July 2004

NATIONAL RECOVERY STRATEGY

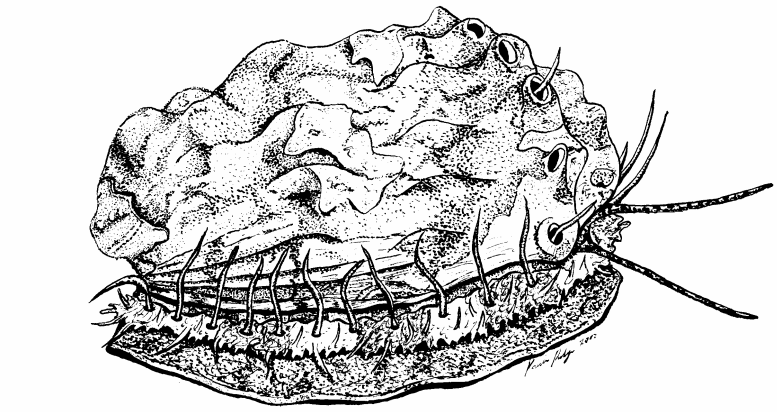
FOR THE

NORTHERN ABALONE

(*Haliotis kamtschatkana*)

IN

CANADA



Disclaimer

The National Recovery Strategy for the Northern Abalone in Canada has been prepared under the lead of Fisheries and Oceans Canada in cooperation with the Abalone Recovery Team in consultation with participants and observers to identify recovery actions that are deemed necessary, based on sound biological principles, to protect and recover the species. It does not necessarily represent the positions of agencies and/or the views of individuals involved in the plan's preparation. The goals, objectives, and recovery actions identified in the recovery document are subject to the priorities and budgetary constraints of participating jurisdictions and organizations, as well as modifications to accommodate new objectives or findings.

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Cover Illustration: *Northern Abalone by Pauline Ridings.*

Recovery of Nationally Endangered Wildlife (RENEW)

The Wildlife Ministers' Council of Canada formed RENEW in 1988 to facilitate the rescue of wildlife species which were at risk of extinction and to prevent other species from becoming at risk. The approach proposed was to include all interested organizations and individuals in a recovery team that would draft a recovery strategy for an action plan to recover affected species. The ***recovery plan (recovery strategy + action plan)*** *becomes the basis by which recovery is carried out by all interested parties. The following document is a recovery strategy detailing the broad science-based strategy to recover northern abalone. An action plan will be completed by March 31, 2003.*

Definitions of Terms and Risk Categories

COSEWIC: Committee on the Status of Endangered Wildlife in Canada is

"a committee of experts that assesses and designates which wild species are in some danger of disappearing from Canada."

www.cosewic.gc.ca/

SPECIES: for the purposes of COSEWIC classification, any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.

EXTINCT: a species that no longer exists.

EXTIRPATED: a species no longer existing in the wild in Canada, but occurring elsewhere.

ENDANGERED: a species facing imminent extirpation or extinction.

THREATENED: a species that is likely to become endangered if limiting factors are not reversed.

SPECIAL CONCERN: a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

NOT AT RISK: a species that has been evaluated and found to be not at risk.

DATA DEFICIENT (formerly "indeterminate")**:** a species for which there is insufficient scientific information to support status designation.

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Executive Summary

The northern or pinto abalone has been declining in numbers and distribution in surveyed areas of British Columbia (B.C.), Canada, as documented by regular surveys since the late 1970s. The northern abalone fisheries in B.C. were closed to all harvest in 1990. Northern abalone were assigned a threatened status by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in April 1999. A recovery team was formed in November, 2001, to assist Fisheries and Oceans Canada to prepare this National Recovery Strategy for the Northern Abalone in Canada.

The decline of the northern abalone may be attributed to many factors, which include illegal harvest and low recruitment. It is unclear whether disease may have had a role in the decline of this species in the wild. Future threats may also include habitat loss due to developments in, on, and under the water, as well as previously unstudied interactions with predators and competitors.

The recovery team considers illegal harvest to be the most significant threat to northern abalone. The northern abalone is especially vulnerable to over-exploitation because this species has a patchy distribution, a short larval period, is slow growing, relatively long-lived, has low or sporadic recruitment, and mature individuals, which tend to accumulate in shallow water, are easily accessible to harvesters.

The immediate recovery goal is to halt the decline of the existing wild northern abalone population in order to reduce the risk of northern abalone becoming endangered.

The long-term recovery goal is to increase the number and densities of wild northern abalone to levels where the population becomes self-sustainable within 5 biogeographic zones: Haida Gwaii (Queen Charlotte Islands), Queen Charlotte and Johnstone Straits, North and Central Coast, Georgia Basin, West Coast of Vancouver Island, in order to remove northern abalone from threatened status.

Major approaches to facilitate these goals include:

1) maintaining the fisheries closures;
2) developing and implementing a proactive protective plan;
3) developing a communication campaign to stop illegal harvest and raise public awareness;
4) undertaking research and rebuilding experiments;
5) monitoring the population status.

In order to meet requirements of the new Species At Risk Act (*SARA*), Fisheries and Oceans Canada has facilitated the completion of this recovery strategy in cooperation with the Abalone Recovery Team. Through workshops, public consultations and external reviews, other government agencies, stewardship groups, First Nations communities, universities, external experts, businesses, private citizens, international organizations and non-government organizations (NGOs) have contributed to the strategy. Some of these groups have already begun activities to help remove this species from the threatened status list.

I. BACKGROUND[1]

1. Introduction

Wild abalone populations in many areas of the world have shown a decline. Countries such as Japan, South Africa, New Zealand, Australia and the United States of America as well as Canada have documented declines in several abalone species. While many countries have taken steps to limit abalone harvest, populations continue to decline.

The northern or pinto abalone (*Haliotis kamtschatkana*) inhabits the west coast of North America from Alaska to California. In Canada, northern abalone generally occur in patchy distributions on exposed and semi-exposed coasts of B.C. (Sloan and Breen 1988). Northern abalone usually occur on rocky substrates from the low intertidal zone to about 100 m depth, with most of the adult population in B.C. found at <10 m depth. The northern abalone population has been declining steadily in B.C. since surveys began in the late 1970s, despite fisheries closures since 1990.

