# NOVA SCOTIA

# TROUT MANAGEMENT PLAN

**FINAL DRAFT**

**NOVA SCOTIA DEPARTMENT OF AGRICULTURE AND FISHERIES**

**Inland Fisheries Division**

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# Introduction

Nova Scotia's sport fishery provides opportunities for anglers throughout every season of the year. Trout are the most important sport fish in the province and require special attention to insure that the value of this resource is maintained. Changes to habitat and exploitation have resulted in changes to the trout fishery. This management plan was developed specifically for trout in response to requests made from anglers through the Inland Fisheries public involvement process. The purpose of fisheries management is to develop and implement strategies to maintain a sustainable fishery and to address the needs of anglers. The Inland Fisheries Division of the Department of Agriculture and Fisheries has a direct role to play in managing the fishery through population enhancement (stocking), habitat restoration, regulations, promotion, and resource assessment, as well as through indirect roles in enforcement and protection of the resource.

Provincial management of the recreational fishery is partially supported through a user-pay system from angling license sales; however, the true value of the recreational fishery to the economy far exceeds licence revenue. In 2000, an estimated 60,000 licensed anglers spent 86 million dollars on expenses related to their sport. Even though the current value of the sport fishery to the economy is substantial, declines in license sales since the early 1980s has heightened the need for more promotion and marketing of sport fishing in the province.

The recent signing of the Canada - Nova Scotia Memorandum of Understanding on Recreational Fisheries has legitimized the responsibility of the Nova Scotia Government in recreational fishing management. Through this agreement the Province of Nova Scotia is responsible for freshwater species such as the four trout species, smallmouth bass, white perch, yellow perch, chain pickerel, and landlocked Atlantic salmon, while the federal government manages diadromous species such as smelt, eel, sea run Atlantic salmon, and shad (Appendix A).

Of the 38 species of fish found in the freshwater lakes and streams of this province, anglers have traditionally favoured brook (speckled) trout. The last three sportfishing surveys for Nova Scotia indicate that angler preferences for some species have changed. By 1990, rainbow trout surpassed Atlantic salmon, to take second place in popularity among resident anglers. By 2000, smallmouth bass, was ranked the third in popularity below brook trout and rainbow trout while Atlantic salmon was the fifth most popular sportfish behind brown trout. Of the three main trout species only brook trout are native to the province. Rainbow trout, a West Coast species, was introduced to the province in 1899. Brown trout, a European species, was introduced in 1924. Lake trout remain a species of limited significance to the sportfishery due to their confined distribution and cryptic life cycle. It is unclear whether existing populations of lake trout are remnants of stocking or post-glacial colonization in Nova Scotia.

The Trout Management Plan provides an overview of the trout resource, as well as, current and future management of brook trout, rainbow trout, brown trout, and lake trout. Specific initiatives designed to benefit the fishery resource are located in a work plan (Appendix B). The majority of initiatives in this plan are directed toward improving and sustaining the fishery for brook trout. The format of this plan was modified from Trout Management Plans in other provinces and the United States.

# Policy and objectives

It will be the policy of the Nova Scotia Department of Agriculture and Fisheries to protect, conserve, and enhance the quality and diversity of the fishery resources of this province and to provide continued and varied angling opportunity through resource assessment and classification, enhancement, and management of that resource. To achieve the objectives of this policy, the Department will:

1. Broaden the current data base on the quality and quantity of the aquatic and fishery resources of the Province for effective environmental protection and resource management.
2. Establish consistent standards to classify waters by the dominant habitat type and species on a province-wide basis.
3. Manage self-sustaining fish populations as a renewable natural resource to conserve that resource and the angling it provides.
4. Use hatchery fish to provide angling opportunities in waters where fish populations are inadequate to sustain the fishery at desired levels; help sustain and restore populations of trout affected by the fishery and habitat loss; promote angling as both as healthy recreational activity and a viable industry; help maintain a diverse inland fishery that attracts both resident anglers and participants from abroad.
5. Develop appropriate regulations, enhancement initiatives, and operational strategies to support management through the resource classification system for target species.
6. Conduct cooperative applied research initiatives with community groups, other government departments and universities to address issues related to exploitation, habitat loss, and restoration/enhancement.
7. Support habitat protection and enhancement through the Sportfish Habitat Fund.
8. Promote and market the sport fishery to increase current levels of participation and value of the resource.

# Public support and involvement

Public involvement in the management of the Recreational Fishery has been, in large part, responsible for the past successes of the Inland Fisheries Division. The general public and members of non government organizations are encouraged to participate in the Department's public advisory process. In order to promote equal representation, Nova Scotia has been divided up into six management zones called Recreational Fishery Management Areas. Meetings of the Recreational Fishery Area Committee (RFAC) occur on a biannual basis during spring and fall in each management area. Government staff provide an overview of activities and issues related to the recreational fishery, providing a forum for public discussion regarding issues of regional concern.

In addition to regional representation of the six Recreational Fishing Advisory Committees there is also the Inland Fisheries Advisory Committee (IFAC) that is made up of representatives from non government organizations that are provincial in scope. The Inland Fisheries Advisory Committee include representation from the Canadian Association of Smallmouth Anglers, Nova Scotia Federation of Anglers and Hunters, Nova Scotia Salmon Association, Trout Nova Scotia, Atlantic Salmon Federation, and the Fisheries Institute of Nova Scotia.

# Resource assessment and classification

Resource assessment is an important component of fishery management. The basis of any successful management strategy is dependant on a knowledge of the users (anglers), habitat, and fish. For example, in order for a regulation designed to reduce harvest to succeed, angling should be or have been an important factor limiting the number of fish in the population and the habitat should be present to support a greater number of individuals in the fish population. Similarly, the success of other management strategies such as habitat restoration and direct population enhancement (stocking) depends on the management strategy's ability to address specific problems impacting the health of the fishery. For this reason a habitat classification system has been developed to benefit the design of management strategies. Much of the habitat data used in the classification system has been collected with the help of volunteers and community-based organizations.

# Habitat

Stream and lake surveys are methods by which habitat and population information is collected. Stream habitat data has been collected on 27 of the 100 river systems in Nova Scotia. Of the 6,674 lakes in the province just more than 1,000 of these (16%) have been surveyed for their physical, chemical, and biological characteristics. These data were used to classify trout habitats.

The stream and lake classification system was based on habitat preferences for each of the four trout species, and will function as the bases for the design of population, habitat, and regulatory enhancement strategies. On occasion, angler surveys and anecdotal information will also contribute to the evaluation until resources become available to conduct proper assessments. The habitat classification system for trout lakes was based on depth, water acidity, lake size, and the presence of competitors. Trout streams were classified based on water temperature and acidity. For management purposes, classification of resource data will be prioritized as follows:

Class "A" – Waters defined as Class "A" represent good to ideal potential for success of a management option. In these areas where water quality does not limit production a variety of management strategies can be considered. For lake populations, changes to exploitation through the use of new regulations in Special Management Areas may be considered a first management option. For stream populations, instream enhancement and protection of habitat may be considered a first management option.

Class "B" – Waters defined as Class "B" will represent moderate habitat or population conditions. Designation of this water classification level will permit the application of any combination of management strategies depending on what factors are potentially limiting to the target population.

Class "C" – Waters of this designation will receive the lowest priority in terms of effort except in areas where they predominate. These waters may figure prominently as waters that are highly impacted by habitat conditions that may limit management options. Outside of stocking large trout that are immediately available to the angler, the use of regulations to recycle trout may be a consideration to maintain current angling opportunity.

Total fish production in streams and lakes is often limited by certain habitat variables. Production for a given fish species in a waterbody is often related to its habitat requirements. For this reason, Class B and C systems will potentially support a much greater production of non-salmonid species compared to salmonid species. The biomass of trout in many lakes may be only a fraction of the total fish biomass present (Alexander and Merrill 1976, Smith 1938).

A total of 21 fish species has been sampled from 781 Nova Scotia lakes assessed during the lake survey program (Alexander et. al 1986). Habitat parameters collected from Nova Scotia lakes have been used as indicators of productivity. In general, the low level of conductivity and total dissolved solids indicate that Nova Scotia lakes are relatively unproductive (Alexander 1975). Ryder (1972) developed the morphoedaphic index (ratio of total dissolved solids and mean lake depth) to estimate fish production in a lake. The few comparative studies conducted in Nova Scotia indicate that the morphoedaphic index may be a useful fishery management tool in the province; however, further study is needed (Alexander 1975, Ives 1975a, 1975b).

# Angler profile and trout populations

Information from anglers and target species is collected in a number of methods. The license Stub Program and Nova Scotia Sportfish Survey provide relatively long term data to gage changes in angler preference and catches on a provincial or regional level. Direct sampling of populations can be accomplished through netting and electrofishing surveys. The most common assessment methods implemented by the Inland Fisheries Division are listed below.

License Stub Program – Attached to every license sold is a license stub. Since 1966, anglers were requested to fill out the stub and return license stubs to the Inland Fisheries Division. The percentage of anglers that return license stubs has ranged from three to 19 percent and has been sufficient to provide an estimate of catch. The returns have been used to estimate the total catch of different sportfish, catch per angler, and an index of abundance.

Nova Scotia Sportfish Survey – Since 1980, every five years the Federal and Provincial governments have undertaken surveys of anglers in each province. The sportfish survey includes detailed information on economic values, catches, and angler preferences. The information collected through this survey is often used to determine the values of the sportfishery and gage and support for management options.

Angler logbook – This program provides site specific (lake or river) data on catch by waterbody. The logbook data information has been used in the design of regulations for different regions (i.e., Cape Breton highlands vs Mainland lakes). The angler logbook program has been scaled down in recent years and now is only used in special situations. For example, when some groups of anglers are interested in assessing populations on a site specific bases.

Creel and angling surveys – Creel surveys usually include angler interviews and counts to collect information of the fish populations being exploited and the level of fishing pressure. Angling alone or with another method can be used to collect biological parameters of fish populations. These methods are usually undertaken on a site specific or regional basis.

Trap netting, gill netting, and fish counting fences – Direct sampling of the population can be conducted through trap netting (non-lethal) and gill netting (lethal) means. These methods can be used to estimate population size and production, as well as other population characteristics, such as mortality rate, growth, and fecundity.

Electrofishing – Backpack electrofishing is the most common method employed to catch fish to estimate fish population densities in a stream or small river.

