125 fish per hectare for each strain or 250 fish per hectare for each lake. Populations of trout were monitored annually in the fall for 4 years after stocking.

Nearly 98% of the Assincia trout were lost in the flowage during their first year after stocking from unknown causes. In a meromictic lake all trout died in the third winter as the result of a winterkill. For the remaining two lakes, domestic trout survived through age IV in both and a few are expected to survive an additional year whereas Assinca trout survived through age IV in one lake.

Growth rate of Assinca trout was superior to that of domestic trout in all lakes. From composite growth curves, Assincia trout attained 19% greater length than domestic trout in each of the 4 years after stocking. Growth in length was most rapid during the first year after stocking age, particularly in two lakes containing no minnows and peaked in the third year at age III. Growth rate was sustained best in the lake containing minnows; maximum size fish was achieved in this lake, 437 mm for domestic trout and 472 mm for Assincia trout, both age III.

More than one-half of the domestic trout were sexually mature at age I; most had reached maturity at age II to age IV. For Assincia trout, only a few precocious males were mature at age II and about 62% of the females were mature at age III.

In the two lakes where trout survived best, 4 year production of Assinca trout in one lake (46.89 kg/ha) exceeded that for domestic trout (39.03 kg/ha) while domestic trout production (48.28 kg/ha) was greater than Assinca trout production (45.52 kg/ha) in the other lake.

The superior growth of Assincia trout over domestic trout provides an opportunity for improving the stocks of brook trout in the Michigan hatchery system and ultimately the catch of more desirable size trout by anglers.

GOWING, H. 1986. Survival and growth of matched plantings of Assinica strain brook trout and hybrid brook trout (Assinica male x domestic female) in six small Michigan lakes. North American Journal of Fisheries Management 6(2) : 242-251.

Matched numbers of Assinica strain brook trout (*Salvelinus fontinalis*) and hybrid brook trout (Assinica male x domestic female) were planted in the fall in five lakes and a pond - each at a rate of 125 fingerlings/ha. At the outset, the Assinica strain had an average total length of 96 mm and a standing crop of 1.27 kg/hectare compared to 86 mm and 0.94 kg/hectare for the hybrid. These populations were monitored for 5 years (1977-1982). There was no significant difference in average annual survival rates of Assinica and hybrid brook trout in these waters. Males were sexually mature at an earlier age than females. In any given spawning season, males reached this stage before females. Age at first sexual maturity appeared to be a variable trait. Growth and production were influenced by the inherent productivity of the receiving water and the status of the biota at the time of planting. Average annual growth in length of the two strains was similar. Rapid growth generally occurred in the first year following stocking and diminished thereafter. Production of Assinica and hybrid brook trout was comparable. Both strains generally achieved maximum production in the first year. For the most productive water, annual production of Assinica and hybrid strains varied from 22.83 and 19.72 kg/hectare, respectively, in the first year to 7.72 and 7.95 kg/hectare in the fifth year. There was no evidence of heterosis in survival and growth. Both Assinica and hybrid brook trout were attractive alternative to hatchery brook trout now being used.

GOWING, H. and W. T. MOMOT. 1971. Growth and survival of hatchery trout in lakes and ponds in relation to food supply. Populations of crayfish subject to varying rates of predation by trout, and growth and survival of hatchery trout stocked at different rates. Michigan Department of Conservation. 8 p.

GRAY, J. E. and D. MARALDO. 1981. A historical look at the fisheries of Saddle, Sill, Goulais, Gong, Megisan, Astonish, Flack and Elliot lakes. Algoma Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 99 p.

Astonish Lake is an 80 ha lake in Nicholas Township which historically supported a native brook trout fishery. The lake had minimal fishing pressure until the 1940s and 1950s when access to the lake was became available. Stocking of brook trout was initiated in 1952 in an effort to maintain a high quality brook trout fishery. Stocking continued every 2-3 years until 1978. An average of 3,500 yearlings (44 fish ha^{-1}) were planted annually. By 1970 fishing pressure was relatively heavy and white sucker were found to be a prominent component of the fish community (81% of the gill net catch). Hatchery-reared trout represented 7% of the trout captured. Fishing pressure decreased from 1975-1980 as fishing quality was perceived to have declined.

Sill Lake is a 37 ha lake located in Van Koughnet Township which had a native brook trout fishery that was basically unutilized until 1955. From 1959 to 1963 brook trout were stocked annually with between 320 and 3,000 fish (8.6-81 fish ha^{-1}). A standard lake survey was conducted in 1964 and routine gill netting indicated that approximately 22% of the brook trout sampled were hatchery-reared having been planted the previous year. The average length of sampled brook trout was 27.9 cm but ranged from 8.1 – 44.5 cm. The average age was 2.0 years with a wide range of ages represented. Brook trout stocking was discontinued in the mid 1960s as the lake supported only moderate fishing pressure. Between 1964 and 1971, Sill Lake became more accessible to anglers through the use of snowmobiles and a logging road. From 1971 to the present time, fishing pressure has increased somewhat but remained relatively stable.

Saddle Lake has a surface area of 111 ha and is situated in Lamming Township. Saddle Lake has been known as one of the best brook trout lakes in the Sault Ste. Marie area. As early as 1937 domestic brook trout were stocked into the lake. Fishing pressure doubled during the 1950s as fishermen, tourist outfitters and guides utilized aircraft for easier access to the lake. This increase in fishing pressure may have been the reason for stocking brook trout in 1951 and 1956. By the late 1950s the average weight of retained trout was under 0.9 kg (2.3 kg in late 1940s). From 1962 to 1969 a tourist business operated with an average of 150 fishermen visiting the lake per season. A logging road was completed in 1967 and resulted in a winter fishery. A standard lake inventory was completed in 1967 and a total of 166 brook trout were sampled with one year old fish representing 74% of the catch.

GREENE, C. W. 1951. Results from stocking brook trout of wild and hatchery strains at Stillwater Pond. Transactions of the American Fisheries Society 81 : 43-52.

In 1948 and 1949, 1,000 fingerling brook trout of a wild strain and 4,500 fingerlings of a hatchery developed strain were stocked in Stillwater Pond, a 55 acre pond in Putnam County, New York. All fingerlings were fin clipped for recognition. Returns from plantings in both years followed similar patterns. Yields from the wild strain were disproportionately low in the first season after planting and disproportionately high in the second season. Field observations indicated that individuals of the two groups were consistently different in appearance and generally could be separated by characteristics of body shape and color. Length-weight data, expressed as condition factors, illustrate morphological differences in trout of the two groups after they had been in the pond for 18 months. Angling returns indicate that better angler satisfaction may be obtained here from stocking trout of both strains together than from stocking either one alone. It is concluded that differences in these two strains of trout as exhibited in this situation are hereditary (racial) and are of sufficient magnitude to be important in management of a brook trout fishery.

GREEN, D. M., Jr. 1962. Stamina and behavior in relation to survival of domestic and wild brook trout (*Salvelinus fontinalis*) in current. M.Sc. Thesis, Cornell University, Ithaca, New York. 101 p.

GREEN, D. M., Jr. 1964. A comparison of stamina of brook trout from wild and domestic parents. Transactions of the American Fisheries Society 93 : 96-100.

The object of this investigation was to measure the limits in the ability of three groups of brook trout to swim against a current. One domestic strain (Berlin) and two wild strains (Honnedaga Lake and Long Pond Outlet) were used in the current experiment. Stamina tests were conducted at water velocities of 1.9 and 1.5 feet per second. Ten fish of a group were tested at a time with five replicates or a total of 50 fish for each trial in each of the two flows. Larger fish have greater swimming ability. The principal difference in swimming ability is between the two wild stocks and the domestic stock. The observed differences in performance in these stamina trials could also be attributed to genetic differences. Behavioral differences in the rearing troughs might also tend to produce wild fish with more stamina.

GUTHRIE, R. C., J. A. STOLGITIS, and W. L. BRIDGES. 1973. Pawcatuck River watershed fisheries management survey. Division of Fisheries Report, Rhode Island Department of Natural Resources. 59 p.

Return rates for spring plantings of rainbow trout, brook trout, and brown trout were approximately three times as great as those from fall plantings. Marginal trout streams contained large numbers of suckers and fallfish.

HALE, J. G. 1952$_a$. Results from plantings of marked yearling brown trout (*Salmo trutta*) in the Sucker River and west branch of the Split River, and marked yearling brook trout (*Salvelinus fontinalis*) in Sucker River, Minnesota, 1951. Investigational Report No. 118, Minnesota Department of Conservation, St. Paul, Minnesota. 11 p.

An equal number of fin clipped adult brown trout (1,000 fish) and adult brook trout (1,000 fish) were released in the Sucker River in the spring of 1951. On the same date, 800 fin clipped yearling brown trout were stocked in the West Branch of the Split Rock River. The contribution to the catch during the subsequent fishing season was determined by creel census and angler postal card reports. Marked brown trout returned to the creel from these streams made up from 2.5 to 4.0% of the entire trout catch. Marked brook trout, on the other hand, composed 16% of the entire catch from the Sucker River. The catch of marked brook trout represents a survival to the creel of 43% of the marked brook trout stocked. The brown trout survival to the creel was 10% in these streams.

Bud Creek, a tributary to the West Branch of the Split Rock, was also censused in 1951. This stream was stocked with unmarked fingerling brook trout.

Length-weight data on the two species of marked trout caught from the Sucker River indicated that marked brook trout were larger on the average than “resident” brook , but marked brown trout, on the other hand, were smaller on the average than “resident” brown trout.

The majority of marked trout returned to the creel were caught within three quarters of a mile of the site of planting.

It was concluded that from a planting of an equal number of both trout species that adult brook trout yield a much larger return (43%) to creel than adult brown trout (10%). In the Sucker River, brook trout stocking is necessary to maintain a population of catchable-sized fish.

The brown trout population of catchable-sized fish in this stream maintains itself without artificial stocking. Therefore, the brown trout stocking quota should be converted into a comparable number of brook trout. since approximately 50% of the marked brook trout were caught in May and no marked trout were caught after July, it is advisable to stock 50% of the quota in May, 25% in June and 25% in July.

HALE, J. G. 1952$_b$. An investigation of survival to the creel from three plantings (April, June, July) of marked yearling brook trout (*Salvelinus fontinalis*), catch of “resident” fish and of trout populations in the West Branch of the Split Rock River, 1952. Investigational Report No. 132, Minnesota Department of Conservation. 11 p.

In 1952, anglers (856) caught 5,007 trout of which 87% (4,374 fish) were unmarked from the West Branch of the Split Rock River. This demonstrates that the Split Rock raises the majority of the fish caught from it. Stocked brook trout, however, appear to have a role in that their survival to the creel is high (about 80%) and their size is superior to that of resident fish.

The survival of marked brook trout to the creel was the highest attained from any marked trout stocking study ever conducted on north shore streams. Since the Split Rock River was the only stream in which the marked trout plantings were split into more than one planting, it appears that this method of stocking is responsible for a higher survival. Other factors such as fishing pressure and stream conditions may also have affected the high survival. It is recommended, on the basis of the high survival of hatchery trout in the West Branch of the Split Rock River, that the present stocking procedure be continued and carried out on other trout streams; i.e., 50% of the annual stocking quota of yearling trout should be stocked prior to the opening of angling season and the remaining 50% should be stocked in two plantings of an equal number of fish, the early part of June (25%) and July (25%).

HALE, J. G. 1954. Regeneration of pelvic fins on fingerling brook trout following fin clipping. Minnesota Division of Fish and Game, St. Paul, Minnesota. 4 p.

HARKNESS, W. J. K. 1940. Catches of speckled trout from the plantings of hatchery-raised fish in private waters of Ontario. Transactions of the American Fisheries Society 70 : 410-413.

Records have been kept for a number of years of plantings and catches of speckled trout in three small privately controlled lakes in Ontario. These records are presented and have afforded information on productivity and magnitude of the populations.

HARKNESS, W. J. K., F. E. J. FRY and R. R. LANGFORD. 1945. Report on planting of hatchery fish in the waters of Algonquin Park. Ontario Fisheries Research Laboratory Report. 2 p.

HARTLEB, C. F. and J. R. MORING. 1994. Interspecific competition and dietary overlap between nonsalmonid fishes and stocked brook trout. p. 96 *In* Proceedings of the Annual Meeting of the American Fisheries Society, Halifax, Nova Scotia. (Abstract Only).

Over 130 Maine lakes are stocked with spring yearling, hatchery-reared brook trout each year. A large number of the lakes stocked are considered marginal waters due to the poor survival of these stocked brook trout. Interspecific competition and dietary overlap between brook trout and nonsalmonid species are believed to cause the poor survival and growth of the trout. This study examined the food consumption and dietary overlap of the nonsalmonid species to document what interactions existed prior to the stocking of trout. Largemouth bass and chain pickerel had similar diets (C = 0.95; C = diet overlap coefficient), while yellow perch, pumpkinseed sunfish and brown bullheads shared many food items (yellow perch vs pumpkinseed sunfish C = 0.59; yellow perch vs. brown bullheads C = 0.95). Stocking of trout into lakes that have dietary competitors may limit the survival and growth of the trout if the trout compete for the same food resource. Competition between piscivores may lead to poor trout survival if the piscivores utilize the trout as a new food source. Further studies will examine these possible outcomes following the stocking of brook trout.

HARTZLER, J. R. 1977. An analysis of angler effort and the catch of one- and two-year old hatchery trout on Spring Creek (Centre County), Pennsylvania. M.Sc. Thesis, Pennsylvania State University.

Creel census and angler use counts were conducted on the 4.8 km (3.0 mile) Penintentiary section of Spring Creek, Centre County, Pennsylvania, in 1976. The study began on the first day (April 17) of the trout season and continued for 65 days. Five stockings (one pre-season and four in-season) of one and two year old brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) and one year old brook trout (*Salvelinus fontinalis*) and Palomino rainbow trout were made. Each age of trout in each stocking was given an identifying fin clip prior to planting. In addition, electrofishing surveys were done before the pre-season stocking and after the study was terminated to estimate the resident trout population.

Eventual estimates of harvest which were calculated using a modification of the Delury technique indicate that 77% of the 6268 stocked trout were caught by anglers. Returns of yearling brook, brown and rainbow trout were 83, 77 and 74 per cent, respectively. Eighty-three per cent of the 4131 trout in the pre-season stocking were captured while 60-77 per cent of those planted during the season were caught.

In each stocking, brook trout displayed the highest catchability (instantaneous fishing mortality rate) of the three species. The catchability of all three species increased with each successive in-season stocking. The per cent harvest of brook and brown trout from each plant also rose, whereas that for rainbow trout declined. Returns for brook and brown trout seemed to be related to their catchability while the catch of rainbow trout was determined by angling intensity. In general, brook trout were caught most rapidly, followed by rainbow trout and brown trout showed the greatest longevity.

Nearly 25% of the total angler effort during the study was expended on opening day when 43% of the pre-season stocking was captured. Sixty-three per cent of angler effort occurred on weekend days. Fishing pressure rose noticeably on in-season stocking days but the estimated harvest of trout stocked on these days was only 8-14%.

Although each stocked trout provided more than three hours of angling recreation, the quality of fishing, as measured by the catch per hour, was low; the mean catch per hour for the entire study period was 0.192. Mean daily catch per hour for all trout rose above 0.50 on just two of the 65 days and this occurred on low effort days (less than 150 angler hours).

The electrofishing surveys showed that trout densities were higher prior to the pre-season stocking than after the study was completed. Twenty-six of the 46 trout collected in the post-study survey had been planted in 1976. There was no evidence of natural reproduction of trout in the study area.

Management suggestions for this section of Spring Creek include:

- More frequent stockings of fewer trout to distribute angler effort more evenly throughout the season and prevent "truck anticipating". Plants should precede weekends when records show fishing intensity to be greatest.
- Increase the proportion of brown trout in each subsequent planting. This species showed not only higher returns with each successive in-season stocking but provided more recreation by contributing to angler harvest for a longer period of time than either brook or rainbow trout.
- Adjust the stocking rates to anticipated fishing pressure. Heavier stockings, however, may not increase the catch per hour substantially.
- Extend the closing date of the sucker fishing season to the pre season trout stocking date. This would provide anglers with added recreation time and increased opportunity to harvest a portion of the abundant sucker population.

HAVEY, K. and D. LOCKE. 1976. Evaluation of a brook trout (*Salvelinus fontinalis*) brood stock developed through selection to provide progeny of great longevity. Final Report, Project F-27-R, Maine Department of Inland Fish and Wildlife. Augusta, Maine.

A control strain exhibited greater survival than the Tomah Lake strain, a line selectively bred for longevity. Neither strain survived in significant numbers past age 1+. Predation by large salmonids may have masked the potential for longevity in the Tomah Lake strain.

HAVEY, K. A. and D. O. LOCKE. 1980. Rapid exploitation of hatchery-reared brook trout by ice fishermen in a Maine lake. Transactions of the American Fisheries Society 109 : 282-286.

An intensive ice fishing creel census was operated at Eagle Lake, Bar Harbor, Maine, during February and March 1977 to evaluate angler catch from 5,400 age 1+ brook trout (*Salvelinus fontinalis*) stocked on 1 November 1976. A Leslie population estimate indicated 1,556 brook trout survived from stocking to the start of the season on 1 February. Between 1 and 6 February an estimated 1,587 stocked fish were taken during 742 angler trips (4.2 trips per hectare). Only 121 brook trout were caught from 7 February to 31 March in 706 angler trips. Estimated total catch for the season was 1,708 trout, of which 92% were taken in 6 days during the first week of the season. Only 22 of these fish were caught in the open water season of 1977. Near total exploitation early in the ice fishing season is indicated. Stocking of hatchery-reared brook trout to provide winter recreation in special situations is feasible.

HAZZARD, A. S. and D. S. SHETTER. 1938. Results from experimental plantings of legal-sized brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo irideus*). Transactions of the American Fisheries Society 68 : 196-210.

An intensive creel census in conjunction with monthly releases, during the fishing season, of legal-sized trout, approximately one-half of which were jaw tagged or fin clipped, furnished data for the evaluation of such plantings in the Pine River, Michigan. Nearly 8,500 hours of fishing yielded 3,171 brook trout and 3,333 rainbow trout for an average catch of 0.77 fish per hour. Forty-six per cent of the brook trout reported and 21 per cent of the rainbows were from these plantings. Incomplete records of the marked fish showed recovery of 19.8 per cent of 7,513 brook trout and 17.5 per cent of 4,007 rainbows planted. The catch per hour by weekly periods ranged from 0.32 to 1.35. The average catch per hour for the Pine was considerably higher than for the other streams that were covered by a similar census but not planted with large fish. The plantings influenced the catch for a period of from two to three weeks. Apparently few of these fish survive to the next season. Movement of planted fish was mainly upstream regardless of the method of planting. Within two weeks the fish which remained were uniformly distributed over the stream. "Spot" planting resulted in a larger percentage caught than did scattering by boat, but increased "meat fishing". Every planting during the open season caused a decided rise in the catch of wild fish of the same species. It is concluded that although planting legal fish during the season temporarily and artificially increases the catch, it may deplete a stream of wild adults. This depletion will affect natural production and may result in poorer fishing in succeeding years. A program for planting legal-sized trout appears justified only in heavily fished waters incapable of supporting a permanent trout population during the summer or where no results from natural reproduction are possible, or where an overpopulation of stunted trout exists.

HELFRICH, L. A. and W. T. KENDALL. 1982. Movements of hatchery-reared rainbow, brook and brown trout stocked in a Virginia mountain stream. Progressive Fish Culturist 44 : 76-80.

During May 1979, 1061 catchable-sized, hatchery-reared rainbow trout (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*) were tagged and stocked in pool and riffle habitats in Big Stony Creek, Giles County, Virginia. Of this total, the movement patterns of 275 recovered trout were determined through voluntary tag return and creel census information. Most (75%) of the trout were recovered within 1 km of their respective release sites; 16% remained within the initial stocking locations. Most of the recaptured brook trout (69%) and rainbow trout (59% were recovered downstream, whereas brown trout (69%) moved primarily upstream. The median dispersal distances for brook trout (195 m downstream) and rainbow trout (60 m downstream)were not significantly different from one another, but were significantly different ($P < 0.001$) from that of brown trout (90 m upstream). Although trout stocked in pools generally exhibited less movement than those stocked in riffles, the type of stream habitat into which the trout were introduced had no significant effect on the distance or direction of dispersion of the three species.

HELFRICH, L. A. and B. R. MURPHY. 1982. Stocking sportfish in Virginia ponds: Methods and commercial supply sources. Publication 420-009, Cooperative Extension Service, Virginia Polytechnic and State University, Blacksburg, Virginia.

HILL, M. 1990. Nova Scotia's recreational fishery management plan. Inland Fisheries Division, Nova Scotia Department of Fisheries and Aquaculture. Pictou, Nova Scotia.

Nova Scotia's fish stocking program is designed for one of the following objectives:

1. Urban Recreational – where catchable sized fish are stocked in high demand areas.
2. Enhanced Hatchery – domestic fish are stocked to meet high angler expectation in areas that have been historically stocked with these fish.
3. Enhanced Hatchery – in some situations to maintain a high level of genetic diversity in previously stocked areas with enhancement to meet angler demand.

Several impacts of stocking are recognized. These include hatchery impacts (i.e., learned behavior, ease of capture), genetic impacts (i.e., inbreeding, swamping of parent population), and physical impacts (competition, social behavior, etc.)

HOLLOWAY, A. D. 1945. Summary of trout stocking experiments. Fishery Leaflet 137, U. S. Department of the Interior, Fish and Wildlife Service, Chicago, Illinois.

This leaflet attempts to summarize and evaluate stocking experiments with trout. The results of planting various sizes at different seasons of the year are given. The proper planting rate in relation to available food is not measurable from the data collected. It is well known, however, that an increase in the density of planting usually results in greater survival only up to a certain point beyond which it decreases as intensity of stocking is increased. If stocking rates were based on the number of trout or competitors already in the waters we should expect better survival. From the experiments reported on survival and recovery, it is obvious that "winter kill" is a very important factor that must be considered in trout planting. Recovery rates from fingerling brook trout plantings have been low ranging from 0.0-0.8%.

The experiments with legal length trout were apparently made with little consideration of the number of pounds of fish already present and in some cases with too little consideration of the fishing pressure. Where fishing pressure is heavy in relation to the available numbers of legal length trout planted and the number of native fish available in the stream, the recovery of legal length spring and summer planted trout has been correspondingly higher. As with fingerlings, the introduction of legal length trout in streams in sufficient numbers to cause severe competition results in poor recovery. Recovery rates from legal-sized brook trout plantings have ranged from 4.4-92.0%.

HOOPER, W. A. 1966. Stocking brook trout with the aid of plastic bags. File Report, Ontario Department of Lands and Forests, Sault Ste.Marie, Ontario.

Experiments were carried out at the Tarentorus Trout Rearing Station to check the possible advantages of adopting the plastic bag method for transporting brook trout. The results were sufficiently favourable to warrant using this system in the 1966 spring planting program in the Sault Ste. Marie District.

The fish were loaded at a ratio of 16.5 pounds graded brook trout yearlings to 23.5 pounds chilled water with the remainder of the plastic bag (23" x 36" x 4 mil) filled with pure oxygen. By using this method of transport and rate of loading, the maximum weight of fish per Otter aircraft load was increased from 7,200 to 20,000 brook trout yearling and the actual flying time was reduced from 65 hours, 5 minutes to 11 hours, 30 minutes. In addition to the saving in weight and time, numerous other advantages were noted. According to the pilots there was no excess water spillage in the aircraft and no uncomfortable changes in the center of gravity due to movement of water during turbulence. The aircraft is readily available should emergencies arise as it is not loaded down with bulky tanks, trays, cylinders and tubing . The fish carried well and total observed mortality was negligible.

HOOVER, E. E. and M. S. JOHNSON. 1937. Migration and depletion of stocked brook trout. Transactions of the American Fisheries Society 67 : 224-227.

The data seem to indicate that the best results will be obtained from brook trout plantings in heavily fished New Hampshire streams if the fish are well distributed throughout the brook and if small repeated open season plantings are made instead of fall and early spring plantings.

Most of the tagged trout were caught downstream from the point of stocking but the last few were taken upstream from the place where they were planted. Trout planted at intervals along the brook were not caught out as quickly as those which were liberated in large numbers at one place. In both Bear Brook and Moose Brook, fishing grew poorer from the beginning of the season in May until it was revived by stocking in June. In both brooks, maintenance of fishing appears to depend on repeated stocking. There is nothing in the data to indicate that the catch of trout in Bear Brook in 1936 was increased by the stocking in the fall of 1935. Although stocking in these brooks is necessary to provide good fishing, “fisherman’s luck” still plays a big part in determining the catch.

No attempt is made to explain the migration of the trout downstream, but it is believed that the situation may be entirely different at some other time of the year.

HOPELAIN, J. S. 2000. Strategic plan for trout management. Draft document, California Department of Fish and Game, Sacramento, California. 21 p. + appendices.

Policies adopted by the California Fish Game Commission relating the stocking as a component of trout management include:

- Stocking fingerling and sub-catchable sized trout shall take priority over planting catchable-sized trout in the hatchery stocking program when smaller fish will maintain satisfactory fishing.
- Hatchery trout shall not be stocked in waters where they may compete or hybridize with trout which are threatened, endangered or species of special concern.
- Catchable-sized trout shall be stocked only in lakes, reservoirs and streams where natural production and growth are inadequate to maintain populations capable of supporting fishing.
- Catchable-sized trout shall be stocked only when it is reasonable to expect at least 50% by number or weight will be taken by anglers.
- When stocking catchable-sized trout, lakes and larger streams shall have priority over smaller streams.
- Subcatchable-sized trout may be stocked in lakes, reservoirs and streams where appropriate to augment trout populations in such waters to increase fishing opportunities and success.
- Fingerling sized trout shall be stocked primarily in waters where reproduction is limiting and satisfactory angling can be supported with fingerling stocking where the population has been destroyed and in lakes where they will establish a new fishery or augment the existing fishery.
- Domestic strains of catchable-sized trout shall not be planted in designated wild trout waters.

HUGHSON, D. R. 1968. Sudbury District brook trout stocking by helicopter. p. 20-22 *In* Resource Management Report No. 96, Ontario Department of Lands and Forests.

Helicopters were utilized to distribute brook trout to small lakes unsuitable for landing by a fixed wing aircraft. All plantings were made before noon. Fish were carried in double plastic bags measuring 24" x 36”. Approximately 2 gallons of water with 500 yearling brook trout were put into each bag. Cardboard boxes measuring 14" x 16" x 24" were placed on the carrying racks of the helicopter and two plastic bags of fish were stood upright in each of these. This meant that we could easily carry 4,000 fish per load. On short trips, by putting more fish to the bag, we were able to carry up to 6,000.

The total cost of planting 41,000 yearling brook trout in fifteen lakes was $1,112 for 10 hours and 20 minutes of time with the G4 helicopter. While, compared to using a fixed wing aircraft, an increased cost of $700 is quite high (1.7 cents per fish) we feel the probably increased survival and return to the angler justifies the expenditure. If this method is to be continued, it is recommended that light plywood boxes be built for the carrying racks on the helicopter since it would speed up the loading and unloading.

HUGHSON, D. R. and G. M. STASSEN. 1971. Follow-up report on reclamation of Mud Lake, Trill Township. File Report, Ontario Ministry of Natural Resources, Sudbury, Ontario. 3 p.

Mud Lake was reclaimed in the spring of 1970. Prior to reclamation the catch-per-unit-effort (CUE) on Mud Lake was extremely low (below 0.4 fish per rod hour). It was felt that the perch population was the causative factor for the decline in this fishery. As a result planting was curtailed. In September, 1970, 3,000 brook trout (18 months old) were planted. They were approximately 15 per pound and all had the left pectoral fin clipped. They were carried to the lake in plastic bags with water, ice and oxygen (15 pounds water and 10 pounds fish). In January and February, 1971, 106 anglers were checked on Mud Lake during 14 census days. They fished for a total of 326 hours and caught 360 brook trout. The fish caught ranged from 8-11 inches in length (they were 5-7 inches when planted). The fishery had declined markedly in February and it was felt that the population had been reduced to the point where fishing was no longer profitable and anglers stopped going to Mud Lake. The calculated pressure and harvest indicated 311 anglers fishing for 993 hours and harvesting 1,041 brook trout.

HUNT, R. L. 1979. Exploitation, growth and survival of three strains of domestic brook trout. Fisheries Research Report 99, Wisconsin Department of Natural Resources. Madison, Wisconsin.15 p.

Three strains of domestic brook trout (*Salvelinus fontinalis*) were stocked in three study lakes at 15-16 months of age. All three strains proved to be so vulnerable to angling that too few survivors were present after six months to warrant continuation of the study. Although some statistically significant differences were found in exploitation, growth and survival between strains, replacing the standard Osceola strains with the New Hampshire or Assinica strains to improve field performance of stocked brook trout is not justified.

IHSSEN, P. E., M. J. POWELL, and M. MILLER. 1982. Survival and growth of matched plantings of lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*), and lake x brook F_1 splake hybrids and backcrosses in northeastern Ontario lakes. Ontario Fisheries Technical Report Series No. 6, Ontario Ministry of Natural Resources, Toronto, Ontario. 12 p.

Matched plantings of lake trout (*Salvelinus namaycush*), F_1 splake hybrids and lake trout backcrosses, and brook trout (*Salvelinus fontinalis),* F_1 splake hybrids and brook trout backcrosses were made annually in four small northeastern Ontario lakes for three successive years. The relative performance of the three different crosses in each lake was assessed by gillnetting in the fall, for seven consecutive years. F_1 hybrids were recovered at rates two to three times greater than the backcrosses, brook trout or lake trout, from all lakes, except one, where only one lake trout to 346 F_1 hybrids was recovered. The number of kg recovered per kg planted ranged from 2.5 to 4.4 for the F_1 hybrids, 0.3 to 1.3 for the backcrosses, and 0.0 to 1.0 for the brook trout and lake trout. The first planting gave the best returns, both in terms of numbers and kilograms recovered; the middle plant, the poorest. The growth rates, recoveries, and condition factors were correlated among crosses, lakes and plantings. The plantings, crosses, or lakes that gave the highest returns also gave the fastest growth rates and the largest condition factors. The F_1 hybrids from the two lakes that gave the fastest growth and highest rates of return matured significantly earlier in life (50% mature at about age 2.5 to 3.0, sexes combined) than those from the two lakes with the slower growth and lower returns (age 3 to 3.5).

INDIANA DEPARTMENT OF NATURAL RESOURCES. 1999. Indiana fish stocking guidelines – Responsible use of introduced fish. Division of Fish and Wildlife. Indianapolis, Indiana. 4 p.

There are several considerations and criteria for determining fish stocking activities. These include:

- Some documentation of public support for new stocking.
- Ecological considerations including fish movements, habitat/niche availability, genetics, forage base, species interactions and potential for reproduction of stocked fish.
- Past fish stocking history of waterbody.
- Contaminants – recognizing the value of both fishing and consumption opportunities.
- Fish availability in terms of hatchery production capability.
- Economics in terms of an evaluation of costs with expected angler benefits.

ISLEY, J. J. and C. KEMPTON. 2000. Influence of costocking on growth of young-of-year brook trout and rainbow trout. Transactions of the American Fisheries Society 129 : 613-617.

We examined the effects of costocking on growth of hatchery-produced young-of-year brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss*) in the laboratory. Fry of both species (brook trout = 0.16 ± 0.01 gm; rainbow trout = 0.18 ± 0.01 gm; mean weight ± standard deviation) were stocked into 400 L recirculation raceways at a rate of 100 fish/raceway and were held at 12º C. Raceways received either rainbow trout only (N=3), brook trout only (N=3) or half brook trout and half rainbow trout (N=3). Trout were fed a commercial trout feed three times per day at an initial rate of 10% body weight/day, which was reduced to 3% body weight/day by the 6^{th} week of the study as a result of a buildup of excess feed. After 8 weeks of similar treatment, brook trout were significantly larger than rainbow trout (in terms of length and weight) when they were stocked alone. However, rainbow trout were significantly larger than brook trout (in terms of length and weight) in the costocked treatment. A second phase of the study was conducted to evaluate the effect of ration level on growth of costocked brook and rainbow trout using low (2% body weight/day), medium (4% body weight/day) and high (6% body weight/day) ration levels. After 8 weeks, rainbow trout were significantly larger than brook trout (in terms of length and weight) in all costocked feeding treatments. This suggests that behavioral interaction might have resulted in decreased growth of brook trout when they were costocked with rainbow trout.

JACKSON, B. 2000. Atikokan fish stocking activities, 1990-99. File data, Ontario Ministry of Natural Resources, Atikokan, Ontario. 3 p.

Brook trout were introduced to South Crook Lake in 1994 in order to establish a self sustaining brook trout fishery for diversity of road accessible angling opportunities and to reduce effort on local lake trout fisheries. A lake inventory was completed before the introduction. No small fish of any kind were found.

An average of 4,333 brook trout yearlings were stocked annually in South Crook Lake between 1994 and 1999 (inclusive). This represents a stocking rate of 91- 136 fish ha^{-1}. Brook trout were reared at the Dorion fish culture station near Thunder Bay.

Assessment to date has been based on the collection of volunteer creel data from angler diaries. These records indicate that brook trout up to 2.7 kg have been angled.

JESIEN, R. V. and D. W. COBLE. 1979. Contribution of stocked, legal-sized trout to the sport fishery of three small Wisconsin lakes. Fisheries Management 10 : 139-145.