It is unclear what the natural state of northern abalone populations may have been historically. There may have been many population fluctuations over time, which may have been related to changes that affected the entire community. For example, the extirpation of sea otters had an effect on all invertebrate populations, including northern abalone. With the re-introduction and recent expansion of the sea otter population, restoration of the northern abalone population to the levels seen in the late 1970s may not be possible (J. Watson, *pers. comm.*). It is necessary to determine at what level northern abalone can maintain self-sufficient populations. An important focus of the recovery strategy will be to effectively curtail human-related negative impacts on the northern abalone population.

As research into the threats to northern abalone continues, knowledge gaps will be addressed and goals and objectives of this strategy may be better defined. It is recommended that this recovery strategy be re-evaluated every five years.

Strategies should be considered regarding the management of northern abalone once the species has been removed from COSEWIC's threatened list. Crucial to the continued survival of northern abalone, management strategies for maintaining a healthy, self-sufficient population should be developed long before the plans need to be implemented.

[1] *SARA* requires that the recovery strategy identify "a description of the species and its needs that is consistent with the information provided by COSEWIC" [*SARA* s.41(1)(a)].

2. Current Status

2.1 Species Information

Common Name: northern abalone (pinto abalone).

Scientific Name: *Haliotis kamtschatkana* (Jonas, 1845).

Assessment Summary : May 2000.

Status: Threatened.

Reason for COSEWIC designation: A patchily distributed marine mollusc found along the west coast. Highly prized for harvesting, it continues to decline since complete closure of the fishery in 1990, probably as a result of continued high levels of poaching. There is evidence that the decline and fragmentation of the population are impairing the reproductive ability of the species even though there exists a reservoir of reproductive adults.

Occurrence: Pacific Coastal Waters.

Status history: Designated Threatened in April 1999 by COSEWIC. Status re-examined and confirmed Threatened in May 2000 by COSEWIC. May 2000 assessment based on new quantitative criteria applied to information from the existing 1999 status report.

The statement of designation is from the report produced by COSEWIC (www.cosewic.gc.ca) following assessment under new criteria of northern abalone in 2000. A COSEWIC re-assessment of northern abalone's status in Canada is scheduled for 2009.

2.2 Distribution

Global Range

Found off the west coast of North America from Yakutat, Alaska (O'Clair and O'Clair 1998) to Turtle Bay, Baja California (McLean 1966), the northern or pinto abalone is one of approximately 65 species of abalone (*Haliotis* spp.) found world-wide (Geiger and Poppe, 2000).

Canadian Range

Throughout coastal British Columbia.

Percent of Global Distribution in Canada

The percent distribution of northern abalone in Canada compared to the total distribution in western Northern America is unknown.

2.3 Nationally Significant Populations

COSEWIC defines a nationally significant population as any group within a biological species or subspecies that is recognized as a distinct entity for separate status designation.

No distinct entities of northern abalone for separate status designation by COSEWIC are currently known; genetic studies to date have not identified distinct entities within the known Canadian population.

2.4 Population Sizes and Trends

The northern abalone population has been assessed since 1977 through surveys of index sites using a standard survey design (Breen and Adkins 1979). Many of the surveys and much of the commercial fishery for northern abalone were conducted in areas along the south-east Queen Charlotte Islands (QCI)) and the central coast of B.C. during 1978-90 (Winther *et al.* 1995; Harbo 1997; Campbell *et al*. 1998). Although there were a few surveys of southern B.C. (Quayle 1971; Breen *et al*. 1978; Adkins 1996; Wallace 1999), they did not afford the extended coverage provided by the northern surveys. Most surveys were conducted in areas with significant commercial harvests, where northern abalone were most abundant (Sloan and Breen 1988). Surveys at index sites in south east QCI and the central coast of B.C. have provided general time-series trends indicating that the abundance of northern abalone declined more than 75% between the period of 1977-84 and remained low and or continued to decrease through 1998 (Winther *et al*. 1995; Thomas and Campbell 1996; Campbell *et al*. 1998, 2000a). The mean total northern abalone density at comparable index sites changed from 2.4 to 0.2 abalone per m^2 for the central coast, during 1979-97, and from 2.8 to 0.5 abalone per m^2 for south east QCI during 1977-98. The similarity in northern abalone density between new random sites and index sites indicated that the mean densities from all index sites were reasonably representative of adult northern abalone sampled in areas of the central coast of B.C. in 1997 and south east QCI in 1998 (Campbell *et al.* 1998, 2000a). A transect survey in the central coast of B.C. in 1998 (Lucas *et al*. 1999) confirmed the low densities of northern abalone found by the index surveys in the same area. Surveys and observations in southern B.C. during the 1990s have indicated low densities of northern abalone (A. Campbell and B.G. Lucas, *pers. comm*.). However, Wallace (1999) reported relatively high population abundance of northern abalone in an area close to William Head Penitentiary, near Victoria, where the presence of penitentiary guards may have discouraged poachers from nearshore access.

Breen (1986) and Sloan and Breen (1988) suggested that abalone populations probably fluctuated even in the absence of commercial fishing. Exploratory surveys conducted in south eastern QCI during 1955 by Quayle (1962) suggested that northern abalone were less abundant in 1955 than in both 1914 (Thompson 1914) and in the late 1970s (Sloan and Breen 1988).

Examination of surveyed index sites in both QCI and the central coast indicated a general decline in the number of sites with > 1 northern abalone per m^2 between 1978 and 1998 (Campbell 2000b). Index sites with no large abalone (i.e., $\geq$ 100 mm shell length (SL)) generally increased from zero and 25% to 55% and over 65% for the central coast and QCI, respectively, in the late 1970s to the late 1990s. There were fewer sites during 1997-98 (10-20%) than 1978-79 (45-80%) with densities of $\geq$ 0.25 large abalone per m^2. The decrease in density and decline in the number of sites with northern abalone suggested serial depletion of large abalone during most of the 1990s.

3. Factors affecting vulnerability and contributing to threatened status

3.1 Biologically Limiting Factors

The northern abalone is vulnerable to over-exploitation because this species has a patchy distribution, a short larval period, is slow growing, relatively long-lived, has low or sporadic recruitment and mature individuals, which tend to accumulate in shallow water, are easily accessible to harvesters.