A number of different methods to survey trout populations have been used in studies to determine catch rates, population density, size, timing of runs, and production in Nova Scotia. White (1940, 1941, 1942), Wilder (1952) and Miles (1985) used fish counting fences to assess the status of two sea run trout populations. MacMillan and Crandlemere (2005) used fyke nets to assess population size and migration patterns of brook trout in River Denys, and Cold Brook of Middle River and in Lake O' Law Brook of Margaree River. LeBlanc

(1998) and MacMillan and LeBlanc (2002) used a creel survey to estimate catch and angling pressure on several sea run populations. Candlemere (2005) used creel and lake surveys to assess the status of a brook trout fishery in two popular angling lakes in Halifax County. Angler check points have been used to collect information on catches of trout from lakes in the Tangier Grand Wilderness Area (Sabean 1980). Sabean (1975,1983,1985) and Hayes and Livingstone (1955) used creel and electrofishing surveys to assess stocking success and the status of fisheries in lakes and rivers. McNeill (1998) used angling to obtain a mark and recapture estimate on Ingonish Lake in the Cape Breton Highlands. Alexander and Merrill (1976) conducted a mark and recapture using nets to determine productivity in Big Indian Lake, an unexploited trout lake. Alexander (1972) and Vromans (1979) used netting surveys to determine survival of hatchery trout under different stocking strategies. A survey conducted with creel, angling, and electrofishing was used to assess the trout fishery and habitat use in Lumsden Pond, a large Hydroelectric impoundment on the Black River system (MacMillan 1999). MacMillan and Crandlemere (2004) used electrofishing to test the assumptions used as the bases of the stream habitat classification system. A similar initiative will be undertaken to test the lake habitat classification system.

Repeating and expanding on surveys will provide valuable insight as to how conditions have changed. The main focus on trout research over the next five or ten years will be to gain a better understanding of the role of exploitation and environment by using a combination of the above listed methods.

# Trout Species

## Brook (speckled) trout *Salvelinus fontinalis*

Brook trout are the number one sportfish in the province (MacLean 2003). Approximately two million brook trout are stocked annually. The annual catch of brook trout has ranged from 800,000 to 2.2 million and declined by approximately 60 percent over the past 25 years. Current trends in catch of brook trout have indicated a decline in the trout resource. However, difficulties arise when attempting to differentiate reasons for a decline. For example, the decline in catch of trout has corresponded with a decline in license sales. Arguably, some of the decline in the catch of brook trout is related to a change in angler effort. As well, changes in fish communities via illegal introductions, global warming, and land use resulted in a reduction of available trout habitat and angling opportunity. Both overfishing and changes in habitat are believed to be the main factors in the decline of trout in Nova Scotia. The challenge is to implement the correct enhancement strategy that addresses a factor limiting production at one or more stages in the life cycle of trout.

In the fall of the year, mature brook trout will migrate to find a suitable spawning location, often in the gravel substrate of a lake or stream. Once a spawning site is selected, the female excavates a depression or 'redd' in which she deposits her eggs. Groundwater upwelling and spring seeps are believed to be important habitat variables in the selection of trout spawning sites. The eggs remain in the gravel throughout the winter until the fry emerge in spring. During this time, soil erosion that results in siltation of the trout redd can lead to high mortality of eggs and fry. As well, acid precipitation has resulted in reduced reproductive potential in some regions of the province.

After trout fry emerge from the redd, growth can vary and depending upon location and conditions.

Usually, trout require about two to four years before they mature and reach a size desired by anglers; rarely, do Nova Scotia brook trout reach the age of five or six years. Brook trout face a number of challenges that can impact their survival during their relatively short life span. Competitory species, like perch and bass, predate or out compete trout for food and space. Habitat loss from poor land use can lead to a loss in the protective riparian areas that support habitat for trout, as well, climate changes lead to warm water and low flow conditions that can severely restrict summer habitat. Inspite of this situation, during the emergence of mayflies in spring, even trout populations at low density can be easily exploited. Many mainland trout populations are influenced by a number of factors or disturbances that could reduce survival and could benefit from enhancement initiatives.

Some trout fisheries may benefit from a degree of disturbance to a population. For example, populations in mainland lakes tend to grow faster than in the Cape Breton highlands. This difference is believed to be a result of the level of crowding between populations in the two regions (MacMillan and Crandlemere 2004). Trout can overpopulate habitat in regions that contain good spawning and rearing habitat, abundant cold water, suitable pH (water acidity), and low numbers of fish species. As a result, in the Highland lakes of Cape Breton many populations are crowded comprising many 'stunted' small individuals. Habitat conditions are much more diverse in mainland regions and, as a result, mainland populations tend to be thinned out and growth is more rapid. The better mainland trout fisheries are probably those where competition from other species is minimal and good water quality with suitable cold water summer refugia is present.

The habitat classification system for brook trout lakes is based on depth (presence of cool water n summer), competition, water acidity, and lake size (Appendix C). The presence of competitors of trout is related to lake size. For example, approximately 33% of lakes with surface areas less than 30 hectares have low competition for brook trout, while only 8% of lakes more than 90 hectares in size have low competition for brook trout. In Maine, Bonney (2001) used white sucker as an indicator species for the presence of other brook trout competitors. The number of brook trout was 37 per hectare in lakes inhabited by white sucker and was 111 per hectare in the absence of white sucker in Maine. Competitors of trout included in the Nova Scotia classification system are white sucker, brown bullhead, white perch, and yellow perch, smallmouth bass, and chain pickerel. American eel were present throughout waterbodies of Nova Scotia and were therefore not used to classify one habitat from another. Cool water refugia in lakes can be provided by stratification and the presence of springs and groundwater seeps. The depth of stratification is variable in Nova Scotia and some dark or tea coloured lakes stratify at depths of two meters or more. Well-oxygenated deep water in lakes will provide an area where trout can move to during warm periods. The presence and degree of groundwater influence in lakes has not been adequately measured to incorporate into the lake classification system. The Nova Scotia brook trout lake classification system will potentially require additional revision as more information becomes available to help define the relationship between brook trout production and habitat variables in lakes.

Popular sea run fisheries are located across the province, with the majority of the angling pressure occurring in estuaries and river mouths in the spring of the year. The number of trout in populations that migrate to the ocean can change from year to year, depending on juvenile recruitment and environmental conditions (Ryther 1997). Sea run brook trout remain in fresh water for about two to three years before migration to salt water in the spring (MacMillan and LeBlanc 2002). The purpose of the migration is believed to satisfy a need for more food and space. Estuaries, the place where river water meets salt water, tend to be very productive

and are nursery areas for smelt, flounder, gaspereau, shad, and many other species. As a result, food is plentiful and growth rates of sea trout reflect favourable conditions present in estuaries. The best sea run trout populations tend to be located in the more northern regions of the province where water temperatures are cool and geological conditions support healthy habitat.

Water quality monitoring and electrofishing were used to classify trout streams into cool (Class A), intermediate (Class B) and warm (Class C) (Appendix D). The mean biomass of brook trout in each of the categories was 61 kg per hectare in class A streams, 15 Kg per hectare in class B streams, and 2 Kg per hectare in class C streams. The identification, maintenance, protection, and enhancement of instream habitats of class A and class B waters can benefit the trout fishery. Methods to improve trout production of Class C streams are limited to those that address the thermal nature of the system or access.

The maximum bag limit is five brook trout or combination of brook trout and other trout species during the traditional angling season from April 1 to August 31. Many rivers are delayed until April 15 to protect slink sea run trout and the month of September are catch and release only with a gear restriction. Special Trout Management Areas to enhance angling of sea run trout and lake populations include changes to bag limits, gear, season, and size.

# Rainbow trout *Oncorhynchus mykiss*

The annual number of rainbow trout caught by Nova Scotia anglers ranged from 40,000 to 130,000. Rainbow trout are native to the West Coast of Canada and the United States. They have been stocked in Nova Scotia since the early 1900s and more recently have been used in aquaculture. Approximately 65,000 rainbow trout are stocked annually in approximately 20 sites across the province (LeBlanc and Larkin 2003). Rainbows are sometimes preferred to other sportfish because of their apparent ability to excel in some lake habitats. This characteristic may be related to an increased tolerance of warmer conditions compared to other salmonids and is reflected in the habitat classification for rainbow trout lakes (Appendix E). New stock enhancement proposals are assessed through the Introductions and Transfers Committee, which is made up of representatives from the Provincial and Federal Governments. A Policy for Rainbow Trout Introduction that provides guidelines for future stocking initiatives is available from the Inland Fisheries Division.

Rainbows are one of the most acid-sensitive salmonids and seem to be unable to reproduce in the vast majority of Nova Scotia waters. Successful reproduction has been detected in a few Cape Breton stream systems; however, the ability of these populations to self-sustain is questionable. As a result the Nova Scotia rainbow trout fishery is almost entirely supported through direct enhancement to the population or through an aquaculture escapement. Rainbow trout angling is open year round on the Bras d'Or Lakes in Cape Breton. The rainbow fishery in the Bras d'Or Lakes was largely dependant on an escapement of rainbow trout from aquaculture sites. In response to the decline of rainbow trout aquaculture operations, angler organizations have requested that the province review options to maintain the quality of angling in the Bras d'Or Lakes region.

Several rainbow lakes are stocked again in December to provide opportunities for winter angling. The maximum possession limit is five trout during the traditional angling season from April 1 to September 30, however, the limit has been reduced to two rainbow trout for the winter fishery. Regulations associated with rainbow trout are directed toward spreading the catch among anglers, rather than conservation. Most rainbow trout lakes support winter fisheries to increase angling opportunities.

# Brown trout *Salmo trutta*

Brown trout were introduced to Nova Scotia in the 1920s and have since established self-sustaining populations in many rivers. Approximately 100,000 brown trout were stocked to support fisheries. The estimated number of brown trout caught per year has ranged from 25,000 to 75,000. Brown trout, like brook trout, can become anadromous, and while in freshwater prefer slow-flowing areas with cover. Browns are longer lived and more resistant of habitat alterations, warm water, and are more difficult to catch compared to native brook trout. The habitat preferences are reflected in the habitat classification system for brown trout streams and lakes and have potentially benefited the survival of brown trout over other salmonids (Appendices F and G).

Despite being more tolerant of some conditions, brown trout behaviour and habitat will overlap with that of brook trout; therefore, brown trout are potentially impacted by many of the same types of challenges that face brook trout. As a result, many of the initiatives undertaken to protect brook trout will potentially have positive benefits for brown trout. The increased tolerance of brown trout may reduce post-stocking mortality in many stocking locations, compared to brook trout. For example, stocking of brown trout in systems under hydroelectric development (Mersey River) has been reported to be a success by anglers. Fall fingerling brown trout may be used to enhance sites where competition from other species is low and water is suitable. The use of yearling and trophy brown may follow similar criteria as described under the urban stocking program for brook trout.

The maximum bag limit is five brown trout or combination of brown and other trout species during the traditional angling season from April 1 to September 30. Special Trout Management Areas to enhance angling of sea run browns and lake browns include changes to bag limits, gear, and size. Some brown trout populations are considered to be healthy enough to sustain further exploitation through night fisheries in Cornwallis River of Kings County, Stewiacke River of Colchester County, River John of Pictou County, and Salmon River of Guysborough County.