Legal-sized trout stocked in spring in three lakes in Wisconsin, USA, provided a short term, popular sport fishery. Frequently, half or more of the stocked fish were caught in the first month of the fishing season and few were caught thereafter. Separate estimates of the percentage of numbers (and weight) returned in the first month of the fishing season were 46 (47), 73 (76), 62 (113), and 31 (22) for rainbow trout (*Salmo gairdneri*) and 64 (81) for brook trout (*Salvelinus fontinalis*). Most anglers interviewed at two of the lakes were fishing primarily for trout including in one case 95% of the anglers interviewed over the 9 month season, even though the trout fishery persisted for less than 2 months. Fishing pressure also was highest at the opening of the angling season and declined exponentially thereafter. Of an estimated total of 7,906 angler hours in one lake, 67% occurred in the first month of the season and 79% in the first two months. Because the trout were harvested rapidly, relatively little of the productive capacity of the lakes were channelled into production of trout flesh. Therefore, the stocked trout provided a put-grow-take fishery at little expense to the existent warmwater fishery.

JOHNSON, M. G. 1964. Production of brook trout in eight Ontario farm ponds. Progressive Fish Culturist 26(4) : 147-154.

Brook trout (*Salvelinus fontinalis*) populations were studied in eight Ontario farm ponds located north of Toronto. Growth, survival, standing crops, and harvests were estimated after stocking. At the time of stocking in 1959, the fingerlings measured 2.4 inches and yearlings were 6.5 inches in length. Stocking rates of fingerlings averaged from 850 to 2,750 per acre and averaged 1,540 per acre in six ponds. Yearling were stocked in two ponds at rates of 150 and 1,000 per acre.

The rate of stocking did not appear to have affected the survival of trout in the study ponds. Production was influenced by the age of trout, the presence or absence of coarse fish and the magnitude of the standing crop. Angling success was influenced more by the standing crop of trout than by the amount of fishing effort expended.

In view of the general decrease in production after the trout reached age 1 – a decrease caused by decreased growth rate, continuous moderate mortality and no reproduction – harvest methods should be directed toward obtaining the maximum yield of yearling and two year old trout. Since a non-reproducing population of older trout usually cannot attain the standing crop that it once reached as fingerling or yearling stock, it should be harvested and more stocks added. In waters where average growth and survival of trout have occurred, the restocking probably should be done in alternate years.

JOHNSON, M. W. 1978. The management of lakes for stream trout and salmon. Special Publication Number 125, Minnesota Department of Natural Resources, St. Paul, Minnesota.

The introduction and maintenance of populations of stream trout or salmon in lakes almost always depends on annual stocking since the spawning habitat required by salmonids is rarely found. Assuming that fishing pressure and regulations remain constant, the number and size of trout creeled can be regulated by four factors: time of stocking, size of fish stocked, strain of trout and stocking rate. The cost and availability of trout must also be considered in stocking plans.

Trout and salmon are usually stocked either in the spring or in the fall (preferably October) because of high summer surface water temperatures. Stocking lakes during winter ice cover is not recommended because of the difficulty in tempering fish to low temperatures. Substantial mortality has been noted in wintertime plants in Minnesota lakes. Fingerling trout stocked in the fall are subject to only a short period of predation before freeze up and fish surviving to the following spring are apparently not as seriously reduced by avian or mammal predators. If the fall stocked fish are too small to be retained by the angler at the beginning of the season, the fishery will depend on older fish during early season and recruited fish from the fall stocking later in the season. Fishing success will be relatively uniform throughout the summer. If the fall stocked fish are large enough to be acceptable to the angler the following spring, an early season fishery will result with few fish available after June or July. To remedy this situation, it is recommended that a combination stocking of catchable or nearly catchable size fish with smaller three to five inch fingerlings be made in the fall. The smaller fish should recruit to the angler later in the summer and replace the depleted fish.

The fishery manager usually has the choice of stocking spring fingerlings, fall fingerlings or yearlings. Because spring fingerlings are subject to high mortality from bird predators for nearly the entire open water season and fall fingerlings are exposed for only a short time, the fall fingerlings usually show good survival and attain a significant weight gain in the lake. Yearling stocking is an expensive practice and the fish are usually removed by anglers during the first summer in the lake. In Minnesota, it has been found when brook or rainbow trout are stocked at a size of 100 to the pound or smaller there is usually substantial mortality. It is therefore recommended that fingerlings larger than this be used for any stocking.

The number of fish to be stocked per unit of lake area depends on species, size of fish, productivity of the lake, time of year stocked, expected intensity of fishing pressure, cost and availability of fish and the mechanical problems of hauling and stocking the fish. Ideally, stocking rates should be governed by biological factors, but budget limitations and production capabilities often necessitate modifications in stocking plans. Stocking recommendations are based on recorded returns to the creel from various stocking rates used in Minnesota lakes over the past twenty years. Brook trout available for planting in the fall are smaller than rainbow trout and should be stocked at a higher rate. Small (> 100/lb.) fingerling brook trout should be planted at rates of 200-300 (lightly exploited lakes) up to 500 fish acre^{-1} (heavily exploited lakes). Large fingerlings (10-100/lb.) should be planted at rates of 150-200 fish acre^{-1} in lightly exploited lakes to rates up to 400 fish acre^{-1} in heavily exploited lakes. Brook trout yearlings (< 10/lb.) should be planted at rates of 100-150 fish acre^{-1} in lightly exploited lakes to rates of 250 fish acre^{-1} in heavily exploited lakes.

JOHNSTON, D. R. 1965. Public fishing ponds for trout. Ontario Fish and Wildlife Review 4(1) : 18-24.

The development of intensively managed public fishing areas is a relatively recent innovation by the Department of Lands and Forests in southern Ontario. One such public trout fishing area in southern Ontario is a five acre pond on the Provincial Forestry Station near St. Williams in Norfolk County. As part of the program to stimulate better use of land and waters in public ownership, this pond was rejuvenated to create better trout fishing conditions. This involved deepening the pond, constructing an island and reconstructing the banks. The pond was stocked with 3,500 7-13 inch brook trout prior to the opening of the 1963 trout season on April 27. Creel census information collected on the opening weekend indicated that more than 1,300 anglers fished in St. Williams pond harvesting over 1,500 of the 3,500 fish stocked. Some of the 3,500 trout (during a sudden rainstorm a week before the opening) escaped over the dam when it was partially opened to relieve the flood threat to it.

It was estimated by Forestry Station personnel that more than 22,000 angler days were spent at the pond during the 127 day trout fishing season in 1963. Fishing pressure was extremely heavy during late April, May and early June when an average of 340 persons utilized the pond daily. As the summer progressed, the number declined to as low as 30 per day during late August. In total, over 5,300 of the 7,100 trout stocked were harvested. Sixty-seven per cent of the trout planted in late April and May were harvested within two weeks with a total recovery of 76.6% over the entire season. Of the fish planted in June, 44% were harvested in two weeks and 64% by the end of the season. The highest return to the angler was 86% of 1,000 trout planted during early May and the lowest was 63% of 600 planted during mid June.

JOSEPHSON, D. C. and C. C. KRUEGER. 1995. Contributions of hatchery brook and rainbow trout and native brook trout to the Moose River fishery. p. 11-12 *In* 1995 Annual Report of the Adirondack fishery research program, Department of Natural Resources, Cornell University, Ithaca, New York.

An angler diary study was conducted on the South Branch of the Moose River during the 1995 angling season. The objectives of the study were to compare the catchability, survival and yield of stocked brook trout, and to determine the relative abundance of stocked and wild brook trout.

Of the 500 brook trout stocked from the Fernwood Hatchery, 26.4% of these were caught over the season from the river. A slightly lower percentage catch (21.2%) was recorded for the 1000 brook trout stocked from the Little Moose Hatchery.

No differences between brook trout and rainbow trout occurred in terms of their relative contributions to catch in proportion to the numbers stocked. Of the 500 rainbow trout stocked, 24.0% were caught over the season as compared to 22.9% of all brook trout stocked (1500 fish total).

Unmarked brook trout, presumably from natural reproduction in the tributaries, provided an important contribution to the overall fishery. A total of 581 brook trout were caught during the season of these 190 trout or 32.7% were unmarked and thus of wild origin.

In conclusion, the species stocked (brook or rainbow trout) and hatchery origin (Little Moose or Fernwood) caused little variation in angler catch. Based on this assessment, a mix of stocked brook and rainbow trout will provide similar returns to anglers under the current management practice of stocking catchable trout in the Moose River.

JOSEPHSON, D. C. and W. D. YOUNGS. 1996. Association between emigration and age structure in populations of brook trout (*Salvelinus fontinalis*) in Adirondack lakes. Canadian Journal of Fisheries and Aquatic Sciences 53 : 534-541.

The historic range of brook trout (*Salvelinus fontinalis)* in the Adirondacks has been significantly reduced with most present day populations restricted to small (<80 ha) headwater lakes. To mitigate the loss of natural brook trout populations, a fall fingerling stocking program has been implemented to maintain or supplement 90% of the existing brook trout populations in Adirondack lakes. The purpose of this study was to evaluate emigration and its possible effect on brook trout populations in several Adirondack lakes.

Patterns of emigration by brook trout from five Adirondack lakes indicated a synchronized, repetitive response to seasonal stimuli over a 13 year period. Emigration occurred in the spring and fall with virtually no movement in the winter and summer. Spring emigration coincided with peak runoff from snowmelt and consisted of small numbers of mostly yearlings (94.8% of emigrants). Large scale emigration from four lakes (32.7-68.8% potential losses from populations) by mostly mature fish (94.6% of emigrants) coincided with the spawning season for brook trout. Fall emigrants were likely searching for spawning sites which were limited or unavailable within the lakes. In a larger set of 14 lakes, the greatest proportion of older (age 3) brook trout occurred in lakes with no outlets, which prevented emigration. In drainage lakes with outlets present, the proportions of older fish in lakes with later maturing strains (age 2-3) were greater than in those with earlier maturing strains (age 1-2). Larger age at maturity would have delayed fall emigration from these lakes. Fall emigration appears to be a major factor that causes the virtual absence of older brook trout in many Adirondack lakes and must be assessed in future population dynamic studies.

KELLER, W. T. 1979. Management of wild and hybrid brook trout in New York lakes, ponds and coastal streams. Bureau of Fisheries Report FW-P148, New York State Department of Environmental Conservation, Albany, New York. 40 p.

This document presents a 15 year program plan and operational policies to guide Department of Environment Conservation efforts in managing wild and hybrid strains of brook trout in New York lakes, ponds and coastal streams.

Recent (1978) management of brook trout ponds called for the stocking of about 438,560 fall fingerling brook trout in 346 ponds of 10,472 acres surface area. Approximately 74,380 spring yearling brook trout were to be stocked in 91 additional ponds with about 2,881 acres surface area and also in some ponds that receive plants of fall fingerlings.

The apparent ability of wild and hybrid brook trout to spawn in waters where domestic brook trout had not spawned previously indicates the need for flexibility in establishing stocking rates and sportfishing regulations. Abundance of naturally reproduced trout can cause overcrowding and poor growth. This may become a serious problem in underfished populations and stocking on top of an already dense population of fish is wasteful. Stocking rates should reflect the new stocking criteria. A water should be monitored for natural reproduction two or three years after the stocking of wild or hybrid strain fish in order to ascertain spawning success. Shoreline seining or visual observation in late spring and early summer are easy means for determining reproductive success, but population estimation is the only way to quantify natural recruitment.

KELLER, W. T. 1972. Comparative angling contributions provided by wild, hybrid, and domestic trout in Black Pond, New York. New York State Division of Fish and Game. 13 p.

KELLER, W. T. and D. S. PLOSILA. 1981. Comparison of domestic, hybrid and wild strains of brook trout in a pond fishery. New York Fish and Game Journal 28 : 123-137.

The survival and harvest of stocked fall fingerling brook trout of domestic, hybrid and wild strains were compared in a pond where the fishery was managed by regulations that permitted the use of worms as bait and allowed a daily creel of 10 trout of any size. The performance of the hybrid and wild strains was generally superior to that of the domestic strain. It was concluded that allowing the use of artificial lures only should decrease hooking mortality among sub-legal fish and provide an increased harvest of older and larger trout as well as additional sport through the catch and release of sub-legal fish.

KELSO, J. R. M. and M. A. SHAW. 1995. Annual biomass and production of brook charr (*Salvelinus fontinalis*) introduced into a historically fishless lake. Ecology of Freshwater Fish 4 : 47-52.

Brook charr 15 months old were introduced in 1985 into one of two self-contained basins of Batchawana Lake, Ontario, Canada, where they survived and reproduced. Population survival rates (ages ≥ 1) remained high (> 50%) from 1986 to 1992. Annual growth rates peaked (G_x = 3.1) the year following their introduction and remained between 0.8 and 1.6 thereafter. Brook charr biomass (B) was highest, ≅ 55 kg ha^{-1}, in 1987 and 1990 and production (P) gradually declined from 80-90 in 1986-1987 to ≅ 30 kg ha^{-1} $year^{-1}$ in 1990-1991. Initial high P:B ratios for brook charr, ≅ 30, declined and stabilized to ≅ 1.3 in the third year after introduction.

KENNEDY, W. A. 1941. Instructions for planting fish in Algonquin Park south. Ontario Fisheries Research Laboratory Report. 10 p.

KERR, S. J.. 1979. A critical assessment of planted brook trout yearlings in six selected study lakes, Wawa District. File Report, Ontario Ministry of Natural Resources, Wawa, Ontario. 44 p.

The results of a three year stocking evaluation, by test netting, are presented. Recovery rates of planted brook trout (*Salvlinus fontinalis*) were found to range from 2.1% to 8.4% of the total number planted. Catch-per-unit-of-effort (CUE), based on the number of fish captured per one hundred feet of gill net, varied from 0.04 to 4.94 for brook trout. Survival rates of planted brook trout, based on population estimates, ranged from 2.2 to 9.9%. Possible factors responsible for the poor survival of planted brook trout are discussed. The average contribution of hatchery-reared brook trout to the total brook trout population was calculated to be 95.4%. Data regarding growth, size of sampled fish, and state of sexual maturity are presented. Sampling and assessment techniques are outlined and recommendations for improvement are offered.

KERR, S. J. 1980. Assessment of yearling brook trout (*Salvelinus fontinalis*) plantings in three selected lakes, Wawa District. File Report, Ontario Ministry of Natural Resources, Wawa, Ontario. 32 p. + appendices.

Experimental gill netting was carried out on three local lakes in order to assess the success of spring plantings. Brook trout catch-per-unit-of-effort (CUE) varied from 0.86 to 3.25. Planted brook trout comprised from 90.0% to 94.2% of the total estimated brook trout population. Based on netting results, survival estimates ranged from 1.9% in Souloup Lake to 11.7% in Doc Greig Lake. Growth rates and condition factors revealed that Doc Greig Lake brook trout were largest and most robust while those from Souloup Lake were in poorest overall condition. Influencing variables, reasons for poor survival and management implications are discussed.

KERR, S. J. and R. E. GRANT. 2000. Brook trout – Potential interactions and impacts. p. 137 *In* Ecological Impacts of Fish Introductions: Evaluating the Risk. Ontario Ministry of Natural Resources, Peterborough, Ontario. 473 p.

Brook trout are territorial in nature although this behavior is usually not as pronounced as in other salmonids. Competitive interactions among fish species may be partially temperature regulated. For example, at temperatures less than 20º C brook trout were competitively equal or superior to other resident fishes but lost their competitive advantage at water temperatures exceeding 22º C. Brook trout have been found to dominate over rainbow trout in stream habitats with lower water velocities, in pools, in areas close to cover and at colder water temperatures.

Some of the most serious impacts of brook trout have been documented in midwestern North America. The introduction of brook trout has been associated with the disappearance of Yellowstone cutthroat trout and Lahontan cutthroat trout in the western United States. Within five years of finding brook trout above a barrier protecting a native cutthroat trout population in Colorado, the cutthroat population was extirpated. It has been concluded that brook trout would eventually eliminate golden trout if stocked with that species. Predation and competition with brook trout was identified as a range limiting factor for Apache trout in Arizona. In Montana, introduced brook trout now inhabit approximately 40% of bull trout streams and are thought to be replacing the species through the process of hybridization.

Brook trout are known to predate on the eggs of other salmonids including lake trout, steelhead and other brook trout. Brook trout have also been known to impact the invertebrate community. The introduction of brook trout into two fishless Adirondack lakes resulted in the rapid reduction of several aquatic insect assemblages.

Finally brook trout are known to be a host for numerous parasites and are known to hybridize with at least six other salmonid species including Arctic charr, brown trout, bull trout, Kokanee salmon, splake and lake trout.

KERR, S. J. and S. K. TAYLOR. 1981. 1980 brook trout (*Salvelinus fontinalis*) stocking assessment in Nancy and Ward lakes, Wawa District. File Report, Ontario Ministry of Natural Resources, Wawa, Ontario. 37 p.

Standard brook trout stocking assessment gill netting conducted on Nancy and Ward lakes revealed an estimated 2.6% and 1.5% survival rate, respectively, of yearling brook trout planted approximately four months earlier. Brook trout were netted in greatest frequency in 5-10 feet (1.6-3.0 m) of water utilizing 2 inch (5.1 cm) and 2.5 inch (6.4 cm) gill net. Assessment gill netting is estimated to have removed 86.4% and 68.8% of the brook trout populations from Nancy and Ward lakes, respectively. Age 1+ hatchery-reared brook trout were estimated to comprise 59.1% of the total brook trout population in Ward Lake but only 44.7% in Nancy Lake. Planted brook trout were characterized by relatively good growth rates accompanied by early maturation. The capture of two age 0+ native brook trout would tend to indicate that limited natural reproduction is occurring in Nancy Lake. The continuation of brook trout planting at reduced densities in Nancy Lake is recommended. Discontinuation of brook trout plantings in Ward lake is advised due to the documented abundance of a recently introduced yellow perch population. The introduction of rainbow trout to establish an alternate coldwater fishery is suggested.

KRUEGER, C. C. and B. W. MENZEL. 1979. Effect of stocking on genetics of wild brook trout populations. Transactions of the American Fisheries Society 108(3) : 277-287.

The study was undertaken to evaluate the long term genetic impact of maintenance stocking upon wild brook trout (*Salvelinus fontinalis*) populations in Wisconsin. Trout were collected from streams of the Wolf and Fox River drainages and from the Osceola State Trout Hatchery. The stocking histories of the streams ranged from unstocked to heavily stocked for many years. The planted fish consisted primarily of fingerling and catchable brook trout and brown trout (*Salmo trutta*). Blood plasma and whole eye homogenate samples were analyzed electrophoretically for transferrin (Tf) and lactate dehydrogenase (Ldh-B2) systems. Esterase was monomorphic in all samples but Tf and Ldh displayed genetic polymorphism. The occurrence of several Tf A/A phenotypes among wild fish is notable because previous genetic studies considered the combination to be lethal. The hatchery stock was genetically distinct from most wild populations at both loci. Variation of Tf allelic frequencies among wild populations suggested an undisturbed natural geographic pattern. There were significant correlations between Ldh-B2 allelic frequencies and stream stocking histories, however, with the wild type allele decreasing in importance as stocking intensity increased. This relationship does not seem to reflect interbreeding between wild and hatchery trout. Rather, it may indicate alteration of selective pressure induced by ecological interactions between the two stocks.

KUEHN, J. H. and R. E. SCHUMACHER. 1957. Preliminary report on a two year census on four southeastern Minnesota trout streams. Investigational Report No. 186, Minnesota Department of Conservation, St. Paul, Minnesota. 41 p.

A creel census was conducted on four southeastern Minnesota trout streams over a two year period. Electrofishing population estimates were made before and after each season. A two way fish weir was installed at the lower end of one stream to measure migration into and out of the stream. Stocked trout made up 51% and 79% of the catch in each of the two respective years. Returns varied from 29.7% to 72.8% among the various streams and brown and rainbow trout which were stocked in equal numbers contributed almost equally to the catch. A natural mortality of 40% was found for brook brown and rainbow trout stocked. The streams having the best number of trout available per angling hour provided the highest rate of catch. Downstream movement resulted in a loss to the stream of 5.3% of the stocked trout and consisted mostly of rainbow and brook trout. Sixty-seven (67) per cent of fall stocked brown trout were lost before the angling season began.

KWATEROWSKY, P. A. 1962. 1961 creel census on selected Kapuskasing District waters. File Report, Ontario Department of Lands and Forests, Kapuskasing, Ontario.

During recent years approximately 40 lakes have been surveyed, found suitable for speckled trout and subsequently planted with this species. The introduction of speckled trout was a complete success not only as far as the survival rates are concerned but also in regard to their excellent growth rates as indicated by specimens scaling 7 pounds and more, two and three years after introduction.

In an effort to evaluate the contribution of these introductions to the local fishery a creel census was initiated in the summer of 1961. Log books were issued to each Conservation Officer as well as tourist outfitter camps and local Park attendants. Data was obtained for a total of 636 anglers. Of this total, 454 anglers (71.4%) fished 2565 hours or 76% of all rod hours for speckled trout. The remaining 182 anglers (28.6%) spent a total of 784 hours (24%) for the capture of pike and pickerel. Each angler spent an average of 5.6 hours seeking speckled trout. Based on information from a total of 15 stocked lakes, anglers spent an average of 3.2 hours to catch a fish (0.36-9.0), averaged 1.7 fish per angler (0.6-10.4) and the average size of angled trout was 15.5 inches (7-18 inches).

The rate of capture for speckled trout does not reflect a true average picture as data were collected from the latter part of June through August, at a time when speckled trout fishing is very poor. It was evident that, in more accessible lakes (Arnott, Hart, Little Hart) the introduced speckled trout did not have an opportunity to grow to respectable sizes because of more intensive fishing pressure due to the favorable accessibility. It is strongly recommended that during the ensuing years, a concerted effort be made to obtain more fishing data for specific lakes and areas to lay the foundation for appropriate fisheries management plans for studying the survival rates, utilization and preference of particular trout waters.

LACHANCE, S. and P. MAGNAN. 1990$_a$. Performance of domestic, hybrid, and wild strains of brook trout (*Salvelinus fontinalis*) after stocking: The impact of intra- and interspecific competition. Canadian Journal of Fisheries and Aquatic Sciences 47 : 2278-2284.

Wild and hybrid strains of brook trout (*Salvelinus fontinalis*) showed better rates of recovery (by angling) and yield (kilograms of fish recovered per kilogram planted) than a domestic strain, during the two years following planting in six small oligotrophic lakes on the Laurentian Shield. Native brook trout and white sucker (*Catastomus commersoni*) had a significant impact on planted brook trout. Recovery, per cent of increment in weight and yield of each planted strain were inversely correlated with (1) the relative abundance of native brook trout, and (2) the occurrence of white sucker, supporting hypotheses of intra- and interspecific competition. Furthermore, the response variables were also inversely correlated with the number of potential competitors, indicating that the impact of native brook trout and white sucker was additive. The recovery in number of planted trout (both years and all strains) was approximately four times higher in lakes with effectively no competitors than in lakes containing both white sucker and native brook trout; the increase in weight was nearly three times higher, and the yield was more than nine times higher. The performances of planted fish were intermediate in the lake containing only native brook trout as a competitor.

LACHANCE, S. and P. MAGNAN. 1990$_b$. Comparative ecology and behavior of domestic, hybrid, and wild strains of brook trout (*Salvelinus fontinalis*) after stocking. Canadian Journal of Fisheries and Aquatic Sciences 47 : 2285-2292.

Two years after planting in six small oligotrophic lakes, domestic, hybrid, and wild strains of brook trout (*Salvelinus fontinalis*) used space and food resources in the same way as native trout. Although trout living with or without white sucker (*Catastomus commersoni*) were similarly spatially distributed, they had different diets, suggesting a feeding niche shift of trout in the presence of sucker; we concluded that this shift is under phenotypic control because each planted strain came from similar genetic backgrounds. Sexual maturity was related to the size of individuals, regardless of the strain, and males matured before females. Almost all males and females were sexually mature in the first fall after stocking except wild females (3.0 and 75% matured during the first and second fall, respectively). Gonadosomatic indices (GSI) of domestic and hybrid females were similar during the first fall but the GSI of domestic females was significantly higher than that of hybrid and wild strains in the second fall. Mean egg diameters were similar among the three strains during the two falls but fecundity of domestic females, after correction for size differences, was significantly higher than that of hybrid females which, in turn, was significantly higher than that of wild ones.

LAROCHE, A. L. 1979. The impacts of stocking hatchery-reared trout on the native brook trout population of two streams in central Virginia. M.Sc. Thesis, Virginia State University, Blacksburg, Virginia. 183 p.

LAROCHE, A. L. and G. PARDUE. 1978. Impacts of stocking catchable-size hatchery trout on the native brook trout populations of two streams in central Virginia. *In* Abstracts of Papers Presented at the Brook Trout Workshop, December 5-8, 1978, Asheville, North Carolina.

A two year study to determine the impacts of stocking catchable-size, hatchery-reared brook trout (*Salvelinus fontinalis*), rainbow trout (*Salmo gairdneri*) and brown trout (*Salmo trutta*) on populations of native brook trout was conducted on the North and South Forks of the Tye River in Nelson County, Virginia. Areas investigated included changes in population structures due to stocking hatchery trout; harvest of native brook trout during periods of heavy fishing pressure; and competition for food among native brook trout and hatchery trout.

Population estimates of native brook trout during 1977 and 1978 revealed no significant ($\alpha > 0.75$) population changes between stocked areas and unstocked areas in both rivers. There were highly significant ($\alpha > 0.01$) shifts in population densities in all areas of both streams on a seasonal basis as the result of severe droughts in the summers of 1977 and 1978. The average number of native brook trout per 50 meters of stream dropped 76.5% (±12.4%) and 78.3% (±15.6%) in both the North and South Forks, respectively, from the summer of 1977 to the spring of 1978. A considerable percentage of this reduction in numbers was the result of little or no reproduction during the fall of 1977 resulting in essentially no young-of- the-year in 1978. A similar reduction of less magnitude took place in the number of native brook trout per 50 meters of stream from the summer of 1978 to the fall of 1978 after the second summer of severe drought.

Creel surveys indicated that native brook trout contributed little to the total harvest of trout during periods of extremely heavy fishing pressure. However, contribution to the harvest on a percentage basis generally increased as fishing pressure decreased. Catch per unit effort (number per hour) figures for native brook trout were considerably higher in unstocked areas than in stocked areas of both streams during times of heavy fishing pressure. Creel surveys also indicated that hatchery trout contributed heavily to the catch for only a short period with dramatic decreases in fishing pressure shortly after stocking. This was especially true after “follow the truck” stockings.

Food habit analysis on trout from both streams during the spring of 1978 indicated that hatchery trout and native brook trout feed primarily on the same food items. Hatchery trout, however, consumed fewer organisms per fish than did native brook trout and appeared to be less selective, often consuming great quantities of wood, hemlock needles, and insect exuviae.

LATTA, W. C. 1963. Semiannual estimates of natural mortality of hatchery brook trout in lakes. Transactions of the American Fisheries Society 92(1) : 53-59.

Mark-recapture estimates of the number of hatchery-reared brook trout (*Salvelinus fontinalis*) have been made each April and October since October 1956 in Ford Lake (10 acres) and Hemlock Lake (6 acres), at the Pigeon River Trout Research Station, Vanderbilt, Michigan. Fish were captured by angling, by trapping with wire traps, and by shocking with direct current at night with underwater lights. A permit-type creel census insured a nearly complete record of the catch.

Instantaneous mortality rates and conditional mortality rates were calculated for each year class. The largest natural loss of trout occurred during the first summer after planting. The rate of natural mortality during summer decreased with a decrease in the number of trout present each spring. Overwinter loss was negligible. The causes of the mortality are unknown.

LIIMATAINEN, V. A. 1988. pH depression in transport tank water during transfers of brook trout (*Salvelinus fontinalis*) from Tarentorus Fish Culture Station, a soft water hatchery. File Report, Fish Culture Operations, Ontario Ministry of Natural Resources, Maple, Ontario. 8 p.

An investigation was conducted in May of 1988 to determine the extent and duration of pH depression during transport of fish from the Tarentorus Fish Culture Station, a soft water hatchery near Sault Ste. Marie, to Wawa, Ontario. A better understanding of pH changes during transport in soft water may lead to modifications in transport techniques with the ultimate goal of improving long term survival of fish. During both sampling runs, pH dropped quickly in the first hour and then gradually recovered over the next 6-8 hours. The slow steady rise in alkalinity and conductivity was likely related to the release of ions and other waste matter by fish. Dissolved oxygen declined 1.5 to 4.4 mg L^{-1} during the first two hours of transport and then gradually recovered to near saturation levels. Neutralization of transport water with sodium bicarbonate should be considered as a means to offset the pH depression observed during fish transport. A second aerator could also be installed on a tank on a trial basis to determine if a higher rate of exchange of dissolved carbon dioxide with the atmosphere could be achieved.

LISKAUSKAS, A. and N. QUINN. 1991. Stocking assessment studies on brook trout and splake in the Algonquin Park district, 1986-1990. File Report, Ontario Ministry of Natural Resources, Whitney, Ontario. 33 p. + appendices.

The survival of planted brook trout and splake in Algonquin Park district lakes were assessed over a six year period. Brook trout and splake were both recovered from a majority of the lakes in which they were stocked (82 and 100% respectively). Brook trout and splake did not differ significantly ($P > 0.10$) in size after almost two years of growth. The mean percentage recovery and CPUE for splake (1.9%; 4.4 fish/gill net set) was much higher than that for brook trout (1.05%; 1.61 fish/gill net set). The variability in fish size and the number of fish recovered per lake was high within both the brook trout and splake assessment lakes.

For the twenty-eight brook trout lakes, correlation and regression analysis revealed that the size and condition factor of recovered fish was greater on average in lakes where the mean size of planted fish was smaller and where simple fish communities were present. For the splake lakes, the number of fish recovered from a lake was positively correlated with stocking density and negatively correlated with lake maximum depth.

Brook trout and splake stocking assessment lakes differed in their assessment protocol as well as in several important biotic and abiotic variables which confounded comparisons between the two data sets. It was also noted that an increase in gill net effort in both the brook trout and splake lakes had a pronounced effect in reducing gill net variability.

LOCK, F. E. 1966. The use of catchables in relation to habitat. *In* Proceedings of the 46th Annual Conference of the Western Association of State Game and Fish Commissioners, Buett, Montana.

In the state of Oregon we try to release catchables at from 3-5 fish per pound., In general, catchable trout planted in streams are available in numbers for a period of about two weeks. After the second week, few hatchery trout are seen in the creel. A large percentage of the trout are caught within a few miles of the liberation site.

Experiments conducted in four stream systems show that anglers harvested from 20.9-35.6%. The average return or tagged trout in the second summer was only 1.4%

The obvious future increase in population makes it imperative that catchable trout programs be continued. In order to enhance such programs, it will be necessary to thoroughly evaluate trout returns, continue to search for lower production costs, improve the hatchery product, design release schedules which will provide the greatest return and encourage more anglers to fish for sport rather than for a limit of trout.

LOFTUS, D. H. and C. J. BRADY. 1986. The Meach lakes brook trout fishery, 1981 to 1985. Haliburton-Hastings Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Bancroft, Ontario. 46 p.

Creel surveys were conducted on Meach Lake (42 ha) and Little Meach Lake (30 ha) in north Hastings County continuously from the spring of 1981 through the winter of 1985. Results indicate that the lakes jointly support an exceptionally good fishery for native brook trout. Average annual fishing effort amounts to 65 hrs/ha/year on Meach Lake and 82 hrs/ha/year on Little Meach Lake. Yields of native brook trout from the two lakes have averaged 3.19 kg/ha/year and 0.66 kg/ha/year, respectively. Yields of hatchery-reared brook trout planted in the lakes averaged 0.51 kg/ha/year and 0.66 kg/ha/year, respectively, and represent returns of 13.6 to 44% by weight of the fish planted. In this instance, stocking is unnecessary.

The native brook trout population exhibits an annual mortality rate of about 90%. The mean age of harvested fish is 29 months. The mean age at first maturity (Lysak's formula) is 27.2 months. Sixty per cent spawn for the first time in their second year. The growth rate is moderate: the average fork length of 4 year old fish is 37 cm. Available data suggest this population is fished very heavily. Although brook trout yields greatly exceed those recommended by SPOF working group 12, they seem consistent with those from other productive fisheries.

Recovery rates for the three plantings for which complete data are available ranged from 1.2% to 14% by number and from 13.6% to 44% by weight. Returns appear to vary directly with size at planting. It appears that the practice of planting hatchery-reared brook trout in the Meach Lakes is not warranted either by a need for supplemental production or by good returns of planted fish. Our tentative view is that plantings may, in fact, be detrimental in cases such as this where good populations of native brook trout are present. The presence of large numbers of hatchery fish may result in increased competition among young brook trout. Successful spawning by hatchery fish may also lead to dilution of the native gene pool. Most important, though, is the possibility that the known presence of hatchery fish attracts anglers to lakes thereby increasing pressure on native brook trout.

LUDWIG, B. 1995. British Columbia's trout hatchery program and the stocking policies that guide it. American Fisheries Society Symposium 15 : 139-143.

In 1993 817,000 brook trout were stocked in a total of 118 British Columbia waters. The main reason for stocking fish is to provide a harvestable product to meet the demand for angling opportunities. Most stocked lakes are high productivity, high-use lakes in the southern portion of the province and these lakes generally do not support wild populations. Under the Wild Indigenous Fish Policy, stocking is permitted only if there has been a previous history of stocking or if it can be carried out without compromising wild stocks. Unstocked lakes must be inventoried before fish stocking will be considered.