Spawning and Patch Size

The appropriate size and distribution of northern abalone populations required to provide effective reproduction and subsequent sufficient recruitment are unknown. Current knowledge of abalone, in general, suggests there needs to be sufficient densities within patches of large mature abalone close enough together to successfully spawn and produce viable offspring. Size at maturity and fecundity of northern abalone may vary between areas and time periods depending on local habitat conditions. Based on histological examination of gonads, Quayle (1971) found northern abalone became initially mature at about 50 mm SL, and Campbell *et al*. (1992) found 50% mature at 55 mm SL and 100% mature at sizes $\geq$ 70 mm SL. Large female northern abalone (e.g., $\geq$ 100 mm SL) contribute substantially more to population fecundity than small mature abalone (Campbell *et al*. 1992; Campbell 1997).

Northern abalone spawn synchronously, with groups of males and females in close proximity in shallow waters, broadcasting their gametes into the water column (Breen and Adkins 1980). Cues that cause mass spawning in abalone can include environmental factors such as temperature changes (Sloan and Breen 1988), and minor storms and typhoons (Sasaki and Shepherd 1995). Shepherd (1986) suggested that abalone should be protected from fishing during the spawning season because of the vulnerability of these spawning aggregations to exploitation. Recent studies on abalone (Clavier 1992; McShane 1995a,b; Shepherd and Partington 1995) and sea urchins (Levitan *et al.* 1992) have emphasised reduced fertilisation success can be caused by dilution of gametes through reduced adult spawner densities (Levitan and Sewell 1998). Since fertilisation success depends on the aggregation density of abalone, exploitation rates and high natural mortality on abalone aggregations may be important in influencing egg production (Campbell 1997).

After fertilisation, the planktonic phase of northern abalone is short (12 days at 14 degrees Celsius, 13 days at 17.5 degrees Celsius) (Standley 1987). Recent studies have suggested that larval exchange in some abalone species may occur in small geographic areas (on a scale of hundreds of meters to several kilometres) (Tegner and Butler 1985a; Prince *et al.* 1987; McShane 1992, 1995a,b; McShane *et al.* 1988). Almost nothing is known about the early juvenile stages (1 - 3 years) of the northern abalone in B.C. and further study is required (Sloan and Breen 1988). Estimates of the age at which northern abalone reach 100 mm SL are between 6 to 8 years in B.C. (Quayle 1971; Breen 1986). "Surf" abalone at exposed sites in B.C. may never reach 100 mm SL and their age can be difficult to determine (Sloan and Breen 1988). The frequency and size of patches and size composition of northern abalone required to

maintain sufficient egg production and recruitment for a healthy population needs investigation and should be part of the research for the rebuilding strategy program.

Due to the slow growth rate, sporadic recruitment, and cryptic juvenile stage, the stock-recruitment relationship of northern abalone may be difficult to determine.

Recruitment

Recruitment is defined as the number of juveniles growing and surviving to the adult population (the defined recruit size in the adult stage can vary between studies). Generally, high densities of adult northern abalone are required to ensure sufficient recruitment. Shepherd and Partington (1995), using a Ricker stock recruitment curve, suggested that there was a critical stock density threshold (0.15 per m^2) for the *H. laevigata* in Waterloo Bay, South Australia, below which the risk of recruitment failure was high. Later studies by Shepherd and Rodda (*pers. comm.*) have shown higher thresholds at around 0.3 per m^2. Shepherd and Brown (1993) found that a "minimum viable population" of more than 800 individuals of *H. laevigata* was required at West Island, Australia; anything less caused recruitment failure. Shepherd and Baker (1998) suggested that recruitment to an abalone fishery could be relatively lower and more variable in small abalone populations than in larger populations. In this case small populations would need to have more egg production to prevent depletion. These studies supported the influence of the Allee effect or depensation (Allee *et al*. 1949) in which low abalone densities and few aggregations reduced reproductive success due to low fertilisation of gametes.

Stock and recruitment relations for northern abalone and the causes of poor recruitment of northern abalone in B.C. are unknown (Breen 1986; Sloan and Breen 1988). Breen (1986), assuming a natural mortality (M) of 0.20, estimated pre-recruit and new recruit northern abalone densities required would be 0.55 and 0.45 per m^2, respectively, to maintain an estimated pre-fishery density of 2.5 per m^2. Breen (*pers. comm.*) suggested that densities were sensitive to the assumed growth curve and growth rates could vary widely.

3.2 Habitat Requirements

Northern abalone are normally found on firm substrates, such as rocks, boulders, or bedrock, and in areas of moderate to high sea water exchange, such as in exposed or semi-exposed coastlines. Most of the adult northern abalone occur in near shore, exposed or semi-exposed coastal waters at <10 m depth (Breen and Sloan, 1988). Adult northern abalone aggregate in warm shallow water areas to broadcast their gametes simultaneously (Breen and Adkins 1980).

Currently there is ample habitat available for the northern abalone population on the coast of B.C. In general, abalone populations have declined, however, there has been no known significant reduction in available habitat. Therefore, habitat loss is not a major concern in the recovery of northern abalone at this time in comparison with the identified threats.

Northern abalone growth can vary considerably between areas depending on the extent of exposure to wave action and availability and quality of food. Growth of adults tends to be stunted in highly exposed outer coastal areas where food may be limited because of strong wave action and water currents. Feeding opportunities may be reduced because abalone would be less able to catch and hold onto drift algae. When "surf" abalone are transplanted to calmer, kelp abundant habitats, growth rates may be higher than for abalone in high-energy areas (Emmett and Jamieson 1988). Abalone growth is more rapid in moderately exposed areas with giant kelp, *Macrocystis integrifolia,* or bull kelp, *Nereocystis luetkeana,* kelp forests than at highly exposed areas with *Pterygophora californica* kelp forests (Sloan and Breen 1988).

Small juvenile (<10 mm SL) northern abalone are hard to find, but are usually associated with crustose algae (Sloan and Breen 1988). Juvenile northern abalone (10-70 mm SL) are found under and on exposed areas of rocks, whereas the majority of adults (>70 mm SL) are found on exposed rock surfaces. As the juveniles develop to maturity, their diet changes from benthic diatoms and micro-algae by moving to shallower, more exposed areas to feed on drift macro-algae. The general habitat areas of the adults and their juvenile offspring could be within close proximity of each other.