# Lake trout *Salvelinus namaycush*

Lake trout is the only *Salvelinus* species that is restricted to freshwater. They are an uncommon fish in Nova Scotia; known populations are present only in Sherbrooke Lake and Dollar Lake. Lake trout are also thought to be present in Pockwock Lake, Big Indian Lake, and Lochabor Lake. Lake trout follow a unique life cycle: they move from shallow to deep regions when surface water temperatures warm to 15$^{o}$C in spring. Beyond the lake trout's limited confirmed distribution in two lakes in Nova Scotia, very little is known about this species. Although a small group of anglers target this species in at least one lake, there is no significant fishery in the province. The common brook trout is often reported as lake trout by anglers, thus reducing the reliability of many reports by anglers. Lake trout require a large deep well-oxygenated hypolimnion (deep cold water layer) (Appendix H). The Inland Fisheries Division will continue to work with volunteers to collect baseline information on lake trout populations.

# Challenges to the health of trout fisheries

## Habitat loss

### Instream habitats

Initial removal of forested areas in the 1800s involved log drives, and watercourses were used as travel corridors. In this process streams were straightened and stream widths widened to facilitate the downstream transport of logs. Damaging land use practices have resulted in the removal of stream side trees, which would have eventually fallen into the stream, contributing to the amounts of instream large woody instream debris and stream side trees. A further impact of stream side clearing is bank erosion and stream widening. Increased width of streams has resulted in more surface area exposure to sunlight and a reduction in shade. As a result many streams have been left with little instream woody debris to scour pools and provide cover, as well, are wide and shallow and susceptible to warming in summer (Bancroft, personal communication).

### Warm water temperature and low flow conditions

Water temperature is the most important habitat variable in the world distribution of salmonids (McCrimmon and Campbell 1969), and has had a profound influence on trout behaviour in Nova Scotia (Elson 1942 and Huntsman 1942). Regional differences in both climate and geology can play important roles in the production of brook trout. Geological conditions that support high groundwater discharge can result in relatively stable water temperatures, stream flows, and healthy trout populations. Cool streams tend to be located in Annapolis Valley and in Northern regions with deep soils, underlying sandstone, limestone, gypsum, and siltstone. Warm streams tend to be located in Southwest and Eastern regions that are rich with granite and slate covered in shallow soils.

Predictions indicate that climate change may reduce summer rainfall and increase our reliance on alternative water sources, like rivers, to satisfy increasing demands for water (Schindler 2000). Ongoing research has indicated that water temperatures and low flow conditions are a probable limiting factor to trout in many areas of Nova Scotia. Land clearing, water withdrawal or irrigation, poor nutrient and manure management practices may further reduce trout habitat and compound the impacts of climate change. In response to these concerns a water temperature monitoring program was initiated (MacMillan et al 2005).

The Province, Atlantic Salmon Federation, Nova Scotia Federation of Anglers and Hunters, and the Nova Scotia Salmon Association have initiated and supported a volunteer-based, water quality monitoring project that provided baseline data to assess the thermal habitat of freshwater fish species. The results of this program and others have indicated that temperatures in the main branch of many river systems warms above 20$^{o}$C for prolonged periods in summer, resulting in a restriction of suitable habitat for brook trout. When water warms to stressful levels, many individuals in salmonid populations migrate to colder areas located in the small shaded tributaries that flow into the main branch of the river or in deep areas of pools and lakes. Thermal restriction of habitat can result in overcrowding of fish in small cold water sites or refugia (Gibson 1966). Overcrowded populations are more susceptible to predation, parasites, disease transmission, and over fishing (Coutant 1987). For these reasons, the number of trout in a system may be directly related to the amount and

quality of cold water habitat available in summer. The identification, enhancement, and protection of cold water refugia can benefit trout fisheries.

## Lack of healthy riparian zones

Stream side disturbances associated with poor land use practices, improper use of all terrain vehicles (ATVs), and development can damage riparian (stream side) zones, while affecting water quality and degrading spawning and rearing areas. Shade is important in maintaining cool water temperature in Nova Scotia (Sabean 1976). The establishment and maintenance of stream side vegetation (riparian zone) or buffer zones (grass corridors) between altered land and the aquatic system, can contain land run-off (i.e., pesticides, sediment, and nutrients) and serve to provide cover for fish populations. In 2001, the Nova Scotia Department of Natural Resources implemented Wildlife Habitat and Watercourse Protection regulations on forestry land to maintain and protect riparian zone vegetation. These regulations call for a 20m riparian zone on each side of streams (width $\geq$ 0.5m) where selective harvest can take place and ensuring that protective trees remain along stream banks. The lack of riparian zone vegetation and continued clearing along waterways during some of the land use and development activities remains a concern.

## Hydroelectric and other impoundments

Nova Scotia Power is the main supplier of electricity to the province, approximately 90% of power production is the responsibility of four coal-driven and one oil driven thermal generating plants. The remaining 10% is provided by hydroelectric generation at 33 stations. A small number of private hydroelectric impoundments are also present in Nova Scotia. Impoundments have also been constructed for water storage facilities and waterfowl enhancement, and some impoundments stand as reminders of the historic sawmill industry. During the initial construction phase of many impoundments, the importance of fish passage was not a consideration. Several hydroelectric impoundments have been retrofitted with passage facilities to encourage anadromy and reduce mortality of migratory species. However, the benefits of future passage efforts on impoundments may have to be weighed against other potentially beneficial projects to the recreational fishery. Another enhancement strategy is to pipe water using a gravity feed system (bottom draw) from the impoundment and divert it downstream to create a tail-water fishery.

## Nutrient loading

A wide array of activities can increase nutrients to watercourses and influence habitat in lakes. Preliminary studies on several deep (>6m in depth) lakes in the province have indicated that the level of dissolved oxygen in the cool water trout habitat has diminished significantly over the past 10-30 years (Brylinsky 2002). This decline in dissolved oxygen may be related to an increase in nutrient loading and/or a warmer climate. Sources of nutrients like phosphorus and nitrates can fuel plant production in aquatic systems. Excess plant production can result in low levels of dissolved oxygen. Bacteria use up the dissolved oxygen in the process of breaking down the excess dead plant material. Ongoing research initiatives by Queens University involve the use of paleolimnological techniques to assess the long term changes in nutrients and dissolved oxygen in trout lakes (Queens University website 2005). The studies will help to clarify whether the declines in dissolved oxygen are natural or related to human activities.

## Acid rain

Industrialization has increased our reliance on fossil fuels, coal and oil, as energy sources. Air pollution, mainly related to the use of fossil fuels, has contributed to emissions of sulfur oxides, nitrogen oxides, and carbon dioxide, which, in turn, is thought to be responsible for acid rain and global warming. The regions of Nova Scotia that are most impacted by warm water conditions are also the most impacted by acid precipitation. Water acidity has affected spawning success of salmonids in many regions of southwestern and eastern Nova Scotia. Southern and eastern regions have a preeminence of slates, granites, and shallow soils, thus reducing the soils ability to buffer against acid precipitation. Small deposits of limestone in drumlins moved and deposited by glaciers can function as acidic refugia within acid sensitive regions. These areas can be identified from the presence of cool streams that have a close to neural level of acidity.

Of the 65 salmon rivers in the southern uplands about 50 show signs of various stages of acidification. At present, at least 18 Atlantic salmon populations are thought to have become extirpated, and many others are not supporting the number of spawners required to maintain population levels (Hindar 2001). Compounding the influence of low freshwater salmon production is the critically high sea mortality experience by salmon smolts (Amiro 1998, 1998a). A paleolimnological study is being undertaken on several acidified lakes to further understand the long term changes in acidity in Nova Scotia (Queens University website 2005). Brook trout have a higher tolerance to acidic conditions than Atlantic salmon, and they have managed to maintain populations in some acidic areas where salmon populations have been lost. Maintaining refuges from acidity for salmonids, through liming or other means, may be a mitigative measure until the larger scale problem of atmospheric pollution is addressed and the natural buffering capacity of effected soils improves.

# Over exploitation

Changing habitat conditions in streams in lakes have reduced the size of many trout productions. Low trout production may increase the sensitivity to the impact of angling. In spite of a decline in license sales, fewer productive trout waters may attract more angling effort and result in over exploitation. A contributing factor is the increased accessibility from forestry activities that have resulted in more roads to remote areas, while the advent of the all-terrain vehicles have opened up former wilderness areas to greater numbers of people. Not only has an affluent population put increasingly more pressure on water bodies close to urban areas, but this same population is also better able to travel to remote areas with better, faster highways.

Previous studies have indicated that trout fisheries were being overfished and trout production is relatively low in mainland Nova Scotia compared to other provinces (Alexander 1975, Alexander and Merrill 1975, Sabean 1980). A study on Big Indian Lake, Halifax County indicated that production was 2.2 Kg or 22 trout per hectare and estimated maximum sustainable yield to be 1.1 Kg or 11 trout per hectare (Alexander and Merrill 1976). In a related study, the estimated angling yield in Cooper Lake, Antigonish County, was 1.1 trout per hectare (Hayes and Livingstone 1955). The results of ongoing studies indicate that trout production in other lakes of Halifax County was similar to the results of studies on Big Indian Lake and Copper Lake. Sabean (1980) used the morphoedaphic index to determine yields on two lakes and concluded that one lake (i.e., Egg Lake) was probably being overfished. A number of changes have been implemented to provincial regulations to address overfishing since the 1980s. The daily bag limit for trout has been reduced from 20 trout to five trout

and the retention season for brook trout has been reduced by one month. As well, since the year 2000, a number of Special Management Areas have been put in place to improve trout fisheries through regulatory enhancement.

The formation of a Trout Research Cooperative involving scientists and biologists from universities and government agencies will help to facilitate applied research initiatives to achieve a better understanding of the population dynamics of brook trout in Nova Scotia. Studies have been ongoing in Special Management Areas to assess the response of the trout fishery. The focus of future cooperative research initiatives will be to investigate the impact of new regulations and exploitation on the trout fishery and more specifically develop a trout production model for the province.

# Competition and illegal introductions

Brook trout and other salmonids are considered to be poor competitors among freshwater fish species. Trout tend to be found in greater numbers in habitats that are occupied by few other fish species (Jackson 2002). Smith (1938) found that brook trout production was minimal in lakes that contained 7 to 10 fish species in lakes in Southwest Nova Scotia. Native competitor species include white perch, yellow perch, white sucker, brown bullhead, ans American eel. Reductions in competitor populations in Cooper Lake, Antigonish County, resulted in a doubling of the trout yield from 1.1 Kg per hectare to 2.2 Kg per hectare (Hayes and Livingston 1955). Overfishing of brook trout can reduce the influence of brook trout predation on some competitor species and free up more food and space for competittor populations. Many non-salmonid freshwater fish have a greater thermal tolerance of warm water conditions, and, as a result, climate changes and land use that lead to warming in riverine habitats may increase habitat for competitor populations (Kanno and MacMillan 2002).