The experience in British Columbia indicated that the key to protecting wild stocks is a waters classification system that includes a no stocking designation and a system that requires all fish transplants to be reviewed by an independent committee.

MacCRIMMON, H. R. 1960. Observations on the standing trout populations and experimental plantings in two Ontario streams. Canadian Fish Culturist 28 : 45-55.

Studies were made on two small southern Ontario trout streams representing two common but dissimilar types of streams stocked annually with hatchery-reared speckled trout. The trout population of Stream A was dependent entirely on these plantings. Stream B supported a substantial population of native trout. Standing resident trout populations at the opening of the trout season were 0.01 and 0.13 fish per yard in the respective streams. Spring plantings of yearling hatchery-reared trout increased these populations to a density of 0.02 and 0.15 trout per yard, respectively, but contributed nothing directly to the legal sized trout population (fish 7" or over) of approximately 0.01 trout per yard in both streams.

Five plantings of advanced fingerlings or yearling trout at densities of 0.01 to 0.09 fish per yard resulted in the establishment in the streams of from three per cent to 53 per cent of those trout planted. The natural overwinter repopulation of Stream B by trout from neighboring waters proved more efficient in re-establishing a trout population than did an autumn planting of 200 advanced fingerling fish. The annual re-stocking policy for this stream with adequate natural reproduction was observed to be an unnecessary and perhaps harmful practice. Studies in Streams A and B point out the necessity of an ecological basis for fish planting programs.

Studies in Streams A and B indicated that legal length limits (7" total length in Ontario) serve no useful purpose in the management of southern Ontario trout streams but rather may limit the potential harvest of both native and planted trout.

MacCRIMMON, H. R., J. E. STEWART and J. R. BRETT. 1974. Aquaculture in Canada: The practice and promise. Bulletin 188, Fisheries and Marine Service, Department of the Environment, Ottawa, Ontario.

Freshwater aquaculture in Canada dates back to 1857. Samuel Wilmot has been acclaimed as the progenitor of systems of fish culture which have persisted in Canada and other countries until the present time. In addition to pioneering the volume production of locally available Ontario salmon, eastern brook (speckled) trout and lake (salmon) trout, Wilmot was the first Canadian to culture rainbow trout and Pacific salmon beyond their native range.

Private aquaculture of the late 19th century was concerned principally with salmonid production and several commercial hatcheries were constructed at the same time, if not before, the first efforts of Samuel Wilmot. By 1870, one facility, operated by David Brown and located at Galt, Ontario, carried a brood stock of some 10,000 parent brook trout besides fry and fingerlings. Other private Ontario hatcheries in operation before the turn of the century were at Redickville, Alton and Hillsburg annually rearing between 60,000 and 70,000 brook trout each.

MacFIE, J. A. 1957. Fish planting in Gogama District. File Report, Ontario Department of Lands and Forests, Gogama, Ontario. 3 p.

Speckled trout occur naturally in parts of the district particularly in northern rivers. Speckled trout planting was stepped up during the period from 1953-56 and this species accounts for most of our stocking. It has been distributed in increasing quantities since aerial planting came into use. This new technique laid open for planting a great number of small, clear lakes. In 1956, 46 waters were stocked with speckled trout - about half of them for the first time. A good rate of success has resulted from earlier introductions and some phenomenal rates of growth have taken place in these virgin waters. If only one-quarter of the lake stocked to date produced the district will have more than enough speckled trout to meet the present demand which is not great due to the still small volume of tourist traffic and an apparent reluctance on the part of these lake dwellers to take bait. We have trout of better than four pounds in lakes that, so far as is known, have never had a line in them. We, therefore, have reduced our speckled trout requirements for the next five years to less than half the number handled in 1956 and an effort will now be made to assess the results of introductions made so far. A number of lakes were tested in 1955 and 1956 and we have already had nets in four lakes this spring.

MacKAY, H. H. Undated$_a$. Fish management in Ontario with special reference to the role of hatcheries. Unpublished manuscript, Ontario Department of Lands and Forests, Toronto, Ontario. 6 p.

During the past thirty years considerable research has been carried out on this continent and throughout the world on the results of planting hatchery-reared stock. The stocking of fingerling or sublegal brook trout in suitable ponds and lakes in which natural reproduction is either lacking or inadequate is an economical and generally successful method of providing good fishing, under heavy angling pressure. As evidence of this, the experiment conducted by Mr. James Gage, biologist of the Lake Huron district, may be cited. Marked sublegal trout were planted in Eugenia Pond and Williams Lake in Grey County with a high rate of survival and excellent conditions for growth.

Annual planting of fingerling trout properly assessed while it does not ensure heavy opening day catches, as may be provided by planting legal-sized trout, appears to provide a more economical and a more natural type of fishing and probably makes the best use of the lake's food supply according to extensive research by biologists in the State of Michigan. They have found, also, that so far as small lakes are concerned that 80% to 94% of legal-sized trout planted are taken out the opening weekend.

Unsuccessful plantings of fingerling trout have been recorded because of the presence of warm water fish such as bass. In such cases, the planting of larger trout is recommended.

Sublegal brook trout have been introduced to suitable waters not formerly inhabited by them, for example, to lakes in the Sudbury District. With these we may include introductions to barren lakes, that is lakes barren of fish but not of food, or to lakes where replacement of exterminated species is desirable or to newly created waters or to a suitable niche in a lake.

Stocking of fingerling or sublegal trout in streams in attempts to maintain natural trout populations and to produce trout for the angler's creel has been definitely discredited. Stocking legal-sized trout in streams subjected to heavy fishing pressure has given results. Stocking of small fingerling trout at any time adds little (about 1.16% return from experimental plantings in Michigan) to the angler's catch in streams having suitable conditions for natural reproduction. It has been found that even after heavy fishing, a sufficient brood stock may be left to fully seed the waters with all the trout that the stream can support. Evidence of this has been shown by finding an abundance of wild trout fry in the spring of the year in feeder streams and in suitable areas along the margins of large trout streams. A few hatchery fingerlings may survive to reach the angler's creel but they do so, it is believed, at the expense of an equal number of wild trout because of the competition for food and shelter. In general, there is good evidence to show that natural reproduction in streams provides the backbone of trout fishing in these streams.

To meet the demands of heavy fishing pressure especially in less productive streams near metropolitan centres, stocking of large-sized trout would seem to be the only solution, otherwise there would be little if any trout fishing. The means by which this method of stocking may be affected is an important consideration. A number of states of the United States stock legal-sized trout for the purpose of providing higher fish yields than the streams will naturally supply. This kind of planting is called "put and take" because under heavy fishing pressure the contribution that is made is of short duration. In Michigan streams, it has been found that after 40 days only 4% of the brook trout remain. Less than 1% of the trout caught in the season planted contributed to the catch in subsequent years. In other words, survival over winter is negligible.

MacKAY, H. H. Undated$_{b}$. Fishing waters of Ontario Departmental restocking or fish cultural programme. File Report, Ontario Department of Lands and Forests, Toronto, Ontario.

All Ontario waters to be restocked are to be surveyed by the district biologist to determine their suitability for the particular species concerned as to temperature of waters, availability of food, presence of other species with which they may come in competition either to the detriment of those being stocked or of those being present. Consideration is given to the number of stocked fish so that they will be adequate to meet the requirements but not in such numbers as to create overcrowding and stunting. In many parts of Ontario, waters with no game fish are stocked with speckled trout as appears suitable from the surveys.

MANITOBA DEPARTMENT OF NATURAL RESOURCES. 1988. An evaluation and revision of Manitoba's fish stocking strategy and implementation plan. Fisheries Branch, Winnipeg, Manitoba. 27 p.

A small but significant demand for brook and brown trout exists in Manitoba. Brook trout production has been a problem due to poor water quality and the high susceptibility of this fish to disease. This is reflected in the erratic performance of this fish in terms of hatchery production. Buying brook trout eggs was not an option as commercial hatcheries don't generally deal in brook trout due to their high susceptibility to disease. Moreover, the costs of purchasing eggs could not be covered on top of the costs of maintaining a brood stock.

Brook trout yearlings appear to be sufficient to meet the vast majority of requests for brook trout. Brook trout production will fall short until 1994 at the Whiteshell hatchery and likewise until 1993 at Grand Rapids. Efforts will be made to improve this situation through securing sufficient brood stocks in 1991.

MARKS, D. R. 1979. Brook trout and rainbow trout test netting program, 1977 and 1978. File report, Ontario Ministry of Natural Resources, Ignace, Ontario. 34 p.

During the summers of 1977 and 1978, a total of fourteen lakes were test netted in order to evaluate the brook trout and rainbow trout stocking program in the Ignace area. The program was conducted to determine survival of planted fish, examine growth rates of stocked fish and determine if any natural reproduction was occurring. From the lakes surveyed it is evident that natural reproduction of brook trout is taking place in Big Butler and Big Snowstorm lakes. The stocking of brook trout in these lakes should be discontinued. There is also the possibility that natural reproduction of brook trout is occurring in Reguly Lake. This should be determined before any future stocking program is carried out. Good survival and growth rates of stocked brook trout were evident in Berglund, Hakli, Krisko, O'Dell, Little Bulter, Little Snowstorm and McLaurin lakes. These lakes should continue to be stocked with brook trout and managed to provide artificial fisheries. The 1975 plant of 20,000 brook trout fry in Emerald Lake was a complete failure. The 1978 stocking of 2,000 yearling fish should be closely monitored to determine if any future stocking should take place. The brook trout population in Shrimp Lake appears to be suffering from competition for space with the white sucker population in the lake. A lake reclamation program should be carried out before any future stocking of brook trout occur.

MARNELL, L. F. 1986. Impacts of hatchery stocks on wild fish populations. p. 339-347 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management, Fish Culture and Fisheries Management Sections, American Fisheries Society, Bethesda, Maryland.

This paper deals exclusively with impacts of hatchery-reared game fishes upon wild fish populations. Salmonids are emphasized because they are the dominant hatchery products.

- Impacts of hatchery-reared sport fish on wild fish populations may be summarized as follows:
- Introduction of pathogens and parasites;
- Hybridization, introgression and intergradation;
- Trophic alteration through predation, cannabilism and competition for food;
- Spatial alterations (e.g., territorial shifts, altered dominance hierarchies, stress and aggression and altered movements);
- Altered growth and survival characteristics; and
- Displacement, replacement and extinction.

MARTIN, N. V. 1953. The creel census and fish management in Algonquin Park. Ontario Department of Lands and Forests, Whitney, Ontario.

For many years hundreds of thousands of speckled trout fry were planted in lakes throughout Algonquin Park with little or no success. In later years the policy has been to plant specific lakes in which the environmental conditions would indicate a better chance of survival. In general, yearling trout have been stocked. These plantings have been found to be particularly successful in small lakes where no game fish are known to exist.

MASON, J. W., O. M. BRYNILDSON, and P. E. DeGURSE. 1967. Comparative survival of wild and domestic strains of brook trout in streams. Transactions of the American Fisheries Society 96(3) : 313-319.

Survival and growth of progeny of domestic, domestic x wild, and wild strains of brook trout (*Salvelinus fontinalis*) were compared after these trout were released during the fall as fingerlings 9-10 months old in selected sections of streams. One group of the wild strain was hatched and reared in the wild. Other groups were hatched and reared in the hatchery. The domestic strain had the highest overwinter survival in three of the five streams. In only one stream did the wild strain have the highest overwinter survival. In the four streams investigated in the fall, the wild strain had the highest summer survival. Survival of the domestic and domestic x wild strains through the summer fishing season was generally too low to evaluate survival of these strains through the second winter. The domestic strain grew most rapidly in the hatchery followed by the domestic x wild strain. The growth advantage was not maintained after release into streams. Brook trout of the domestic strain were harvested early in the fishing season and did not contribute to the late season catch, whereas the domestic x wild and wild strains were harvested throughout the fishing season.

MATKOWSKI, S. M. D. 1989. Differential susceptibility of three species of stocked trout to bird predation. North American Journal of Fisheries Management 9 : 184-187.

Piscivorous birds can remove substantial proportions of stocked salmonids from lakes. To determine whether susceptibility to bird predation differs among trout species, 321 brook trout (*Salvelinus fontinalis*), 330 rainbow trout (*Oncorhynchus mykiss*), and 321 splake (*Salvelinus namaycush* x *S. fontinalis*) were stocked in a small lake in Duck Mountain Provincial Park, Manitoba, in spring 1982. Principal avian predators were common loons (*Gavia immer*) and great blue herons (*Ardea herodias)* which together averaged 1.5 visits per day to the lake from June through October. No post-stocking mortality was observed; the primary cause of mortality appeared to be birds. Intensive gillnetting in fall 1982 and spring 1983 produced 41 rainbow trout, 138 brook trout, and 173 splake. The pelagic habits of rainbow trout make them most susceptible to bird predation; brook trout, which stay nearer the substrate, and splake, which prefer deep areas, would be more difficult for birds to see and capture.

McCRACKEN, G. F., C. R. PARKER and S. Z. GRIFFEY. 1993. Genetic differentiation and hybridization between stocked hatchery and native brook trout in Great Smoky Mountain National Park. Transactions of the American Fisheries Society 122(4) : 533-542.

Starch gel electrophoresis was used to examine the protein products of 34 presumptive loci in nine populations of brook trout (*Salvelinus fontinalis*) from Great Smoky Mountains National Park and in two brook trout hatchery strains that were derived from northeastern U.S. populations and used extensively for stocking in the southern Appalachian Mountains. Five of the streams sampled had not been stocked and presumably contained only native brook trout. Three other streams contained native populations but also had been stocked and the remaining stream originally was devoid of natives and presumably contained only introduced brook trout. Mean genetic similarity was high among the native populations (I = 0.985 ± 0.017 SE) and among the hatchery derived populations (I = 0.986 ± 0.003). Mean genetic similarity between the native populations and hatchery stocks was 0.906 ± 0.024. These results are consistent with previous studies suggesting that native brook trout in the southeastern United States are taxonomically distinct from northeastern brook trout. Genotypes at diagnostic loci demonstrate that introgressive hybridization has occurred between hatchery and native trout in all three stocked populations. Average individual heterozygosity was lowest in the native populations (H_o = 0.025), highest in the hatchery stocks (H_o = 0.112) and intermediate in the stocked populations (H_o = 0.053).

McDERMOTT, L. A. and A. H. BERST. 1968. Experimental plantings of brook trout from furunculosis infected stock. Journal of the Fisheries Research Board of Canada. 25(12) : 2643-2649.

Preliminary sampling revealed the presence of furunculosis disease in the resident brook trout population of the southern Ontario trout stream used in this study. Two plantings of marked yearling brook trout were made in the study area in 1966; one in the spring and the other in the fall. The spring planting consisted of 1000 brook trout with a predetermined incidence of furunculosis infection and an equal number of trout with no evidence of infection. The fall planting consisted of 2000 brook trout with a known incidence of furunculosis. The stream was electrofished periodically during the two year period after the first planting. A total of 445 brook trout (140 of the planted hatchery stock and 305 resident trout) and 127 fish of associated species were captured and examined for the presence of *Aeromonas salmonicida*, causative agent of furunculosis. Recovery rates of the infected and noninfected stocks of brook trout were similar and there was no evidence of transmission of *A. salmonicida* from the infected fish to the control fish, nor the resident population of brook trout and other species of fish captured.

McDONALD, D. G., M. D. GOLDSTEIN, and C. MITTON. 1993. Responses of hatchery-reared brook trout, lake trout, and splake to transport stress. Transactions of the American Fisheries Society 122 : 1127-1138.

The stress of routine transport practices on hatchery-reared brook trout (*Salvelinus fontinalis*), lake trout (*Savelinus namaycush*), and splake (*S. fontinalis* x *S. namaycush*) was evaluated by measuring changes in plasma levels of the stress hormone cortisol, the key stress metabolite glucose, and the plasma electrolytes Na^+ and Cl^-, and by measuring net ion and ammonia exchanges with the water in the transport tanks. We examined actual trips and standardized net confinement stress in the laboratory to quantify differences in stress response among the species. Brook trout were the least sensitive to both transport stress and net confinement, and responded in a similar fashion to both treatments. Splake responded to transport like brook trout but were the most sensitive to net confinement. Species differed most in their ability to maintain ion exchanges with the water under stress. Lake trout experienced ion losses during transport that were about 10 fold higher than losses from brook trout and splake. Trip duration (3.5-11 hours) had only a minor effect on physiological responses and wide variations in loading density (6.9-17 kg/100 L) had no significant effect. Increasing O_2 levels in the water (due to oxygenation rather than aeration of the tanks) proved to be moderately stressful to brook trout, based on elevations in plasma cortisol levels. Our results permit an evaluation of the relative contribution of different transport variables to the transport sites imposed on salmonids.

McKEOWN, W. J. 1970. McConnell Lake area creel census, 1969-1970. File Report, Ontario Department of Lands and Forests, North Bay, Ontario. 18 p.

The McConnell Lake area is comprised of four townships (McAuslan, Wyse, Parkman and LaSalle) which lie northwest of the Village of Thorne. There are approximately 16 lakes in the area producing brook trout, rainbow trout pickerel, bass and lake trout. Results of 51 creel census days during the summer of 1969 and winter of 1970 in the McConnell Lake area showed 745 anglers fished a total of 1,965 hours for a catch of 1,179 fish. Total catch consisted of 800 brook trout, 108 lake trout, 252 pickerel, and 19 smallmouth bass. Of lakes containing hatchery marked fish, 83% of the 1969 summer catch were marked fish while winter angling produced 87% marked fish.

McNAUGHTON, J. 2000. Stocking assessment on several stocked lakes in Lanark County. File Data, Ontario Ministry of Natural Resources, Kemptville, Ontario.

Assessment netting was conducted on several stocked lakes in Lanark County during the summer of 1998. Gill nets, with mesh sizes of 2.5, 3.8 and 5.1 cm mesh, were set during the day for periods of 1.5-2.0 hours. In some lakes seining was done in nearshore areas.

Green Lake, Lavant Township, was stocked with 1300 yearling brook trout in 1997 and 800 yearlings in 1998. Green Lake was assessed on June 23, 1998. Two seine net hauls produced a total catch of 69 common shiners. Fourteen white suckers and 7 yellow perch were captured in the gill nets.

Minnow Lake, Darling Township, was stocked with 500 yearling brook trout in both 1997 and 1998. The lake was netted on June 25, 1998. Two seine net hauls produced a catch of 1 common shiner and 51 pumpkinseed. A total of 4 brook trout and 8 common white suckers were captured in gill nets. Brook trout ranged from 185-259 mm in total length and from 50-400 gm in weight.

Netting was conducted on Napier Lake on June 29, 1998. Two seine hauls produced a catch of 3 northern redbelly dace, 13 common shiners, 13 pumpkinseed and 1 creek chub. A total of 13 brook trout and 12 white suckers were captured in the gill nets. Brook trout ranged in total length from 200-340 mm and from 55-700 gm in weight.

Peterwhite Lake was stocked with 3500 yearlings in 1997 and 1000 yearlings in 1998. Netting was conducted on Peterwhite Lake on July 21, 1998. Two seine net hauls produced a catch of 7 pumpkinseed and 49 golden shiner. Three gill nets produced a total catch of 19 brook trout and 14 pumpkinseed. No fish were caught in the 3.8 cm mesh net. Brook trout ranged in total length from 85-355 mm and from 10 to 800 gms in weight.

Kate's Lake was stocked with 1925 brook trout yearlings in 1996, 1000 yearlings in 1997, and 1000 yearlings in 1998. Kate's Lake was evaluated on August 13, 1998. Two seine hauls produced a total catch of 119 common shiners. Ten brook trout and 70 white sucker were captured in gill nets.

McNEILL, A. 1998. 1997 fish distribution report. Annual Report, Nova Scotia Department of Fisheries and Aquaculture, Pictou, Nova Scotia. 55 p.

Brook trout (*Salvelinus fontinalis*) have long been the favoured species for anglers in Nova Scotia and constitute the backbone of the recreational fishery. They are distributed ubiquitously throughout the province and occur in a variety of habitat types from small feeder streams to large rivers, lakes and even marine environments. In response to this, the Department has allocated the majority of its hatchery efforts into raising and distributing brook trout. In fact, over the past eight years, brook trout have accounted for an average of 82% of hatchery production. During the past five years brook trout distribution has averaged 1.3 million fish, a 42% increase over the previous five year average. This increase has largely been attributed to an increase in the number of fall fingerlings and fry stocked. In 1997, brook trout from a variety of stocks – sea run, hybrid and domestic, were distributed as eggs and fry, fall fingerlings, yearlings and trophy (> 2 year old) fish. In addition to these, a total of 630,000 eggs or fry were provided to volunteer groups for placement in incubation boxes or directly into nursery streams located at various sites throughout the province.

Brook trout were stocked in all 18 counties in Nova Scotia in 1997. A total of 1,055,198 brook trout were stocked according to the following breakdown by stage: 24,000 as eggs/fry (2%); 744,198 as fall fingerlings (71%), 279,910 as yearlings (26%) and 7,090 as trophy fish (0.7%).

McRAE, A. H. 1966. A catchable trout program's place in Alaska. *In* Proceedings of the 46th Annual Conference of the Western Association of State Game and Fish Commissioners, Butte, Montana.

In Alaska, catchable trout is an expensive method of providing fishing. Under a flat fee licensing formula such as we have, it should never be considered for more than a very limited amount of water; water in high population areas which cannot be managed to rear adequate stocks of trout and which will attract fishing pressure to ensure a high rate of return on the catchables. We regularly stock 120 lakes in the more populated areas but concentrate the stocking on lakes which are competitor free and we stock small fish - up to 100 per pound. The only catchable-sized trout stocked in the state come from cooperative military projects.

MEARS, H. C. 1976$_a$. Effect of fin excision on survival of fingerling brook trout in a reclaimed pond. Maine Cooperative Fisheries Research Unit. Orono, Maine. 43 p.

MEARS, H. C. 1976$_b$. Overwinter regeneration of clipped fins in fingerling brook trout. Progressive Fish Culturist 38 : 73.

Regeneration of clipped fins over a six month period (October 1974 to April 1975) was studied as part of an investigation of the overwinter survival of hatchery-reared fingerling brook trout (*Salvelinus fontinalis*) in a Maine pond. One or more fins were excised from several thousand fingerlings. Markers, supervised by experienced hatchery biologists, removed fins close to the base in an attempt to minimize regeneration.

The percentage of regeneration was evaluated for all clipped fins. Marked fins were characteristically short and stubby and were easily identified. No fins were completely regenerated and therefore unrecognizable. Regeneration had occurred in 9% of all fins observed. The frequency of regeneration was highest (41%) for the anal fin and lowest (0.6%) for the adipose. Regeneration of the pectoral fins was 1.5 to 2.0 times more frequent than that of pelvic fins. Few fins regenerated to more than 50% of their original size.

These results suggest that removal of the anal fin may not be a reliable mark to use for studies if fishermen or inexperienced workers are expected to recognize the mark.

MEARS, H. C. and R. W. HATCH. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Transactions of the American Fisheries Society 105 : 669-674.

In an evaluation of overwinter survival of fin clipped and unmarked brook trout in a reclaimed pond in Maine, 10,000 fall fingerlings were divided into 20 treatment groups, 19 of which were marked by the removal of either single or multiple fins. Analysis of returns from creel and trap net sampling indicated that: (1) survival of unmarked, unanesthetized trout was significantly higher than that of marked, anesthetized fish; (2) survival of trout with multiple fin excisions was lower than that of fish with single fin excisions; (3) removal of the adipose fin had little or not effect on survival; and (4) removal of pectoral fin was no more detrimental than the removal of a ventral fin. Spring recaptures indicated that fish of all groups were equally vulnerable to both sampling methods. Overwinter survival was low for all groups.

MERNER, F. H. 1958. A statistical report of the history of the stocking of the Grand River. *In* Conservation Officer Projects, Ontario Department of Lands and Forests, Southwestern Region.

This project was undertaken to provide a ready record of past stocking of fish in this river. The value of these stockings is assessed and will perhaps provide a basis for future introduction of fish. The records were obtained from the records of the Department of Game and Fisheries, Toronto, from 1928 to 1939 and from 1939 to 1957 reports. During that period a total of 15,000 brook trout fry were stocked. This planting occurred in 1935. Subsequent investigations have proven that no brook trout were ever caught out of the Grand River but a number of trout have been caught in two small private streams which empty into the Grand River. No further stocking of brook trout is warranted.

MICHIGAN DEPARTMENT OF NATURAL RESOURCES. 1987. Fish stocking guidelines. Fisheries Division, Ann Arbor, Michigan. 32 p.

Brook trout fingerlings may be utilized in a manner similar to brown trout for production stocking to maintain resident stream trout populations where a demonstrated lack of natural recruitment exists. Stream planting of yearling brook trout is approvable only for experimental projects. Yearling brook trout are at or near the legal size of 7 inches when planted in the Upper Peninsula and planting yearlings, which are particularly vulnerable to angling, invites return to put-and-take fishing, which is against policy. Generally, the use of brook trout should be restricted to plants in newly rehabilitated streams (softwater streams) or to coldwater streams where summer temperatures rarely exceed 70º F.

Wild brook trout originating from the Assinica and Temescamie strains (Québec) have shown considerable promise in research studies in New York, in the Pigeon River research lakes, and in our management application. Growth of the wild fish and of crosses between Assincia strain and domestic broodstock has been markedly faster than brook trout heretofore used as planting stock. The Québec trout are slow to mature (age III-IV for females), long lived, and are more vulnerable to angling than our usual brook trout. To realize their growth potential they should be stocked sparsely (around 50 per acre).

General guidelines for stocking trout in Michigan waters may be summarized as follows:

- Large oligotrophic multispecies lakes – 2-25 (5-7”) yearlings per acre;
- Multispecies two-story lakes – 25 (5-7”) yearlings per acre;
- Single species trout lakes – 50-150 (3-4”) fingerlings per acre;
- Large fertile trout streams (maintenance) – 50-150 (5-7”) yearlings per acre;
- Small-moderate sized streams with light competition – 100-200 (3-4”) fingerlings per acre;
- Large fertile trout streams – 150-300 fingerlings per acre;
- Small to moderate sized trout streams of average fertility – 100-200 fingerlings per acre.

Expanded use of Québec strains and its hybrids has already occurred and is expected to continue. These new strains have had a dramatic impact on our brook trout lake program but Great Lakes plants of these strains (in bay and island areas) also offer possibilities.

MILLER, M. 1982. 1982 stocking assessment of Moyle Lake. File memorandum, Ontario Ministry of Natural Resources, Espanola, Ontario. 1 p.

A brook trout stocking assessment project was conducted on Moyle (Clear) Lake (Gough Township) from September 14-16, 1982. Four gill net sets were made. Each monofilament gill net was 15.2 m in length and had 2.5 cm and 7.6 cm mesh sizes. A total of 9 brook trout and 500+ white suckers were captured. Four of the brook trout bore an adipose fin clip indicating they had been stocked in May 1982. It is evident that there is an extremely high sucker population which probably provide too much competition to achieve large stocks of brook trout. It is recommended that a small stocking (e.g., 1000 fish) of large brook trout be conducted annually.

MILLER, R. B. 1957. The role of competition in the mortality of hatchery trout. Journal of the Fisheries Research Board of Canada 15 : 27-45.

The literature on the survival of hatchery-reared trout after release in streams is reviewed and the conclusion is reached that survival is poor in lakes and streams where a resident trout population already exists. In streams the deaths of planted trout occur very soon after their release and have been referred to as “delayed mortality”. However, a comparison of survivals after planting in occupied and non-occupied streams shows that many of the deaths are not attributable to hatchery background or transportation methods, but largely to some aspect of competition with resident trout. Some investigations which have sought to measure the relative survival of wild and hatchery trout have not used resident wild trout and thus a crucial aspect of the competition has been omitted. Investigations at the Alberta Biological Station test stream, Gorge Creek, are described; in these a significant difference in blood lactic acid levels was found between hatchery trout with and without competition from resident trout. A tentative role is assigned competition as follows: introduced trout must compete for niches and for food. In the early stages of this competition they are continuously exercising; they exhaust stores of some metabolite and die either of acidosis or starvation.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES. 1982. Lake management planning guide. Fisheries Division Special Publication No. 132, St. Paul, Minnesota. 61 p.

Stream trout for lake management in Minnesota consist of brook, rainbow and splake trout. Lakes managed intensively for stream trout should be small (under 100 acres), at or near the top of the watershed and have an outlet which allows control over ingress of undesirable fish species. Stream trout stocked in Minnesota study lakes have usually shown good growth. Except in some marginal lakes, stream trout stocked at 100 to 300 fish per acre have not experienced slow growth.

MITCHUM, D. L. and L. E. SHERMAN. 1981. Transmission of bacterial kidney disease from wild to stocked hatchery trout. Canadian Journal of Fisheries and Aquatic Sciences 38 : 547-551.

Natural, horizontal transmission of bacterial kidney disease (BKD) from infected wild brook trout (*Salvelinus fontinalis*) to newly stocked brook trout, brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) was shown in a small lake and stream system in southeastern Wyoming, USA. Stocked trout were infected naturally and died in 9 months or less after exposure to infected wild fish. Dead and live fish collected from each of three stations were necropsied. Fluorescent antibody techniques (FAT) were used to detect the BKD organism in all samples. Low severity infections were often detected by FAT at a higher rate when feces were examined as compared to kidney tissues from the same fish. Because other known pathogens were essentially absent, BKD was diagnosed as the cause of all deaths in both stocked hatchery fish and wild fish. Rainbow trout were found to be the most refractory species.

MOMOT, W. T. 1970. Growth of trout in relation to food in lakes closed to fishing. Project Report, Job F-30-R-4, Ohio State University, Columbus, Ohio.

This study attempts to: (1) measure the performance of brook trout planted in six unfished lakes at the rate of 50 per acre (124 per hectare), 100 per acre and 500 per acre; (2) measure the annual productivity of crayfish (*Orconectes virilis*) in West Los, North Twin and South Twin lakes, each at one of the three different stocking densities given above (2 years); (3) measure annual production of crayfish in West Lost Lake stocked with brook trout (8+ inches) at the rate of 171 per acre in North Twin Lake stocked with rainbow trout at the same density and in South Twin Lake without fish; (4) assess the rate of trout predation on crayfish by monitoring the diet of trout throughout the year.

Growth of trout is density dependent; best growth occurred at a stocking density of 50 per acre, intermediate growth at 100 per acre and poorest growth at 500 per acre. Natural mortality was greatest at a stocking density of 500 per acre.

Annual production varied both within a lake and between lakes. In West Lost lake it varied from 84 to 115 pounds per acre. North Twin Lake had the lowest annual production and the smallest variance, 54 to 67 pounds per acre. South Twin Lake had the greatest range, 87 to 127 pounds per acre.

Crayfish are most vulnerable to predation by trout during their first year of life. Total annual mortality (1966-67) for age-0 crayfish varied from 0.957 to 0.998 in West Lost, North Twin and South Twin lakes. Predation by brook trout at densities ranging from about 4 to 31 fish per acre in North Twin to 165 to 315 fish per acre in West Lost Lake accounted for from 1% (North Twin) to 22% (West Lost) of total mortality. Annual mortality (1968-69) of age-0 crayfish in North Twin amounted to 254,094 animals of which approximately 4% were attributable to rainbow trout (40-96 fish per acre) predation.

MOYLE, P. B. 1966. Comparative behavior of different strains of hatchery-reared brook trout (*Salvelinus fontinalis*). M.Sc. Thesis, Cornell University, Ithaca, New York. 107 p.

MOYLE, P. B. 1969. Comparative behavior of young brook trout of domestic and wild origin. Progressive Fish Culturist 31 : 51-56.

This paper provides additional data on behavioral differences in young brook trout of domestic and wild origin. One of the most noticeable behavioral differences between the F_1 wild and domestic trout is the tendency of the F_1 wild fry to remain close to the bottom of the rearing troughs while the domestic fry showed a more uniform distribution. Probably also as a result of their greater activity, the domestic fry had more interactions between individuals than the F_1 wild fry.

MULGREW, C. 1986. Survival and growth of yearling brook trout 1986. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario. 18 p.

Yearling brook trout (*Salvelinus fontinalis*) were stocked in Young and Clare lakes, in Arnott Township, for the purpose of assessing their growth and survival. Fish were air dropped in May of each year. Assessment was based on the use of variable mesh sized gill nets which were set in the fall of each year after the plant had been made. Nets were fished for a minimum of three consecutive nights or until a significant decline in the catch was noted. The brook trout catches from Clare lake were 127 fish in 1983, 181 fish in 1984, and 142 fish in 1985. The brook trout catches in Young Lake were 74 fish in 1983, 73 fish in 1984, and 48 fish in 1985. In 1983, the first year of stocking, population estimates based on the catch-per-unit-effort (CUE) data were incorrect. Since the CUE (fish per meter of net) remained relatively constant for the next two years despite a greater effort being exerted, no population estimates could be made. Rapid growth was apparent with increases in weight of 803 and 850 per cent over the three year period in Clare and Young lakes respectively. Sexual maturity was reached at 2 1/2 years of age in both lakes.

Clearly, brook trout grow well in these lakes but without an effective method of quantifying their survival no future stocking should be undertaken. It is recommended that the sanctuary status be removed from these lakes allowing the remaining stock to be utilized.

MULLAN, J. W. 1956. The comparative returns of various sizes of trout stocked in Massachusetts streams. Progressive Fish Culturist 18 : 35-38.