Critical Habitat

See Section 3.6 Knowledge Gaps.

3.3 Ecological Role

Within the near shore, exposed or semi-exposed coastal waters, northern abalone play the role of herbivore and are prey of many species. Young northern abalone feed on diatoms and micro-algae. Food for juveniles and adult abalone includes macro-algae and kelp. Recovery of northern abalone may be related to the abundance and health of kelp forests in certain areas. Northern abalone compete with other species (e.g., red sea urchins, *Strongylocentrotus franciscanus*) for food, and interactions with these species should be considered in the recovery strategy. Northern abalone are a prey species for sea otter, *Enhydra lutris*; river otter, *Lutra canadensis*; mink, *Mustela vison*; crab, *Cancer* species; sea stars, *Pycnopodia helianthoides*; octopus, *Octopus dofleini*; wolf eel, *Anarrhichthys ocellatus* cabezon, *Scorpaenichthys marmoratus*; and other sculpin fish species, *Cottidae*. These interactions will need to be monitored throughout the recovery of the northern abalone.

3.4 Socio-economic Considerations

Long harvested by coastal First Nations, abalone (*Haliotis* spp.) meat was consumed as food and the shells or pieces of shell of northern abalone or red abalone traded from California were used in B.C. as fishing lures, in jewellery and as an inlay for carvings (Stewart 1977). Abalone buttons on a ceremonial blanket were a sign of wealth to the Tsimshian (Reece 2000). Harvest was generally restricted to the lowest tides, although some, such as the Haida, also used a three-pronged spear to access abalone in sub-tidal areas, 2 m below the lowest tide (Jones 2000). B.C.'s coastal First Nations express continued concern that northern abalone populations are threatened which results in food, social and ceremonial fisheries being closed[2]. Interest in food, social and ceremonial fisheries for abalone has provided an incentive for northern abalone rebuilding programs in some areas. Some of these programs go beyond the objective of the recovery strategy, but nonetheless support northern abalone recovery.

In addition to the concerns of First Nations, the closures of B.C.'s commercial and recreational abalone fisheries represented significant economic and recreational loss to participants, associated industries and coastal communities. While small recreational and commercial fisheries for northern abalone occurred in B.C. as early as 1900, a commercial dive fishery directed on northern abalone began in earnest in 1972. Developing through the 1970s, B.C.'s commercial fishery peaked in 1977 with landings of 481 t. The majority of harvest occurred in the north coast of B.C. and in the Queen Charlotte Islands (Adkins 2000; Campbell 2000b). The value of the commercial fishery peaked at $1.86M (landed value) in 1978 (Sloan and Breen 1988). Northern abalone were also regarded as a gourmet food and recreational divers were known to have had a keen interest in northern abalone harvest. Conservation concerns led to the complete

[2] In the event abalone populations are recovered to sufficient levels, priorities will be given to First Nations' food, social, ceremonial fisheries pursuant to Section 35(1) of the Canadian Constitution.

closure of all B.C. northern abalone fisheries in 1990, including recreational, commercial and First Nations' food, social and ceremonial fisheries.

There is no other abalone species occurring within B.C. with sufficient abundance to directly replace the northern abalone fisheries. B.C.'s recreational and commercial dive fisheries and First Nations' food, social and ceremonial fisheries continue for other invertebrate species (the value of B.C.'s commercial invertebrate fisheries is significant, currently estimated at $111.3M) (*2000 British Columbia Seafood Industry Year in Review*).

There is currently no commercial harvest of northern abalone. There has never been a commercial fishery for northern abalone in Washington State, and Alaska's commercial fishery was closed in 1996. The recreational fishery in Washington also closed in 1994, but there is currently an Alaskan sport fishery. Other species of abalone (e.g., red abalone, *H. rufescens*) from commercial fisheries and aquaculture in other jurisdictions (Australia, Japan, Mexico, China, Taiwan, Europe and the U.S.) are still available in B.C.

There is a growing interest in commercial aquaculture of northern abalone. Culture techniques for northern abalone have yet to be perfected, although pilot projects are underway to develop this technology in conjunction with population rebuilding initiatives. There is interest within the commercial sector to investigate rebuilding initiatives under incentives that also provide for economic opportunities. However, the role that aquaculture may play in northern abalone rebuilding has yet to be evaluated.

Recreational diving and tourism associations have expressed an interest in maintaining healthy aquatic environments, including healthy and abundant invertebrate communities, which generally support abalone recovery efforts. The general public also has an interest in addressing species at risk and maintaining a healthy environment.

3.5 Threats[3]

Continued illegal harvest and low recruitment levels probably have had predominant and widespread impacts and are considered to be the most significant threats to northern abalone recovery. Other threats may include habitat concerns, and perhaps sea otter predation when combined with anthropogenic effects.

Illegal Harvest

Mature northern abalone, which tend to accumulate in shallow water, are easily accessible to harvest. The market value of northern abalone, and the difficulty in enforcing the fisheries closures in a large, mostly uninhabited coastal area has encouraged illegal harvesting of northern abalone. Illegal harvesting not only depletes the already depressed northern abalone population, but also reduces their reproductive potential by removing large mature northern abalone and hinders rehabilitation through closure to harvest. Samples from northern abalone illegally harvested during 1995-98 suggested that harvesters indiscriminately removed mostly large mature northern abalone (Campbell 2000b). Without reductions in illegal harvest, protection of mature broodstock, a continued closure of the fisheries, and other effective rehabilitation methods, northern abalone population abundance may remain low or continue to decline in many areas of B.C.

Low Recruitment

Low recruitment in an area, over a protracted period of several years, may contribute to further declines in northern abalone populations by not replenishing the reproductive adults that have died from natural causes or illegal harvest. Low recruitment caused by unfavourable

[3] *SARA* requires that the recovery strategy identify "…threats to the survival of the species that is consistent with information provided by COSEWIC." [*SARA* s.41(1)(*b*)].

environmental and biotic factors usually can not be predicted nor controlled. Ensuring that there are sufficient adult northern abalone to reproduce each year will allow high recruitment to occur when environmental conditions are favourable.

Habitat Concerns

Works and developments on, in, and under the water may have negative impacts on northern abalone habitat and numbers. Criteria for the authorization of these works and developments will need to be developed in order to maintain habitat in which the northern abalone can be recovered and to prevent losses to important spawning aggregations.