Smallmouth bass, a warm water species, were introduced to several lakes to create angling opportunity through government sanctioned stocking in the 1940s. Over the past fifty years, both chain pickerel and smallmouth bass have been illegally introduced or have migrated through watersheds to over 200 lakes across Nova Scotia (LeBlanc, 2005 and 2005a). Angler interest for catching smallmouth is reflected in the support for approximately 50 annual smallmouth tournaments. Monitoring tournaments provides a useful method by which to collect information on smallmouth populations (MacMillan et al 2002). Juvenile and bass nesting surveys are being undertaken to determine the factors that control recruitment in Nova Scotia (Heighton, personal communication).

Smallmouth and chain pickerel are suited for habitats in lakes and impoundments, and this characteristic may give them a competitive advantage over native cold water brook trout populations (McNeill 1995). In studies outside Nova Scotia, the establishment of smallmouth bass in new systems has been shown to result in dramatic reductions in prey fish populations and result in less salmonid production even in situations where habitat overlap between species is minimal (Vander Zanden and Rasmussen 2002). For example, lake trout production has been shown to decline in the presence of bass even though the two species occupy separate thermal habitats for much of the year. Brook trout are considered to be more sensitive to the impact of smallmouth bass because brook trout are smaller and occupy a slightly warmer thermal niche than lake trout (Brown et al 2000; Bourke et al 1999).

Smallmouth were recently introduced illegally to Lake Ainslie, the largest natural freshwater lake in Nova Scotia. A creel survey was used to assess the fishery for white perch and brook trout in Lake Ainslie (Sabean

1983). Electrofishing surveys have indicated that tributaries of Lake Ainslie support high juvenile trout populations (Sabean, 1983; MacMillan and Crandlemere 2005). Ongoing surveys to assess the impacts of recently introduced smallmouth bass are being conducted on Middle River Lake, Pictou County (Leblanc, personal communication). Past surveys and current initiatives can be used to detect changes in both habitat and competition on native fish populations.

Regulatory effectiveness to control the spread of introduced species is limited. Public awareness campaigns regarding the potential impacts are probably the best method to reduce the spread of nonnative species. The Department of Agriculture and Fisheries has initiated a number of awareness campaigns regarding introduced species, including information in published articles, radio and television shows, the Summary of Regulations, and public presentations.

# Management Strategies

## Population enhancement

Stock enhancement of salmonids has been ongoing since the 1800s in North America. The use of hatcheries has been one of the main enhancement strategies to maintain salmonid populations and angling opportunities. Two complimentary goals of stocking are to supplement natural populations and to improve angling opportunities. The need for supplementing natural populations is based on the assumption that declines in salmonid populations have left available habitat that is suitable for stocked fish residence. Increasing angling opportunities can be indirectly achieved by stocking juvenile salmonids that may eventually recruit into the fishery, or directly achieved by stocking adult salmonids that are immediately available to the fishery. The most important roles of the hatchery are to increase angling opportunity and promote interest in the fishery.

According to the 2000 Sport Fishing Survey, improving stocking programs was the management option most highly rated by resident anglers. Common strategies of stock enhancement that have evolved to increase angling opportunities include stocking juvenile fingerlings between 4cm and 15cm, and stocking older individuals larger than 20cm in length. In many situations, both strategies are practiced due to high survival rates of in-hatchery fish, and reductions in hatchery space as fish grow (i.e., stocking fall fingerlings frees up much needed space for overwintering fish in the hatchery). The results of stocking assessments are varied; however, in most cases stocking large fish usually leads to a relatively high contribution to the creel compared to stocking small fish (Alexander 1972, Smith 1952).

The contribution of stocked brook trout to the total number of brook trout caught per year is estimated to fall within the 15-35% range. Requests by anglers through the public Recreational Fishing Advisory Process and accessibility of the watercourse remain major reasons behind which sites are considered for population enhancement. Main concerns are water quality and competition for food and space as potential factors of reduced growth and mortality of stocked and wild fish. The brook trout habitat classification system will further aid in the assessment of the potential success of stocking strategies.

Several genetic strains of trout are maintained at the hatcheries for use in various stocking programs.

For the most part, brook trout production utilizes the Nova Scotian Fraser's Mills strain that has been selected for its disease resistance, egg producing capability and superior growth rate in the hatchery environment. This strain lends itself well to producing yearling fish for spring stocking as well as producing large size fingerlings for distributions in the fall of the year.

In response to concerns that the selection for these positive traits may negatively impact survival in the wild, the hatcheries also maintain three other strains of brook trout (Cape Breton Highlands, Mainland Nova Scotia, anadromous (sea-run). Genetics is believed to play a role in anadromy (sea run behaviour). These strains were developed using wild fish and will regularly receive genetic input from wild caught trout. While large scale hatchery production using these strains is not easily achieved due to their reduced growth rates and disease susceptibility in the hatchery environment, they are however ideally suited for spring fry distributions, stream-side incubators, restoring sea-run populations and to a limited extent, fall stocking.

## Spring Urban Recreational Trout Stocking Program

Sportfish survey results have indicated that the angling population is aging and youth participation is in decline. Additional emphasis on management strategies to provide angling opportunities to the elderly and encourage youth involvement is needed. An effective and, potentially, the most popular stock enhancement contribution made to the recreational fishery is through the use of yearling and trophy hatchery fish in the Spring Urban Recreational Trout Stocking Program. This program is very important to anglers located near urban areas that may not have the opportunity, normally, to catch sizable trout. These sites frequently service the disabled, the very young, the elderly, and the novice angler. Trout are raised in a hatchery for about one year until they are 'catchable' size (~20cm), and then they are stocked in the spring. Trout are usually caught by anglers within days or weeks of being released. Approximately 200 sites receive brook trout and 20 receive Rainbow trout in this program. Brown trout, because of their low susceptibility to angling are not, for the most part, stocked as yearlings in the spring. Water quality and the presence of competitors are not as important as it is in other categories, and the restrictions on angling are designed to evenly distribute the catch among anglers, rather than to protect the resource. All classifications of watercourses can be considered for this type of enhancement. A list of stocking sites is located in Appendix I. Trout derbies are competitive fishing events and are popular among anglers. In 2005, forty trout derbies were supported through the Urban Stocking Program and are regulated by the Competitive Sportfishing Policy (http://gov.ns.ca/nsaf/sportfishing/).

## Fall Replenishment Program

Approximately 200 sites receive fingerling-sized trout in the fall of the year. These sites are usually more remote than those stocked in the spring urban program, but still receive significant fishing pressure. These fingerlings are used to help sustain this fishery. Both brown and brook trout are used in this manner. While spawning habitat can be lacking, rearing habitat requirements must be met. Water quality must be adequate and numbers of predators must be sufficiently few so as not to significantly limit the rearing of juvenile trout. This enhancement strategy will include Class"B", and only on occasion, Class "C" waters. Waters of this category usually have higher angler expectation (due to historical stocking activities) than can easily be met through restrictive regulations alone, and are, therefore, not considered self-sustaining. For the most part, Class "B" watercourses can be considered for sea-run enhancement.

Habitat conditions and the abundance of food in many estuaries (place where freshwater meets salt water) allow for fast growth of sea run populations because of the abundance of food available. Stocking fall fingerlings in estuaries and the lower reaches of rivers has been successful in Prince Edward Island (Smith and Saunders 1963). Recent fall stocking of larger trout in estuarine waters resulted in a rate of return of about 30% to anglers in a Prince Edward Island stream system (MacFarlane, personal communication). Many relatively cool and productive estuaries surround Nova Scotia and may present an opportunity to enhance sea-run stocks. Stocking lower reaches of systems with large sea run hybrid fingerlings can reduce competition between stocked trout and other fish, placing stocked fish in a situation of high food availability increased growth. This strategy has been reported to be successful in the LaHave River where competition is present from smallmouth bass and other freshwater fish.

## Fry and Egg Distributions

Another popular enhancement technique among community groups is the distribution of fry in the spring of the year. These community groups distribute fry throughout their regions stream systems that have been identified as suitable for enhancement. Fry may come directly from the hatcheries or, in some cases, from incubators operated by the groups for which eggs were provided by the hatcheries. In some streams eggs are deposited directly in the stream-bed allowing the newly hatched fry to forage on their own as soon as they emerge from the gravel. The sea-run and wild strains are ideally suited to this program.

# Habitat enhancement

The Nova Scotia Department of Agriculture and Fisheries provides financial support through the new Sportfish Habitat Fund to community groups through the Adopt-A -Stream Program to undertake habitat enhancement initiatives. Currently there are more than thirty community groups and environmental organizations involved in enhancement and fishery related issues in the province (Appendix J). Habitat enhancement and population enhancement are the two most recommended methods of improving fisheries among anglers in Nova Scotia (Economic and Policy Analysis Directorate 2003); Many anglers understand the relationship between good habitat and good trout populations. Degraded habitats in stream systems can be enhanced through the active participation of volunteers and community groups, with support and guidance from experienced individuals. The Adopt-a-Stream Program distributes funds and provides technical advice to community groups and non government organizations that are interested in enhancement of habitat for salmon and trout. Enhancement projects not only benefit the fishery, but also promote awareness regarding the impacts of habitat loss and poor land use, as well as, the importance of good land use practices.

One of the more difficult aspects of enhancement projects is to insure that the factors that limit the target species are understood. Many of the same volunteers involved in habitat enhancement projects have been involved in habitat assessments. One example of habitat assessment in Nova Scotia is the volunteer water temperature monitoring project that has indicated cold water areas (Class A streams) are critical habitats for trout in summer. Fish population surveys in streams have indicated that the majority of trout were located in Class “A” and Class “B” streams while the majority of Atlantic salmon were located in Class “B” streams (MacMillan and Crandlemere 2004). To maximize the impact of stream habitat restoration activities,

Class “A” streams and Class “B” streams should be considered as priorities for enhancement work. The quality of cool water habitats may greatly benefit from stream habitat enhancement activities by increasing the number of salmonids that can live in those areas during summer. An updated version of the Adopt-A-Stream manual that provides detailed information on most of the habitat enhancement techniques will be available on the Department of Agriculture and Fisheries Website (http://gov.ns.ca/nsaf/sportfishing/). Common habitat enhancement and restoration techniques include the following.

**Digger logs / deflector logs** – Recommended for Class A and Class B streams - Represent an enhancement technique used to improve the habitat quality of a stream for salmon and trout. Diggers and deflectors function like a natural windfall tree, in a watercourse. When a tree falls in a stream, it causes the water to flow over the tree and scour out a pool on the downstream side. Logs secured by rebar to the stream bottom in the correct manner can cause scours and create pools and divert stream flows. Pools are very important holding areas for large trout and adult salmon. In many Nova Scotian streams, pool habitat appears to be lacking. The presence of instream large woody debris once insured a diversity of stream habitats beneficial to all age classes of trout and salmon. The proper installation of digger logs can greatly benefit trout and salmon populations by putting back a little of all that we have taken away from the stream habitat.