Percentage of returns (tag recoveries in hand) by stocking sizes for 62,800 tagged brook, brown and rainbow trout stocked in 5 typical, major stream drainages during the month of March over the last three years shows a significantly greater return for the larger fish as compared to the smaller fish planted. Yearling 6-8 inch fish gave the poorest return, 9-12 inch two year olds gave the highest return, 8-9 inch yearlings or two year olds gave returns between these aforementioned categories, and 12 inch plus brood stock provided returns comparable to those of 9-12 inch fish. It is possible that the apparent differential in return according to stocking sizes is accounted for by the fact that anglers returned tags to a greater degree from the larger trout than from the smaller trout. A more plausible explanation of the results is that the larger trout, owing to greater body size, were better able to cope with stream velocities and competition, thereby surviving longer and being vulnerable to angling over a longer time.

NEEDHAM, P. R. 1959. New horizons in stocking hatchery trout. p. 395-407 *In* Transactions of the 24th North American Wildlife Conference.

This paper summarizes the returns from more than 244 separate trout planting experiments with marked trout which were reported in approximately 36 separate papers.

In terms of returns from lake plants of fingerlings , creeled fish averaged 7.4% of the numbers planted. Nineteen of the 32 plants gave recoveries of less than 5.0%. Highest returns reported were where 2-3 inch brook trout had been planted following chemical treatment to remove predators. Where populations of trout or other fishes are already present, survivals are usually less than 5%. The average recovery rate of fingerlings planted in streams averaged 2.5% (0.0-14.0%).

Plants of legal-sized trout averaged 34.5% (1.1-88.4%) in lakes and 41.3% in streams. Twenty-six of the 68 tests gave returns of less than 30%.

Fall plants of trout had relatively low survival rates over winter. One author reports winter carry-overs from a high of 9.4% to zero from twenty separate lots of eastern brook trout stocked in streams of Cape Cod.

NEEDHAM, P. R. and F. K. SUMNER. 1941. Fish management problems of high western lakes with returns from marked trout in Upper Angora Lake, California. Transactions of the American Fisheries Society 71 : 249-269.

Upper Angora Lake in the high Sierra Mountains was selected for an experimental study conducted from 1934 to 1936 inclusive. It is a small 5 acre lake lying at an elevation of 7,800 feet, 7 miles south of Lake Tahoe. General ecological conditions and management problems of such high lakes are discussed. Low water temperatures over most of the year limit both growth of fish and production of aquatic foods. The standing crop of bottom foods averaged 49 pounds (wet weight) per acre. Dominant aquatic foods were midge larvae, bristle worms (oligochaetes) and scuds (Hyalella). Stomach examinations of trout indicated that dominant foods eaten were midge larvae and pupae. Aquatic organisms formed over 66 per cent by number of foods eaten.

Two lots of marked eastern brook trout were planted: one of 5,028 averaging about 2 inches in length and another of 2,080 averaging 5 1/2 inches in length. The small fish were planted in September 1933 and the larger in June 1935. Both lots were marked by removal of fins. The lake outlet was screened to prevent fish from leaving the lake. A creel census was taken throughout the angling seasons of 1934, 1935, and 1936. Only weight, species, date of capture and the presence or absence of marks were recorded. No record was kept of the length of time each angler fished or of anglers who failed to catch fish.

Catches of both marked and unmarked fish totaled 89 trout in 1934, 809 in 1935, and 211 in 1936. Eastern brook trout were dominant in the catches. A few rainbow and brown trout were taken each year. Over the three year period, only 4.3 per cent of the 5,080 two inch eastern brook trout and 25.6 per cent of the 5 1/2 inch fish were reported caught. Judging from the results of work presented in this paper and the results of the work of other investigators cited, losses of trout planted are extremely heavy regardless of the size of fish planted.

Better survival of small two inch trout was obtained after three winters in the lake than for 5 1/2 inch fish after only one winter in the lake. Marked fish of both plantings formed 77 per cent and 58 per cent, respectively, of fish captured and retained in 1935 and 1936. No marked fish were reported in 1934. The planting of small eastern brook trout made in the fall of 1933 contributed most fish to anglers the second year after stocking. The planting of larger trout contributed most in the same season in which they were stocked. The small marked trout grew at a rate of over 2.5 inches per year for the three year period covered by the creel census, and the larger grew at a rate of 1.7 inches per year. Production in pounds per acre was 15.8 in 1934, 21.2 in 1935, and 17.0 in 1936. Eastern brook trout formed 28 per cent by weight of all trout landed in 1934, 93 per cent in 1935, and 48 per cent in 1936.

Age determinations from scale studies indicated that the majority of eastern brook trout caught were in their third year and the presence of incoming young in their first and second years gave evidence of successful natural propagation in the lake. No rainbow trout less than three years old or brown trout less than five years of age were present in the samples studied.

Fifteen brown trout that averaged 2.18 pounds each and weighed up to 7 pounds were reported caught in 1936. Predation by a few large brown trout is suggested as one cause of the low survival of planted trout and the removal of such fish by selective gill netting operations is presented as s possible management measure in lakes where destruction of entire populations by poisons or other means is not desired.

NELSON, W. C. 1960. Comparison of the effects of the removal of the adipose and pelvic fins on fingerling brook and rainbow trout. Mimeo Report, Colorado Department of Fish and Game. 15 p.

Groups of 300 Ad, 300 LVRV, and 478 unmarked fingerling brook trout were held for 5.5 months at the Bellvue Hatchery, Colorado. Per cent survivals and (in parentheses) Su/Sm were Ad, 87 (1.00); LVRV, 88 (0.99); and unmarked 87 (-). The differences were not significant. Per cent survivals and (in parentheses) Su/Sm for groups of 302 Ad, 300 LVRV and 443 unmarked rainbow trout held under the same conditions were: Ad, 71 (1.10); LVRV, 66 (1.18); and unmarked 73 (-). These values were said to be significantly different (x^2 = 13.29, 2 d. f.) but this conclusion appears to be erroneous as judged by the data presented; the differences are not significant. In any event, the author believed the differences were due to misclassification of LVRV-clipped trout as unmarked because of fin regeneration.

NEWELL, A. E. 1957. Two year study on movements of stocked brook trout and rainbow trout in a Montana trout stream. Progressive Fish Culturist 19(2) : 76-80.

This paper has been prepared to contribute to the general knowledge of fish movements and some factors influencing the movements of hatchery-reared fish in a wild environment. The movements of brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) were studied in 1953 and 1955. All fish used in this study were marked with serial numbered jaw tags and records were made of the exact locations in which the fish were stocked. The spot planting methods – rather than the scatter planting method – of stocking was used.

Low water temperatures apparently have a decided influence on the movements of stocked trout and flow may have little or no influence on the movements of these fish. There is need for additional study, however, with regard to the effects of high temperatures, flow, population densities, and competition on the movements of stocked trout.

NEWMAN, L. E. and J. JOHNSON. 1997. Development of a reintroduced, anadromous brook trout population at Grand Portage, Minnesota, 1991-1996. p. 435 *In* Proceedings of the 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin. (Abstract Only)

In an attempt to re-establish an “anadromous” or “coaster” brook trout population migratory to Lake Superior, experimental techniques were employed to reintroduce a native, regional strain of brook trout

(Lake Nipigon) to streams on the Grand Portage Reservation. Eyed eggs were stocked in redds in natural or created substrates and early stage fry were stocked in other stream habitats. Eyed eggs hatched at rates from 93% to 97% when properly placed in substrates and produced five successive year classes. Stocking of early stage fry also produced five year classes of brook trout in test streams. In each year both experimental stocking techniques produced fingerlings that moved downstream to Lake Superior. Growth rates of stocked fish appeared to be significantly higher in the lake habitat than in the stream. Among fish emigrating to Lake Superior, sexual maturation seldom occurred until age 3+ and at lengths of > 406 mm (16 inches). Spawning runs of large adults (primarily age 3+ and older) have been observed in two test streams in 1995 and 1996.

NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION. 1979. General stocking policies and criteria. Albany, New York. 6 p.

Allocation of stocked fish shall be directed toward obtaining maximum benefits for the angling public from each fish stocked. Fingerling stocking policies will be used in preference to yearling policies wherever there is reason to believe fingerlings will produce comparable results in terms of survival, growth and utilization.

Stocked coldwater lakes and ponds will ordinarily be managed as put-grow-and-take fisheries. Smaller coldwater lakes and ponds without excessive populations of predator or competitive fish will ordinarily be stocked with brook trout fingerlings. Stocking rates will be based on the morphoedaphic index (MEI). Fingerling trout will be stocked at the rate of $30\sqrt{MEI}$ fish/acre, yearlings at the rate of $15\sqrt{MEI}$ fish/acre and split stockings at the rate of $18\sqrt{MEI}$ fingerlings/acre and $9\sqrt{MEI}$yearlings/acre. Base stocking rates may be modified in response to data on abundance of competitive species, trout growth rate, contribution of natural reproduction and projected fishing pressure.

Stocking policies will be evaluated primarily on the basis of weight return. Put-and-take stocking policies will be scheduled for harvest evaluation and will be continued only where return of stocked fish is at least 75% by number. Yearling-stocked waters receiving over 3,500 fish will be scheduled for harvest evaluation by the appropriate means.

NIELSEN, L. A., W. T. KENDALL and L. A. HELFRICH. 1980. Comparison of angler use and characteristics at three catchable trout fisheries in Virginia. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 34 : 330-340.

Creel census data for three catchable trout fisheries in Virginia revealed that desirable attributes of the fisheries increased from a lightly stocked stream to a lightly stocked lake to a heavily stocked stream. Total effort, participation by non-local anglers, evenness of seasonal use, catch rate, and return rate all were higher for the heavily stocked stream than for the lightly stocked stream. For the trout lake, total effort and participation by non-local anglers were similar to the heavily stocked stream but catch-per-effort, return rates of stocked fish, and seasonal distribution of effort were similar to the lightly stocked stream. Most anglers at the lake fished from shore so that a large portion of the potential fishing area was not utilized. Management of catchable trout fisheries may provide higher fishing value if streams are managed so that stocking density, stocking frequency, accessibility of angling, publicity, and opportunities for associated outdoor recreation are maximized.

NILSSON, N.-A. 1972. Effects of introductions of salmonids into barren lakes. Canadian Journal of Fisheries and Aquatic Sciences 29 : 693-697.

There are still many lakes in the Palearctic that are barren of fish because of deglaciation history. Early transplantations of fish into such lakes have been documented and there is a continuous activity of that kind going on for example in Scandinavia and at the North American west coast. Introductions of fish into barren lakes produce noticeable responses in the invertebrate fauna. For example, in a large mountain lake in northern Sweden the fairy shrimp (*Polyartemia forcipata*) disappeared after the introduction of Arctic char and after a period of spectacular growth the fish now tend to get stunted. Changes in the invertebrate fauna after the introduction of new species of fish have been recorded also in many lakes with more complicated species compositions, and also in very large lakes such as Lake Michigan. In the Scandinavian mountain lakes there seems to be a correlation between the composition of fish species and the crustacean plankton. Further studies of introductions into barren lakes should provide a better understanding of predator-prey relations on the whole and, in the long run, of management of fish populations.

NUHFER, A. J. and G. R. ALEXANDER. 1991. Growth, survival and vulnerability to angling of three wild brook trout strains exposed to different levels of angler exploitation over time. Fisheries Research Report No. 1973, Michigan Department of Natural Resources, Lewistown, Michigan.

It has been suggested that the genetic growth potential of trout may be degraded, over time, by differential angler harvest of the faster growing fish of each cohort. To test this hypothesis young-of-the-year wild brook trout from two branches of the Au Sable River and from the East Branch of the Fox River were stocked in three experimental lakes to determine their relative growth and survival after two years of residence. Brook trout populations from the Au Sable River were believed to have been historically exploited more intensively than that from the East Branch of the Fox River. The relative vulnerability to angling for the three strains was estimated in two of the lakes. Further, mean sizes of angler-caught trout were compared to mean sizes of trout captured by intensive gill netting to determine if anglers caught the larger trout in the population and to ascertain possible correlations between growth rate and vulnerability to angling. Some differences in growth were found suggesting that strains differed genetically. Brook trout from the East Branch of the Fox River exhibited significantly greater increases in length and weight than fish from either the North Branch of the Au Sable or the mainstream Au Sable. Growth was similar for both Au Sable River strains. A habitat or lake effect on brook trout growth was evident. Highest growth for all strains occurred in Hemlock Lake and was lowest in South Twin Lake. The superior growth performance of East Branch Fox River brook trout was most evident in Hemlock Lake where all strains grew best. Mature males were significantly longer and heavier than mature females when data were pooled across strains for each lake. East Branch Fox River mature females allocated relatively less energy to gonadal weight than mature females of the au Sable River strains. East Branch Fox River and mainstream Au Sable Brook trout had the highest and lowest survival, respectively, in all three lakes. The difference in survival between East Branch Fox River and mainstream Au Sable strain trout was greatest in Hemlock Lake, where all strains exhibited relatively low survival; the difference was least in North Twin Lake where all strains demonstrated relatively high survival. A significantly higher percentage of the population of East Branch Fox strain brook trout were caught during three days of experimental angling than either of the Au Sable River strains indicating greater vulnerability to angling for this strain. The mean lengths and weights of brook trout caught by angling from North Twin Lake were significantly higher than the means for trout caught with nets. In South Twin Lake, where all strains were more similar in size, no significant differences were detected between lengths or weights of angler and net-caught trout. The results of this study suggest that the intensity of angler exploitation over time, may have altered the genetic potential for growth and catchability of these wild brook trout strains.

NUNAN, P. 1964. Winter angling for brook trout in the Port Arther Forest District. File Report, Ontario Department of Lands and Forests, Thunder Bay, Ontario.

A survey of the effects of winter fishing on brook trout (*Salvelinus fontinalis*) was conducted by Fish and Wildlife staff in the months of February to April, 1964. Angling success was 0.49 fish per hour. This is good enough to justify an earlier opening but not heavy enough to cause any concern to summer anglers. Any lake receiving exceptionally heavy winter angling should be stocked with catchable-sized fish shortly after break-up.

OEHMCKE, A. A. and G. RADONSKI. 1969. Trout stocking: Results wanted. p. 14-15 *In* Wiconsin Conservation Bulletin.

In the 70 plus years that Wisconsin has been stocking trout, things have changed. Research has revealed that the stocking of trout from the hatchery in a stream with an existing healthy population of native fish results in poor survival of the hatchery product. In some cases, deterioration of the native trout population results from excessive competition. In addition, the environmental requirements of trout are quite specific. With these facts in mind Wisconsin fish managers decided that all the trout streams in Wisconsin should be classified with respect to their resident trout population and environmental conditions. This type of long range planning is already bearing fruit. Fish managers no longer need to argue the merits or disadvantages of dubious trout stocking requests. The available fish are placed where they do good.

OHIO DEPARTMENT OF NATURAL RESOURCES. Undated. Fish hatcheries tactical plan. Fisheries Management and Research, Division of Wildlife, Columbus, Ohio.

Catchable trout should be used in inland areas where a high profile and a maximum utilization fishery is desired, often under short term time limitations. Catchable trout are generally stocked in lakes from March through the second week in May before water temperatures reach the mid 60s (ºF) to ensure high angler utilization without adding undue stress to the fish. Catchable trout are also stocked in two story lakes where deep, cold water (< 68º F) is available through the summer with adequate (> 6 mg L^{-1}) dissolved oxygen.

Recommended stocking rates for catchable trout are: 75 trout per acre for waters ≤ 40 acres; 50 trout per acre for waters 41-80 acres; and 25 trout per acre for waters > 80 acres. The minimum number of trout stocked in a water area will be 500 while the maximum of trout stocked in any given area will be 4,000.

OLVER, C. H. 1969. Kerwin Lake brook trout study – Preliminary report. File Report, Ontario Department of Lands and Forests, Sault Ste. Marie, Ontario.

Anglers fished for an estimated 1,418 hours to catch 174 brook trout at Kerwin lake during the winter of 1968. The fishing intensity on this 88 acre lake was 16.1 man hours of effort per surface acre. The average rate of success was 0.14 fish per man hour. The average weight of the fish caught was 0.7 pounds. The harvest of 105 pounds represented a yield of 1.19 pounds per acre.

A growth rate based on calculated total lengths was determined. The brook trout fishery was supported by fish of age group II and age group III. Age II fish dominated the catch. The annual mortality rate between the second and third year of life was estimated at 70%.

Only 19 fish of 4,000 planted in May of 1967 were estimated to have been caught in 1968. The return was 0.5%. The return in terms of weight (15.2 pounds caught of 174 pounds planted) was 8.7%. The calculated costs of rearing 4,000 marked brook trout was $1,000.00 or $5.75 per pound (23/pound). The value of the planted fish caught by anglers was $52.63 per fish or $87.40 per pound. In terms of fish flesh the angler realized a return of 9 cents on the dollar for a cost benefit ratio of 1:0.09.

As a result of this study, the stocking program on Kerwin Lake will be discontinued.

ONTARIO DEPARTMENT OF LANDS AND FORESTS. 1970. Fish stocking rates for brook trout and rainbow trout. Fisheries Policy Procedure SF 2.01.01, Fish and Wildlife Branch, Toronto, Ontario. 3 p.

This procedure outlines the method to be used for establishing fish stocking rates. It does not apply to "put-and-take" fisheries where the harvest rate is directly dependent on regular stocking and ease of access and less dependent on the carrying capacity of the waters.

Two factors (total dissolved solids and area of the zone most suited to the species concerned) were selected as measures of production capacity in lakes. Two ranges of total dissolved solids (TDS) were selected as an index to lake productivity. Assuming other physical and chemical conditions of the environment are favorable, the total area of littoral and shoal zones (< 20 feet deep) is the most significant area of production. For this reason we selected a basic stocking rate per acre of lake surface having a water depth not greater than 20 feet for each of the two ranges of TDS.

To calculate stocking rate, your first must determine the area of littoral zone (acres), then multiply this area by the basic stocking rate as follows:
(a) More than 100 ppm – 150 yearling fish per acre of water between 0-20 feet; or
(b) Less than 100 ppm – 100 yearling fish per acre of water between 0-20 feet.

This product is then multiplied by the appropriate fishing pressure factor selected from the following angling pressure index:
(a) Light (0-10 person days/acre/year) – Factor 0.5;
(b) Medium (10-20 person days/acre/year) – Factor 1.0;
(c) Heavy (> 20 person days/acre/year) – Factor 1.5.

ONTARIO MINISTRY OF NATURAL RESOURCES. 1979. Guidelines for stocking of hatchery fish: Draft policy. Fisheries Branch, Toronto, Ontario. 20 p. + appendices.

General guidelines are presented for stocking of various salmonids in Ontario waters. Brook trout stocking is most likely to succeed in those waters which are barren or contain only very simple fish communities. Brook trout should be stocked in lakes less than 100 acres in surface area having minimum depths of 15 feet. Total dissolved solids in waters stocked with brook trout should usually be less than 50 mg L^{-1}. The morphoedaphic index (MEI) in waters stocked with brook trout should ideally be less than 2.

ONTARIO MINISTRY OF NATURAL RESOURCES. 1999a. Fish stocking as a management tool: Summary of workshop recommendations. *In* Proceedings of the Northeastern Region Fish Stocking Workshop, December 1-3, 1998, Timmins, Ontario.

This summarizes deliberations of the brook trout stocking working group from the workshop. The group developed several criteria for selecting waterbodies for stocking brook trout. These included: avoiding lakes with complex fish communities (especially the presence of spiny-rayed fish), using wild strain fish for introductions (after an Environmental Assessment has been completed), ensuring suitable summer water temperatures (< 21° C) and levels of dissolved oxygen (> 4 mg L^{1}), and ensuring public access to the waterbody. Stocking densities should be based on biomass and not simply numbers of fish. Stocking density guidelines should be considered as a maximum taking into account the size of the hatchery-reared product being stocked. In terms of stocking frequency, consideration should be given to the strain of brook trout being stocked. For example the use of long-lived strains (e.g., Nipigon) should be planted less frequently to avoid cannibalism. Stocking frequency will also depend on the stocking method (i.e., less accessible lakes stocked by helicopter should likely be stocked less frequently than lakes stocked by hatchery truck). Consideration must also be given to stocking accessible, heavily fished lakes on a more regular basis (i.e., annual or semi-annual).

ONTARIO MINISTRY OF NATURAL RESOURCES. 1999b. Stocks catalogue. Fish Culture Section, Fish and Wildlife Branch, Peterborough, Ontario.

The stocks catalogue is designed to provide clients of the Ontario Ministry of Natural Resources (OMNR) fish culture program with basic information on the fish culture system, the hatcheries and on the species and stocks of fish available from that system. This information has been updated to reflect conditions current to 1999.

With respect to brook trout, there are currently four strains in the system: (i) Hills Lake domestic (HLHL), (ii) Lake Nipigon wild (LN), (iii) Lake Nipigon x Hill's Lake hybrid (LNHL), and (iv) Aurora trout of Alexander Lake origin (AXHL). The background of these strains, their life history characteristics, and recommendations of their use are presented.

ONTARIO MINISTRY OF NATURAL RESOURCES. 2000. Best management practices for fish stocking inland waters of the Northeastern Region. Unpublished guidelines, South Porcupine, Ontario. 14 p.

These best management practices for fish stocking have been developed as a starting point for making sound stocking decisions. Stocking decisions made outside these best management practices should reflect either new science, recommendations from stocking assessment and/or local knowledge which is defensible.

The best management practices for brook trout stocking may be summarized as follows:

- Brook trout should be stocked every 2nd or 3rd year. If stocking occurs on an annual basis the rate should be reduced. Stocking frequency should be decreased for long-lived stocks such as Nipigon.
- Brook trout should not be stocked in streams and rivers. Lakes with spiny-rayed competitors and complex fish communities should be avoided.
- Brook trout should not be stocked in lakes having a viable, naturally reproducing population.
- Suitable lakes should have favorable lake summer temperature and oxygen profiles (some water > 4 ppm dissolved oxygen and colder than 21º C) and late winter dissolved oxygen (some water > 4 ppm)
- There should be legal access to the waterbody.

ORENDORFF, J. A. and N. C. FRASER. 1984. Stocking of salmonids in inland lakes: A summary for Algonquin Region, 1974 to 1983. Fish Stocking Assessment Program Report No. 84-3, Fish Culture Section, Ontario Ministry of Natural Resources, Toronto, Ontario. 43 p.

Fish stocking information from 1974 to 1983 was collated for the Algonquin Region. Brook trout stocking events occurred most often followed by lake trout, rainbow trout and F_1 splake, respectively. Brook trout were stocked at the highest mean numerical densities (192 fish/ha), followed by F_1 splake (110 fish/ha), rainbow trout (105 fish/ha) and lake trout (21 fish/ha). Put-grow-take brook trout plants into fish communities containing predators were common. Over 98% of all stocking occurred in the spring as recommended. Of the salmonids stocked, brook trout waters were the smallest in terms of both mean area (25 ha) and mean depth (4.5 m). Secchi disc readings for stocked brook trout lakes averaged 3.8 m. Stocked brook trout lakes had a mean morphoedaphic index (MEI) of 12.9.

PARDUE, G. B. 1979. Impacts of hatchery trout on native brook trout populations. Job Completion Report, Project F-38-R-1, Virginia Commission of Game and Inland Fisheries.

There were significant seasonal fluctuations in abundance and biomass estimates for native brook trout from the North and South Forks of the Tye River during 1977 and 1978. Standing crop estimates for native brook trout dropped to 85.0% from 93.1% in all areas of both rivers during the study period. These fluctuations were probably the result of two successive years of summer drought and one winter of heavy ice formation. These poor environmental conditions, combined with poor condition factors and reduced numbers of adult native trout may have been responsible for a missing year class in 1978.

There were no significant location differences witnessed in standing crop estimates for stocked and unstocked areas of the two rivers in the three "post-treatment" sampling periods. Standing crop estimates for native brook trout decreased to the same degree in stocked and unstocked areas. However, it cannot be concluded that hatchery trout did not have an impact on the native brook trout populations.

Population estimates for native brook trout in areas of the North Fork subjected to long-term stocking were consistently lower than estimates in unstocked areas. This may be evidence that native brook trout populations in areas of streams subjected to long term stocking programs may be adversely affected by the presence of hatchery trout.

Analysis of creel survey data indicated that harvest and catch-per-unit-effort figures for native brook trout were low during times of peak fishing pressure for hatchery trout. Hatchery trout contributed to the creel for a short time, generally being heavily depleted in a few days. As hatchery trout harvest declined, native brook trout began to fill out the anglers creel.

Competition for food between native brook trout and hatchery trout did not appear to be a limiting factor. Native trout were found to be opportunistic feeders, feeding heavily on aquatic and terrestrial drift the majority of the year. Feeding habits of native trout did shift to primarily benthic organisms in late fall, winter, and early spring. Hatchery trout were also opportunistic feeders with a tendency towards benthic feeding.

In conclusion, no definite impacts to native brook trout populations of the North and south Forks of the Tye River could be attributed to hatchery trout during the study period because of the overwhelming environmental conditions which prevailed. However, results of this study point out the vulnerability of these populations to environmental catastrophes which are not uncommon to this area of Virginia. Because of this high vulnerability and the decreasing range of the native brook trout in the southern Appalachian region, hatchery stocks would perhaps be best utilized in streams where there is little or no natural reproduction and competition with native trout in negligible.

PARTRIDGE, R. M. 1981. Test netting in the Ignace District, August-September, 1980. File Report, Ontario Ministry of Natural Resources, Ignace, Ontario. 6 p.

Test netting was performed on several lakes in the Ignace District from August 30 through September 3, 1980. Shrimp Lake was test netted to check on the survival and growth of the spring 1980 planting after reclamation in September, 1979. A 50 foot gill net with one inch mesh was set overnight. When lifted it yielded eight 6-8 inch brook trout. This is excellent growth over the four months the trout were in the lake as they were stocked as sizes of 3-5 inches in length. There were no other species of fish present in the lake.

McLaurin Lake was netted to determine the survival of recently planted fish and determine if any natural reproduction of brook trout was taking place. McLaurin Lake required two days of netting to obtain a sample of 5 brook trout. The last planting of the lake was in the spring of 1979. All five fish caught were large. This would indicate that there were residual fish from an earlier planting. There was no evidence that any natural reproduction was taking place. McLaurin lake should be maintained as a put-and-take brook trout fishery as it is very popular with anglers and growth rates are excellent.

PATRICK, N. D. 1959$_a$. 1959 creel census for Esker Lakes Provincial Park. File Report, Ontario Department of Lands and Forests, Swastika, Ontario.

One of the major stumbling blocks in the district fisheries management program is the determination of planting rates for hatchery fish. With the establishment of Esker Lakes Provincial Park with a full time attendant at the gate, the opportunity arose to obtain absolute creel information for a series of trout waters in the park.

Several lakes were stocked with brook trout in the spring of 1959. These included Pall Lake (700 yearlings), Bea Lake (900 yearlings), Mall Lake (1,500 yearlings), Lavery Lake (600 yearlings), Roach Lake (800 yearlings), Ramey Lake (1,350 yearlings) and Lallan lake (2,200 yearlings). Panagapka Lake was planted on three occasions with a total of 4,200 yearling brook trout (1,100 on June 26, 1,100 on August 1, and 2,000 on September 14).

Data was obtained for 1,051 persons fishing 3,574 hours during which time some 526 speckled trout and 2 pike were taken. Some 914 anglers reported fishing on Panagapka Lake (2,568 man hours) to harvest 496 brook trout. Forty-nine anglers spent 615 hours to harvest 12 trout from Mall Lake. Thirty-six anglers spent 165 hours to harvest 7 trout from Ramey Lake and 41 anglers (178 hours) harvested 11 trout from Lallan Lake. These results are not very encouraging and the only consolation can be obtained from the fact that this is the first year of intensive management in the park. There will almost certainly be a lag in the development of the fisheries. The data is considered to be at least 90% complete for Panagapka Lake and over 85% complete for the remaining lakes.

It would seem that some consideration should be given to restricting some of the fish plantings in view of the small amount of use made of certain lakes. There is justification for continuation of plantings in Mall, Ramey and Lallan lakes, for these waters produce trout in the trophy class (Mall Lake produced only 12 fish but they weighed a total of 34.2 pounds) and this type of angling provides for the ardent trout fishermen.

No trips were recorded for Bea, Pall, Lavery or Roach lakes and as these do not produce large fish or quantities of fish, there seems little justification for continued plantings. Even if we missed 50% of the anglers using the back lakes (which is doubtful) there would still not be sufficient angling to warrant continued planting.

Early reports for the 1960 season indicate much improved catches (probably in excess of 500 lbs. for May alone) and it appears that Panagapka Lake at least is producing better.

Of the fish observed, 9 of 291 showed malformation of pectoral fins and this can be considered as normal fin disfiguration of fish planted from the hatchery.

PATRICK, N. D. 1959$_b$. Hill's Lake hatchery experiment on aerial fish planting. File Report, Ontario Department of Lands and Forests, Swastika, Ontario.

During recent years, a number of agencies have been experimenting with the use of plastic containers for transporting live fish. Reports of these experiments indicate that this method has considerable potential and may well prove to be an improvement on methods presently being used at Hill's Lake hatchery in Swastika district. Several experiments were carried out in the summer of 1969.

Results of the hatchery drop confirmed observations made previously that dropped fish generally went to the bottom of the pond and remained motionless for varying lengths of time. Observations at Lawgraves Lake fail to demonstrate clearly what happens when fish are dropped into deep water but some did to go the bottom and sank into the soft bottom ooze. We have one confirmed report of a complete failure of an aircraft planting and have records of a number of unexplained unsuccessful plantings.

The use of plastic bags with a buffer, anaesthetic and oxygen, as well as water is the best method of carrying fish over considerable distances manually that has been used by staff in this district to date.

PATRICK, N. D. 1960. Hill's Lake hatchery experiment #8 – Fish transportation methods. File Report, Ontario Department of Lands and Forests, Swastika, Ontario.

Experimental work on fish shipping methods is continuing at Hill's lake hatchery and this report covers an attempt to increase truck capacity by using a buffer to stabilize water acidity. The experiment was a failure because the fish were not crowded enough in spite of the fact that some tanks were carrying well over twice the "normal" load. It is obvious that our present truck shipment method (at least from Hill's Lake) is inefficient and requires study.

PATRICK, N. D. 1965. Annual report of 1965 fish plantings in the Tweed District. File Report, Ontario Department of Lands and Forests, Tweed, Ontario.17 p.

A total of 209,500 yearling brook trout were planted in Tweed District waters in 1965. In Hastings County 52 lakes and 19 streams were planted with 58,750 and 31,750 trout respectively. In Lennox-Addington County, 26 lakes were stocked with a total of 30,000 brook trout. In Frontenac County, 39 lakes and 1 stream were stocked with 48,000 and 1,000 trout respectively. In Renfrew County 26 lakes and 10 streams were stocked with 30,000 and 9,000 trout respectively. One stream in Prince Edward County was stocked with 1,000 trout.

Results from the 1964 trout angler questionnaire are summarized. During the 1964 fishing season, 255 anglers reported fishing on 220 lakes and 44 streams stocked with brook trout. On brook trout streams respondents reported 579 fishing trips and a harvest of 2,056 trout (3.55 fish per trip). On brook trout lakes, respondents reported 3,358 trips to catch 6,304 brook trout (1.87 fish per trip).

PELLEGRINI, M. and S. LEBEL. 1986. Assessment of short term survival and growth and comparison of four population models for a plant of Lake Nipigon strain brook trout in a small Precambrian Shield lake. File Report, Ontario Ministry of Natural Resources, Wawa, Ontario. 31 p.

Four population models (Zippin, Leslie, Schnabel and Petersen) are compared in estimating a brook trout population and a white sucker population in a 13.1 ha Precambrian Shield lake. All four models produced a statistically similar estimate of the small brook trout population. However, in estimating a large white sucker population the Leslie, Zippin and Schnabel methods produced questionable estimates.

Estimated per cent survival of planted yearling brook trout ranged from 1.8% to 2.4% over a 118 day period. Low per cent survival is related to the demonstrated slow growth of the Nipigon strain brook trout and subsequent vulnerability of these fish to the standard gear types used.

PENNSYLVANIA FISH AND BOAT COMMISSION. 1997. Management of trout fisheries in Pennsylvania waters. Bureau of Fisheries, Division of Fisheries Management, Bellefonte, Pennsylvania. 132 p.

According to a 1991 trout angler telephone survey, 80% of Pennsylvania's licenced anglers fish for trout at some time during the season. The state policy objective of the hatchery trout program is to provide recreation in those waters where wild trout populations are inadequate to sustain the fishery at desired levels. There are several general guidelines for the stocking of hatchery-reared trout including:

- Streams or stream sections classed as wild trout fisheries will not be stocked with hatchery trout. The abundance of wild trout is generally considered inversely proportional to the management intensity required to provide a trout angling experience through stocking.
- Minimum stream flow must be at least 5 cubic meters per second (3 cfs) at the time of stocking at any time prior to June 15.
- Water temperature shall not exceed 24° C at any time prior to June 1.
- The pH at the time of stocking shall not be less than 6.0 for brook trout and brown trout and not less than 6.5 for rainbow trout.
- No stream section shall be stocked if pollutants are known to be present at concentrations equal or greater to Department of Health action limits.
- Access for the general angling public must be available to at least 75% of the stream section.
- The stocking strategy should provide a 65% return to the creel or total catch of the preseason plant, a 75% return to the creel or total catch of an inseason plant and one angler trip should be generated per trout stocked following both the preseason and inseason plantings.
- A minimum number of 300 trout will be necessary to constitute an individual planting.
- No lake shall be approved for stocking prior to a field survey.