Sea Otter Predation

Sea otter expansion may have an effect on already depleted abalone populations, and may make meeting recovery goals impossible. This interaction has been highlighted as a knowledge gap (refer to Section 3.6). Refinements to the recovery strategy may be necessary with improved knowledge of species interactions.

3.6 Knowledge Gaps[4]

Survey Requirements

Index Surveys

Although there have been a few surveys in southern B.C., they did not provide as extensive a coverage as the index site surveys in northern B.C. (Refer to this discussion in Section 2.4 'Population Sizes and Trends – abundance'). Establishing baseline surveys in the southern biogeographic zones is required to monitor recovery or decline in these areas.

Continued broad-scale surveys at index sites throughout B.C. are required to monitor status of the northern abalone population in comparison to the existing time-series of survey data.

Survey Methodology

Development of appropriate survey methodology will be necessary to detect significant changes in northern abalone abundance in small and large spatial scale surveys.

Fine Scale Surveys

Intensive local fine-scale surveys should be conducted to determine variability within and between areas of biologically different northern abalone populations. Understanding the spatial scale of stock units or meta-populations of northern abalone is important for developing appropriate experimental rehabilitation strategies.

Biological/Ecological Research Requirements

Larval Dispersal, Patch Size and Recruitment

Currently very little is known about the relationship between northern abalone adult concentrations, breeding success and subsequent dispersal of larvae and settlement of juveniles. (Refer to this discussion in Section 3 'Biologically Limiting Factors'). Juvenile northern abalone are cryptic and difficult to survey effectively until they reach maturity. Low abundance and fragmentation of the population are considered to be impairing the potential reproductive success of northern abalone. The frequency and size of patches of northern abalone required to maintain sufficient recruitment for a healthy population requires further investigation. Due to the slow growth rate, sporadic recruitment and cryptic juvenile stage, assessment of the stock-recruitment relationship for northern abalone may be difficult to determine.

[4] *SARA* requires that the recovery strategy identify "a statement about whether additional information is required about the species" [*SARA* s.41(1)(*f*)'].

Genetics

Unique genetic markers need to be identified for northern abalone (Withler 2000; Withler et al. 2001).

Species Interactions

A better understanding of the ecological interactions between northern abalone and abalone predators (e.g., sea otters) and competitors (e.g., sea urchins) is required. The sea otter, a significant predator of northern abalone, is expanding its range in B.C. following extirpation and re-introduction. Currently, the factors that facilitate co-existence of sea otters and northern abalone are unknown, and further research on these factors is needed. Increased predation from expanding sea otter populations on an already reduced and fragmented northern abalone population may pose a concern for northern abalone recovery. Experimental efforts in developing rebuilding methods should include areas with and without sea otters to better understand the ecological factors that allow both species to coexist, or not, in a particular area.

Rebuilding Techniques

Investigations into and evaluation of different rebuilding techniques to test egg production and survival at different life stages is necessary to support northern abalone rebuilding efforts.

Diseases/Parasites

Abalone disease has severely impacted wild abalone stocks in California (e.g., foot withering syndrome), however it is unknown if the causative agent (a rickettsia-like organism that infects the epithelium of the digestive tract) or other parasites reported in California (e.g., kidney coccidia) occur in northern abalone in B.C. As random sampling of wild northern abalone in B.C. for a disease survey is not a feasible approach due to low population levels, other strategies must be adopted in order to obtain the required knowledge. One strategy would be to sample abalone in culture. Broodstock obtained from the wild populations will harbour parasites enzootic to the area of collection and these organisms may become evident under culture conditions. Also, abalone produced in culture will reflect the agents of disease occurring in the vicinity of the culture facility (given the current restrictions with transplanting abalone between different regions of the province, cultured abalone should not develop "exotic" diseases). As well, in the event cultured abalone are used in rebuilding (out-planting) experiments, these animals should have prior disease screening to ensure that only healthy abalone are introduced into the wild population.

Identification of critical habitat

SARA defines critical habitat as "*the habitat that is necessary for the survival or recovery of a listed wildlife species that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*"[5]. While the general habitat requirements for northern abalone can be described (Section 3.2), the critical habitat for northern abalone as defined under *SARA* can not be defined at this time without further research.

Although abalone habitat (Section 3.2) is not considered to be limiting, there may be certain habitat where juvenile survival is better, or where the reproducing adults contribute to a larger portion of the total recruitment. Identification of this key habitat is included as part of the abalone research and rebuilding plans. Research to clarify the extent that works and developments on, in and under the water may pose a threat to northern abalone habitat and numbers (Knowledge Gaps Section 3.6) and to develop criteria around authorizing these works and developments in order to maintain habitat in which the northern abalone can be recovered and to

[5] *SARA* s.2(1).

prevent losses to important spawning aggregations is also needed.

Appendix II outlines a schedule of studies[6] that will aid in identifying critical habitat for northern abalone.

Threat Clarification

Extent of Illegal Harvest

Known quantities of illegally harvested B.C. northern abalone have ranged from <45 to 4500 kg (Jubinville 2000). Prior to the closure of the commercial, recreational, and First Nations fisheries in 1990, and continuing afterwards, there has been illegal harvesting at unknown exploitation rates, and despite the closure, northern abalone has not shown signs of natural recovery. The population has continued to decline at survey index sites, and is reported to be declining at other locations. Anecdotal information suggests that illegal harvesting occurs on a scale significant enough to cause a severe conservation risk to this species, but there may be other biological and ecological factors involved in the currently low level of recruitment. Further investigation is required to clarify the extent to which illegal harvesting is impacting recovery of the northern abalone in B.C.

Clarification of Habitat Concerns

Clarification of the extent that projects or developments on, in or under the water (e.g., finfish farms, floating camps) pose a threat to the northern abalone population by direct and indirect impact(s) is required.

II. RECOVERY

1. Recovery Goal[7]

Immediate Goal (over the next 5 years):

Halt the decline of the existing wild northern abalone population in B.C. in order to reduce the risk of this species becoming endangered.