**Cover logs** – Recommended for Class A and Class B streams - The presence of instream and overhanging cover can be directly related to the abundance of trout in a stream. Cover is provided naturally by large woody debris (fallen trees and rootwads), aquatic vegetation, undercut banks, and overhanging shrubs. Cover logs can be in the form of half logs or slabs that are rebarred though wooden supports and into the stream bottom. The supports secure and area between the bottom of the half log and stream substrate where the fish can hide from predators and seek cover. The proper installation of instream cover logs or digger/cover log combinations can greatly benefit trout and salmon populations and make a positive environmental contribution.

**Riparian enhancement** –Recommenced for all streams Class A and B streams, secondary Class C streams - Most enhancement strategies involve a degree of coordination with community and landowner. About 70% of the land mass in Nova Scotia is privately owned, and although our watercourses are public property, the importance of developing a good relationship with community members is immeasurable. Therefore, permission should be obtained from landowners prior to commencing enhancement initiatives on or near their property. Community groups such as the Clean Annapolis River Project and the Friends of Cornwallis River have been successful in working with landowners in cooperative endeavors to fence livestock from streams and establish protective riparian zones by planting trees in newly protected areas. Healthy riparian zones can act as nutrient filters and help to protect rivers and lakes from nutrients inputs and eutrophication.

**Barriers to upstream migration** – Recommended for all streams, secondary Class C streams - Unnatural Barriers to upstream migration can occur from improper installation of culverts and impoundments.

Guidelines and regulations pertaining to the construction of stream crossings require provisions for adequate fish passage; however, fish passage was not always a priority, and some barriers remain from past construction work. Improving access to upstream reaches of river systems is one of the more important ways of enhancing stocks, because the upper reaches may contain good spawning and rearing habitats. The community groups that are interested in trout habitat improvements should continue to identify blockages to upstream fish migration and initiate mitigative measures.

**Acid rain mitigation** – The Nova Scotia Department of Agriculture and Fisheries participates in the Nova Scotia Salmon Associations Acid Rain Mitigation Committee. Membership on this committee includes representation from Trout Nova Scotia, Atlantic Salmon Federation, and Fisheries and Oceans. Their efforts have resulted in the construction and use of a Lime doser to mitigate acidity on the West River of Sheet Harbour. Baseline data are being collected on this system and future operational funding sources are being secured. In a similar fashion, the Department of Agriculture and Fisheries is involved with the Salmon River Salmon Association in studying the impacts of kiln dust (a by-product of cement production) on water quality in rivers in Digby County, Nova Scotia. Preliminary results indicate that the use of kiln dust may provide an alternative means to address acidity problems. Partners in these two initiatives include Fisheries and Oceans Canada, Acadia University, Lafarge Corporation Ltd., Salmon River Salmon Association, Environment Canada, Trout Nova Scotia, Nova Scotia Salmon Association, Sackville Rivers Association, and the Atlantic Salmon Association.

**Cold water stream restoration on Impounded rivers** – Recommended for Class B and Class C streams - While impoundments benefit warm water species such as perch, smallmouth bass, and chain pickerel, cold water habitat for trout and salmon is often compromised. In some impoundments, a large body of cold water may be present below the thermocline and warm surface waters in summer. Methods to utilize the cold, deep water in some impoundments may involve tapping into cold deep water and drawing the cold water over or through the dam to feed downstream reaches. This method has been used in the establishment of popular tail water trout fisheries on many impounded rivers in the United States. In Nova Scotia, the bottom draw facility in the James River impoundment in Antigonish County supply's cool well-oxygenated water to downstream reaches and benefit salmonid habitats. A similar project undertaken on Goose Harbour Lake will supply water to the St. Francis Harbour River throughout the summer months. The Goose Harbour Lake initiative was undertaken by the Mulgrave and Area Lake Enhancement Committee a community group who worked with the impoundment owners, Stora Incorporated, and Trout Unlimited (Gullo 2004). Further assessment of the Goose Harbour Lake project is required to estimate the impact on trout habitat on that system. Community groups are encouraged to investigate options to enhance cold water habitats with the cooperation of impoundment owners.

One of the major obstacles for community groups to overcome has been the lack of funding to support enhancement related activities. The Department of Agriculture and Fisheries through the Inland Fisheries Advisory Committee developed and promoted the newly implemented Sportfish Habitat Fund. The

fund is supported through the addition of $5.00 on every angling license sold starting in 2005. The revenue will support initiatives like the Adopt-A-Stream Program and others to enhance the inland fishery. Other potential sources of funding for habitat restoration include compensation paid during construction projects (eg.,highway upgrades), fishery violations, other government programs (i.e., Green Cover, Eastern Habitat Joint Venture, and Eco-Action, etc.), and/or donations from industry or other resource users.

# Special management areas

The license stub data indicated that brook trout catches have declined since the early 1980s and established the need for new provincial regulations. Additional measures to protect trout populations from being overfished and increase the catch of large trout involved changes to gear, bag limits, and length limits. The following provides a description of how the habitat and fish population information has been used to develop enhancement strategies for Nova Scotia brook trout. Streams and lakes that are categorized in Class "A" and on occasion Class "B" will be considered for new regulatory enhancement strategies. Streams and lakes classified as Class "C" may be considered for different enhancement strategies. All systems considered for regulatory enhancement must be tabled for discussion during the Recreational Fishery Advisory Process. Sites that are approved may be designated Special Management Areas.

**Size limits (minimum/maximum)** – Minimum size limits are intended to allow small fish, not highly valued for either food or trophy, to grow to a larger size before harvest. Size limits may have a biological basis, such as limiting the catch to fish that are sexually mature. Such limits may also have a social basis, such as recycling larger "trophy" fish that may be in limited supply in relation to demand. Recycling these large fish will also lead to an increase in the reproductive capacity of the stock, since they contribute greater numbers of eggs than smaller fish.

**Bag limits/possession limits** – These regulations decrease the fishing harvest and effort and can redistribute it throughout the angling population.

**Catch and release regulations** – These may be used in conjunction with other regulations, such as size or gear restrictions, or can stand alone. The intended result is to recycle fish to a larger number of anglers and at the same time reduce angling mortality.

**Gear limitations** – Examples of these include fly fishing only and/or artificial lures only. These regulations are intended primarily to increase the chances of survival of fish that are hooked and subsequently released. Their secondary effects include a decrease in capture rates in some fisheries (i.e. where bait fishing results in increased catches), and a decrease or, at least, displacement of effort, since not all anglers are willing to switch to these methods of capture.

**Closed seasons/sanctuary areas** – These measures decrease effort on stocks that are vulnerable at specific times, (eg. during spawning periods). Sanctuaries may also provide areas where stock numbers can be increased for recruitment into the fishery elsewhere.

The Nova Scotia Department of Agriculture and Fisheries has initiated some of the above listed special regulations on 11 lakes in the Woodens River system, Blueberry Lake, Jacket Lake, East Taylor Bay Lake, all of Halifax County, Harrison Lake of Colchester County, Margaree River of Inverness County, East River and West River of Pictou County, West River of Antigonish County, Cornwallis River of Kings County, Middle River and Baddeck River of Victoria County, Stewiacke River of Colchester County, and St. Francis

Harbour River and Salmon River of Guysborough County. A number of research initiatives have been undertaken to assess the impacts of new regulations on some of the above listed Special Management Areas.

Through the Recreational Fisheries Advisory Committees, anglers often cite the need for enforcement as a major issue both within and outside Special Management Areas. Many anglers suggest that Special Management Areas should be a priority among enforcement initiatives that are directed toward the Inland Fishery. Regulatory agencies that protect fish and their habitats are the responsibility of Nova Scotia Department of Environment, Nova Scotia Department of Natural Resources, and Fisheries and Oceans Canada. The legislative acts used to protect the fishery resources include the Federal Fisheries Act, Wildlife Act, Endangered Species Act, Environment Act, and Fisheries and Coastal Resources Act. Enforcement agencies often provide field assistance during habitat and population assessments, as well, provide valuable advice and perspectives on regulatory strategies.

# Promotion and opportunities

Declining participation in the recreational fishery has resulted in declines in the purchase of angling licences in regions throughout North America. Angling license sales in Nova Scotia has declined by an average of 1,000 per year since 1970. As partial revenue from license sales is used to support activities carried out by the Inland Fisheries Division, declines in license revenue will result in less money available for enhancement and research initiatives. The following are initiatives used to increase participation of the public though promotional events, activities, and increased opportunities. Many angling opportunities are complimentary to enhancement initiatives previously discussed.

**Fishing Derbies and Urban stocking -** Trout derbies are competitive fishing events and are popular among anglers. Close to 40 trout derbies were supported through the Urban Stocking Program. The Urban Stocking Program provides angling opportunities for individuals in an urban setting that may not otherwise have the opportunity to angle trout.

**Special Management Areas and Extended seasons** – Several Special Management Areas have been established across the province to provide anglers with increased opportunities to catch large trout. An extended season for the retention of brook trout in the Cape Breton Special Trout Management Area has been established to promote angling for trout. Fall and winter seasons for rainbow trout provide angling opportunities at times outside traditional seasons for sportfish. As well extended angling seasons for smallmouth bass and under-utilized sportfish, such as perches and chain pickerel, may reduce the potential for over-exploitation of traditional species such as trout and salmon by redirecting the angling effort.

**Angler Access** – Many lakes across the province do not have proper boat launch facilities and opportunities to angle these lakes are limited. Funding is available through the sportfish fund to support new boat launch sites. While the Angling Act protects the rights of anglers to cross uncultivated land to access watercourses, many water bodies are inaccessible by boat.

**Sportfishing Weekend** – This free fishing weekend is the first weekend in June and has increased participation and interest in angling. During this special weekend, residents may fish without a general angling license. Other regulations on bag limits and those in Special Management Areas are enforced during the Sportfishing Weekend.

**Guiding** – Although many sportfishing adventures are easily had in Nova Scotia, an experienced guide can often result in a better angling success. However, the use of guides in Nova Scotia is not a requirement for nonresident anglers. Angling maps are available and provide detailed information about popular fishing sites along a number of popular angling rivers.

**Free license** – To accompany a free angling license that is provided to the physically challenged, more than 25 barrier-free sites have been constructed. The Sportfish Fund will provide support for the construction of new barrier free sites.

**The River Watch Program** – This community-based volunteer program has educated participants in the proper observation, recording, and, reporting of violations affecting habitats and fisheries' resources. The River Watch Program and the Adopt-A-Stream Program have projects in all six Recreational Fishing Areas in Nova Scotia. The Adopt-A-Stream Program not only provided funds to conduct habitat enhancement work, but also functioned as an effective educational tool by which the public gains further understanding of some of the important factors that impact trout and salmon populations.

**Becoming an Outdoors Woman** – Program to encourage more women to become interested in outdoor activities. Internationally, this program has proven so popular that it is now offered in more than 40 states and several Canadian provinces. Today, more than 20,000 women attend Becoming an Outdoors Woman events every year. The program has been operating in Nova Scotia since 1997. The workshops introduce women to a variety of activities equally balanced between fishing, hunting, and other outdoor activities. In Nova Scotia, female participation has increased and more than 450 women have participated in at least one of the workshops. The province now offers two opportunities for women to participate during fall and winter sessions.