Stocking criteria are based on a classification system as follows:

(1) High Yield waters – those flowing waters which are managed with the planting of catchable trout. Stocking rates are 475 fish/acre (200 fish/acre pre-season and 275 fish/acre in-season). A minimum of three in-season plantings are required for a section to qualify

(2) Optimum Yield waters – flowing waters subdivided into various alternatives based on status of resident trout population, stream access, size, and ownership. These comprise the majority of stocked trout waters in Pennsylvania. Stocking rates vary from a total of 75-425 fish/acre and stocked at frequencies of 1-3 times annually.

(3) Low Yield waters – flowing waters which should not be stocked at a high rate with multiple frequencies and would only be stocked a maximum of once per season at a rate of 75 fish/acre.

(4) Lakes – vary in classification from Class 1 to 5 and are managed with catchable trout. Stocking rates vary from 75-625 fish/acre.

Overall, brook trout stocked as fall fingerlings may furnish a fishery the following spring and early summer. Unless harvest is low, angling quality declines the first summer after stocking in smaller lakes.

Brook trout are best suited for small, spring-fed lakes which have been reclaimed to remove all competitive fish species. In larger lakes with depressed pH and low fertility, brook trout may represent the only opportunity to provide a fishery. In general, brook trout plantings in Pennsylvania have not led to the provision of a consistent and dependable fishery.

PHILLIPS, A. M., Jr., D. R. BROCKWAY, F. E. LOVELACE, and H. A. PODOLIAK. 1957. A chemical comparison of hatchery and wild brook trout. Progressive Fish Culturist 19 : 19-25.

A number of samples of wild brook trout from widely separated areas of the United States and Canada were analyzed and compared with hatchery-reared trout on the basis of chemical composition. Wild trout contained significantly less water in their bodies than hatchery trout. The average protein content of wild trout (21.2%) was significantly higher than that of hatchery trout (13.7%). The average percentage of ash in the bodies of wild trout was higher (3.3%) than that of hatchery trout (2.0%). There was significantly less fat in the bodes of wild trout (average 3.4%) than in the bodies of hatchery trout (average 5.5%). On the basis of these analyses, wild trout are considered chemically superior to hatchery trout. The efficiency of natural food in terms of body protein produced is almost twice that of hatchery food. It is possible that natural food is more completely absorbed than hatchery food because of more efficient digestion and thus that a greater portion of natural food is utilized.

PIPER, R. G., I. B. McELWAIN, L. E. ORMER, J. P. McCRAREB, L. G. FOWLER and J. R. LEONARD. 1982. Transportation of live fishes. p. 348-371 *In* Fish hatchery management. Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C.

One extremely important aspect of fish culture and fisheries management is the transportation of live fishes from the hatchery to waters in which they are to be planted. Stress associated with loading, hauling, and stocking can be severe and result in immediate or delayed mortality. Under ideal conditions, the maximum load of 8-11 inch trout is 2.5-3.5 pounds per gallon of water for 8 to 10 hours. For transporting live fish in 12 x 28 inch, 4 mil plastic bags a loading rate of 0-360 fish is usually recommended.

It has been an established practice to acclimate fish from the temperature of the transportation unit to that of the environment into which they are stocked, a process called tempering. In the past, temperature was the main reason given for tempering fish. Evidence in many cases has failed to demonstrate a temperature shock even though there was a difference of as much as 30º F; changes in water chemistry and dissolved gas levels may be more important than temperature changes.

PLOSILA, D. S. 1972. Hatchery performance of wild and hybrid strains of brook trout. New York State Division of Fish and Game 16 p.

POTTER, B. A. and B. A. BARTON. 1986. Stocking goals and criteria for restoration and enhancement of coldwater fisheries. p. 147-159 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management, Fish Culture and Fisheries Management Sections, American Fisheries Society, Bethesda, Maryland.

Fish stocking is a management technique which can be used either alone or in combination with habitat protection or rehabilitation, regulation enforcement and population management. Consequently, an analysis of stocking goals begins with a review of general fisheries management goals. Important elements of stocking goal statements common to most agencies include the following:

1. Meet the demand for angling opportunities.
2. Restore stable, naturally reproducing fish populations.
3. Protect existing genetic resources.
4. Provide a diversity of fish species and angling opportunities.

It is the responsibility of fisheries managers to design stocking programs that, when implemented, will meet general management and stocking goals. Important criteria include:

- Species and stock or strain considerations.
- Size and age of fish at stocking.
- Numbers and weight stocked (stocking rates)
- Suitability of stocked waters.
- Timing and frequency of stocking.
- Economic considerations.
- Angler returns from stocking.
- Fish health.

Recent advances in salmonid stocking practices include: (1) recognition of the need, in many cases, to manage natural and stocked fisheries independently of one another, (2) application of the stock concept (i.e., selecting locally adapted fish stocks for restoration stocking programs), and (3) attempts to meet specific quantified fisheries objectives such as average size of fish at harvest and angler catch rates. Continued public education efforts are also needed to explain to affected user groups both the fish resource potential and the limitations of stocking.

POWELL, M. J. 1977. An assessment of brook trout planting in a neutralized lake as compared to four other Sudbury area lakes. File Report, Ontario Ministry of Natural Resources, Sudbury, Ontario. 29 p.

An assessment of planted brook trout growth and relative survival in five Sudbury lakes in presented. One of the five lakes studied was a previously acidic lake which had been neutralized by the addition of Ca CO_3 and Ca $(OH)_2$. It was found that none of the brook trout planted in the neutralized lake survived their first summer. Those brook trout which were captured one month after planting in the neutralized lake had not grown while trout planted in the other four lakes all showed substantial increases in length and weight. It is suggested that the high copper concentration in the neutralized lake was the prime factor responsible for the demise of the brook trout.

PREVOST, C. 1935. Experimental stocking of speckled trout from the air. Transactions of the American Fisheries Society 65 : 277-278.

Several experiments were conducted in which brook trout of varying sizes were dropped from different altitudes to a lake below. Damage to gonads was observed and some mortality was recorded. It seems to me that these experiments are sufficiently conclusive to demonstrate that the stocking of lakes from the air is not only possible but practical.

PREVOST, C. and L. PICHE. 1938. Observations on the respiration of trout fingerlings and a new method of transporting speckled trout. Québec Department of Mines and Fisheries and the University of Montreal, Montreal, Québec.

PRINCE, E. D. 1958. How to establish a trout pond. Ontario Department of Lands and Forests, Toronto, Ontario. 6 p.

It is difficult to give definite directions respecting the number of fish which can be safely retained in a pond but a spring 1 1/2 inches square in volume at a temperature of about 50º F and flowing through a tank 24 feet long, 2 feet wide and 1 1/2 feet deep (i.e., 72 cubic feet capacity) will accommodate a thousand trout 9-15 inches long. Generally one can figure 10 trout to each cubic foot of flowing water.

Some trout culturists prefer to stock ponds with small trout fry, either newly hatched, 5-6 weeks old, or fingerlings 6-12 months old. If conditions are favourable, this stocking with young fish, either alevins or fingerlings, may be successful but three of four years at least must elapse before the pond will furnish any angling.

PUNT, K. 1995. Brook trout re-introduction to Scully Lake, Renfrew County. File Memorandum, Ontario Ministry of Natural Resources, Pembroke, Ontario. 7 p.

Scully Lake is a small (4.9 ha) lake in Renfrew County. Historically, the lake was stocked regularly with 300-2500 brook trout (61-510 fish ha^{-1}) between 1951 and 1969. In the early 1970s, brook trout stocking was discontinued because of concerns regarding competition with resident smallmouth bass as well as a perceived access problem to the lake. After a stocking hiatus of twenty years, Scully Lake was stocked with brook trout on an experimental basis in 1994. Volunteer angler records were maintained during the winter and spring of 1995. During seventeen fishing trips between January 6 and March 31, 1995, anglers reported exerting 2380 rod (line) hours of angling effort to catch 65 brook trout. This represents a catch-per-unit-effort (CUE) of 0.027. Scully Lake has two distinct basins: a relatively deep basin with plenty of good coldwater habitat, and a very narrow band of shallow littoral water near the shore. The distribution of brook trout and smallmouth bass is mutually exclusive and interspecific competition is probably minimized for most of the year.

PYLE, A. B. 1973. Investigations in the mortality of stocked trout in New Jersey streams. Miscellaneous Report No. 36, Division of Fish, Game and Shellfisheries, New Jersey Department of Environmental Protection, Lebanon, New Jersey. 28 p.

Trout from the New Jersey state fish hatchery suffered severe and often complete and rapid mortality when stocked into six central New Jersey streams under conditions approximating those that customarily prevail in the winter through March. Twelve other streams were not found to have this problem. Characteristics of the winter conditions associated with the mortality are temperatures ranging up to 49º F but averaging less than 40º F; and increased concentrations of sulfates and aluminum over those found during warmer autumn conditions.

The inability of the newly stocked trout to adjust to their new environment, rather than because of toxicity, is adjudged to be the principal cause for mortality since the streams maintain resident trout populations throughout the year. The order of tolerance, most to least, of the trout to the conditions responsible for this mortality is brook, brown and rainbow.

These streams can be safely stocked with trout when their temperatures reach 42º F after April 1st which is when a pattern of continuing temperature escalation can be expected. The matter of recognizing other "problem" streams might best be accomplished by a stream "fingerprinting" technique that takes trout acclimation into consideration. The contribution of disease to the loss of trout stocked when water temperatures exceed 50º F should be investigated.

QUÉBEC MINISTÈRE DU LOISIR, DE LA CHASSE ET DE LA PÊCHE. 1988. Technical file for stocking of brook charr (*Salvelinus fontinalis*) using the put-grow-and-take technique. Direction de la gestion des especes et des habitats, Québec City, PQ.

When stocking brook charr on a put-grow-and-take basis the following rates are the maximum permitted. Where the level of competition is nil to low fingerlings should be stocked at rates of 200/ha and 100/ha in mesotrophic and oligotrophic lakes respectively. Where the level of competition is moderate (e.g. *Catostomatidae* and/or *Cyprinidae*) fingerlings should be stocked at rates of 125/ha and 60/ha in mesotrophic and oligotrophic lakes respectively. In streams brook trout fingerlings should be stocked at rates of 60/m x # km (maximum of 1,200/km) where there is little competition and at rates of 40/m x #km where there is a moderate amount of competition. Stocking of this species is not recommended where populations of *Esocidae, Centrarchidae, Percidae* or *Ictaluridae* are found. Fingerling stocking should be conducted in the fall on an annual basis. In lakes, fingerlings should be released in areas having water depths of 0-6 m. In streams the fish should be dispersed by lots at various points of access.

Where brook trout are being stocked on a put-and-take basis, it is up to the manager to determine the size of fish he wishes to obtain. Stockings are always to be carried out with fish no less than one year old however. Stocking rates are based on the size of the waterbody and the expected fishing pressure:

Brook trout stocking rates for lakes:

	Expected Fishing Pressure (days/ha)		
Surface Area (ha)	10-30	30-100	> 100
0-2	250/ha	1,000/ha	2,000/ha
2-4	200/ha	800/ha	1,600/ha
4-12	120/ha	480/ha	960/ha
12-20	75/ha	300/ha	-
20-50	35/ha	140/ha	-
Maximum per project	1,750	5,000	5,000

Brook trout stocking rates for streams and rivers:

	Expected Fishing Pressure (days/km)		
15-50	50-150	> 150	
Rate	50/m x #km	200/m x #km	400/m x #km
Maximum per project	1,750	5,000	5,000

In lakes, brook trout should be released in areas where water depth varies from 0-6 meters. In streams, fish should be dispersed by lots at various points of access.

QUIG, L. F. 1968. Downtown trout. Rod and Gun in Canada. 70(5) : 12-14.

Nine mile quarry sits on 200 acres of land, formerly owned by Ontario Hydro, near Cornwall, Ontario. The quarry was gouged out of the land to supply the crushed stone and gravel necessary for the construction of the huge Robert Saunders Generating Station at Cornwall. In places it is 70 feet deep. The quarry is spring-fed with water temperatures at the time of stocking a perfect 50º F.

Initially, the quarry was poisoned (rotenone) to remove undesirable fish species which were present. Three thousand yearling brook trout, reared at the Codrington Fish Culture Station, were stocked on April 25 and 26. During the first two days of the fishing season, more than 400 of the trout were tallied by officials of the Ontario Department of Lands and Forests at the checkpoint leading out of the area.

RABE, F. W. 1967. The transplantation of brook trout in an alpine lake. Progressive Fish Culturist 29(1) : 53-55.

Brook trout (*Salvelinus fontinalis*) were transplanted from an overcrowded lake to a lake sparsely populated with fish in order to determine whether mature fish from a stunted population were capable of better growth and, if so, how long it would take for these changes to become apparent. On August 29, 1957, lake X-30 was stocked with 2,700 brook trout fingerlings that averaged 2 inches. After 13 months, transplanted fish were about 1 pound heavier and 6 inches longer than control fish. Where the standing crop of fish food organisms in an alpine lake is high, trout growth may be rapid even when the period of ice-free days is short. Planners of stocking programs should recognize that alpine lakes are poorer producers and hence usually have much less carrying capacity.

RAINE, G. E. 1969. Cornwall recreation area proves popular. Ontario Fish and Wildlife Review 8(4) : 13-14.

In 1968, with the opening of the Cornwall recreation area and its put-and-take brook trout fishing pond, trout fishing in Kemptville Forest District took on a new dimension. Previously, a lack of suitable trout waters in this district, especially in the extreme eastern portion, has meant that local trout anglers have had to travel a considerable distance to pursue their sport. With the completion of the St. Lawrence Seaway, the 65-foot deep quarry was abandoned and eventually filled water. Physical, chemical and biological conditions were found to be satisfactory for the establishment of a brook trout fishery on a put-and-take basis. Netting operations revealed that northern pike, maskinonge and at least twelve other fish species had managed to gain access from the nearby Raisin River. To eliminate fish species incompatible with brook trout, the water was treated during October 1967 with 210 gallons (0.75 ppm) of Pro-Noxfish fish eradicant. To prevent re-entry of competing fish both the seasonal inlet and outlet drainage ditches were blocked and the water course re-routed.

On April 25 and 26, 1968, 3,000 yearling brook trout about 8 inches long were planted in preparation for the official opening on Saturday April 27, a day that saw some 400 anglers and many more observers visit the recreation area. Four additional plantings during the summer months boosted the total stocking to 8,000 trout and maintained a favourable uniform catch per unit of effort. From the opening date to the closing of the brook trout season (September 30), approximately 5,500 angler visits had resulted in 9,700 hours of fishing and a catch of 4,200 trout. Creel census over the winter season ending on March 31 indicated that 1,600 trout had been caught in 2,000 hours of fishing during 500 angler visits.

RAINE, G. E. 1970. Brook trout stocking assessment on Long Sault Creek, Dalhousie Township. File Report, Ontario Department of Lands and Forests, Kemptville, Ontario. 2 p.

Hatchery-reared brook trout were first introduced to Long Sault Creek, Dalhousie Township, Lanark County, in 1939. Stocking over the past five years may be summarized as follows: 1965 – 2000 yearlings, 1966 – 250 yearlings, 1967 – 750 yearlings, 1968 – 250 yearlings, and 1969 – 500 yearlings.

On July 30, 1969, several portions of Long Sault Creek were electrofished. The first section was a 1/4 mile section immediately upstream of the bridge. This section of creek has been where brook trout have been stocked over the past several years. In that section of stream, 20 fingerling and 26 yearling brook trout were captured, checked and released. All captured fish were from natural reproduction. A few mudminnows and white suckers were also captured. The second section of creek electrofished was a 1/4 mile stretch between the two bridges. The catch results included 9 native brook trout, 1 hatchery-reared brook trout (RP clip), 1 2-3 year old brook trout (weighing 1 pound) and 7 native fingerling brook trout. The final section of stream sampled was a 1/4 mile section immediately downstream of the highway bridge. The catch consisted of 8 native yearling brook trout and 6 native fingerling brook trout.

With only 1 hatchery stock fish recovered, either the remaining stocked fish have been angled or the trout have dispersed upstream of downstream from the sample sites. The stream appears to be very suitable for brook trout in the area under study.

RATLEDGE, H. M. 1966. The impact of increasing fishing pressure upon wild and hatchery-reared trout populations. Proceedings of the Annual Meeting of Southeastern Association of Game and Fish Commissions 20 : 375-379.

Twelve years of trout stream management on the Standing Indian Wildlife Management Area in North Carolina has involved a fixed annual stocking of marked hatchery-reared trout. A complete creel census has been mandatory on the Area streams so that the catch of both stocked and wild trout could be followed.

It was concluded from this study that: (1) wild trout populations deteriorated after two consecutive years of 40 trips per acre per year; (2) hatchery-reared trout provided only a buffer to the destructive harvest of wild trout up to a point, then when the wild trout have been depleted, the hatchery fish became dominant in the harvest; (3) up to that point, harvest of wild trout not the harvest of the stocked trout upheld the trout fishery; and (4) increased fishing pressure resulted in a decreased average catch and catch per hour, whereas, decreased pressure resulted in higher average catches.

READ, D. 1981. Brook trout stocking assessment study, Robert Lake. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 22 p.

Robert lake is a small (187.0 ha) lake which, with the exception of 1978, has been stocked annually with yearling brook trout since 1970. Stocking rates have been as high as 176 fish/ha but have averaged 59 fish/ha.

This study was conducted on Robert Lake in order to further our knowledge of the survival and growth of stocked brook trout in the Temagami area. The lake was gill netted for three consecutive nights (July 7-9, 1981) with a total of 122 m of multifilament net and 30.5 m of monofilament net. Mesh sizes were 5.1 cm, 6.4 cm and 6.7 cm. During the first net night, two gangs were set. On the two subsequent nights, the multifilament gang was divided into two equal lengths.

In total, 17 brook trout and 4 white suckers were taken by the nets. The survival rates, fourteen months after being stocked, for age groups II-IV was 0.34%. Of the 17 brook trout sampled, 12 were sexually mature. Nine fish in age group II were mature indicating early maturity.

The survival rate of stocked brook trout in Robert Lake appears to be poor, much lower than other stocked brook trout lakes in northeastern Ontario. It is felt, however, that the amount of gill net used in this study may have been inadequate. These results may have been improved by employing twice as much net in future studies.

RINNE, J. N. and J. JANISCH. 1995. Coldwater fish stocking and native fishes in Arizona: Past, present and future. p. 397-406 *In* H. L. Schramm and R. G. Piper [eds.]. Uses and Effects of Cultured Fishes in Aquatic Ecosystems, American Fisheries Society Symposium 15, Bethesda, Maryland.

Since the 1930s almost 70 million fish representing 17 normative species have been introduced into lakes and streams of the Little Colorado and Black River drainages in the White Mountains of east-central Arizona. The two drainages historically contained populations of native Apache trout (*Oncorhynchus apache*) and a native cyprinid species, Little Colorado spinedace (*Lepidomeda vittata*). Both are classified as threatened species. The declines of these fishes have resulted from stocking of normative species, principally rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*). Establishment of normative salmonids was facilitated in many cases by stream renovations with fish toxicants and baitfish introductions. Habitat alterations related to land management activities, principally timber harvest and livestock grazing, further affected the Apache trout and Little Colorado spinedace. Proposed changes in stocking strategies and innovative management activities will be instrumental in sustaining these two species and other native fishes of the state.

RITCHIE, B.J. and J. BLACK. 1988. Status of the Lake Nipigon brook trout fishery and assessment of stresses, 1923 to 1987. Technical Report, Lake Nipigon Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Nipigon, Ontario. 57 p.

Spawn-taking operations from Lake Nipigon brook trout took place annually in South Bay and West Bay from 1924 to 1931. Spawn taking has not occurred since 1984. Brook trout have been stocked in Lake Nipigon, on an irregular basis, since 1928. In the past five years, a total of 2,952 sub-adult and 14,073 adult brook trout have been stocked into Lake Nipigon.

The contribution of stocked fish to spawning populations and angler harvest is difficult to assess because most brook trout stocked in Lake Nipigon were not marked. However, surplus hatchery brood stock released as adults can usually be identified by fin wear. Unmarked fish stocked as fry, fingerlings or sub-adults are impossible to distinguish from native fish.

The first occurrence of identifiable hatchery fish on the spawning areas of West Bay and South Bay was in 1984 and 1985, respectively. In 1984, 8% of fish handled during the spawning investigation at West Bay were hatchery fish but none were identified in 1987. During South Bay tagging operations, 17% of fish handled in both 1985 and 1987 were identifiable hatchery fish. All hatchery fish sampled in 1987 from South Bay were age 3 to 5 years.

Fifteen hundred tagged hatchery fish (age 2+ to 5+) were released at the Sand River in 1983 and 1,000 adipose clipped fish (age 2+) were released at the Macoun Islands in 1984. Six fish from the Sand River stocking and 1 fish from the Macouns were captured during the 1984 spawning investigation.

RYDER, R. A. 1957. Obtaining maximum benefits from our speckled trout hatcheries as dictated by modern management practices. Paper presented at the Port Arthur Fish and Wildlife Advisory Meeting, April 3-6, 1957, Port Arthur, Ontario.

In the early days of speckled trout propagation, the primary objective of the hatcheries was to produce as many trout as could possibly be maintained. Stocking was done promiscuously employing speckled trout fry and fingerlings with little regard to the suitability of the habitat. Even less attention was paid to the creel returns to the angler which resulted from these plantings. Today we have come a long way towards improved methods of propagation thanks to research. Hatcheries can now produce larger, healthier fish at smaller costs than formerly. Unfortunately, the fate of these bigger and better hatchery speckled trout is much the same as their predecessors. Employing hatchery-raised speckled trout in the role for which they were intended (introductions and recruitment) and reaping the benefits of the past twenty years of research, we should be able to devise a satisfactory management plan for the speckled trout hatcheries of this province.

Introductions should never be attempted until biological surveys show that they are justified. Restocking of waters where the native population has been annihilated should include fingerling trout for lakes and yearlings or adults for streams. Where the immediate establishment of a “fishable” population, legal-sized fish should be used in place of fingerlings. In lakes and streams where natural reproduction is poor, yearling and adult speckled trout provide a better return to the angler than do fingerlings. The answer to overfishing appears to be the planting of legal-sized speckled trout in both lakes and streams on a put-and-take basis.

The former plan of running a hatchery at peak efficiency thereby producing the maximum number of fingerlings or fry possible is no longer justified by present day demand. Fingerling trout should be maintained only for introductions in lakes which have been found satisfactory to their survival. Yearling fish are required for stream introductions and to supplement native populations where spawning conditions are poor or angling pressure heavy. Legal-sized speckled trout should be used in waters of extremely heavy fishing pressure where planting on a put-and-take basis is desirable.

RYDER, R. A. Undated. Farm ponds for trout in Ontario. Fish and Wildlife Branch publication, Ontario Department of Lands and Forests, Maple, Ontario.

Two species of trout have met with most success in Ontario ponds: the brook (speckled) trout and the rainbow trout. Brook or rainbow trout may be obtained from one of the many private hatcheries in Ontario. Stocking has its greatest effect if accomplished in the springtime at least before the surface water warms up above 65º F. In the spring it is more likely that hatchery water temperatures will conform more closely to pond temperatures, reducing the chance of a planting mortality. Midsummer stocking during hot weather should be avoided as, for best survival, it is preferable to plant fish in the spring and allow them to acclimate to the gradually warming waters and decreased oxygen concentrations. Barring the possibility of spring introduction of trout, fall plantings are usually successful if made after the surface water temperatures have returned to 65º F. Best results are usually achieved if all one sized fish of one species are stocked. Brook trout-rainbow trout combinations are not as successful as a single species. All other species of fish should be completely eliminated from the pond. Minnows should not be introduced as food as they might reproduce and establish themselves in the pond.

Stocking rates for Ontario ponds are not firmly established. A good deal of variability exists in the productivity of different ponds, which will greatly influence the stocking rates. Satisfactory results will usually be obtained by planting 1,000 fry per acre of pond surface or about 300 fingerlings for the same area. It is better to understock your pond than overstock it. Overstocking will result in decreased growth rates and reduce the overall population.

It is not likely that your trout will reproduce in a small pond. This is especially true of runoff ponds. Spring-fed ponds or ponds fed by streams may experience some natural reproduction providing suitable gravel spawning areas area available.

Farm ponds should probably be stocked every second or third year to assure good fishing

SASKATCHEWAN DEPARTMENT OF ENVIRONMENT AND RESOURCE MANAGEMENT. 1999. Fish stocking policies and procedures. Fisheries Branch, Regina Saskatchewan.

Approximately 160,000 brook trout are stocked annually in Saskatchewan waters. The number of trout fingerlings stocked per hectare is not fixed but biologists generally stock 100 fingerlings per hectare and then adjust stocking rates based on growth rate of the fish and angler demand.

The policy on fish stocking is currently to limit or prevent any introduction of non-native fish species. Fish stocking will not be undertaken where public access is not available, where natural reproduction is capable of maintaining the fish populations or where conditions are not suitable for fish survival on a year-round basis. No native species are allowed to be stocked by any group other than the Department of Environment and Resource Management.

SAUNDERS, J. W. and M. W. SMITH. 1961. Transplantation of brook trout (*Salvelinus fontinalis*) within a small stream system. Transactions of the American Fisheries Society 91 : 388.

Native brook trout were transplanted within the Ellerslie Brook system, Prince Edward Island, in summer to determine how well they could compete with trout already resident in other habitats of the same stream. The resident trout in a habitat appeared to have a competitive advantage. This advantage was greater in habitats of low trout carrying capacity. Transplanted trout fared better in partially depopulated habitats. Mortalities were higher among the transplanted trout during the ensuing 12 month period. Few transplanted trout homed to the area from which they had been displaced.

SAUNDERS, J. W. and M. W. SMITH. 1964. Planting brook trout in estuarial waters. Canadian Fish Culturist 32 :L 25-30.

Planting hatchery-reared brook trout of the year in the estuary of Ellerslie Brook, Prince Edward Island, resulted in a survival of 28 per cent to the anglers in the following season. These fish, age 0 and approximately 4 ? inches in length could have experienced salinities ranging from 0 to 30%.

SCHNEBERGER, E. and L. O. WILLIAMSON. 1943. The results of planting legal-sized trout in the Deerskin River, Vilas County, Wisconsin. Transactions of the American Fisheries Society 72 : 92-96.

A creel census was conducted on the Deerskin River to determine the results of stocking trout of legal size. The stocking was done in December and May and consisted of 1,002 brook and 1,621 rainbow trout. A yield of 3,438 trout was obtained. Native fish made up 71% of the catch. Native brook trout supplied the most fishing (50.5% of the total). All stocked fish, especially the larger rainbow trout planted in December, were inferior in condition and sporting value. There were no reports of either species carrying over to the second season.

SCHUCK, H. A. 1948. Survival of hatchery trout in streams and possible methods of improving the quality of hatchery trout. Progressive Fish Culturist 10 : 3-14.

This paper is restricted to a discussion of improving the quality of hatchery-reared trout whose survival is necessary over a considerable period of time before the fish are available to anglers. Possible reasons for the lessened ability of hatchery trout to survive are examined. An experimental program is presented to alter existing culture techniques to improve the quality of hatchery-reared trout.

SCHOFIELD, C. L., Jr. 1962. Water quality in an acidotrophic lake of the Adirondack Mountains in relation to survival of hatchery-reared brook trout (*Salvelinus fontinalis*). M.Sc. Thesis, Cornell University, Ithaca, New York. 148 p.

SCHOFIELD, C. L. S. P. GLOSS, B. PLONSKI and R. SPATEHOLTS. 1989. Production and growth efficiency of brook trout (*Salvelinus fontinalis*) in two Adirondack mountain (New York) lakes following liming. Canadian Journal of Fisheries and Aquatic Sciences 46 : 333-341.

Yearling and spring fingerling brook trout (*Salvelinus fontinalis*) stocked in two Adirondack lakes after liming in the spring of 1985 produced 10-14 kg ha^{-1} $year^{-1}$ at average standing crops of 8-10 kg ha^{-1} during the first year after stocking. These values were similar to levels observed in other limed and circumneutral Adirondack lakes, which collectively support a limited range of biomass (10-20 kg ha^{-1}). This level of predation was sufficient to significantly alter the size structure and composition of the invertebrate prey community within a few months after stocking. However, mean production efficiency in these populations remained at levels of 20-25% and the development of adverse water quality conditions in the first year after liming appeared to be of greater significance than food limitation in regulating production and biomass of these stocked brook trout populations. Reacidification of one lake 5 months after liming resulted in rapid declines in biomass and production as a result of both increased mortality and reduced growth.

SEAMAN, W. R. 1966. Use of catchable trout in Colorado. *In* Proceedings of the 46th Annual Conference of Western Association of State Game and Fish Commissioners. Butte, Montana.

Colorado has used a “formula” system of catchable trout stocking since 1948. Prior to that time stocking was the responsibility of the individual hatchery superintendent and encompassed only the local area served by the hatchery. Many waters were overlooked completely and others received a disproportionately high share of the fish available.

The formula developed involved the size of the waterbody (in acres), the fishing pressure (as a factor of one where heavy pressure is 1.0), and a habitat suitability factor expressed in terms of a factor of one. A suitable streams having 75 acres of water in a heavy fishing area would therefore receive 75 planting factors (75 x 1.0 x 1.0). Lakes are scaled down by size on factors as follows: 100% for the first 110 acres, 75% for the next 100 acres and 25% for the balance.

We now schedule approximately 1,200,000 pound of catchable trout each year at a rate of 70 pounds per planting factor. Catchables may not be substitutes for good habitat but where they are used we need to plant the best product which can be tailored to the management needs of the water planted.

SEAMANS, R. G., Jr. 1959. Trout stream management investigations of the Saco River watershed. Survey Report No. 9, New Hampshire Fish and Game Department, Concord, New Hampshire. 71 p.

This report contains the findings of a study designed to test, on an extensive basis, techniques developed to produce better returns to the fisherman for each dollar spent on propagation. Results are presented in terms of individual waters contained by the Saco River watershed.of New Hampshire.

In the Saco River, it was found that May, 1957 stocking of 1,187 brook trout resulted in only a 20% return (240 trout). It was considered best to discontinue May stocking in this stream. In June, 1957, 1495 brook trout were stocked and it was estimated that 35% were returned by the end of the season. This is still a low return but considerably better than that for May. In 1958, 1396 brook trout were stocked and it was estimated that 460 (33%) were taken by anglers. It is recommended to stock 1400 brook trout at a rate of 700 in June and 700 in July. The stream should be stocked twice each month approximately two weeks apart.

In 1957, the Sawyer River was scheduled to receive 1500 brook trout each year in monthly stocking of 500 each month for May, June and July. During the 1957 census period on the Sawyer River, 774 brook trout were stocked and an estimated 280 or 36% were taken by anglers. This is considered a fairly good return for streams in this watershed. In 1957, anglers took wild trout at a rate of 1.5-2.0 fish/hour. This is an extremely high success rate from native trout and it is a waste to continue stocking this stream.

In 1957, the Wildcat River was scheduled to receive 4000 brook trout in monthly stockings of 500 in May and September and 1000 in June, July and August. Because of a statewide reduction in stocking, only 3343 were planted yet the success rate was 1.84 fish/man hour. For this reason it was decided to cut the stocking to 2000 fish in 1958. These were stocked at the rate of 200 the last week in May, 350 the second and fourth weeks of June and July and 400 the second week in August. It was believed that stocking in this manner would result in a more evenly distributed success rate and better utilization of stocked fish.

The Rocky Branch was stocked with 2597 brook trout in 1957. During the 1957 census period (July and august) 1000 brook trout were stocked. Fishermen caught an estimated 310 of these for a 31% return. The creel census data collected for this stream indicated that returns were poor and that the existing native population was enough to support the extremely light fishing pressure. It was costing the sportsman approximately $850.00 per year to stock this stream and fish in the creel were valued at $5.00/pound or $12.50 for a limit of ten fish. At this rate, stocking this stream is not warranted.

The stocking formula for Ellis River called for stocking brook trout each year at a rate of 500 in May, 1250 in June and 500 in August. Stocked trout contribute almost 50% of the total catch. Stocking must, therefore, be continued in order to maintain the fishery. The stocking schedule for brook trout should be increased to 4000 each year and should produce the best fishing if 500 are stocked about May 28, 500 the first week in June, 1000 the third week in June, 1000 just before the July 4 holiday, 500 the third week in July and 500 about the second week in August. No fish should be stocked in September or October since the fly fishing only season was primarily designed to salvage the fish that would not carry over the winter.

SEQUIN, R. L. 1957. Management, fishing results and growth of speckled trout (*Salvelinus fontinalis*) in Baldwin Pond, Stanstead County, Québec. Canadian Fish Culturist 20 : 29-37.

At one time, Baldwin Pond had the environment favorable to speckled trout. Unfortunately, its sport value was decreased by a single factor: the introduction of unwanted species of fishes with consequent serious reduction in the number of trout. In the fall of 1953, a complete poisoning of Baldwin Pond took place to destroy undesirable species making it possible to recondition the lake for speckled trout angling. Plantings, made from the Eastern Townships fish hatchery, were conducted in the spring of 1954 (20,000 yearlings), fall of 1954 (5,000 fingerlings) and spring of 1955 (2,500 yearlings). These three plantings were distinctly marked and available for study when the first day's angling was allowed in the lake on May 23, 1955.

The opening day was very successful: 384 anglers caught 2,759 speckled trout. To prevent rapid depletion of the fish from the lake, in cooperation with the organized anglers, a limit was set of ten fish per angler per day. The 5,407 speckled trout caught and reported from May 23 to the end of September prove that the plantings of hatchery stock gave good results. The yield of 1.28 trout per hour per angler for all the season proves the value of the lake as a speckled trout producer.