Long-term Goal (over the next 30 years):

Increase number and densities of wild northern abalone to self-sustainable levels in each biogeographic zone of B.C. (Haida Gwaii, Queen Charlotte and Johnstone Strait, North and Central Coast, Georgia Basin, West Coast of Vancouver Island), in order to remove northern abalone from threatened status. The goal of increasing northern abalone to sustainable levels can be expected to take several decades.

2. Short-term Recovery Objectives[7]

In carrying out the approaches to recovery and in order to address the threats and fill knowledge gaps, the short-term recovery objectives for the next five years will be:

- To ensure that mean densities of adult ($\geq$ 100 mm SL) northern abalone do not decline below 0.1 per m^2 at surveyed index sites in Haida Gwaii and North and Central Coast, and that the percentage of surveyed index sites without adult ($\geq$ 100 mm SL) northern abalone does not increase to greater than 60%.

- To develop measurable indices for northern abalone in the Queen Charlotte Strait, Georgia Basin, and West Coast of Vancouver Island.

[6] *SARA* requires that the recovery strategy identify "a schedule of studies to identify critical habitat, where available information is inadequate" [*SARA* s.41(1)(*c.1*)].

[7] *SARA* requires that the recovery strategy identify "a statement of the population and distribution objectives that will assist the survival and recovery of the species" [*SARA* s.41(1)(*d*)].

3. Strategies / Approaches for Recovery[8]

There are five strategies for reaching the goals and objectives of the recovery strategy for northern abalone. Details are provided in the step-down outline following.

1) Maintain the fisheries closures.
2) Develop and implement a proactive protective plan.
3) Develop a communication campaign to stop illegal harvest and raise public awareness.
4) Undertake research and rebuilding experiments.
5) Monitor population status.

Step-down Outline

This section provides the specific steps that will be taken to implement each strategy for recovery.

1) Maintain the fisheries closures for northern abalone. This is necessary to limit human-induced mortalities on the population and allow for natural recovery. Costs to enforce the closures are currently un-estimated.

2) Develop and implement a proactive protective plan for the recovery of northern abalone. This is necessary to reduce mortalities of northern abalone from illegal harvest, and to increase community involvement, awareness and fishery officer support. The estimated cost of these strategies are estimated to be $75K in each of the next five years. The specific steps are as follows:

a) Use reactive, preventative and proactive enforcement to curtail illegal harvest and trafficking of northern abalone.

b) Develop methods to identify different abalone species using genetic markers to identify illegal abalone in the marketplace.

c) Promote communication, awareness, stewardship and policing (e.g., First Nations guardians).

d) Promote coastal watch programs to involve communities in monitoring abalone populations.

e) Foster public support of court imposed sentencing that is appropriate to the threatened status of northern abalone. This may be achieved by educating the general public through publications, other communication media, and the provision of impact statements to the court.

3) Develop communication campaign to stop illegal harvest and raise public awareness for northern abalone. The following will help to curb illegal harvest, increase support for enforcement efforts, and encourage community stewardship and public involvement. The estimated costs are $170K for each of the next five years. The specific steps are as follows:

a) Develop and implement a long-term communications plan.

b) Promote northern abalone habitat stewardship projects.

c) Continue to upgrade and update a northern abalone web site.

d) Initiate a northern abalone newsletter for interested parties and the general public.

e) Initiate liaisons with First Nations, interested local parties, stakeholders and international agencies.

f) Produce communication materials (e.g., posters, stickers, and brochures).

g) Initiate a proactive media relations campaign, and identify and co-ordinate media opportunities.

[8] *SARA* requires that the recovery strategy identify "a description of the broad strategy to address those threats" [SARA s.41(1)(*b*)] and "a general description of the research and management activities needed to meet those objectives" [*SARA* s.41(1)(*d*)].

4) **Undertake research and rebuilding experiments for northern abalone.** Research and rebuilding may lead to increased breeding success, recruitment and population densities. Research on northern abalone should lead to a broader understanding of northern abalone biology and ecological interactions. The estimated costs of these activities are $130K a year over the next five years. The specific steps are as follows:

   a) Establish experimental pilot research areas and test rebuilding methods (e.g., juvenile enhancement through abalone culture technology, aggregating reproductive adults, out-planting, modify habitat on a small scale to protect early life-stages).

   b) Research the effect of disease and parasites.

   c) Consider experiments to fill knowledge gaps (see Section 3.6).

   d) Consult and work co-operatively with First Nations on proposals for projects that are in a First Nations' local area, this includes sharing of information on abalone population, project goals, rebuilding techniques, impacts, etc.

   e) Work co-operatively with coastal communities to share information on local abalone populations and develop rebuilding techniques.

   f) Incorporate information on abalone from other jurisdictions where appropriate.

   g) Consider a broad ecosystem approach in the research of northern abalone.

5) **Monitor the population status of northern abalone.** Monitoring is required in B.C. to determine population levels and changes for ongoing population assessment. The estimated costs of monitoring are $85K for each of the next five years. The specific steps are as follows:

   a) Continue index site surveys.

   b) Establish baseline abundance data with surveys in southern B.C.

4. Considerations for Recovery

4.1 Recovery Feasibility[9]

Recovery of northern abalone will require a high level of effort to:

   i) Address threats (see Section 3.6); and
   ii) Fill knowledge gaps (see Section 3.5).

Given time, favourable environmental conditions, and reduced mortalities, significant population recovery is feasible, as there is a reservoir of reproductive adult northern abalone and high quality habitat available.

However, in the event of a species collapse, a population may not recover due to subtle ecosystem shifts or Allee effect (Allee *et. al 1949*). Modeling collapsed populations gave time periods to recovery of 50-100 years (S. Shepherd, *pers. comm.*).

4.2 Anticipated Conflicts or Challenges

Enforcement Challenges

While the fisheries closures were anticipated to provide for natural stock recovery in the absence of any harvest, northern abalone densities nonetheless have continued to decline. Illegal harvest has been highlighted as a key factor inhibiting natural population recovery. Enforcement is deemed crucial to the abalone recovery efforts. Northern

[9] *SARA* requires that "the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. The determination must be based on the best available information, including information provided by COSEWIC" [*SARA* s.40].

abalone are accessible in shallow water in many remote areas of B.C.'s extensive coastline and can be harvested with simple tools. Current enforcement measures and court-imposed penalties have not been sufficient to deter illegal harvest and sale of northern abalone. The high value of northern abalone in the marketplace poses a challenge to compliance with the harvest prohibition. Without an increase in enforcement and deterrences to offenders, continued illegal harvest will likely counteract positive measures taken towards halting declines and rebuilding northern abalone populations. In light of the remote nature of the B.C. coastline, enforcement efforts require increased community awareness and vigilance in order to succeed in controlling and preventing illegal harvest. The challenge will be to ensure that all coastal communities are aware and support the recovery of northern abalone.