**Nova Scotia Government Website** – The Inland Fisheries Division homepage, http://www.gov.ns.ca/fish/ sportfishing/index.htm, provides an overview of the Department's activities.

**Outreach Programs** – The Department recognizes the role that education plays in fisheries management. Education includes a heightened awareness of the fishery resources of this province, their biological and physical requirements, the importance of habitat protection and the objectives of fisheries management. The Department of Agriculture and Fisheries will continue to attend public meetings and provide videos and presentations to groups, conferences, schools, youth camps, and other organizations to increase awareness associated with introducing the concepts of ecology, conservation while encouraging an interest in angling and environmental stewardship

**Hatchery Tours** – Every year, Fraser's Mills Hatchery and McGowan Lake Hatchery are visited by hundreds of school children and adults.

**Fish Fact Series** – Fact sheets on seventeen fish species found in freshwater and can be obtained through the Inland Fisheries Division homepage. This series is an excellent educational tool for both teachers and students.

**4-H Fisheries Project** – This project is used to promote and examine the many aspects of the fishing industry in Nova Scotia. The three components of the Fisheries Project are commercial fishery, (fishermen, boats, equipment and fish caught in the Atlantic Ocean off Nova Scotia) aquaculture, (fish farming and what is involved) and sportfishing (inland species and habitat requirements).

**Intergovernmental committees –** Participate in inter and intra governmental committees to insure the interests of Nova Scotia anglers and the Inland Fisheries are represented.

Additional information on some of the above listed programs and initiatives is or will be shortly available on the Department Website (http://gov.ns.ca/nsaf/sportfishing/).

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## **Appendix A** Freshwater and Diadromous Species in Nova Scotia

### Freshwater Species

**Salmon, trout and whitefish**
**Rainbow trout *Oncorhynchus mykiss***
**Landlocked Atlantic salmon *Salmo salar***
**Brown trout *Salmo trutta***
**Arctic char *Salvelinus alpinus***
**Brook trout *Salvelinus fontinalis***
**Lake trout *Salvelinus namaycush***
**Lake whitefish *Coregonus clupeaformis***

**Smelt**
**Landlocked rainbow smelt *Osmerus mordax***

**Pike**
**Chain pickerel *Esox niger***

**Minnows or Carps**
**Northern redbelly dace *Phoxinus eos***
**Lake chub *Couesius plumbeus***
**Golden shiner *Notemigonus crysoleucas***
**Common shiner *Luxilus cornutus***
**Blacknose shiner *Notropis heterolepis***
**lacknose dace *Rhinichthys atratulus***
**Creek chub *Semotilus atromaculatus***

**Fallfish *Semotilus corporalis***
**Pearl dace *Margariscus margarita***
**Goldfish *Carassius auratus***

**Suckers**
**White sucker *Catostomus commersoni***

**Catfish**
**Brown bullhead *Ameiurus nebulosus***

**Temperate Basses**
**White perch *Morone americana***

**Sunfishes**
**Smallmouth bass *Micropterus dolomieui***

**Perch**
**Yellow perch *Perca flavescens***

**Killifishes**
**Banded killifish *Fundulus diaphanus***
**Mummichog *Fundulus heteroclitus***

**Sticklebacks**
**Fourspine stickleback *Apeltes quadracus***
**Brook stickleback *Culaea inconstans***
**Threespine stickleback *Gasterosteus aculeatus***
**Blackspotted stickleback *Gasterosteus wheatlandi***
**Ninespine stickleback *Pungitius pungitius***

### Diadromous Species

**Lamprey**
**Sea lamprey *Petromyzon marinus***

**Sturgeons**
**Atlantic sturgeon *Acipenser oxyrhynchus***

**Cod**
**Atlantic tomcod *Microgadus tomcod***

**Herring**
**Blueback herring *Alosa aestivalis***
**Alewife *Alosa pseudoharengus***
**American shad *Alosa sapidissima***

**Salmon and Whitefish**
**Sea-run Atlantic salmon *Salmo salar***
**Atlantic whitefish *Coregonus huntsmani***

**Smelt**
**Sea-run rainbow smelt *Osmerus mordax***

**Eels**
**American eel *Anguilla rostrata***

**Temperate Bass**
**Striped bass *Morone saxatilis***

**Appendix B**

# Management initiatives and work plan 2005- 2010

Management strategies and work plans have been developed for the period between 2005 to 2010. Limited resources to support enhancement projects or related initiatives are a challenge to obtaining goals. For this reason, many strategic goals can only be achieved through the participation and support of anglers, community groups, universities, and other government agencies. External funding may also be required to undertake some of the below listed projects. These projects will be discussed for support through the Recreational Fishing Advisory process.

# Population enhancement

## Issue: Bras d'Or Lakes rainbow fishery

**Goal:** Improve current catch of rainbow trout in Bras' d'Or Lakes or surrounding area

**Strategy:** Develop strategies to increase the catch of rainbows in Cape Breton

**Time Frame:** 2005-2008

## Issue : Lake Classification

**Goal:** Increase the effectiveness of population enhancement and increase the number of trout angling opportunities.

**Strategy:** Review the current lake classification system as it relates to population enhancement strategies and identify potential opportunities to increase and improve the ability of hatcheries to serve the trout angling public.

**Time Frame:** 2005-2008

# Habitat Enhancement

## Issue: Funding

**Goal :** Provide funding to community groups through the Fish Habitat Fund for:

1) Habitat restoration initiatives: instream, riparian, and access.

2) Improve angler access to lakes by increasing the number of boat launches

**Strategy:** Sport Fish Habitat Fund has been established to support enhancement projects

**Time Frame:** 2005-ongoing

## Issue: Trout habitat enhancement

**Goal 1:** Utilize stream habitat classification system as a guide to stream habitat restoration initiatives

**Strategy:** Encourage community groups to refer to the trout habitat classification system prior to undertaking enhancement activities and to collect additional temperature information.

**Time Frame:** 2005-ongoing

**Goal 2:** Expand the number of streams classified in Nova Scotia

**Strategy:** Providing guidance, support, and encouragement to non-government organizations and community groups to collect water temperature data on their rivers of interest.

**Time Frame:** 2005-ongoing

## Issue: Hydroelectric and other Impoundments

**Goal 1:** Identify sites where bottom draw facilities could improve cool water habitats

**Strategy:** Approach impoundment owners and appropriate regulatory departments for input on the feasibility of bottom draw sites on a selected number of impoundments.

**Time Frame:** 2006-2007

**Goal 2:** Assess the impact of bottom draw facilities on cold water habitat

**Strategy:** Conduct fish population and habitat assessments on streams systems impacted by bottom draw projects.

**Time Frame:** 2005-ongoing

**Goal 3:** Establish bottom draw facilities on all suitable impoundments to create cold water trout habitat in impounded rivers

**Strategy:** Encourage community groups to work with impoundment owners to investigate the potential for the establishment of bottom draw facilities on all suitable impoundments.

**Time Frame:** 2005-ongoing

# Special Management Areas

## Issue : Lake Classification

**Goal 1:** Continue to collect data on trout production and habitat variables to refine and develop the current lake classification systems for salmonids

**Goal 2:** Develop a list of classified lakes to use as a reference of future management considerations for all trout species.

**Strategy:** Continue to work with IT and NS Department of Environment and Labour to implement the lake classification system on lake data within the FINS database

**Time Frame**: 2005-2007

## Issue: Over exploitation

**Goal:** Designate additional waterbodies as Special Management Areas (SMAs)

**Strategy:**1) Utilize lake classification system and angler organization participation to select potential sites for special management, 2) At a fall Recreational Fishing Advisory Committee (RFAC) table sites under consideration for inclusion in the SMA Program, 3) Include new sites in the Nova Scotia Summary of Regulations as a way of facilitating angler feedback, 4) Re-table proposed sites for inclusion in SMAs at fall RFAC and if supported by RFAC include the new site to Special Management Area Program.

**Time Frame:** 2005-ongoing

## Issue: More enforcement needed in Special Management Areas

**Goal:** Increase enforcement effort in Special Management Areas

**Strategy:** Continue to consult enforcement staff of the Nova Scotia Department of Natural Resources, Nova Scotia Department of Environment, Fisheries and Oceans Canada as to the design of regulations and areas under consideration for inclusion in the Special Management Area Program.

**Time Frame:** 2005-2010

## Issue: Overcrowded trout populations in the Cape Breton Highlands Special Management Area

**Goal:** Increase angler catch of trout in Special Management Area

**Strategy:** Investigate opportunity to allow winter fishing for brook trout in the Cape Breton Highlands Special Management Area through the RFAC process.

**Time Frame:** 2005-2008

# Resource assessment and research initiatives

## Issue : Lake Classification

**Goal 1:** Conduct 20 new lake surveys by 2010

**Strategy:** Continue to assess lakes that were tabled for inclusion into the lake survey program by community groups through the Recreational Fishing Advisory Committees

**Time Frame**: 2005-2010

## Issue: Impact of Exploitation on the Trout Fishery

**Goal 1:** Establish a Trout Research Cooperative

**Strategy:** Form a Nova Scotia Trout Research Cooperative with the participation of Federal Fisheries and Oceans and other government agencies, Universities, and Non Government organizations.

**Time Frame:** 2005-2006

**Goal 2:** Obtain funding to support research initiatives

**Strategy:** Through the Trout Research Cooperative seek funding to support a Master of Science Program to carry out research initiatives that relate to trout population dynamics.

**Time Frame:** 2005-2007

**Goal 3:** Develop a trout production model for Nova Scotia lakes

**Goal 4:** Test the Ryders (1972) morphoedaphic index to estimate fish production in Nova Scotia lakes

**Strategy:** Conduct research initiatives on lakes protected by special management measures and others to determine biological characteristics of the populations and the changes associated with a change in exploitation. Mark and recaptures will be used to assess production. Carry out lakes surveys on target lakes and compare morphoedaphic index with mark and recapture estimates. As with most of the research initiatives undertaken by the Inland Fisheries Division a sizable volunteer effort may be required in the data collection component of the project.

**Time Frame:** 2005-ongoing (assess 10 lakes by 2011)

## Issue: Impact of Special Management Areas on the trout fishery

**Goal 1:** Repeat MacMillan and Crandlemere (2004) Cape Breton Highlands Project

**Strategy:** Repeat assessment on Cape Breton Highland lakes (Moose, Larkin, Timber, and MacDonalds) and include and mark and recapture population estimate on a number of sites previously assessed.

**Time Frame:** 2009-2010

**Goal 2:** Repeat MacMillan and Crandlemere (2004) East Taylor Bay project

**Strategy:** Repeat assessment on East Taylor Bay Lake and include and mark and recapture population estimate

**Time Frame:** 2007-2009

## Issue: Historical changes in the status of the fishery

**Goal 1:** Repeat Sabean (1980) Mooseland to Murchyville Creel Survey

**Strategy:** Work with Nova Scotia Department of Natural Resources to obtain support to operate two angler check points to assess current status of this trout fishery.