SHETTER, D. S. 1939. Success of plantings of fingerling trout in Michigan waters as demonstrated by marking experiments and creel censuses. p. 318-325 *In* Transactions of the Fourth North American Wildlife Conference. Detroit, Michigan.

Since the fall of 1936, several marking experiments have been initiated to learn more concerning the survival of hatchery-reared trout fingerlings in natural waters. Returns have been received in five of the eleven experiments but in no experiment have the returns (in the form of legal fish) been greater than the 1.6 per cent of the total number of fingerlings planted. The spring planting of advanced brook trout fingerlings in Canada Creek resulted in the highest return in legal brook trout. Five hundred of these fish, averaging 5.5 inches in total length and bearing jaw tags, were planted in April, 1937. One hundred and thirty-three (133) fish or 26.6 per cent of the total number planted were reported and captured and released in 1938. It seems unlikely that any large number of brook trout moved very far away from the localities of release.

Although no data are yet available which demonstrate the best size of fingerling trout to plant or the more advantageous season in which to plant them, all of the experimental evidence thus far presented points toward the inevitable conclusion that the planting of fingerling trout in the waters studied have resulted in a negligible return to the fishermen.

SHETTER, D. S. 1947. Further results from spring and fall planting of legal size hatchery reared trout in streams and lakes of Michigan. Transactions of the American Fisheries Society 74 : 35-58.

Further tagging experiments in Michigan with spring and fall plantings of brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Salmo gairdneri irideus*) from which recoveries were made during the 1942 trout season confirmed the conclusion that spring releases of adult or near adult hatchery-reared brook trout and rainbow trout is more desirable than the fall planting of fish of a similar size. In some instances fall stocking of brown trout may furnish as good fishing in the following seasons as does spring planting.

Recoveries of planted fish past the first season of availability ranged from 0.0 to 2.5 per cent in the second season and from 0.0 to 0.5 per cent in the third season. In either spring or fall planting of legal sized fish, no advantage was gained by scattering the fish widely over the stream areas stocked.

Eighty-five per cent or more of the planted trout recovered were caught within 10 miles of the point of release, regardless of the season or method of planting. Brown trout moved the least and rainbow trout the most. About one-fourth of the brook trout tended to move 3 to 10 miles downstream and the majority of the remainder were caught within 3 miles of the locality of release. More rainbow trout than any other species were recaptured 10 or more miles from the point of release.

Fall plantings of adult brook trout in lakes were recovered at the rate of 56.7 per cent (range 13.0 to 88.1 per cent). Unfortunately, a small percentage of the anglers removed an average of 89.4 per cent of the total catch during the opening weeks of the trout season. The average recovery from two spring plantings of brook trout in East Fish Lake in Michigan was 68.5 per cent.

A brief review of the literature substantiates the conclusions reached as a result of the Michigan experiments. Differences in experimental procedure are pointed out and some reasons are offered for the failure of fish planted in streams in the fall to survive the winter season.

SHETTER, D. S. 1950. Results from plantings of marked fingerling brook trout in Hunt Creek, Montmorency County, Michigan. Transactions of the American Fisheries Society 79 : 77-93.

Fin clipped fingerling brook trout (*Salvelinus fontinalis*), both hatchery-reared and wild, were released in Hunt Creek in late summer or fall of 1939 and 1940. Their contribution to the catch in subsequent years was determined by creel census and anglers' reports. The extensive experiments involved the release of 35,109 and 17,635 marked fingerlings, respectively, throughout the length of Hunt Creek. Marked fish entered the anglers' catches in 1941 and 1942 and made up from 0.27 to 2.56 per cent of the observed catch of legal brook trout in various years. The total known percentages of recovery were 0.07 per cent (26 fish) of the 1939 release, and 0.28 per cent (49 fish) of the 1940 planting.

Intensive experiments with both wild and hatchery-reared brook trout fingerlings marked by different fin combinations were carried on simultaneously in Section C of the experimental waters of Hunt Creek. Marked hatchery-reared fingerlings released in 1939 contributed from 0.0 to 0.26 per cent of the total observed catches of legal brook trout in later years; 1940 marked hatchery fingerlings made up from 0.00 to 0.45 per cent of total observed catches in later years. Wild fingerlings marked at the same time made up from 0.00 to 1.80 per cent of catches recorded in subsequent seasons. Larger percentages of recovery were noted for the smaller of the two releases (1940).

Through the use of the formula $M = 1{,}000A/BC$ where M = migration or abundance index from a release locality to a recovery locality, A = number of marked fish recovered in a given locality, B = number of fishing units of effort in a given locality, and C = total number of marked fish released in a given locality, it was demonstrated that the majority of wild and hatchery reared marked fingerlings in the intensive experiment stayed within the limits of the experimental sections, although they did move out of Section C except for the hatchery-reared fingerlings recovered in 1942 which were farther downstream than usual.

General growth data on marked fingerlings of both types indicated that probably those fish which were largest at the time of marking and release came into the legal catch first.

It was concluded that brook trout fingerling planting is a wasteful procedure because a low percentage reaches the anglers creels. Creel census data demonstrate that despite the elimination of fingerling stocking in Hunt Creek following 1940, angling quality has not deteriorated.

SHETTER, D. S. and A. S. HAZZARD. 1940. Results from plantings of marked legal-sized trout in streams and lakes of Michigan. Transactions of the American Fisheries Society 70 : 446-467.

Intensive creel censuses served as the chief basis for estimates of the effectiveness of plantings of marked legal-sized brook trout, brown trout and rainbow trout at various seasons over a period of from 1 to 3 years in sections of five public streams and two private streams. Similar data are presented for plantings of rainbow trout in five lakes. Returns from fall planting in streams never exceeded 5.3 per cent; spring and open season plantings resulted in the recovery by anglers of from 4.9 to 61.9 per cent of the fish released. Fall plantings of rainbow trout in lakes yielded returns up to 66 per cent. Plantings of from 100 to 160 trout per mile of stream averaging 50 feet in width yielded higher percentage returns than did plantings of larger number of fish, benefited more anglers, and did not stimulate the catch of native fish. The increase in the catch-per-hour and the percentage of hatchery fish in the total catch appeared to be inversely proportional to the density of the native population of the species stocked and directly proportional to the number of fish planted. The percentage of the total catch contributed by plantings of moderate numbers of trout in the spring or during the season varied from 1.8 to 30.4. It is concluded that in northern Michigan streams, major dependence for good fishing must be placed on the native or "wild" stock. Rainbow trout and brown trout were caught for at least 8 weeks following planting although the majority was removed by the end of

4 weeks; few, if any, brook trout were taken after 4 weeks. Very few planted trout survived one or more winters even in private streams not subject to intensive angling. Most of the trout were taken within 5 miles of the point of release and usually downstream; of the three species, rainbow trout migrated most extensively. From 5.7 to 20.6 per cent of the fisherman day records showed the capture of marked trout. Apparently as many anglers benefited from "spot" plantings as from wider distribution by boat. Control experiments proved that jaw tagging and fin clipping provided effective methods of tracing fish during the period of investigation and that mortality and the effect on growth of either method were negligible.

SHETTER, D. S. and A. S. HAZZARD. 1942. Planting "keeper" trout. Michigan Conservationist 11(4) : 3-5.

SHETTER, D. S., W. C. LATTA, M. G. GALBRAITH, J. W. MERNA and G. P. COOPER. 1964. Returns of hatchery trout in Michigan. Fisheries Report No. 1691, Division of Fisheries, Michigan Department of Conservation, Lansing, Michigan.

The trout stocking program is a well regarded activity of a public agency dating back to 1873. In coldwater streams of northern Michigan the brook trout, particularly, provided excellent fishing following the initial introductions of fry. This went on until about 1900. Between 1900 and about 1938, the size of trout planted was gradually shifted from fry (3/4 inch-1 1/4 inch) to fingerlings and most of the planting was done in the fall months.

Reference to the planting records of the 1920-1935 period indicates that total trout plantings (brook, brown, rainbow and lake trout) were in the tens of millions annually. For example in 1927, 35 million trout were released, two-thirds of them brook trout fry. In the next 10 years the bulk of the fish released were fingerlings (1-4 inches). By 1958-1962 the planting program had changed from fingerlings to trout of legal size.

SIEGLER, H. R. 1948. Adaptability of brook trout. Journal of Wildlife Management 12(3) : 326-327.

Lakes and ponds with borderline oxygen and temperature ratings for trout often produce perplexing problems for biological survey crews. Seldom do we recommend stocking of brook trout (*Salvelinus fontinalis*) in a pond in which water is warmer than 72º F and in which the dissolved oxygen content drops below 5 parts per million. This, I believe, with minor variations is a standard practice in most of the states. Experience has repeatedly shown us that fish stocked in such waters will often die at the time of stocking.

Data are, however, gradually being accumulated to show that fish which are stocked under optimum conditions can adapt themselves to temperatures and dissolved oxygen which are lethal under ordinary conditions. Our survey crew found a healthy trout population in a pond with supposedly lethal conditions.

Copp's Pond in Melvin, New Hampshire, was created in 1944. It is a shallow, marshy pond with a surface acreage of approximately thirty acres and a maximum depth in summer of seven feet. The pond is stocked with fingerling or legal brook trout in the autumn months or immediately after the ice breaks up in spring and has become one of the best trout ponds in the region. A routine chemical survey was made of the pond on August 25, 1947. Had our survey crew obtained the resulted listed in the following readings, before the pond was stocked, Copp's Pond would have been classified as a warmwater fish pond and unsuitable for trout.

Depth (feet)	Temperature (ºF)	pH	Dissolved oxygen (ppm)	% Oxygen Saturation	Carbon Dioxide
0	86	6.4	7.7	102.91	6.0
4	78	6.2	4.0	49.16	11.0
6	77	6.2	3.1	37.74	13.0
7	68	-	0.9	10.00	-

The only water with temperature considered suitable for trout, 68º F at the 7 foot level, had but 0.9 ppm of oxygen. A gill net was then placed in the area where the readings were made. Four trout and one sucker, all in good condition, were caught within two hours.

Data such as these now lead us to believe that trout stocked in the late autumn months can adapt themselves to various temperatures of our southern New Hampshire lakes which to date have been listed as unsuitable.

SMITH, E. L. 1961. Fish census taken at Spence's Pond, Mono Township, 1961. p. 6-7 *In* Conservation Officer's Projects, 1960–1961, Ontario Department of Lands and Forests, Southwestern Region.

This census was taken to determine how many fish were harvested from a trout pond of 5.5 acres during the regular fishing season and also the number of fish per acre. It will also give us some information in regard to the fishing pressure which is taken from public waters by the development of private ponds. Census forms were posted in the boat house at the pond requesting the information from each party who fished the pond. Anglers reported exerting 205 hours of angling effort to harvest 446 salmonids comprised of rainbow trout, brook trout and splake. Brook trout accounted for the majority of trout (429 of 446 fish, 96.2%) which were harvested. An additional 32 brook trout were caught and released. If the harvest is equal in other ponds of this kind, they no doubt alleviate the fishing pressure in public waters.

SMITH, L. L. 1941. The results of planting brook trout of legal length in the Salmon Trout River, northern Michigan. Transactions of the American Fisheries Society 70 : 249-258.

A creel census and tagging study was conducted on the Salmon Trout River in northern Michigan for a three year period to determine the most effective method of planting 7 to 9 inch brook trout. The creel census indicated that the fishing load was relatively light and that the average yield in the different years varied from 4.3 fish to 5.2 fish per rod per 4 hour day. Recoveries of jaw tagged brook trout planted in the fall and in the spring of three successive years showed a maximum of 1.0 per cent of fall planted fish was returned to the fisherman's creel, and that a maximum of 19.6 per cent of spring planted fish was returned. Tagged fish were returned throughout the entire season instead of being exhausted during the first few weeks. The movements of planted fish were not extensive but had a tendency to be downstream. In three successive seasons hatchery-reared trout contributed 44.0 per cent, 38.6 per cent, and 24.9 per cent, respectively, of the total catch.

SMITH, L. L. and B. S. SMITH. 1943. Survival of seven to ten inch planted trout in two Minnesota streams. Transactions of the American Fisheries Society 73 : 108-116.

Jaw tagged 7 to10 inch brook trout were placed in two Minnesota streams to determine their survival. A creel census conducted on Duschee Creek showed that trout were returned at the rate of 1.49 and 1.55 fish per hour in succeeding seasons. Brown trout planted in this stream in the fall and spring yielded returns of 21.7 per cent and 28.0 per cent respectively but no brook trout and only 2.0 per cent of the brown trout planted in summer were caught the following year. Planted trout contributed 8.8 per cent and 22.7 per cent of the total catch in successive seasons.

Catchable-sized brown trout and brook trout planted in the Knife River in the fall and in the spring showed a total return of 1.9 per cent from fall planting and 14.1 per cent from spring planting. Two and four-tenths per cent of the brook trout and 1.4 per cent of the brown trout planted in the fall and 19.6 per cent of the brook trout and 8.6 per cent of the brown trout planted in the spring were recaptured. The contribution of planted fish to the total catch in the Knife River was 23.0 per cent. The studies indicated that in the streams studied fall planted brown trout may have survival comparable to that of spring planted fish, that the majority of planted fish recovered are taken the first 3-4 weeks of the season, and that planted fish contribute only a minor portion of the total catch.

SMITH, M. W. 1954. Planting hatchery stocks of speckled trout in improved waters. Canadian Fish Culturist 16 : 1-5.

The planting in natural habitats of fish hatched and reared under artificial conditions is one of the oldest procedures designed to maintain and improve sport fishing. The procedure is based upon the assumption that, for whatever reasons, naturally reared stocks of game fish, such as speckled trout, are insufficient to utilize fully the productive capacities of many of our fresh waters. However, we have progressed in fish cultural matters to the realization that we are indeed fortunate if any one procedure by itself give anticipated results. The planting of hatchery stocks of speckled trout is no exception and the history of the procedure discloses more failure than success when data have been available for assessment. Rather, we have seen that benefits from fish cultural procedures have been most frequently obtained when two or more actions have been taken consecutively or concurrently. It is the intent of this paper to show that when the trout producing capacity of a natural lake was increased by fertilization and mortalities were reduced by control of predatory mammals, birds and fish, the planting of hatchery stocks proved to be an integral part of the program and contributed strongly to the improved angling that was realized.

SMITH, M. W. 1967. Movement of planted hatchery-reared trout from a natural lake. Canadian Fish Culturist 39 : 35-40.

Extent to which hatchery-reared underyearling and yearling brook and rainbow trout in 21 plantings attempted to leave Crecy Lake, New Brunswick, was determined by year-round operation of a trap on the outlet. A greater proportion of brook than rainbow trout left the lake. Yearlings of both species, particularly those maturing, were most prone to run. Most prominent runs were associated with greatest water discharge from the lake.

SMITH, N. W. Undated. Brook trout management in Kent and Patterson creeks. File report, Ontario Ministry of Natural Resources, London, Ontario. 4 p.

Kent and Patterson creeks are very similar trout streams. Both are headwater tributaries to the Lynn River and both contain wild brook trout populations. Both creeks are historically known for their brook trout fishing however they also have a long history of stocking. These stocking reports suggest put-and-take stocking of legal-sized trout occurred annually in both creeks during the 1950s. This stocking may have continued until 1972 when Normandale Fish Culture Station stopped rearing brook trout. Beginning in 1975, Kent and Patterson creeks were stocked on an annual basis with hatchery-reared brook trout. This was initiated in response to angler requests and on the assumption that fishing effort on the creeks was greater than the wild brook trout populations could sustain while still providing an acceptable angling experience. The purpose was identified as maintenance to supplement a small native population.

In the fall of 1983, Ministry of Natural Resources (MNR) staff electrofished over 1 km of creek and handled 93 wild trout. None of these trout were clipped suggesting that they were of wild origin. These results, along with the apparent lack of heavy angling effort prompted us to initiate an experiment to determine whether Kent and Patterson creeks needed to be stocked with hatchery-reared trout. Beginning in 1984, Kent Creek was not stocked with hatchery-reared trout. Stocking was to continue on Patterson Creek until the effects of no stocking in Kent Creek were evident.

Anglers were interviewed during the opening weekend between 1982 and 1989. Fishing success has generally increased on Kent Creek since we stopped stocking hatchery fish (from 0.4 fish/hour in 1982 to over 1.4 fish/hour in 1989). As a result of the positive results on Kent Creek, plantings in Patterson were stopped in 1986.

SNUCINS, E. J. 1992. Relative survival of hatchery-reared lake trout, brook trout and F_1 splake stocked in low pH lakes. North American Journal of Fisheries Management 12(3) : 460-464.

A matched planting experiment was conducted to determine the most suitable salmonid genotype for stocking in former lake trout lakes that currently are too acidic to support lake trout reproduction. Hatchery reared lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*), and F_1 splake (*S. namaycush* x *S. fontinalis*) were planted in May 1989 at 18-19 months in four lake with pH values of 4.9-5.4. Relative survival of the three genotypes was assessed during a four day holding period immediately after stocking and by gill netting during the summer of 1990. During the four day holding period, survival of lake trout (23%) was significantly lower than that of brook trout (98%) and splake (92%). Gill netting recovery rates were 0-0.9% for lake trout, 0-1.8% for brook trout, and 1.1-15.0% for splake. The results of this study suggest that splake are the most suitable of these three salmonid taxa for stocking on a put-grow-take basis in lakes of pH 4.9-5.4.

SNUCINS, E. J. and J. GUNN. 1994. Preserving brook trout diversity: The Aurora trout. p. 168-169 *In* Proceedings of the Annual Meeting of the American Fisheries Society, Halifax, Nova Scotia. (Abstract Only).

The aurora trout is a unique genetic stock of the brook trout (*Salvelinus fontinalis*) distinguished by its coloration and native to only two small lakes in northeastern Ontario, Canada. The stock was extirpated from the wild during the 1960s by acidification of the lakes from atmospheric deposition of industrial pollutants. Captive breeding, that began in 1958 before the stock was eliminated from the wild, rescued it from extinction. The gene pool was maintained in hatcheries for over 8 generations until restoration of water quality by liming in 1989 facilitated the re-establishment of a reproducing population in one of the native lakes. Allozyme data indicates that the Aurora trout is currently the most genetically uniform stock of brook trout in Ontario. This low genetic diversity may be natural and reflect narrow adaptation to the home environment by the original wild stock or, alternatively, it may have arisen more recently when captive breeding began from a founding population of only 6-9 individuals. Initial observations of good reproduction and growth indicate that the return of the Aurora trout to its native waters has been successful but the prospects for long term viability of the reintroduced stock are not known.

SOLDWEDEL, R. H. 1974. Development of trout management practices in the Spruce Run Reservoir tributaries. Fish Game and Shellfisheries, New Jersey Department of Environmental Protection, Lebanon, New Jersey. 46 p. + appendices.

Spruce Run Creek and Mulhockaway Creek, two tributaries of Spruce Run Reservoir, served as sites for an evaluation of the practice of establishing “put-and-take” trout stocking programs in minor streams. Three species of trout (brook, brown and rainbow) were utilized in the stocking programs. Plantings of 100-300 brook trout were made on a monthly or bimonthly basis from 1969-1971 in Spruce Run Creek and in numbers of 50-100 fish on a similar stocking schedule in Mulhockaway Creek.

In Spruce Run Creek the return of brook trout remained fairly constant rising slightly and exceeding that of the rainbow trout in 1970. Brook trout predominated the catch early in the season (late April and early May) and it is those releases which are made at that time which are of the greatest benefit to the total harvest figure. Tag return information indicated that brook trout tended to move the most and that those book trout and brown trout involved in the pre-season releases tended to move more than those stocked in-season.

In Mulhockaway Creek, the return of rainbow trout remained quite consistent until brook trout and brown trout were added to the stockings. Once this occurred the return of rainbow trout began to drop off markedly. As compared to Spruce Run Creek there seemed to be a greater tendency for brook trout and brown trout to remain in the stream and a greater tendency for rainbow trout to leave it. In terms of the angler harvest, the data reveals that there was a rapid harvest of brook trout much more so than shown in Spruce Run Creek with few fish remaining to be harvested after the third week following their release.

Some natural reproduction of both rainbow trout and brook trout was observed in Norton Brook and Black Brook, former tributaries of Mulhockaway Creek.

SOLDWEDEL, R. H. 1975. Evaluation of winter trout stocking programs in Round Valley and Spruce Run reservoirs. Fish, Game, and Shellfisheries, New Jersey Department of Environmental Protection, Lebanon, New Jersey. 51 p.

Trout stocking during the months of November, December, January and February was compared with the normally practiced March pre-season stocking in two reservoirs. The study also included a comparison of the relative merits of brook trout, brown trout, and rainbow trout, the three species normally stocked under New Jersey’s program. One hundred fish of each species were stocked regularly in each reservoir during the winter months of 1971-1973.

Round Valley Reservoir, 2,350 acres in surface area, is an oligotrophic reservoir with year-round salmonid habitat. On average, the return of brook trout from the stockings made from November through February were found to be significantly higher that that from the regularly scheduled March planting. On an individual stocking basis, returns ranged from a high of 34.0% to a low of 16.0%. The return of brook trout was relatively equal for the 1971 (25.0%) and 1973 (24.6%) trout seasons compared to the return for the 1972 season (18.8%). If brook trout were to become available, this species would be recommended over either the brown trout or the rainbow trout.

Spruce Run Reservoir, 1,290 acres in surface area, is eutrophic and has only marginal year-round salmonid habitat. Overall, the return of brook trout was greatest from the January (37.7%) and November (34.0%) releases. On an individual stocking basis, returns ranged from a high of 62.0% (January 12, 1971) to a low of 16.0% (February 20, 1973) for the pre-March releases and from 30.0% to 18.0% for the March releases. Overall, the return of brook trout (30.3%) was considerably greater than that for either brown trout (19.8%) or rainbow trout (21.0%). However, on the basis of “effective” yield the return of brook trout (14.7%) was slightly less than that of brown trout (15.9%) and rainbow trout (15.8%).

In summary, the percentage of trout caught from the winter stocking (as based on actual tag returns) were less than half those from the in-season stockings from both impoundments.

SOLMAN, V. E. F., J. P. CURRIER and W. C. CABLE. 1952. Why have fish hatcheries in Canada's National Parks? p. 226-233 *In* Proceedings of the 17th North American Wildlife Conference, Miami, Florida.

The first national park fish hatchery was established in Banff Park in 1913 when there was general agreement that hatcheries were the most important tool in fishery management Two other national park hatcheries, at Waterton Lakes and Jasper, were established in 1928 and 1941 respectively. During the period 1913 to 1943, inclusive, these three hatcheries distributed 40,000,000 trout as eyed eggs, fry and fingerlings. Beginning in 1944, the rearing of fish to yearling and 2 year old size was undertaken at the Jasper hatchery and since that time distributions of fish have been continued at a reduced rate using fish of larger sizes. Of the 3,000,000 fish distributed from 1944 to present, more than 10% have been yearlings or older. Cutthroat trout, rainbow trout and eastern brook trout were widely distributed by this work.

The percentage of marked (stocked) trout, as reported caught by anglers, varies considerably from lake to lake. In eastern brook trout waters, such as Trefoil, Mildred and Beauvert lakes, the proportion of marked fish caught by anglers exceeds 75%. In Trefoil Lake, which is considered one of the most productive trout waters in the Mountain Parks, the catch of eastern brook trout, as indicated by angler reports, amounted by 1950 to 24% of all fish planted since 1948, in the early part of which year a total winter kill occurred. After the winterkill which occurred in the spring of 1951 an additional 11% of the planted fish were counted dead on the shore of the lake. Therefore, the total recorded survival to the spring of 1951 is 35% which is a minimum.

We can report that 71 pounds of eastern brook trout planted in 1949 and 1950 in Mildred Lake have resulted in the reported catch by anglers from this lake of about 400 pounds of these trout in 1950 and 1951. In Trefoil Lake, the planting of 190 pounds of 2 year old eastern brook trout in 1948 and 1949 has produced about 300 pounds of trout in the angler's creel. In 1949, the total catch of eastern brook trout taken from Trefoil Lake was estimated at 30 pounds per acre.

As expected, growth varies from one lake to another. In Crandell Lake (Waterton Lakes National Park), eastern brook trout yearlings gained an average of 6.5 ounces from a planted weight of 0.7 ounces during the 50 week period between October 1950 and October 1951.

In the Mountain National Parks, hatcheries are essential for the production and maintenance of angling because of inadequate natural reproduction in many high, barren lakes, introduced species are better suited to these environments and it is desirable to restore fish populations destroyed by occasional winterkill.

STANFIELD, L. W. 1982. Brook trout (*Salvelinus fontinalis*) stocking assessment on Bartle Lake, Hudson Township. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 14 p.

Bartle Lake is a small (13.8 ha) spring-fed oligotrophic lake situated 13 km west of New Liskeard, Ontario. The lake was reclaimed in 1954 after bass had been introduced. The lake was restocked with brook trout annually from 1955-1967. Stocking was discontinued after 1967 but reinstituted in 1969 after a petition from local cottage owners. The lake has historically produced large fish and a high standing crop.

In response to angler concern over fishing success, a brook trout stocking assessment was conducted between August 23-25, 1982. The lake was netted for three consecutive nights with a total of 212 m of gill net (mesh sizes of 3.8, 5.0 and 6.3 cm). A total of six large brook trout (1.4-3.7 kg in weight) were caught producing a harvest of 10.6 kg (0.8 kg/ha).

It is recommended that Bartle Lake be stocked with 1,000 brook trout annually, that stocking success be re-evaluated in four years and that more efforts be directed to obtaining creel information.

STANKIEWICZ, R. 1981. Brook trout (*Salvelinus fontinalis*) stocking assessment, Herbert Lake. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 20 p.

This project was undertaken to obtain specific information on growth and survival rates of stocked brook trout. Herbert Lake is a 11.7 ha lake which was stocked with 1,500 yearling brook trout, averaging 71.1 fish/kg, in 1980. Assessment consisted of gill netting for three consecutive nights (July 20-22, 1981). Gill net mesh sizes ranged from 5.1-6.7 cm.

A total of 23 brook trout were captured. This represents a catch-per-unit-of-effort (CUE) of 7.19 fish/100 m net during the three day period. Estimates indicate an initial population before netting of 25 ± 4.4 (95% confidence limits) brook trout. All of these fish were two years of age originating from the stocking of fourteen months previous. This represents a survival rate of 1.7% and a standing crop of 1.22 kg/ha. A total of 62.1% of the initial weight of fish stocked was recovered during the assessment. These results show Herbert Lake to be more productive than any other brook trout lake which has been assessed in the Temagami area. It is recommended to continue to stock Herbert Lake with 1,500 fish in alternate years in the future.

STONE, M. D. 1995. Fish stocking programs in Wyoming: A balanced perspective. American Fisheries Society Symposium 15 : 47-51.

Introduction of non-native salmonids into Wyoming began with stocking brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss*) in 1880. Both good and bad experiences from the use of cultured fishes to manage sport fisheries have been documented. Fifty-three fish species are native to Wyoming; four of these are now considered extirpated from the state. None were extirpated by stocking. The Wyoming Game and Fish Department (WGFD) has developed a balanced fisheries management program that addresses both the ecological integrity of waters capable of sustaining native or wild fisheries and public demands for sport fisheries. Practices appropriate for one setting may be inappropriate for another. Maintenance of native subspecies of cutthroat trout (*O. clarki*) has been a management priority for over 40 years. Early stocking of brook trout and rainbow trout was detrimental to certain native trout stocks. Cultured trout have since been instrumental in cutthroat trout restoration. Most trout streams in Wyoming are managed as wild fisheries in accordance with WGFD guidelines. Low returns of stocked trout in streams and the demonstrated ability of streams to support acceptable wild trout fisheries, lead to these guidelines. Reservoirs constitute 68.5% (159,800 acres) of the standing water acreage in Wyoming. Most reservoirs are managed with cultured fish due to habitat conditions that limit natural trout reproduction. Altered habitats present the greatest challenges in terms of overall fisheries management and use of cultured fish.

STOTT, W. 1999. Selectivity of gill nets for brook trout stocked into two lakes in Algonquin Park. Project summary, Algonquin Fisheries Assessment Unit, Ontario Ministry of Natural Resources, Whitney, Ontario.

Two lakes in Algonquin Park were stocked with known numbers of one and three year old brook trout and then netted utilizing a standard protocol to test the selectivity of four different mesh sizes of gill net. The two lakes chosen for study (Bena and Cecil) had similar surface areas (10.5 ha and 11.4 ha respectively) and no record of naturally producing brook trout populations.

Similar numbers of yearling and three year old brook trout were stocked on June 4, 1999. A total of 749 brook trout were transported from the Tarentorus Fish Culture Station near Sault Ste. Marie. The brook trout stocked in the project ranged in size from 160 mm to 390 mm and were on average 267 mm in length.

The year classes overlapped somewhat in length; a fish from 220 to 260 mm might be either a yearling or a three year old.

Bena and Cecil lakes were sampled during the week of June 6, 1999. Four gangs of nets were used each of a different mesh size (1', 1.5", 2" and 2.5"). There were three panels in each of the four gangs. Nets were set perpendicular to shore for 30 minutes. Each lake was divided into eight sectors of equal size. Nets were set at randomly chosen sites. Each sector was sampled with each mesh size an equal number of times. The clip and fork length of each brook trout was recorded.

Bena Lake was sampled for three days and Cecil Lake was sampled for four days because the catch rate in Cecil Lake was low. Half of the brook trout caught in both lakes were caught in the 2" mesh. The 2" mesh caught brook trout ranging in size from 190 mm to 370 mm. The size range excluded 11.5% of the hatchery sample and the majority of these fish (10.5% and 11.5%) fell into the yearling size range. The 2.5" mesh caught 20% of the brook trout which were 210 mm to 370 mm in length. Similar to the 2" mesh the size range excludes fish that are yearlings. Only the 1.5" mesh caught any brook trout under 170 mm. While the 1.5" mesh caught the widest size range of fish (150 mm to 370 mm) it accounted for less than 20% of the total catch of stocked brook trout. The 1" mesh caught both the smallest size range of fish (250 mm to 370 mm) and the smallest number of brook trout (11% of the total catch).

SURBER, E. W. 1940$_a$. Lost : 10,839 fingerling trout! An appraisal of the results of planting fingerling trout in the St. Mary River, Virginia. Progressive Fish Culturist 49 : 1-13.

The poor results of planting fingerling trout in the St. Mary River are discussed. A study of the results of planting large fingerling brook and rainbow trout revealed a staggering waste. Of 11,107 marked trout planted since 1935, only 268 or 2.4 per cent have been recovered. These studies revealed (a) a very slow growth rate for stocked fish, (b) a downstream movement of rainbow trout, (c) an increase in the abundance of brook and rainbow trout resulting from natural propagation and (d) a general diminution in numbers of planted trout, even brook trout which appear to stay pretty well where they are planted. The stocking of fingerling brook and rainbow trout in St. Mary River has not resulted in any improvement in the abundance of the population. Further stocking of fingerlings in this or other similar streams in the region does not appear to be advisable.

SURBER, E. W. 1940$_b$. An appraisal of the results of planting fingerling trout in St. Mary River, Virginia. Progressive Fish Culturist 49 : 1-13.

It has been obvious to many fish culturists and anglers that the planting of fingerling trout has not brought results commensurate with the number planted. Although this matter has been the subject of investigation only recently, the facts were sufficiently obvious to lead fish culturists to experiment with the rearing of trout to legal size with results that were immediately popular. The present as well as other recent studies indicated that in certain cases the planting of fingerling trout has produced results poorer than was imagined possible. This suggests an unfitness for survival probably brought about to a considerable extent by common hatchery methods. Results in stream rich in food have been nearly as poor as in streams such as St. Mary River which is only average in this respect. The planting of fry or fingerling trout will no doubt continue in remote sections but if the results reported here are typical, and it becomes more and more apparent that they are, then we should either abandon the planting of trout fingerlings in populous sections or discover methods of producing fingerlings better adapted for survival. The major objective of this study has been to follow up a series of plantings of fingerling trout to determine how many of the planted fish finally reached anglers creels.

SURBER, E. W. and W. W. AIKENS. 1932. Observations on plantings of fingerling rainbow, brown and brook trout from circular ponds. Transactions of the American Fisheries Society 62 : 133-140.

The purpose of this study was to observe the behavior of 3" to 4" fingerling trout immediately after they were planted in suitable streams from circular pools. Gregariousness has been a characteristic of trout planted from the circular pools. The probability that the trout in the circular pools use one another as points of references while swimming is likely. These data indicates that trout should be well scattered along a stream in planting and that the head spring is probably one of the most dangerous places to plant them.

THOMAS, B. 1993$_a$. 1993 Round Lake stocking assessment. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 2 p.

Round Lake is a small (15.5 ha) lake which has a brook trout stocking history dating back to 1944. The current stocking rate is 1,500 fish (97 fish ha^{-1}). Fish planted in 1992 were given a right ventral (RV) fin clip for recognition. A stocking assessment was conducted in 1993 to determine the success of the stocking, determine the percentage of fin clipped fish, examine changes in fish species composition and record growth of planted brook trout.

Two 61 m gangs of gill net, with mesh sizes ranging from 2.5-6.4 cm, were used. The assessment was conducted over a seven day period during thermal stratification. The shoreline was divided into 40 sectors and netting sites were randomly selected. Nets were set perpendicular to shore between 1600 and 2200 hours and left fishing for 30 minutes. A total of 33 net sets were completed over a five day period from August 4-10, 1993. The total catch was 16 brook trout, 34 white sucker, 95 pumpkinseed and 14 creek chub.