Challenge from Sea Otters

Historically, sea otters were common in coastal regions of the North Pacific. They were hunted to near extinction from the mid-1700s until protected in 1911, and were reintroduced to B.C. by the Federal and Provincial governments in a series of three translocations in 1969, 1970, and 1972 (Watson 2000). Since reintroduction, the B.C. sea otter population has increased at a rate of about 18.6% per year (Watson *et al*. 1996). The expansion of sea otter populations, listed as threatened by COSEWIC, may pose a significant challenge to northern abalone recovery objectives. Sea otters prey on northern abalone in B.C., reducing the density, size, and distribution of northern abalone compared to areas without sea otters (Breen *et al*. 1982; Watson 1993). In areas off the west-coast of Vancouver Island and in the Goose Group on the central coast of B.C., where sea otters are now established, sea otter predation may negate rebuilding and recovery efforts for abalone. As the range of sea otters expands, northern abalone populations may only be sustained at low levels. In the longer-term, sea otter recovery strategies may be in conflict with recovery goals for northern abalone in some areas.

Technical Challenges to Population Rebuilding

To date, rebuilding techniques for northern abalone have not been fully developed. Earlier attempts at aquaculture in southern B.C. (Saanich Inlet and Sooke, on Vancouver Island) during the 1980s were unsuccessful (Bower 2000). An evaluation of the pilot projects (which were started in 2000) is required to determine whether culture may be a viable contribution to population recovery. Although the success of population rebuilding by out-planting juvenile northern abalone has not been tested in B.C., outplanting juvenile abalone has had some limited success in other jurisdictions (Seki and Taniguchi 2000; Shepherd *et al* 2000; Tegner 2000). Some technologies may be transferable from the culture of abalone species in other countries.

Prior to out-planting, these projects will need to be reviewed and approved by appropriate agencies, including screening of juveniles to ensure disease and epidemics do not threaten existing wild populations (Bower 2000). For example, genetic markers may assist in identifying differences in northern abalone population(s). Some measures are needed to ensure that out-planting of juveniles does not compromise the genetic integrity of wild populations.

Rebuilding experiments to increase productivity of the existing wild northern abalone population could include aggregating adults to increase reproductive potential and adding artificial habitats (substrates) to increase surface rugosity for abalone refuges from predators. The technical challenges will be to evaluate the success and relative efficiency of the different procedures used by showing that (a) adults remain aggregated during several spawning periods, (b) their juvenile offspring can be traced and shown to increase recruitment, and (c) artificial habitats help to exclude predators and

increase survival of the critical benthic life stages of northern abalone. Protecting the experimental areas from illegal harvesting of abalone will also be a special challenge.

4.3 Recommended Approach / Scale for Recovery

The northern abalone has been considered for the single species recovery approach because it is a distinct species with respect to the issues that threaten its survival. Illegal harvest and low recruitment are seen as the main reasons for a continued decline in the wild population, even though there has been complete fisheries closures for northern abalone since 1990. The northern abalone is the only marine invertebrate listed as a species at risk in B.C. Although being recommended for a single species approach, there are several actions outlined in the approach for recovery which may directly benefit other species within the geographical area that is included within northern abalone habitat and communities. Sea otters (threatened) also exist within this ecosystem, and do interact with northern abalone. Therefore, within the recovery strategy, a shift to an ecosystem approach may be required in the future. This will require an adaptive approach as knowledge of the species and related species interactions improve.

5. Actions Already Completed and/or Underway

5.1 Surveys of Key Index Sites have been conducted from 1977 to present (every 1-4 years) to monitor population abundance and evaluate recovery. These large area scale surveys are considered representative in providing time-series trends of the northern abalone population. Surveys monitoring the populations should continue. Although there were a few surveys in southern B.C. (Quayle 1971; Breen *et al.* 1978; Adkins 1996; Wallace 1999), they did not afford the extended coverage as provided by the northern surveys; establishing baseline surveys in the south is recommended.

5.2 Closures to Commercial Fishing (1971-1990). The Lower Johnstone Strait, Georgia Basin and Strait of Juan de Fuca were closed in 1971 to commercial fishing to provide for recreational fishing opportunities. In addition, there were a number of closures to the commercial fishery to provide for First Nations and recreational harvest (Farlinger, 1990).

5.3 Total Fisheries Closures December 1990. All B.C. fisheries, including commercial, recreational and First Nations' food, social and ceremonial fisheries, were closed to abalone harvest in 1990. A complete harvest prohibition was expected to allow for natural recovery and to halt declines in the wild population. However, surveys undertaken in 1998 (Campbell *et al.* 2000a) indicated that the wild population continued to decline. The fisheries closures will continue as a necessary component to northern abalone recovery in order to continue to limit mortality. There are currently no commercial fisheries for northern abalone anywhere.

5.4 Listing Status. Northern abalone in B.C. were listed by COSEWIC as threatened in 1999. Status was re-examined under new assessment criteria and confirmed Threatened in May 2000.

5.5 Enforcement measures have been undertaken by regular patrols in support of the harvest prohibition and in response to reports of illegal activity. Covert operations and investigations target specific poaching operations.

5.6 An international **Workshop on Rebuilding Abalone Populations in British Columbia** was held in February 1999, and convened individuals from local communities, First Nations, international research institutes and government organizations to focus on developing solutions to rehabilitate northern abalone populations (approximate cost $100K). Thirteen peer-reviewed papers were presented (Campbell 2000a) and *A Strategy for Rebuilding Abalone Populations in British*

Columbia was prepared for DFO by Dovetail Consulting Inc. The broad approaches and strategies of the Abalone Recovery Strategy (this document) were drawn from this workshop.

5.7 Pilot Projects in support of rebuilding wild abalone populations. In 2000, DFO in co-operation with several First Nations, coastal communities, and the aquaculture industry, initiated several pilot projects in support of rebuilding wild abalone populations.