**Time Frame:** 2008-2010

**Goal 2:** Repeat Wilder (1952) assessment of sea run brook trout of Moser River in conjunction with an assessment of sea run component in West River Sheet Harbour.

**Strategy:** Work with Trout Research Cooperative to facilitate and support this initiative

**Time Frame:** 2006-2007

**Goal 3:** Assess current status of brook trout fishery in Musquodoboit River

**Strategy**: Work with the Trout Research Cooperative to reassess the electrofished sites conducted the Fisheries and Oceans Canada to determine trends in juvenile abundance.

**Time Frame:** 2007-2008.

## Issue: Nutrient Loading in lakes

**Goal:** Determine the impact of nutrient loading on trout habitat

**Strategy:** Ongoing: continue to work with Queens University and Acadia University to carry out research initiatives to obtain data on trends in trout habitat in lakes

**Time Frame**: 2005 -2006 (field work component), 2008- 09 (analysis completed and reports received)

## Issue: Sportfishing Survey

**Goal:** Monitor trends in catch per angler, economic value of sport fishery, and angler attitudes relating to fish management in Nova Scotia.

**Strategy:** Continue to support Provincial and Federal Nova Scotia Sportfishing Survey 2005.

**Time frame:** 2005-06 survey data collected, 2006-2007 report completed

## Issue: Acidity in rivers

**Goal:** Collect data to demonstrate the impact of:

1) kiln dust watershed application with Salmon River Salmon Committee
2) lime doser on West River Sheet Harbour with Nova Scotia Acid Rain Committee

**Strategy:** With the cooperation of Acadia University, Atlantic Salmon Association, Nova Scotia Salmon Association, Trout Nova Scotia, Salmon River Salmon Association, and Fisheries and Ocean Canada conduct research initiatives on the river systems enhanced with kiln dust and limestone to determine response of water quality, fish and invertebrate populations to the changes associated with projects to improve water quality.

**Time Frame:** 2005-2010.

## Issue: Hydroelectric and other Impoundments

**Goal:** Determine the impact of the Bottom Draw Facilities of trout habitat in Goose Harbour Lake and in St. Francis Harbour River.

**Strategy:** Assess the impact of the increase in flow and salmonid habitat quality changes in the St Francis Harbour River as a result of the bottom draw project.

**Strategy:** Assess the change of the salmonid habitat in the Goose Harbour Lake as a result of the bottom draw project.

**Time Frame**: 2006-2008

# Promotion and development

## Issue: Lack of healthy riparian zones along rivers and lakes

**Goal:** Maintain, establish, and enhance riparian zones along all waterways

**Strategy 1:** Encourage community groups to work with landowners to establish riparian areas

**Strategy 2:** Promote awareness of the importance of riparian areas

**Strategy 3:** Work with other government agencies on initiatives to promote healthy riparian zones

**Time Frame:** 2005-ongoing

## Issue: Angler access

**Goal:** Maintain angler access to lakes within Halifax Regional Municipality (HRM) and elsewhere

**Strategy:** Create a committee that will attempt to maintain recreational access to lakes with representation from HRM planning sector, Non Government organizations, and the Inland Fisheries Division.

**Time Frame:** 2005 - 2010

## Issue: Declining participation in sportfishery

**Goal:** Increase the recruitment of youth and the number of anglers participating in the sportfishery

**Strategy1:** Performing presentations to the general public, schools, non government organizations, and 4-H groups.

**Strategy 2:** Write, publish, and distribute educational materials (eg, Fish fact Sheets) to schools, hatchery tours, and non -government organizations and to the general public

**Strategy 3:** Promote angling through a number of programs designed to encourage participation of outdoor activities and angling such as the Becoming and Outdoors Women Program, Sportfishing Weekend, Complementary license, Barrier Free sites, and River Watch Program.

**Strategy 4:** Continue to promote angling through publication of fishery related articles in magazines and newspapers

**Time Frame:** 2005-ongoing

## Issue: Awareness of Fishery : Departmental Website

**Goal: Use website to inform the public about sport fishing information and issues**

**Strategy 1:** Maintain and update current information on the Departments website: http://gov.ns.ca/nsaf/sportfishing/

**Strategy 2:** Submit reports (i.e., new Adopt-A-Stream manual, research publications, etc. ) and updates (i.e., field season summary, enhancement initiatives, etc.) on an annual basis to update website on the activities of the Inland Fisheries Division

**Time Frame:** 2005-ongoing

## Issue: Introduced Species

**Goal:** Reduce the rate of illegal introductions

**Strategy 1:** Continuing to work with enforcement agencies to improve initiatives to reduce illegal introductions of smallmouth bass, chain pickerel and other non - native species.

**Strategy 2:** Continuing to support initiatives to promote awareness to the public in regards to potential impacts of introduced species on native species

**Time Frame:** 2005-ongoing

## Issue : Ability to Share Lake Survey Data (FINS database)

**Goal:** Develop a MS Access Database that can be accessed or shared with other government departments, interest groups, Universities, and the public.

**Strategy 1:** Work with IT and Nova Scotia Department of Environment and Labour to develop an accessible database of our lake survey program water quality parameters of over 1500 lakes

**Time Frame:** 2005-2007

## Issue: Promotion of the interests of anglers and Inland Fisheries

**Goal:** Insure that the interests of anglers and the Inland fisheries are represented in relevant meetings and committees (eg. Climate Change committee, Acid Rain Committee, Species At Risk Committee(s), etc.)

**Strategy:** Participate in inter and intra governmental committees to insure the interests of Nova Scotia anglers and the Inland Fisheries are represented.

**Time Frame :** 2005 - ongoing

**Appendix C** Habitat classification for brook trout lakes

For class A lakes : all of the criteria must be met
For class C lakes : only one of the criteria must be met
Exception lakes of the Cape Breton Highlands do not have to meet lake size criteria

| | Class A | Class B | Class C |
|---|---|---|---|
| Physical habitat | | | |
| Depth | >2m | | |
| Lake size | < 90 Ha | | |
| Water quality | | | |
| pH | | | < 4.7 |
| Predators and Competitors | | | |
| Moderate = white sucker, brown bullhead | Absent | Present | - |
| Serious = Smallmouth bass, chain pickerel, Yellow perch, White perch | Absent | Absent | Present |

**Appendix D** Habitat classification for brook trout streams

Streams and rivers in the Province will be classified based upon water temperature criteria into three classes (A, B, or C).
For class C lakes : only one of the criteria must be met

| | Class A | Class B | Class C |
|---|---|---|---|
| Water quality streams | | | |
| Average summer temperature | <16.5°C | 16.5-19.0°C | >19°C |
| pH | | | < 4.7 |

**Appendix E** Habitat classification of rainbow trout lakes

Rainbow trout are usually stocked at a large size and are immediately available to be caught therefore the only habitat considerations include depth, acidity, and high competition
For class A lakes : all of the criteria must be met
For class C lakes : only one of the criteria must be met

| | Class A | Class B | Class C |
|---|---|---|---|
| Physical habitat | | | |
| Depth | >2m | | |
| Water Quality | | | |
| pH | > 6.0 | 5.5 - 6.0 | < 5.5 |
| Predators and Competitors | | | |
| Serious = smallmouth bass and chain pickerel | Absent | Absent | Present |

**Appendix F** Habitat classification for brown trout streams

For class A lakes : all of the criteria must be met

For class C lakes : only one of the criteria must be met

| | Class A | Class B | Class C |
|---|---|---|---|
| Water quality streams | | | |
| Average summer temperature | <18°C | 18-21°C | >21°C |
| pH | > 5.5 | 5.0 - 5.5 | < 5.0 |

**Appendix G** Habitat classification for brown trout lakes
For class A lakes : all of the criteria must be met
For class C lakes : only one of the criteria must be met

| | Class A | Class B | Class C |
|---|---|---|---|
| Physical habitat | | | |
| Depth | >2m | | |
| Water quality Lakes | | | |
| pH | > 5.5 | 5.0 - 5.5 | < 5.0 |
| Predators and Competitors | | | |
| Moderate = White sucker, Yellow perch, brown bullhead and white perch | Absent | Present | |
| Serious = smallmouth bass and chain pickerel | Absent | Absent | Present |

**Appendix H** Habitat classification for lake trout lakes
For class A lakes : all of the criteria must be met
For class C lakes : only one of the criteria must be met

| | Class A | Class B | Class C |
|---|---|---|---|
| Physical Habitat | | | |
| Water depth | max depth >30m | max depth >20m | max depth < 20m |
| Water Quality | | | |
| pH | > 5.5 | 5.0 - 5.5 | < 5.0 |
| Predators and Competitors | | | |
| Moderate = White sucker, Yellow perch, brown bullhead and white perch | Absent | Present | |
| Serious = smallmouth bass and chain pickerel | Absent | Absent | Present |

## **Appendix I** Urban stocking program lakes

2003 SPRING STOCKING LIST

Note: Coordinates in first set of brackets after lake name are location codes in the1992 edition of the map of Nova Scotia. The second set of brackets contain coordinates from the Nova Scotia Atlas 2001 edition. All fish stocked are speckled trout unless otherwise noted.
R=Rainbow; S=Speckled; B=Brown ;
LL=Landlocked salmon; D=Derby;

Recreational Fishing Area # 1

CAPE BRETON COUNTY
#20 Dam(43A3) (15V1) S+R
Amaguadees Pond (39D1)(23Y2) R
Colliery Park Pond (43C3)(10Z5) D
Gabarus Lake44B2) (24x4) LL
Levers Lake(44B1) (24Y4) R
Lingan Bay (43C2)(14Z1)
Little Pond43B2) (10X5)
MacAskill's Brook43D3) (15W3) D
Tank Pond (43D4)(15V5) D
Schooner Pond (43E3)(15W2)
Scotch L.(43A3) (14W2)

INVERNESS COUNTY
Etang a Johnny(37A3) (6V2) D
Hector Lake(34C4) (33W3)
McIntyre Lake(34B4) (33X2) D
West Mabou Pond 33B4)(12V4)

RICHMOND COUNTY
Forrest Lake (40B1)(44V1) D
Grand Lake(39A5) (33Z4) D
MacLeods Lake(39C3) (34X2)
MacMullin Pond(39B3) (23W5) D
Shaw Lake(39A5) (33Z5)
Victoria Lake34E5) (33Y5)

VICTORIA COUNTY
Baddeck River(38B4) (13W3)
MacIntyre Pond(38B2)(13V2)