The capture of 16 brook trout results in a moderate catch-per-unit-effort (CUE) of 0.485 fish/61 m of net). Two of these fish had right ventral (RV) fin clips which comprised only 12.5% of the sample. Three native fish were captured during the project. Judging by the ratio of clipped vs. unclipped fish (2:14) it appears that stocked fish are not doing as well as our historical information would suggest. The low returns of stocked fish could be due to competition for food with other species (pumpkinseed and native brook trout), oxygen deficiencies and increased susceptibility to angling. It is recommended that brook trout stocking be discontinued to protect native stocks and eliminate further waste of hatchery-reared fish.

THOMAS, B. 1993$_b$. 1993 stocking assessment on Little Widgeon Lake. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 3 p.

Little Widgeon lake is a small (17.6 ha) lake which receives moderate fishing pressure throughout the year. The lake has typically been stocked with 2,000 brook trout yearlings (114 fish ha^{-1}) on a two or three year rotation. Fish stocked in 1992 were marked with a right ventral (RV) fin clip for subsequent recognition. A stocking assessment was conducted in 1993 to evaluate the success of stocking, determine growth rates of stocked fish and examine changes to the fish community structure.

Two 61 m gangs of gill net, with mesh sizes ranging from 2.5-6.4 cm, were used. The assessment was conducted over a seven day period during thermal stratification. The shoreline was divided into 40 sectors and netting sites were randomly selected. Nets were set perpendicular to shore between 1600 and 2200 hours and left fishing for 30 minutes. A total of 26 net sets were completed over a five day period from July 19-23, 1993. In total, eight brook trout, 1 splake, 86 white sucker and 25 golden shiner were captured.

The capture of eight brook trout results in a moderate catch-per-unit-effort (CUE) of 0.308 fish/61 m of net. All eight fish possessed a RV fin clip . Common white suckers were very numerous and the total weight exceeded 21 kg. It appears that the brook trout fishery in Little Widgeon is based solely on stocked fish. These fish appeared healthy and exhibited good growth with weights ranging from 6000-880 gm. Actual returns are difficult to estimate with such a low sampling effort and an unknown number of fish being removed during the fishing season. The imbalance of such a large population of suckers may have some negative impact, in the form of competition, with brook trout growth and survival. It is recommended to continue stocking brook trout to provide a put-grow-take fishery for local anglers.

THOMAS, B. 1993$_c$. 1993 stocking assessment on Hungry Lake. File Report, Ontario Ministry of Natural Resources, Bracebridge, Ontario. 3 p.

Hungry Lake is a small (14.2 ha) lake which has been planted with brook trout, lake trout, and rainbow trout in the past but brook trout appear to be the only sport fish currently inhabiting the lake. Brook trout stocking was re-initiated in 1989 and 1992 after an eighteen year hiatus dating back to 1971. One thousand marked (right ventral fin clip) yearling brook trout (70 fish ha^{-1}) were stocked in both 1989 and 1992. An assessment project was initiated in 1993 to evaluate the success of these plantings and record any changes to fish community composition.

Two gangs of monofilament gill net, with mesh sizes ranging from 2.5-6.4 cm, were set during a three day period during thermal stratification (August 11-13, 1993). Netting sites were randomly selected and nets were set perpendicular to shore. A total of 15 net sets were made and produced a catch of 12 brook trout, 11 white sucker, 72 yellow perch, 4 pumpkinseed and 175 common shiner. The capture of 12 brook trout produced a catch rate of 0.880 fish/61 m of net. One of these fish had a right ventral fin clip (only 8.3% of the sample). Native fish ranged in weight from 50-450 gm with a mean of 233 gm while the single stocked fish attained a weight of 500 gm.

Judging by the ratio of clipped vs. unclipped brook trout (1:11) the survival rate of stocked fish is poor. One of the reasons may be competition for food and space with a strong population of common shiners and yellow perch. These species had mean weights of 19.4 gm and 17.4 gm, respectively, and these imbalances could be resulting in strong competition for food and space with the less adaptive 20 gm hatchery-reared brook trout. It is recommended that brook trout stocking be discontinued to protect native stocks and eliminate further waste of hatchery-reared fish partially caused by the presence of a spiny-rayed predator.

THORPE, L. M., H. J. RAYNER, and D. A. WEBSTER. 1944. Population depletion in brook, brown and rainbow trout stocked in Blackledge River, Connecticut, in 1942. Transactions of the American Fisheries Society 74 : 166-187.

A section of the Blackledge River, 1.7 miles long, was blocked off by weirs and fish traps and a total of 4,757 marked brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) were stocked in the experimental area in three plantings. Only a small number of the marked trout attempted to leave the area as indicated by the 46 fish taken in the traps. Subsequent recapture of these trout which were tagged indicated no inclination to move any great distance. The mortality of the marked trout after planting was slight during the period of observation except in one planting where the brook and brown trout stocked showed advanced symptoms of furunculosis. The total catch of marked trout during the season of April 17 to August 31 was 3,446 trout taken by 3,152 anglers spending 9.746 hours on the stream. There was about an 80 per cent return of the available population from each planting and from each of the three species of trout planted. Of the 97 unmarked trout which were caught, only 23 were judged to be "wild" fish, the others being recently stocked trout which had moved into the area from adjoining waters before the weirs were in place. The distribution of the angling pressure was such that each planting was depleted within a few days. About three-fourths of the total catch of trout made from an one planting was taken within four days of the date of stocking. The population of brook trout was depleted most rapidly, that of brown trout most slowly, and rainbow trout were intermediate. Only 5 days of fishing were provided during the season where the catch per unit of effort approached 1 trout per hour or more. There was a high correlation between the population of trout in the stream and the catch-per-unit-effort, except in the second planting of trout. The relationship between the available population and the catch-per-unit-effort showed progressively higher yields for the same number of trout as the season advanced. Because of the rapid population depletion, in only one instance could possible differences in behavior between newly stocked trout and those from previous plantings be noted. The number of brown trout caught from the second planting showed no correlation with the fishing effort while brown trout caught from the first planting at the same time were closely related to the fishing effort. The distribution of each angler's catch indicated that under a limit of 15 fish about one-third of the catch on the first few days of fishing following each planting.

THURSTON, L. D. W. 1977. Evaluation of plantings of brook and rainbow trout within the Parry Sound District. File Report, Ontario Ministry of Natural Resources, Parry Sound, Ontario. 7 p.

Brook trout and rainbow trout populations in lakes planted within the Parry Sound District were assessed using either winter creel census or gill netting statistics. The success of brook trout in Cadgeroad, Wilds, Hunter and Silver Sands lakes (which do not have populations of spiny rayed fish such as perch and rock bass, etc.) has been most gratifying. The success of rainbow trout has, however, been less spectacular. The future management of rainbow trout in this district will be dependent on the success of a planned 1978 planting in Boy Lake.

TREMBLEY, G. L. 1943. Results from plantings of tagged trout in Spring Creek, Pennsylvania. Transactions of the American Fisheries Society 73 : 158-172.

Data on anglers' catches, the growth and migration of stocked trout and the efficiency of fall and spring plantings were obtained by means of a creel census in Spring Creek, Pennsylvania during 1939. Of 2,130 tagged trout planted, 50.8 per cent were recovered by anglers. Due to heavy fishing pressure, more than 40 per cent of all tagged trout taken during the entire season were removed on the first day. A high first day kill (76 per cent of the total recoveries) of brook trout was noted. The quality of fishing declined rapidly during the early season. Fishing for brook trout was good for only a few days, brown trout fishing was fair for about a month while rainbow trout fishing lasted slightly longer. Catches of tagged trout after 6 weeks were negligible. Only 10 trout were recovered during 1940 and 1 during 1941. Six of these fish were brown trout and 5 were rainbow trout. There was no evidence that any brook trout survived from one fishing season to the next.

Growth studies of trout planted in the fall indicated that rainbow trout grew fastest, followed by brown trout and brook trout. There was evidence that the growth rates of brown trout and rainbow trout decreased as the size of the fish increased. This was not true of brook trout.

Migrations of fall planted trout were not extensive. Those undertaken averaged considerably less than 1 mile. Brown trout favored upstream and brook trout downstream movement while rainbow trout moved in equal numbers in either direction. Spring planted trout, captured after less than a month in the stream, had moved very little. A majority of brook trout and brown trout remained within the planting areas. About half of the rainbow trout migrated.

Fall planting of the three species of trout was nearly as efficient as spring planting, as 49 per cent of the former and 54 per cent of the latter were recovered. Eight per cent more brown trout from the fall plantings were recovered than from the spring planting. Recoveries of spring planted brook trout and rainbow trout exceeded those of fall planted trout by 8.8 per cent and 13.6 per cent respectively. Contrary to the common belief of anglers, fall planted trout did not become "wild" over the winter. They were taken even more readily in the early fishing season than were trout of the spring plantings. The high returns from the fall plantings were attributed largely to the heavy fishing pressure, the moderate winter conditions, the lack of important predators, and to a possible scarcity of wild trout from natural spawning in Spring Creek.

TYLER, D. B. 1964. Hatchery growth and mortality in inter-strain hybrids of brook trout (*Salvelinus fontinalis*) of wild and domestic origin. M.Sc. Thesis, Cornell University, Ithaca, New York.

Two wild strains of brook trout, one from a stream (Long Pond outlet) and one from a lake (Honnedaga Lake) and a domestic strain were planted in an Adirondack pond in 1960 and 1961. In fall 1962, survivors of these plantings were mated as follows: domestic x domestic, Long Pond outlet x domestic, Honnedaga x domestic, Honnedaga x Honnedaga, and Long Pond outlet x Long Pond outlet. A domestic strain of hatchery origin was also available for comparison. Observations were made on the eggs and the young for the first 126 days after hatching.

Eggs from domestic females had significantly higher mortality than those from wild females. Eggs and subsequently sac-fry from wild females were larger than those from domestic females. When feeding began, fry of the wild strains were the largest, the reciprocal hybrid crosses, which had been combined, were intermediate and the domestics were smallest. By March 16, the Long Pond domestic fish were largest; the hybrids were intermediate, and the wild lots were smallest. These relative positions remained unchanged until termination May 25. Fingerling mortality ranged from five to ten per cent with no consistent trends noted.

TYNELA, R. and S. L. JONES. 1993. Brook trout stocking assessment on Kaufman and Finn lakes, July 1990. File Report, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. 8 p. + appendices.

This report discusses the brook trout stocking assessment carried out on Kaufman and Finn lakes during July of 1990. It assesses the survival rate of the planted fish and whether or not these lakes should be stocked in the future.

Each lake was netted for three nights using six gangs of 45.7 m by 2.4 m monofilament gill net. Each gang consisted of three 15.2 m section having mesh sizes ranging from 3.8-6.4 cm. Each lake was divided into reaches, along the shoreline, based on habitat and each reach was netted at least once, with more productive reaches being netted two or three times.

In Finn Lake, 215 brook trout were captured and in Kaufman Lake, 206 brook trout were caught. The estimated population was 242 ± 25 fish for Finn Lake and 264 ± 10 fish for Kaufman Lake. The survival rate of the 800 brook trout planted in Finn Lake this spring was 30%. The survival rate of the 1,200 brook trout planted in Kaufman Lake this spring was 22%.

Finn and Kaufman lakes are in an area designated as a high intensity day use area, in the Sault Ste. Marie district's Fisheries Management Plan, and given the high survival rates of stocked brook trout, it is recommended that stocking of brook trout be continued in these lakes to provide angling opportunities.

UNIVERSITY OF MAINE. 1975. Fish pond stocking. U.S. Department of Agriculture Publication ME/398/4, Orono, Maine.

UNITED STATES DEPARTMENT OF AGRICULTURE. 1979. Managing a trout pond. Information Sheet MA/6, Soil Conservation Service, Amherst, Massachusetts.

VAN LEEUWEN, G. P. 1985. Brook trout (*Salvelinus fontinalis*) stocking assessment on Maidens Lake, South Lorrain Township, 1984. File Report, Ontario Ministry of Natural Resources, Temagami, Ontario. 17 p.

District concern on the success of stocking brook trout (*Salvelinus fontinalis*) in Maidens Lake prompted an assessment of that lake in 1984. The lake was netted for three consecutive nights (July 17-19) with 183 m of gill net each night. While 47 brook trout were caught, 41 of these were suspected as representative of the 1984 planting due to their small size (e.g., fork length less than or equal to 21.0 cm) while the remaining 6 fish probably represented other year classes. The total population estimate for brook trout was 63 fish. Of importance were the presence of large numbers of yellow perch (*Perca flavescens*) with the 244 fish giving a total weight of 5.12 kg and the unexpected discovery of the presence of walleye (*Stizostedion vitreum*) with 6 fish producing a cumulative weight of 4.61 kg.

The total biomass estimate for the lake was 5.27 kg/ha while only 0.27 kg/ha represented the brook trout component. The lake is not felt to be a good producer of brook trout due to the low observed angler success and the presence of large numbers of spiny-rayed fishes. We recommend that stocking of Maidens Lake with brook trout be discontinued.

VAN OFFELEN, H. K., C. C. KRUEGER, and C. L. SCHOFIELD. 1993. Survival, growth, movement and distribution of two brook trout strains stocked into small Adirondack streams. North American Journal of Fisheries Management 13(1) : 86-95.

Six field trials were conducted in two streams to compare the survival, growth, movements and distribution of young-of-year Assinica strain and Temiscamie strain brook trout (*Salvelinus fontinalis*) 15-91 days after stocking. No consistent differences between strains in recovery after stocking or in growth were detected; however movement and distribution within streams differed consistently between strains. Approximately four Temiscamie to one Assincia fish moved downstream 2-15 hours after stocking. At the conclusion of five trials, the strains were dissimilarly distributed within streams (distribution was not assessed in the sixth trial): a large proportion of Assinica fish were found in the most upstream section of the streams, whereas a large proportion of Temiscamie fish were found in the downstream section. These differences in movement and distribution may be related to the origins of the strains in large lake systems in Quebec where spawning occurs in inlet and outlet streams. Assinca fish, which have a probable outlet origin and which moved upstream in this investigation, may be better suited for stocking in areas downstream of where brook trout are to be established. Conversely, their probably inlet origin and demonstrated downstream movement make Temiscamie fish candidates for stocking in upstream areas.

VERMONT DEPARTMENT OF FISH AND WILDLIFE. 1993. The Vermont management plan for brook, brown and rainbow trout. Waterbury, Vermont. 73 p. + appendices.

The brook trout is the most widely distributed trout species in the state and is the only one of the three that is endemic to Vermont. Brook trout was the fish species targeted by the most Vermont resident anglers (79%) and was selected as the most preferred species for open water fishing by both Vermont resident and nonresident anglers in the Vermont Angler Survey. More brook trout are reared in the state hatchery systems for release into public waters than brown and rainbow combined. In excess of 347,400 brook trout were stocked into Vermont lakes and streams in 1992 compared to about 348,700 brown and rainbow trout (excluding Lake Champlain). Stocking has expanded fishing opportunities into many waters that otherwise are not capable of supporting wild trout populations due to inadequate habitat. Waters having nearly optimal habitat conditions are sometimes managed for put-grow-and-take fisheries; others with less suitable habitat are stocked with catchable-sized trout on a put-and-take basis. For programs where catchable-sized trout are stocked for immediate harvest, returns to the angler of stocked trout generally average around 30-40%. The smallest size of trout most anglers are willing to keep is 8 inches. For put-and-take stocking in streams subject to high fishing pressure, the recommended stocking rate is < 20 lbs/acre, < 200 trout/mile ≥ 6 inches). Brook trout stocked for maintenance programs are best suited for relatively “clean” waters, free of substantial competitor and predator species. The base stocking rate for brook trout in coldwater lakes and ponds is 30 √MEI for fingerlings and 15√MEI for yearlings. This species should be considered the least suited for maintenance stocking in waters with substantial competitor or predator populations. While this species will provide ice angling opportunities, they are generally confined to smaller lakes and ponds which have traditionally been closed to ice fishing in Vermont.

VINCENT, R. E. 1960. Some influences of domestication upon three stocks of brook trout. Transactions of the American Fisheries Society 89(1) : 35-52.

Three stocks of brook trout – domestic, wild, and first generation removed from wild stock – were tested and observed for effects of domestication. The domestic stock had been selectively bred for 90 years, whereas the wild stock came from an isolated lake in the Adirondack Mountains. To reduce differential environmental influence to a minimum, the three lots were reared from eggs in adjacent rearing troughs at the same water temperature. After one year under these hatchery conditions the domestic fish were 5.2 inches in length and the wild 3.6 inches. Throughout the rearing domestic stock were tamer and exhibited less fright than wild stock fish. Laboratory tests showed that wild stock could stand a greater concentration of accumulated metabolites, that they could endure higher water temperature, and that domestic stock had a surface response whereby they moved to the surface of a rearing trough or a tall aquarium. Domestic fish also lacked the desire to conceal themselves. Stamina tests conducted by swimming 1,522 fish individually until exhausted in a small trough showed that the wild stock had greater stamina throughout the size range tested. Survival trials in a small stream and a pond indicated that wild fish experienced less mortality and had growth rate similar to or better than domestic fish in both habitats. After 73 days in the small stream, 20 per cent of the domestic and 33 per cent of the wild stock survived. Domestic fish grew 0.34 inches and wild fish 0.48 inches. Survival was 43 per cent for the domestic and 65 per cent for the wild after 108 days in a pond, while length increase was 2.6 inches for the domestic and 2.5 inches for the wild stock. The domestic increased more in weight. After being in a pond for nearly four months, the domestic stock had acquired little wariness.

VON ROSEN, H. K. 1972. Brook trout stocking seasons : A cost-benefit analysis of different stocking seasons. File Report, Ontario Department of Lands and Forests. 21 p.

Due to low stocking costs, fall plantings of fingerling brook trout (*Salvelinus fontinalis*) produced a standing crop of fish at costs below 30 cents per fish in most lakes despite 45% average mortality. Brook trout yearlings stocked through the ice suffered very high mortalities resulting in excessive costs. Brook trout stocked in May suffered very little mortality but produced a standing crop at approximately 30 cents per fish due to high initial stocking costs.

The planting of fall fingerlings into selected waters may produce satisfactory fishing at a cost reduction of 20% while providing the added benefit of easing crowded hatchery conditions thereby reducing potential losses through disease.

VUKELICH, M. F. and E. MacGREGOR. 1984. Survival and growth of yearling brook trout. File Report, Ontario Ministry of Natural Resources, Hearst, Ontario.

WAGNER, W. C., R. G. SCHORFHAAR, and R. N. LOCKWOOD. 1994. Evaluation of hatchery-reared brook trout stocked in the Upper Peninsula of Michigan. Michigan Department of Natural Resources. 54 p.

WALDEN, F. A. 1956. The hatchery as a fisheries management tool. Paper presented at the Fur Advisory Committee Meeting, April 12-14, 1965, Dorset, Ontario.

The indiscriminate use of a hatchery-reared fish contributes very little to better fishing. There still appears to be an unduly large number of plantings made on a purely maintenance basis. While routine maintenance plantings generally give little return for the money spent, the careful use of hatchery fish may make a valuable contribution to the recreational and economic welfare of an area.

In developing the annual program of hatchery operations, we might ask ourselves "what are we trying to do?" Surely, it is to provide more fishing. If stocking could be correlated with the existing fish population and related to the carrying capacity of the waters, management stocking would be a near reality. Success, however, would still be conditioned by the factors, chiefly meteorological conditions which affect the native populations, and which are one of the chief obstructions in the full realization of hatchery fish values.

Stream plantings of salmonids appear to provide little return where the species already exists. Survival and returns from lake plantings is much greater. Plantings of legal-sized fish in streams contribute to fishing where the fishing pressure is great enough to cause depletion.

There is evidence to show that yearling fish dropped in lakes, at a distance from the protection offered by the cover usually found near shore, are subject to predation, immediately on striking the water. Too many fish planted in streams are still placed near road crossings. Attention should be paid to the known lethal temperatures when planting trout from springwater hatcheries during warm periods.

It is suggested that the economic aspects of hatchery operations should be evaluated in terms of their proven contribution to improved fishing. The public relations aspect should be related to the overall fisheries management plan.

WALES, J. H. 1946. Interrelationships of four species. California Fish and Game 32(3) : 109-143.

The objective of this investigation was to determine the most suitable species of trout to plant in mountain lakes, the optimum size of fish at planting time and the optimum number to plant. Three species were used in equal numbers but the question of the most desirable was obscured by the fact that in a mixed population the success of the component species may be quite unlike their success if they inhabited the lake singly. There was practically no natural propagation of rainbow, brook or brown trout in Castle Lake. Both fingerling and yearling trout were planted. From 1941-1945 brook trout accounted, on average, for 15% of the catch and an average yield of 32 lbs. Based on the numbers of brook trout planted, the survival in terms of return to anglers, ranged from 0.4-3.2% (average 1.9%). The greatest loss, particularly for fingerlings, is probably due to cannibalism during the first days in the lake. From the standpoint of growth it appears that fingerling rainbow, brown and brook trout can be planted to advantage early in the season while they are still relatively small. For the best survival with brook trout the fingerlings should be as large as possible at planting time. Approximate maximum ages for brook trout in Castle Lake was 3 years. Brook trout planted as yearlings cost $0.13 as an angled fish while those planted as fingerlings cost $0.69. It seems reasonable to assume that a mixed population such as that which has existed in Castle Lake is not as efficient from the standpoint of trout production as a population of one species. Beginning in 1946 this belief will be tested by stocking with brook trout alone.

WALES, J. H. 1947. Growth rates and fin regeneration in trout. Progressive Fish Culturist 9 : 86-89.

In four paired experiments, comparing survival of trout fingerlings given pectoral or ventral fin clips and held for one year in a tank at the Mount Shasta, California, the per cent survivals were: RV, 90 and RP, 84 (rainbow trout); LV, 92 and LP, 84 (rainbow trout); RV, 94 and RP 69 (brook trout); and RV, 72 and RP, 60 (brown trout). The initial number in each group was 100 except for that of the LP-clipped rainbow (98). In all four comparisons, survival was higher in groups receiving a ventral clip.

WALES, J. H. 1954. Relative survival of hatchery and wild trout. Progressive Fish Culturist 16 : 125-127.

Several workers have shown that the survival of hatchery fingerlings in streams is lower than that of comparable wild fingerlings. There is no evidence to indicate that hatchery life is not partially responsible for the relatively lower survival. However there are two other factors which may have some bearing on survival, and it is evident that the relative importance of these factors should be studied. My contention is that our hatchery practices are, in certain respects, so very good that survival after planting is bound to be low. Even though our hatchery technique might be perfected so that the planted fish would be as well able to take care of themselves as comparable wild fish we would still have the problem of the suitability of the fish to the particular water where it was planted.

WALES, J. H. and E. R. GERMAN. 1956. Castle Lake Investigation – Second phase: Eastern brook trout. California Fish and Game 42(2) : 93-108.

The present report covers the eastern brook trout phase of the Castle lake investigation and the results are compared with those presented earlier. During this portion of the investigation, covering the period 1947-54 inclusive, the results from planting brook trout have been markedly different from those which were obtained prior to 1946 when the lake was treated with rotenone and all four species of trout removed. In 1947, both brook trout yearlings and fingerlings were planted and in 1948 more fingerlings were planted giving a total of 60,000 fish. The present report is based upon the returns to anglers of these fish during the ensuing eight years.

During the three years (1949-51) no trout were planted in Castle Lake. In 1952 the first of a series of rainbow trout plants was made and in the years 1952-54 both brook and rainbow trout were caught. As late as 1954 some of the marked brook trout planted in 1947 and 1948 were being caught but most were naturally spawned in the spring areas of the lake bottom. The yearling brook trout planted in 1947 were of “subcatchable” size averaging 13 per pound. However many were larger than this and catches were heavy from the time of liberation. This group contributed to the catch for at least four years and the total return to the fishermen was 48.3%. The fingerlings planted in 1947 and 1948 were caught during seven seasons following the liberations and the final returns were 34.6 and 36.4% respectively.

The removal of the highly predatory brown and lake trout in 1946 increased the survival of the fingerling brook trout to the angler’s catch from an average of 1.9% to approximately 35%. The survival of the yearling brook trout was not markedly affected. Before the lake was treated their survival was 40% while following treatment it was 43.8%.

The 1948 plant of fingerlings was divided with one half marked by removal of the adipose fin alone and the other half by removal of the adipose and left ventral fin. During the ensuing seven years, 34.1% of those with the adipose removed were caught while the other group contributed 38.7%. We may conclude that removal of a ventral fin and the adipose does not cause a greater mortality than removal of the adipose fin alone. Similarly, the growth rates of the two groups were practically identical.

Following treatment of Castle Lake with rotenone, the food supply was reduced. This, together with overstocking in 1947 caused the yearling fish to grow slowly and to have a low condition factor. The growth of the fingerlings planted in 1947 was slower than that of the fingerlings stocked in 1948. The average fork length of all brook trout caught during the period 1947-54, inclusive, was 7.0 inches. Few of the fish reached a foot in length and the largest taken was 18.4 inches long.

In common with many similar lakes in California, an initial planting of brook trout resulted in a self-propagating population which by itself provided moderately good fishing. In 1954, 84% of the catch was composed of brook trout nearly all of which were naturally spawned. Although 1,503 pounds of yearling brook trout were planted in 1947, only 978 pounds of fish from this plant were eventually caught by anglers. In marked contrast, 100 pounds of brook trout fingerlings planted in 1948 yielded 923 pounds caught by anglers.

In computing the following costs for each fish caught by anglers in Castle Lake, it is estimated that the fingerlings cost one cent and the yearling 15 cents each at planting time. The average annual yield of brook trout to the anglers prior to the planting of rainbow trout was 493 pounds or 10.3 pounds per acre. It is already evident that the yield in pounds per acre following the planting of rainbow trout in 1952 will be considerably greater than it was when brook trout alone were planted.

WARD, N. 2000. A review of fish stocking assessment in the Kenora District. File Report, Ontario Ministry of Natural Resources, Kenora, Ontario. 7 p.

Kenora District has a long history of stocking fish. Records since 1946 indicate that at least 117 waterbodies have been stocked with either brook trout, lake trout, rainbow trout, walleye, smallmouth bass, musky, whitefish, black crappie, rock bass and splake. In the 1960s rationalization of Kenora's stocking program was well underway. In the 1970s Kenora District's stocking was basically limited to six lakes (Bill, Emerson, East Emerson, Howard, Lake #132 and Tox) planted on a rotational basis with brook trout. Assessment of returns from planted fish consisted of some gillnetting and informal records of stocked fish being angled. Brook trout in Howard Lake had reasonable growth rates reaching an average length of 35.5 cm and average weight of 480 grams at the end of their third year. Intermittent angler catch records suggest that brook trout catch-per-unit-effort (CUE) ranged from 0.36 in Howard Lake to 0.07 in Tox Lake. Angler diaries are available for anglers wishing to record their fishing effort and catch on stocked lakes.

WARRILOW, J., D. JOSEPHSON, W. YOUNGS and C. KRUEGER. 1985. Comparison of emigration by diploid and triploid brook trout. p. 7 *In* 1995 Annual Report of the Adirondack Fisheries Research Program, Department of Natural Resources, Cornell University, Ithaca, New York.

Comparison of equal numbers of yearling diploid and triploid brook trout (*Salvelinus fontinalis*) stocked into an Adirondack lake revealed that triploid females were least likely to emigrate during the fall spawning season. All trout that emigrated were mature. More diploids matured than triploids. More diploids emigrated that triploids; however, the proportions of mature diploids (males and females) were not different. No mature age 1 or 2 female triploids were identified by external examination or dissection. We concluded that triploidy in females arrested emigration by preventing sexual maturation. Stocking triploid females would reduce or eliminate the incidence of fall emigration by brook trout from Adirondack lakes with outlets.

WEBSTER, D. A. and W. A. FLICK. 1981. Performance of indigenous, exotic and hybrid strains of brook trout *(Salvelinus fontinalis*) in waters of the Adirondack Mountains, New York. Canadian Journal of Fisheries and Aquatic Sciences 38 : 1701-1707.

Eleven year classes of wild, domestic, and wild x domestic hybrid strains of brook trout (*Salvelinus fontinalis*) were stocked in a 0.19 ha Adirondack pond. Comparative survival and growth were assessed upon drainage in early fall. Rearing native wild strains to maturity in a hatchery, or domestic strains in a natural environment did not consistently or materially affect survival of progeny suggesting that superior performance of wild strains was largely inherent. Interstrain hybrids of wild x domestic showed survivals equivalent to the wild parents but hybrids of two Canadian strains gave evidence of heterosis in both survival and net yield. Supplementary observations in other waters also indicated that one strain (Assinica) may be less adaptable to Adirondack conditions than the other (Temiscamie).

WEIR, J. C. Undated. Restocking – Planting of hatchery-reared game fish. Unpublished stocking guidelines, Trent District, Ontario Department of Lands and Forests. 5 p.

Some years ago, fish were stocked indiscriminately on the basis of public demand and request. The immediate need in the propagation phase of fish management is not expansion but a more selective stocking program to avoid indiscriminate and unwise stocking practices. It is assumed that Overseers will assist in the planting of fish within their districts.

Some general recommendations for planting fish in the field are:

- You cannot go wrong if you plant fry in areas where adult fish of the same species are known to spawn.
- In general, the younger the fish, the closer to the natural spawning ground is better.
- Practice wide distribution.
- Do not plant in favourite fishing holes, etc. (i.e., under bridges are poor places)
- Try to avoid a sudden change in temperature. Gradually lower or raise temperature of water in cans.
- It looks bad and is injurious to fry to throw or dump them into water. Tip the retainer below the surface of water and let fish swim out.
- Remember that small fish generally spread out in a downstream direction.
- Plant in the best natural cover for fish.
- Avoid areas dominated by predators.
- Avoid planting trout in connecting streams. The danger of the stream drying up is too great. It is better to plant in the lake in the first place if it is suitable.
- Avoid planting on sand, sawdust or silted areas.
- If there are several suitable planting areas in a lake or stream, it is better to rotate your plantings yearly.
- Avoid planting trout in unknown lakes until a survey is made.
- Avoid planting wind-swept shores.

- Plant brook trout fry and small fingerlings in gravel riffles in spring feeder streams where fishing pressure and predator populations are low. The trout will move down to deeper waters as they increase in size.
- In lakes plant brook trout off gravel shores and shoals near springs. If predators are visible in shallow water, plant trout in the center of the lake.

WEITHMAN, A. S. 1986. Economic benefits and costs associated with stocking fish. p. 357-363 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management, Fish Culture and Fisheries Management Sections, American Fisheries Society, Bethesda, Maryland.

Stocking programs are extremely important to fisheries managers who use them in their continuing efforts to maintain and improve the quality of fishing. The only way to estimate the true success of a stocking program is through an economic evaluation expressed as a benefit:cost ratio.

Past evaluations of stocking programs have emphasized associated costs, such as the cost of programs per day of fishing provided or per fish harvested. Benefit:cost ratios have been calculated by expressing the value of the recreation provided or fish harvested in terms of dollars.

I recommend evaluating all important stocking programs on an economic basis. The first consideration in an economic evaluation is a determination of the type of benefits to be measured. Consideration should be given to economics from the perspective of an agency, angler or state and local business. From an agency standpoint, costs of raising and stocking fish can be compared to revenue generated by the program. Net benefits to anglers are best estimated by using the travel-cost or contingent-value methods to estimated consumers surplus. The income-multiplier method is appropriate for estimating benefits to state and local economics. A complete analysis of a stocking program should include an economic, as well as social and biological, evaluation.

WHITE, H. C. 1924. A quantitative determination of the number of survivors from planting 5,000 trout fry in each of two streams. Contributions to Canadian Biology 2(1-14) : 137-149.

This study involved the quantitative determination of the results of planting 5,000 brook trout (*Salvelinus fontinalis*) fry in two southwestern Ontario streams (Gunstone Creek and Buck Creek). Five thousand brook trout fry were planted in each creek in mid June. During the next two months assessment consisted of regular observations and seine netting. By September 10 there were only 181 fry remaining from the original 5,000 planted. This represents a loss of 96% of the fry which were stocked. By the third week of September in Buck Creek, 986 fry remained in the creek. This indicates a loss on this stream of 69.5% of the original 5,000 fry which were planted. Causes of mortality included cannibalism both among the fry and by adult trout, predation by chubs (*Semotilus atromaculatus*) and fish eating birds. I conclude that the differences between the results of the planting in Gunstone and Buck Creeks was, without doubt, due to the difference in the number of enemy fish to which the fry were exposed.

WHITE, H. C. 1930. Trout fry planting experiments in Forbes Brook, Prince Edward Island in 1928. Contributions to Canadian Biology and Fisheries 5(7-10) : 205-211.

Experiments were made to determine the fate of speckled trout (*Salvelinus fontinalis*) fry planted in Forbes Brook, Prince Edward Island. Two experiments were carried out this year in five similar sections. In the three upper sections (Experiment A) an attempt was made to find the relative losses caused by various factors and in the three lowest section (Experiment B) a test was made of the effect of variation in the degree of concentration of the fry. Before the fry were placed in the experimental sections, each section was seined as thoroughly as possible without unduly disturbing the natural condition of the stream.

The presence of yearling and adult trout with the trout fry is a greater menace to the fry than is the presence of sticklebacks (*Gasterosteus aculeatus*). Greater losses occur among the fry when the "fry concentration" is greater. When the concentration of the fry is higher their growth is slower. When planting fry there is an advantage in scattering them. Losses among yearling and two year olds are greater than losses among three year olds.