Recreational Fishing Area # 2

ANTIGONISH COUNTY
Boyds L.(29D4) (32V5)
Cameron Lake(29C5) (32V5) S+R
Donnellys L.(34A5) (32Y5) S+R
Ducks Unlim. Pond (30C1)(32V5)
Gillis Lake(29D5) (32V5) S+R
Jacksons (Tracadie) L.(34A4) (32Y3)
Pomquet Lake(29E4) (32W3)
Lochaber Lake30C1) (41Z2)
Stewart L. (30C1)(41Z1)
South River (30D1)(32V4) R
St. Josephs Lake (29C5)(31Z5

PICTOU COUNTY
Andersons Brk (Little Hbr)(26D4) (30Z3)
Dryden Lake(27B2) (40X3)
Eden Lake(30A2) (41X3) D
Gairloch Lake (27B1)(40W1) S+R
MacPherson Lake(27D1) (40Z1) D
Mill Pond (Sunrise Trail)(30A2) (30X2)
Scotsburn Pond (26B4)(30W2)
Steeltown Park (26C7) (30Y3) D

GUYSBOROUGH COUNTY
Black Brook Lake(30B3) (41Z5)
Bryden Lake(30C3) (41Z5)
Donahue Lake(35E2) (43V5)
Fishermans Harbour Lake(30E5) (52X3)
Goose Harbour L.(34C5) (33V4) R + LL
Horseshoe L.(35B3) (42Z5)
Ice L.(40A2) (43Z4)
Lochiel (Two Mile) L.(30C4) (41Z3)
MacPherson Lake(35C1) (43V2) D
Mulgrave Mill Pond (34C4)(33W3)D
Irving Lake(35B1) (42Z2)
Three Mile Lake(40A2) (43Z4)
Upper Indian Hbr. Lake (30D4)(52V2)
Well's Lake(35B2) (42Z2)

Recreational Fishing Area # 3

HALIFAX COUNTY
Albro Lake(24A5)(67Z2) S+R
Bear Lake (31A1)(51X5)
Big Indian -D (20C3) (58V4)
Brines Lake-Seabright (20C5) (67V3)
Bisset Lake(24B5) (68V2)
Cooks Lake(24C1) (49X5)
Copper Lake (28C1)(60Y4)
East R. Sheet Hbr. (Marshall Flow)(28E1) (51V5)
DFirst Lake(20E4) (58Y5)
Governors Lake(20E5) (67X3)
Grand L. (Sambro)(25A2) (75Y1) D)
Kelly Lake(31A1) (51W4)
Kindervator L.(31A1) (51X5)
Kinsac Lake(20E3) (58Y4)
Lake Charles (24B5)(67Z1) LL
Lake Echo(24B4) (68W1)
Lewis Lake(20D3) (58X4)
Long/Powers Lake(21C2) (67W5)
Loon L.(24A4)(67Z1)
Mill Lake(27A5) (50V3)
Mill Lake(20C4)(67W1)
Mill Lake (31A1)(61X1)
Murphy (Scott) Lake21D1) (67W5)
Oathill Lake(24A5) (67Z2)
Otter Lake (24B4)(59W5)
Papermill Lake (20E4)(67Y1)
Penhorn Lake(24A5) (67Z2) S+R
Round Lake (30A5(51W4)
Round L.(Lewis L. Prk.) (20D5)(67W2)R
Sawler Lake(20B5) (66Z2)
Second Lake(20E3) (58Y5)
Springfield Lake (20E3)(58X4)
Stillwater Lake(20D4) (67W1)
Williams Lake (24A5)(67Z3)
William Lake(24E4) (68Z1)
Webber L.(20E4) (58X5)
LUNENBURG COUNTY
Becks Lake(15D3) (74V4)
Butler Lake(14B4) (65Y1)
Card Lake (14E4)(66X1)
Clearland Lake(15D2) (74W1)
Hennigar Lake(14E3) (66W3)
Henry Lake(15E1) (66W4)D
Hirtles Pond(15E4) (74X5)
Huey Lake (15B3)(74V5)

LUNENBURG COUNTY
Becks Lake(15D3) (74V4)
Butler Lake(14B4) (65Y1)
Card Lake (14E4)(66X1)
Clearland Lake(15D2) (74W1)
Hennigar Lake(14E3) (66W3)
Henry Lake(15E1) (66W4)D
Hirtles Pond(15E4) (74X5)
Huey Lake (15B3)(74V5)LUNENBURG COUNTY
Hutt Lake(15E1) (66X4)
Lake Darling(14D4) (66V1)
Lake Lawson (14D4)(66V1)
Lewis Lake(14D3/14E3) (57W5)
Long Lake(15B4) (73X4)
Maple Lake(20B5) (66Z3)
Moose L.(15C4) (73Z5)
New Canada Lake(15B2) (73Y1)
Stanford Lake (21A1)(66X4)
Sucker Lake(15C2) (73Z1) R
Wallace Lake(15C4) (73Z5) D
Wiles L.(15C3) (73Z3) D

Recreational Fishing Area # 4
DIGBY COUNTY
Andrews Lake(4C1) (71W1)
Bartlett Lake (4A3)(70Z4)
Belliveau Lake(4A3) (70Z4)
Clearwater Lake(4A5) (76Z1)
Doucette Lake(2E1) (76Y4)
Everitts Lake(4C2) (71W1) R
Haines Lake (4C1)(63W5)
Harris Lake(4D1) (63Y4)
Journeays Lake(4A2) (70Z3)
Lake Lemarchant (4E1)(71Z1)
Lake Midway (4A1)(62Z5)
Long Island Lake(1E3) (70W4)
Mallett L. (4C1)(63X5)
Salmon R. Lake(4A5) (76Z2)
Sandy Cove Lake(4A1)(70Z1)
Thibault (Bens)L(4A3).(70Z4)

QUEENS COUNTY
Bar Pond(16B2) (79X5)
Blueberry Pond(16C1) (79Z4)
Cameron Lake(9E4) (73V4)
First Christopher L(9E3).(73V4) D
Hidden Hills Lake15A4) (73W4) - R
Hog Lake(9E3) (73V3)
Little Ponhook Lake(15A4) (73W4)
Meadow Pond(16B2) (79X5)

Medway R. (Westfield)(9D3) (72Z3)
Medway R. (Lake Pool) (15A4)(73W5)
Medway (South Brookfield)(9E3) (73V3)
Medway (Pleasant R.)(15A1) (73W2)
Mill Lake(9D3)(72Z3)
Second Christopher Lake(9E4) (73V4)
Victoria Lake (16B2)(84Y1) D

SHELBURNE COUNTY
Alvins Lake (10A5)(87W1)D
Beaverdam Lake(11A1) (87V2)
Canada Hill Lake(10C4) (83Y4)
Canada Hill Bog (10C4)(83Y4)
Dexter Mill Pond (10D4)(83Z4)
Jordan R.(Four Mile Brk.)(10C3) (83X3)
Hawks Pond(6D3) (88Y2)

YARMOUTH COUNTY
Allen Lake(2E2) (81Y1)
Back Lake(5B3) (82W2)
Beaverhouse Lake(5C1) (77X5)
Biggar Lake(5C3) (82X2)
Bird Lake (5B2)(82V1)
Butlers (Chegoggin) Lake(2E3) (81Y2)
Frost Lake(5C4) (82W4)
Great Pubnico Lake (5D5)(86Y1)
Kegeshook Lake(5C2) (82X1)
Mushpauk (Mespark) Lake(5C4) (82W3)
Randals Lake(5B4) (82W4)
Sloans Lake(5B2) (82V1)
Somes Lake(5B2) (82W1)
Sunday Lake(5C1) (77X3)
Trefry Lake (5A4)(81Z4)
Wilsons Lake(5B3) (82W2)

Recreational Fishing Area # 5
ANNAPOLIS COUNTY
Lake Larose (8A4)(64V1)
Lake Pleasant (14A5)(65W3) D
Lower Wrights Lake(8B4) (64W1)
Milbury Lake(8A3) (55V4)
Pretty Mary Lake(9C2) (72Y1)
Rumsey Lake(8C2) (55X3) R
Sandy Lake(8A5) (55X2)
Sandy Bottom Lake(9A1 (64V4)
Scrag Lake(8C4) (56V5)
Springfield Lake(14A5) (65W3) D
Trout Lake(8D3) (55Z5)
U.Wrights Lake (8B4)(64W1)
Waterloo Lake(8E4) (65V1) B
Zwickers Lake(8D4)(64Z1)
HANTS COUNTY
McGrath Lake(20E1) (48X5)
Meadow Pond (20B2)(57Z1) R
Murphy L (Mt. Uniacke) (20D2)(58W3) D
Pentz L.(20D3) (58W3)
St.Croix Pond(20B1) (57Z1)
Tennycape River(19D3) (38W5)
KINGS COUNTY
Lumsden Pond(14E1) (47W5)
Sunken Lake (14D1)(57V1)R
Silver Lake(13C5) (46Z3)
Recreational Fishing Area # 6
COLCHESTER COUNTY
Davis Lake(23D5) (49Y2) D
Debert (Rayners) Pond(23B2) (39V2)
Deyarmont Lake (39z4)
Kiwanis Pond (39X3) D
Little Dyke Lake (38Z3)
CUMBERLAND COUNTY
Angevine L. (28Z1)
Big Lake (28X1)
Blair Lake (16X5)
Isaac Lake. (28Y4) D
Mattatall Lake (29V2)
Parrsboro Abboiteau (37W2)
Pump. Sta. L.(Nappan) (16Y4)
Oathill Park Lake (6D1) (86Y3)
Tidney Measdows (Still) (10D4) (83Z2)

**Apendix J** Non government organizations involved in the recreational fishery

| Scope | Non Government Organization |
|---|---|
| Provincial | Atlantic Salmon Federation |
| Provincial | Nova Scotia Salmon Association |
| Provincial | Trout Nova Scotia |
| Provincial | Trout Unlimited |
| Provincial | Nova Scotia Federation of Anglers and Hunters |
| Provincial | Canadian Association of Smallmouth Anglers |
| Annapolis | Annapolis Fly Fishers Association |
| Annapolis | Clean Annapolis River Project |
| Cape Breton | Port Morien Wildlife Federation |
| Colchester | Cobequid Salmon Association |
| Cumberland | Cumberland County River Enhancement Committee |
| Cumberland | Wallace River Trout Management Committee |
| Digby | Salmon River Salmon Association |
| Guysborough | Mulgrave and Area Lakes Enhancement Project |
| Guysborough | St. Mary's River Association |
| Halifax | Sackville River Association |
| Halifax | Nine Mile River Association |
| Hants | Wildlife Habitat Advocates |
| Inverness | Margaree Salmon Association |
| Inverness | Lake Ainslie and Margaree R Heritage Assoc |
| Inverness | Stewards of River Denys Watershed Association |
| Kings | Friends of the Cornwallis River |
| Kings | Black River Environmental Committee |
| Lunenburg | Bluenose Atlantic Coastal Action Project |
| Lunenburg | LaHave Salmon Association |
| Lunenburg | Petite Riviere Association |
| Pictou | Pictou County Rivers Association |