WHITFIELD, R. E. 1953. Preliminary report on free-fall planting of fish from aircraft, File Report, Ontario Department of Lands and Forests, North Bay Forest District, North Bay, Ontario. 3 p.

Although fish planting by means of dropping them from aircraft has been carried on since before World War II in California, Québec and possibly other areas in North America, it is a comparatively new venture in the Province of Ontario. Free-fall fish planting from aircraft was introduced to Ontario during the spring and summer of 1952 by Mr. Ken Loftus at Sault Ste. Marie. The North Bay hatchery has been using aircraft for fish planting for a number of years and developed methods of carrying large numbers of fish in reduced quantities of water. However, no free-fall planting was done. Instead, the aircraft was required to land on each lake and the fish released from the tank in the craft to the waters of the lake.

The Sault Ste. Marie fish planting equipment was taken on loan for a few weeks during the summer of 1952 and considerable plantings were made throughout the North Bay district. The press and general public were invited to witness an exhibition of brook trout dropping in Twenty Minute Lake. The usual routine of dropping was carried out and everything worked smoothly. Observers on the lake were able to catch a few of the dropped fish in nets after the fish had landed in the water. These trout were placed in containers and returned to the hatchery and placed in a separate tank. After over a week they were still in good shape which proved beyond a doubt that survival is indeed one hundred per cent.

WILDE, C. W. 1957. Comparative recovery rates of brook, brown and rainbow trout in a Connecticut Lake. Proceedings of the Northeastern Chapter of the American Fisheries Society. Mimeo : 1-7.

WILEY, R. W., R. A. WHALEY, J. B. SATAKE and M. FOWDEN. 1993. An evaluation of the potential for training trout in hatcheries to increase poststocking survival in streams. North American Journal of Fisheries Management 13 : 171-177.

An average of 8.9 million trout (*Oncorhynchus* spp., *Salmo trutta*, *Salvelinus* spp.) were planted in Wyoming each year from 1987 through 1990; 86% were of catchable size (<8.25 in) and 14% were of catchable size (≥ 8.25 in). Of the total fish planted, 1.9 million subcatchable trout and 177,000 catchable trout were planted in streams. Harvest rates of trout stocked in streams was low (average 5.7%), possibly because of the hatchery conditions under which they were reared. Hatchery-reared trout were raised in conditions far different from those of natural waters; densities hundreds of times those in the wild, nearly constant water flow and water temperature, regular feeding, lack of cover, and absence of predators. Hatchery trout may become disoriented, fail to seek cover, forage inefficiently and die when planted in streams with competing fish. Evaluating the survival of hatchery trout fed natural food, rearing hatchery trout in simulated natural conditions, raising them at moderate densities, and evaluating costs associated with management of wild and hatchery trout would provide additional means for judging the potential to train hatchery trout to survive in the wild. Such evaluation also would provide more criteria upon which to judge the success of planting hatchery trout.

WILLIAMSON, L. O. and E. SCHNEBERGER. 1942. The results of planting legal-sized trout in the Deerskin River, Vilas County, Wisconsin. Transactions of the American Fisheries Society 72 : 92-96.

A creel census was conducted on the Deerskin River to determine the results of stocking trout of legal size. The stocking was done in December and May and consisted of 1,002 brook and 1,621 rainbow trout. A yield of 3,438 trout was obtained. Native fish made up 71 per cent of the catch. Native brook trout supplied the most fishing (50.5 per cent of the total). All stocked fish, especially the larger rainbow trout planted in December, were inferior in condition and sporting value. There were no reports of either species carrying over to the second season.

WINGATE, P. J. and M. McINERNY. 1997. The use of genetics in developing stocking strategies in Minnesota waters. p. 389 *In* Proceedings of the 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin. (Abstract Only).

In the past, fish biologist and managers seldom considered the genetic integrity of native fish populations in a waterbody when proposing to stock. This attitude is changing after much genetic and management research has indicated the value of preserving genetic integrity for fish population health. Based on genetics, Minnesota now limits fish stocking through legislation, rules and policy. Species covered under these applications are walleye, muskellunge, northern pike, channel catfish, smallmouth bass, brook trout, and steelhead. Politics, aquaculturists and anglers can be an obstacle to prudent genetic management of fish. Following conservation genetic principles is a critical part of stocking decisions, otherwise, we increase the risk of altering native fish populations.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES. 1999. An evaluation of stocking strategies in Wisconsin with an analysis of projected stocking needs. Bureau of Fisheries Management and Habitat Protection, Madison, Wisconsin. 38 p.

This report specifically addresses the long range stocking goals for the Department of Natural Resources and projected long term propagation needs using the best available scientific information. This plan promotes the most effective use of stocking in the overall management of Wisconsin's fisheries using a goal oriented species and water specific approach that minimizes impacts to existing self-sustained populations.

Wisconsin presently stocks 160,080 brook trout (109,7000 fall fingerlings and 50,380 yearlings from domestic brood stock) into Lake Michigan. Current brook trout stocking in inland waters is 95,200 fish with a projected need of 268,350 fish. The inland stocking program consists of stocking brook trout, brown trout, rainbow trout, lake trout and splake.

A recent analysis of the genetic impacts of past stocking program suggested the need for genetic management zones for conservation of genetic diversity of brook trout. We therefore recommend that transfers of wild brook trout take place from within the same watershed where possible. For restoration or rehabilitation, wild fish transfers are recommended over stocking hatchery fish and native brook trout should be given priority over exotic species where possible. Fish stocked for put, grow and take purposes should be either spring yearlings or fall fingerlings. Trout stocked as put-and-take fish are harvested soon after stocking and have limited survival (< 10% by number) the first year because of harvest or poor habitat. Fish stocked for this purpose should be yearlings or legal-sized fish.

We are proposing to replace about 55% of the current stocking quotas for domestic brown trout and brook trout with increased numbers of wild trout.

WISTROM, C. 1965. Some angles on fish stocking. Wisconsin Conservation Bulletin 30(3) : 12-13.

Fish managers are ever striving to produce needed fish at lowest possible cost. Almost without exception, it is done today at lower cost than in years past. Trout offer the most spectacular example: costs have come down from more than $3 a pound to about 70 cents. One thing more is need to make stocking pay off: plant the fish when and where they will contribute to the fishing. On this point too, we have made progress.

Pinnacle Rock pond of 2 acres located near Melvina is noteworthy because although used for rearing trout it also supplies public fishing in season. The sequence of events begins in September when the pond is drawn down until nearly empty and any remaining trout from the fishing season are captured and stocked into nearby trout waters and the pond is refilled. Arrangements are then made with a state trout hatchery to have brook trout transferred to Pinnacle Rock pond. The climax of the rearing season comes in April when fish are captured from the pond and stocked into suitable brook trout waters relatively close to the pond thus keeping distribution costs lows. After all the fish are captured, the required quota of fish is restocked into the pond so that it is ready for public fishing when the trout season begins in May. This year we raised 40,000 brook trout in the pond. Survival has been as high as 93%.

The real value of trout stocking is to keep those coldwater lakes and streams which do not have natural production producing fish. Streams having plenty of natural reproduction are gradually being taken off the stocking list.

WRIGHT, B. H. and R. D. SOPUCK. 1979. A history of fish stocking in northern Manitoba. Fisheries Research Report 79-6, Manitoba Department of Mines, Natural Resources and Environment, Winnipeg, Manitoba. 69 p.

Over the last ten years (post 1968), over one-half million trout (lake, brook, splake) have been stocked in bodies of water where there were well-established trout populations. The success of stocking in every case has been doubtful. Some observations of brook trout stocking results from individual waters may be summarized as follows:

Borrow pits – Numerous borrow pits have been stocked with brook trout. Borrow pits in the north have been shown to be capable of overwintering stocked trout. All of the borrow pits are basically stocked on a one year “put-and-take” basis.

East Point Creek – This stocking was not considered successful and will not be attempted again. The size of stream and lack of suitable habitat appear to be the limiting factors.

Gemmel Lake – This lake has been stocked with brook trout throughout the 1970s at rates ranging from 43-237 fish/ha. There have been good catches and angler limits have been filled. Catches have been declining recently due to the lack of trout stocking. Trout movement is probably occurring between this and an adjoined lake.

God's River – This river was stocked in 1967 (3125 yearlings) and in 1968 (10,000 yearlings). It is unlikely that further stocking will occur on a regular basis as this waterway has a well established natural brook trout population.

Goose River (Rat Creek) – 1978 represented the first attempt (6,000 yearlings planted) to establish a self-perpetuating population of brook trout in what appears to be suitable habitat. There have been confirmed reports of surprisingly high predation by spring-running walleye on the trout yearlings.

ZERRENER, A. E., D. C. JOSEPHSON and C. C. KRUEGER. 1995. Comparison of visible implant and jaw tag applications on brook trout (*Salvelinus fontinalis*) survival, growth and retention. p. 12 *In* 1995 Annual Report of the Adirondack Fishery Research Program, Department of Natural Resources, Cornell University, Ithaca, New York.

This study compared the survival, growth and mark retention of hatchery yearling brook trout marked by VI tags, adipose fin clips and jaw tags. Each mark type was applied to four lots of forty fish. Four control groups of forty fish were also held. Fish were checked at regular intervals over six months for changes in growth (length and weight) and retention of tags.

After six months, VI tagged and adipose fin clipped fish showed 5% reduced growth over control fish. Jaw tagged fish grew slowest (15% less than control fish). Tag retention was 100% for adipose fin clips and jaw tags, and 75% for VI tags. Mortality was three times greater for jaw tagged fish than control fish. Mortality was highest during the summer when water temperatures were highest and during the fall when the fish were maturing. Jaw tags appeared to stress fish and make them vulnerable to furunculosis infection during the summer. We believe that with greater experience in applying VI tags, long term tag retention of the tags will improve.

ZILLIOX, R. G. and M. PFEIFFER. 1956. Restoration of brook trout fishing in a chain of connected waters. New York Fish and Game Journal 3(2) : 167-190.

During the last half century, the introduction of yellow perch in Adirondack trout waters have caused a serious decline in the brook trout fishery. In return, these introductions have provided little, if any, angling due to slow growth and stunting. The elimination of yellow perch from a chain of connected waters forming the headwaters of the West Branch of the St. Regis River, was undertaken in the years 1952 to 1954. Fourteen ponds and 21.25 miles of inlets, outlets, main river and tributaries were treated with emulsifiable rotenone, 5% (Noxfish), at a concentration of approximately 0.5 ppm. More acre feet of water per man hour were generally treated in larger ponds than in smaller ponds. Compete kills are believed to have been obtained in some ponds; in others, all native species were not eradicated. Netting checks and angling returns up to and including 1956 indicating yellow perch were successfully removed.

Four barrier dams were constructed to prevent the reintroduction of undesirable species of fish into reclaimed waters. Physical and chemical characteristics are presented for waters treated. Dissolved oxygen concentrations of less than 3.0 ppm in the hypolimnion are considered an aid to reclamation. Toxicity tests, using live brook trout, indicated that most waters had lost their toxicity to this species within 30 to 50 hours.

ZILLIOX, R. G. and M. PFEIFFER. 1960. The use of rotenone for management of New York trout waters. Canadian Fish Culturist 28 : 3-12.

Over 100 lakes and ponds have been reclaimed in New York state since 1950. Native associates of the brook trout in the Adirondacks vary from watershed to watershed; but the most common association is the brown bullhead, pumpkinseed, white sucker and horned dace. The stocking of hatchery brook trout of various sizes in such waters has given poor returns.

The yellow perch is the most prevalent introduced species of fish in Adirondack waters and the introduced fish most frequently encountered in waters to be reclaimed. The incidence of various introduced species in 90 waters prior to reclamation was as follows: yellow perch 75; smallmouth bass 14; northern pike 12; chain pickerel 6; largemouth bass 2; black crappie 2; rock bass 2; pikeperch 1; carp 1.

All reclaimed waters in the Adirondacks are managed for salmonids and with few exceptions with brook trout. The primary reason for managing for brook trout are: (1) brook trout provide greater fishing opportunities to a larger number of anglers; (2) brook trout provide angling the year following reclaimation; and (3) rook trout require little in the line of management techniques other than annual stocking.

Acknowledgements

This bibliography was prepared with the assistance of numerous individuals. OMNR field technicians and biologists, too numerous to mention, provided copies of file reports and raw data for Ontario brook trout stocking assessment projects. Similarly, I am indebted to fisheries managers in other states and provinces who responded to my request for policies, guidelines and stocking assessment information from their jurisdiction.

OMNR library staff, Margaret Wells and Elizabeth Gustafsson, were particularly helpful during several searches. Jeanette Arminio and Carol Bennett provided clerical assistance in the preparation of this publication.

Subject Key

1.0 General References

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2.0 Stocking Guidelines

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2.4 Stocking rates
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APPENDIX 1. Brook trout stocking in Ontario waters, 1900-1999.

	Number of Fish Stocked						
Year	Eyed Eggs	Fry	Fingerlings	Yearlings	Adults	Unknown	Total
1900	0	0	0	0	0	0	0
1901	0	0	0	0	0	0	0
1902	0	0	0	0	55	0	55
1903	0	0	0	0	0	0	0
1904	0	0	0	0	0	0	0
1905	0	0	0	0	0	0	0
1906	0	0	0	0	0	0	0
1907	0	0	0	0	0	0	0
1908	0	2,000	0	0	0	0	2,000
1909	0	0	0	0	0	0	0
1910	0	0	0	0	0	0	0
1911	0	0	0	0	0	0	0
1912	0	0	0	0	0	70,000	70,000
1913	0	0	0	0	0	80,000	80,000
1914	0	0	0	0	0	116,000	116,000
1915	0	0	0	0	0	90,000	90,000
1916	0	30,000	90,000	0	0	0	120,000
1917	0	301,000	0	0	0	0	301,000
1918	0	0	0	0	0	402,500	402,500
1919	0	10,000	10,600	0	0	0	20,600
1920	0	10,000	0	0	0	276,700	286,700
1921	0	1,147,000	0	0	0	0	1,147,000
1922	0	2,184,075	0	0	0	0	2,184,075
1923	0	2,328,800	0	0	0	0	2,328,800
1924	0	1,898,500	0	0	0	0	1,898,500
1925	0	676,700	0	0	0	0	676,700
1926	0	1,085,300	0	0	300	0	1,085,600
1927	0	1,444,050	0	0	606	0	1,444,656
1928	60,000	1,609,600	0	0	200	0	1,669,800
1929	30,000	0	1,105,750	28,860	2,572	0	1,167,182
1930	95,000	0	2,436,029	60,257	913	0	2,592,199
1931	50,000	0	2,724,003	68,837	0	0	2,842,840
1932	23,400	256,500	4,634,889	144,512	2,815	0	5,062,116
1933	506,000	725,000	5,950,255	28,237	1,549	0	7,211,041
1934	0	0	6,257,267	34,762	1,652	0	6,293,681
1935	0	1,645,000	5,013,831	35,421	5,420	0	6,699,672
1936	28,600	182,000	1,053,050	557,270	6,081	0	1,827,001
1937	0	0	384,725	1,167,073	16,150	0	1,567,948
1938	1,000	0	373,314	2,083,538	4,452	0	2,462,304
1939	0	0	337,000	2,976,559	6,315	0	3,319,874
1940	0	0	611,375	3,378,114	7,150	0	3,896,639
1941	0	0	394,000	3,060,174	16,732	0	3,470,906
1942	0	500	631,775	2,918,513	7,527	0	3,558,315
1943	0	5,000	9,400	3,083,983	10,292	0	3,108,675
1944	0	0	493,840	2,876,963	4,360	0	3,375,163
1945	0	5,000	117,300	3,005,573	4,460	0	3,132,333
1946	0	50,000	84,730	2,760,780	8,656	0	2,904,166
1947	0	0	517,400	2,802,150	1,860	0	3,321,410
1948	0	1,000	882,450	2,333,910	5,270	0	4,106,080
1949	0	16,000	1,475,300	2,938,325	2,046	0	4,431,671
1950	0	0	1,004,700	3,140,960	8,060	0	4,153,720
1951	0	0	944,900	3,087,350	12,230	0	4,044,480
1952	0	0	536,500	2,720,755	19,020	0	3,276,275
1953	0	0	1,962,835	3,250,910	13,960	0	5,227,705
1954	720,000	0	165,850	2,055,748	4,295	0	2,945,893

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	Number of Fish Stocked						
Year	Eyed Eggs	Fry	Fingerlings	Yearlings	Adults	Unknown	Total
1955	50,000	0	841,500	1,991,332	16,447	0	2,899,279
1956	0	35,000	1,331,870	2,092,403	18,823	0	3,478,096
1957	200,000	90,900	521,600	2,677,195	10,117	0	3,499,812
1958	0	0	788,900	2,079,395	9,586	0	2,877,881
1959	580,000	0	455,160	1,870,855	84,294	0	2,990,309
1960	49,000	15,000	863,925	1,615,960	76,481	0	2,620,366
1961	30,000	0	763,625	2,051,875	72,562	0	2,918,062
1962	493,500	0	651,300	1,655,249	75,445	0	2,875,494
1963	574,580	0	391,570	1,888,781	72,522	0	2,927,453
1964	400,000	8,582	505,750	1,730,310	111,920	0	2,756,562
1965	73,900	0	604,275	1,823,271	69,216	0	3,170,662
1966	0	0	480,490	1,599,092	28,895	0	2,108,477
1967	2,741,000	50	1,125,454	1,667,043	94,283	0	5,627,830
1968	0	0	524,463	1,149,091	39,941	0	1,713,495
1969	2,150,000	0	524,050	1,344,647	37,305	0	4,056,002
1970	311,440	0	918,775	1,474,017	42,970	0	2,747,202
1971	0	0	445,856	1,157,400	39,758	0	1,643,014
1972	0	15,000	388,660	1,770,387	27,237	0	2,201,284
1973	660,000	0	441,000	960,000	37,000	0	2,098,000
1974	0	0	0	1,939,000	0	0	1,939,000
1975	0	0	0	0	0	1,522,000	1,522,000
1976	0	0	0	0	0	1,597,000	1,597,000
1977	0	0	0	0	0	1,878,000	1,878,000
1978	380,000	0	0	0	0	1,078,000	1,458,000
1979	18,000	0	0	0	0	682,000	700,000
1980	0	0	0	0	0	1,260,000	1,260,000
1981	860,000	0	0	0	0	1,459,000	2,319,000
1982	0	0	0	0	0	824,000	824,000
1983	302,000	0	0	0	0	1,757,000	2,059,000
1984	80,000	0	0	0	0	1,127,000	1,207,000
1985	38,000	0	0	0	0	1,138,000	1,176,000
1986	15,000	0	0	0	0	1,688,000	1,703,000
1987	10,000	0	0	0	0	2,066,000	2,076,000
1988	10,000	0	0	0	0	2,385,000	2,395,000
1989	19,000	0	0	0	0	1,870,000	1,889,000
1990	0	80,800	647,500	785,182	6,553	2,500	1,522,535
1991	0	0	767,250	904,128	14,790	550	1,686,718
1992	0	210,000	542,500	973,964	10,148	373	1,736,985
1993	0	177,152	12,000	628,099	4,075	0	821,326
1994	0	181,500	281,000	539,605	11,810	0	1,013,915
1995	0	250,000	0	857,010	4,907	0	1,111,917
1996	0	751,500	0	632,778	2,414	0	1,386,692
1997	0	226,900	0	798,445	3,668	0	1,029,013
1998	0	551,000	115,870	893,296	13,971	0	1,574,137
1999	0	659,264	83,430	961,211	18,961	0	1,722,866

APPENDIX 2. A summary of post-stocking survival rates of brook trout reported from various North American waters.

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Buck Creek (Ontario)	Fry	2-3 months	19.7%	White (1924)
East Pennock Lake (Ontario)	Fry (2 plants)	1-4 years	0.0-0.3%	Dextrase (1986)
Elbow Lake (Ontario)	Fry (2 plants)	1-4 years	0.0-0.2%	Dextrase (1986)
Golding Lake (Ontario)	Fry (3 plants)	3 months-5 years	0.2%	Ball (1988)
Gunstone Creek (Ontario)	Fry	2-3 months	3.6%	White (1924)
Head Lake (Ontario)	Fry (3 plants)	3 months-4 years	0.3%	Ball (1988)
Karilla Lake (Ontario)	Fry (3 plants)	1-5 years	0.0%	Ball (1988)
Little Head Lake (Ontario)	Fry (3 plants)	3 months-4 years	0.4%	Ball (1988)
Marks Lake (Ontario)	Fry (3 plants)	3 months-5 years	0.06%	Ball (1988)
Morrison Lake (Ontario)	Fry (3 plants)	3 months-4 years	0.0-9.2%	Destraxe (1986)
Waller Lake (Ontario)	Fry (3 plants)	1-6 years	0.6%	Ball (1988)
Abbott Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	6.3-13.4%	Dupee and Spurr (1980)
Beebe Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	1.9%	Dupee and Spurr (1980)
Blake Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	7.5%	Dupee and Skinner (1980)
Bumfagon Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	3.5-3.8%	Dupee and Spurr (1980)
Churchill Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	4.5%	Dupee and Spurr (1980)
Crooked Run Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.0-0.5%	Dupee and Spurr (1980)
Crystal Lake (Ontario) F	Fingerlings	24 months	7.7-18.8%	Fraser (1983)

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Appendix 2 (cont'd)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Eastman Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	5.0-33.1%	Dupee and Spurr (1980)
Forbes Brook (Prince Edward Island)	Fingerlings	11 weeks	15.0-45.6%	White (1930)
Giles Pond (Maine)	Fingerlings	6-7 months (November-May)	23.0%	Mears and Hatch (1976)
G. Meadow Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.4-4.7%	Dupee and Spurr (1980)
Gulf Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	1.6%	Dupee and Spurr (1980)
Isinglass Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.0%	Dupee and Spurr (1980)
Lamprey Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.0%	Dupee and Spurr (1980)
Misc. Illinois Streams	Fingerlings	-	0.0-0.8%	Holloway (1945)
Montgomery Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	1.8-3.3%	Dupee and Spurr (1980)
Pickard Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	2.7-3.4%	Dupee and Spurr (1980)
Pike Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	3.5%	Dupee and Spurr (1980)
Red Hill Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.0%	Dupee and Spurr (1980)
Rumley Lake (Ontario)	Fingerlings	9-10 months (September-June)	4.9-7.5%	Fraser (1980)
Sanborn Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	0.6%	Dupee and Spurr (1980)
Skinner Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	6.8%	Dupee and Spurr (1980)
Sportsman Lake (Wisconsin)	Fingerlings	9-10 months (summer-spring)	17-40%	Carline et al. (1976)
	Fingerlings	6-7 months (fall-spring)	48-77%	Carline et al. (1976)
Unnamed Creek (New Hampshire)	Fingerlings	10-12 weeks (June-August)	14.9-23.6%	Dupee and Spurr (1980)
Woods Lake (New York)	Fingerlings	-	25%	Gloss et al. (1989)

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Appendix 2 (cont'd)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Alps Creek (Ontario)	Yearlings	1-5 years	0.0%	Coultes (1992)
Ambrose Lake (Ontario)	Yearlings	3 months	0.0%	Dextrase (1986)
Belmore Creek (Ontario)	Yearlings	1-5 years	0.0%	Coultes (1992)
Bews Lake (Ontario)	Yearlings	2 years	2.6%	Dextrase (1986)
Big Wind Lake (Ontario)	Yearlings	2-3 months	0.0%	Dosser (1996)
Blind Creek (Ontario)	Yearlings	1-5 years	0.0%	Coules (1992)
Bluepaint Lake (Ontario)	Yearlings	2-3 months	0.0%	Dosser (1996)
Boat Lake (Ontario)	Yearlings	2-3 months	10.6%	Dupont and Bernier (1984)
Bojack Lake (Ontario)	Yearlings	2-3 months	6.1%	Dupont and Bernier 1984)
Brilliant Lake (Ontario)	Yearlings	2-3 months	3.8%	Dupont and Bernier (1984)
Chipmunk Lake (Ontario)	Yearlings	1-2 months (May-July)	12.1-18.4%	Fraser (1980)
Colette Lake (Ontario)	Yearlings	4 months	2.2%	Kerr (1979)
Cranberry Pond (New York)	Yearlings	-	54%	Gloss et al. (1989)
Crescent Lake (Ontario)	Yearlings	4 months	9.9%	Kerr (1979)
Dickies Creek (Ontario)	Yearlings	1-5 years	0.0%	Coultes (1992)
Doc Grieg Lake (Ontario)	Yearlings	4 months	11.7%	Kerr (1980)
Eagle Lake (Maine)	Yearlings	3 months (November-January)	28.8%	Havey and Locke (1980)
East Fish Lake (Michigan)	Yearlings	6 months (October-April)	49.0%	Alexander and Shetter (1969)
Emerson Lake (Ontario)	Yearlings	2-3 months	6.6%	Bernier (1978)

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Appendix 2 (cont'd)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Emerson Lake (Ontario)	Yearlings	2-3 months	6.6%	Bernier (1978)
Finn Lake (Ontario)	Yearlings	2 months	30.0%	Tynela and Jones (1993)
Herbert Lake (Ontario)	Yearlings	14 months	1.7%	Stankiewicz (1981)
Kaufman Lake (Ontario)	Yearlings	2 months	22.0%	Tynela and Jones (1993)
Lake # 2J-68 (Ontario)	Yearlings	4 months	1.8-2.4%	Pellegrini and Lebel (1986)
Lake #1 (Ontario)	Yearlings	2-3 months	7.3%	Bernier (1978)
Lake #9 (Ontario)	Yearlings	2-3 months	13.7%	Dupont and Benier (1984)
Lake #37 (Ontario)	Yearlings	2-3 months	19.0%	Dupont and Bernier (1984)
Livingstone Lake (Ontario)	Yearlings	2-3 months	0.0%	Dosser (1996)
Mable Lake (Ontario)	Yearlings	2-3 months	1.8%	Dupont and Bernier (1984)
McGee Lake (Ontario)	Yearlings	6 months	0.9-8.2%	Hunt (1979)
Mickey Lake (Ontario)	Yearlings	15 months	1.7%	Dextrase (1986)
Metivier Lake (Ontario)	Yearlings	2-3 months	4.9%	Dupont and Bernier (1984)
Mountain Lake (Ontario)	Yearlings	2-3 months	11.0%	Bernier (1978)
Mudhole Lake (Ontario)	Yearlings	4 months	9.1%	Kerr (1979)
Mystery Lake (Ontario)	Yearlings	4 months	11.3%	Kerr (1980)
Nancy Lake (Ontario)	Yearlings	4 months	2.6%	Kerr and Taylor (1981)
Oakley Lake (Ontario)	Yearlings	4 months	3.5%	Kerr (1979)
Otter Creek (Ontario)	Yearlings	1-5 years	0.0%	Coultes (1992)
Presto Lake (Ontario)	Yearlings	1-2 months (May-July)	9.0-17.3%	Fraser (1980)

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Appendix 2 (cont'd)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Robert Lake (Ontario)	Yearlings	14 months	0.3%	Read (1981)
Rumley Lake (Ontario)	Yearlings	1-2 months) (May-July	4.8-12.3%	Fraser (1980)
Sandy Lake (Ontario)	Yearlings	2-3 months	3.3%	Dupont and Benier (1984)
Shallnot Lake (Ontario)	Yearlings	1-2 months (May-July)	15.7-50.8%	Fraser (1980)
Siderock Lake (Ontario)	Yearlings	14 months	1.7%	Duckworth (1980)
Souloup Lake (Ontario)	Yearlings	4 months	1.9%	Kerr (1980)
Strums Lake (Ontario)	Yearlings	2-3 months	4.0%	Bernier (1978)
Troutspawn Lake (Ontario)	Yearlings	2-3 months	0.0%	Dosser (1996)
Limburner Lake (Ontario)	Yearlings	2-3 months	0.7%	Dosser (1996)
Livingstone Lake (Ontario)	Yearlings	2-3 months	1.8%	Dosser (1996)
Ward Lake (Ontario)	Yearlings	months	1.5%	Kerr and Taylor (1981)
Watson Lake (Ontario)	Yearlings	2-3 months	3.8%	Bernier (1978)
White Birch Lake (Ontario)	Yearlings	2-3 months	6.3%	Dupont and Bernier (1984)
Woods Lake (New York)	Yearlings	-	25%	Gloss et al. (1989)
Misc. Illinois Streams	Legal-sized	-	4.4-92.0%	Holloway (1945)

APPENDIX 3. Contributions of stocked brook trout to selected recreational fisheries in North America.

Waterbody	Life Stage	Stocked Contribution to Fishery	Time Period	Reference
Canada Creek (Michigan)	Advanced Fingerlings	26.6% of number stocked	16-18 months	Shetter (1939)
Castle Lake (California)	Fingerlings and Yearlings	0.4-3.2 (mean 1.9) of number stocked	5 years	Wales (1946)
Cornwall Recreational Fishing Area (Ontario)	Yearlings	72.5% of number stocked	11-12 months	Raine (1969)
Duschee Creek (Minnesota)	Legal-sized	5% of number stocked	2 years	Smith and Smith (1943)
Eagle Lake (Maine)	Yearlings	31.7% of number stocked	4 months	Havey and Locke (1980)
Ellerslie Brook (Prince Edward Island)	Fingerlings	28% of number stocked	12 months	Saunders and Smith (1964)
Hunt Creek (Michigan)	Fingerlings	0.07-0.28% of number stocked	8-10 months	Shetter (1950)
Kerwin Lake (Ontario)	Yearlings	0.5% of number stocked	8-9 months	Olver (1969)
Knife River (Michigan)	Fall fingerlings Spring yearlings	1.9% of number stocked 14.1% of number stocked	6-8 months	Smith and Smith (1941)
Lallan Lake (Ontario)	Yearlings	0.5% of number stocked	5-6 months	Patrick (1959_a)
McGee Lake (Wisconsin)	Yearlings (3 strains)	73-79% of number stocked	4 months	Hunt (1979)
Meach lakes (Ontario)	Yearlings	Winter - 34.0% Summer – 12.0% Total – 19.0%	1 year	Brady (1983)
Meach lakes (Ontario)	Yearlings (domestic) Yearlings (NP wild) Yearlings (NP wild)	14.0% of number stocked 1.2% of number stocked 2.5% of number stocked	1 year 1 year 1 year	Loftus and Brady (1987)
Moose River (New York)	Catchable	22.9% of number stocked	4-5 months	Josephson and Krueger (1995)
Mud Lake (Ontario)	Yearlings	34.7% of number stocked	6 months (Jan.-March)	Hughson and Stass (1971)
Pall Lake (Ontario)	Yearlings	0.8% of number stocked	5-6 months	Patrick (1959_a)
Panagapka Lake (Ontario)	Yearlings	11.8% of number stocked	5-6 months	Patrick (1959_a)

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Appendix 3 (cont'd)

Waterbody	Life Stage	Stocked Contribution to Fishery	Time Period	Reference
Pine River (Michigan)	Catchable	19.8% of number stocked (46.9% of catch)	4-5 months	Hazzard and Shetter (1938)
Ramey Lake (Ontario)	Yearlings	0.5% of number stocked	5-6 months	Patrick (1959_a)
Reclaimed Maine pond	Yearlings	50%	5-6 months	Foye (1953)
Rocky Branch River (New Hampshire)	Catchable	31% of number stocked	5 months	Seamans (1939)
Round Valley Reservoir (New Jersey)	-	24.6-25.0% of number stocked	-	Soldwedel (1975)
Saco River (New Hampshire)	Catchable	20-35% of number stocked	5 months	Seamans (1959)
Salmon Trout River (Michigan)	Fall Fingerlings Spring Yearlings	< 1.0% of number stocked 19.6% of number stocked	- -	Smith (1941)
Sawyer River (New Hampshire)	Catchable	36% of number stocked	5 months	Seamans (1959)
Split Rock River (Minnesota)	Adults	12.6% of catch	3-4 months	Hale (1952b)
Spring Creek (Pennsylvania)	-	83% of number stocked	3 months	Hartzler (1977)
Spruce Run Reservoir (New Jersey)	-	30.3% of number stocked	-	Soldwedel (1975)
St. Mary River (Virginia)	Fingerlings	2.4% of number stocked	4-5 years	Surber (1940_a)
St. Williams pond (Ontario)	Legal-sized	76.6% of number stocked	4 months	Johnson (1965)
Sucker River (Minnesota)	Adults	43% of number stocked	3-4 months	Hale (1952_b)
Upper Angora Lake (California)	Fingerlings (2") Fingerlings (5.5")	4.3% of number stocked 25.6% of number stocked	- -	Needham (1959)
Ward Lake (Ontario)	Yearlings	1.0% of number stocked	4-5 months	Kerr and Taylor (1981)
Three Wisconsin lakes	Legal-sized	64% of number stocked	1 month	Jesien and Coble (1979)
Five Michigan streams	Fingerlings	< 1.76% of number stocked	5-6 months	Shetter (1939)

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Appendix 3 (cont'd)

Waterbody	Life Stage	Stocked Contribution to Fishery	Time Period	Reference
Misc. waters (N=32)	Fingerlings	Average of 7.4% of number stocked	-	Needham and Sumner (1941)
	Catchables	34.5% of number stocked in lakes; 41.3% of number stocked in streams	-	
Misc. Oregon streams	Catchables	20.9-35.6% of number stocked	1 month	Lock (1966)
Misc. Vermont waters	Catchable	30-40% of number stocked	-	Vermont Department of Fish and Wildlife (1993)