Stock Rebuilding Sites: The Haida Fisheries Program, Kitasoo Fisheries Program, Kitkatla Indian Band, and the Bamfield Huu-ay-aht Community Abalone Project Society, are working on projects that will facilitate the rehabilitation of wild northern abalone populations through local community stewardship projects in Haida Gwaii, the north and central coasts of B.C., and the west coast of Vancouver Island. In 2000/01, habitat and population assessment surveys, community awareness, and stewardship programs were completed (approximate cost $426K; the Pacific Fisheries Adjustment and Restructuring Program provided $289K, and the Habitat Stewardship Program, a conservation initiative sponsored by the Government of Canada and managed co-operatively by Environment Canada, Parks Canada, and Fisheries and Oceans Canada, provided $137K). Community outreach forms a strong component of these projects.

Development of Culture Technology Pilot Projects: Five pilot projects were initiated to develop abalone culture technology for application by coastal communities, including First Nations, as part of a long-range abalone stock rehabilitation initiative: Kitkatla Indian Band, Ethelda Bay Ventures, Community Futures Development Corporation of the Powell River Region, Malcolm Island Shellfish Cooperative, and the Bamfield Community Abalone Project Society. (Contributions/costs were approximately $2.5M with funding from Pacific Fisheries Adjustment and Restructuring, private sources and the Province of B.C. (over $600,000 through Fisheries Renewal B.C. and other Provincial agencies)). Projects are nearing their initial 18-month term and an evaluation of progress/successes to date is planned.

5.8 A **Regional Abalone Co-ordinator** was funded and appointed by the Fisheries and Oceans Canada in April 2000 – March 2001, and was integral in implementing recommendations from the 1999 Workshop on Rebuilding Abalone Populations in British Columbia. DFO subsequently identified a lead resource manager for abalone in late 2001 (assuming the role from the Regional Abalone Co-ordinator).

5.9 An **Abalone Recovery Team** was formed in November 2001, with representatives from the Federal Departments of Fisheries and Oceans Canada and Parks Canada, and Provincial Ministries of Water, Land and Air Protection and Agriculture, Food and Fisheries. The Abalone Recovery Team was formed to facilitate the recovery planning process for northern abalone and to produce an Abalone Recovery Strategy (this document).

5.10 Eight Workshops in coastal B.C. communities (Bella Bella, Port McNeil, Powell River, Port Alberni, Victoria, Nanaimo, Prince Rupert, and Skidegate) in February 2002, were held as forums to receive input on the recovery strategy from all interested parties. Concurrently, the recovery strategy was reviewed by seven external reviewers representing academia, government, and non-government organizations from Canada, U.S.A., Australia and New Zealand.

5.11 Scientific documents and publications produced to increase the knowledge base regarding northern abalone (see also additional publications included within References):

Possible criteria for reopening the northern abalone (*Haliotis kamtschatkana*) fishery in British Columbia (Campbell 1997).

Review of status of northern or pinto abalone, *Haliotis kamtschatkana*, in Canada (Jamieson 1999).

Proceedings of the "Workshop on Rebuilding Abalone Populations in British Columbia" (Campbell 2000a).

Review of northern abalone, *Haliotis kamtschatkana*, stock status in British Columbia (Campbell 2000b).

Discussion on an experimental approach for northern abalone stock rebuilding in British Columbia (Campbell *et al.* 2000b).

High levels of genetic variation in northern abalone, *Haliotis kamtschatkana*, of British Columbia. (Withler *et al.* 2001).

5.12 Anti-illegal harvest communications campaign 2000 and 2001, consisted of multiple activities and the production of communications products to raise public awareness of the current status of abalone populations on the Pacific coast and the harms of continued illegal harvest. Materials produced include a DFO Canada abalone web site, posters *Conserve, Protect, Rebuild*, and *Stop Abalone Poaching*, an *Abalone Fact Sheet*, an *Abalone HELP* kit, and the *Shellfish Game*.

5.13 Abalone Genetics Research. To determine population structure, Withler *et al.* (2001) outlined the analysis of allele frequencies at 12 microsatellite loci in 1800 abalone collected from 20 sites through B.C. and south east Alaska. Laboratory analysis of an additional 1000 samples to determine the temporal stability of the observed population structure has been completed. For species identification purposes, a portion of the lysin gene that distinguishes all species of abalone tested to date has been isolated. The utility of the technique on samples of abalone obtained from California, Mexico, Australia, New Zealand and Asia is currently being confirmed. Plans are for the technique to be put into use during 2002. Funds from Pacific Fishery Adjustment and Restructuring and Fisheries and Oceans Canada Species at Risk ($100K) and Canadian Biotechnology Strategy ($70K) have been used to determine the population structure of northern abalone in B.C. and to develop a forensic DNA technique to identify confiscated abalone to species in support of enforcement on illegal harvest.

6. Statement of when one or more action plans in relation to the recovery strategy will be completed[10]

An Abalone Recovery Action Plan outlining specific programs, costs and timelines over a five-year period will be completed by March 31, 2003.

[10] *SARA* requires that the recovery strategy include "a statement of when one or more action plans in relation to the recovery strategy will be completed" [*SARA* s.41(1)(*g*)].

7. Potential Management Impacts for Other Species/Ecological Processes

Approach	Potential Impact	Probability of Impact
1. Fisheries closures	Fisheries closures were anticipated to halt declines in the abalone population to allow for natural stock recovery and were not anticipated to affect other species.	*Low*
2. Communication	Communication may benefit other species associated with abalone communities and other species at risk by raising awareness and increasing reports of illegal harvesting.	*Medium*
3. Proactive Protective Plan (enforcement)	Increased enforcement activities for abalone will benefit other species by increased vigilance for all illegal fishing, possessing, and marketing activities, and can be expected to increase community reporting of illegal activities.	*High*
4. Research and Rebuilding Experiments	Rebuilding experiments may impact other species on a localized scale. Research may provide a better understanding of species and ecological interactions.	*Medium* *High*
5. Population Monitoring	Time series data may help to better understand species population changes of other species and ecosystem processes.	*Medium*

8. Evaluation

Answers to the following questions will be used to assess the progress and/or success of the recovery objectives and the approaches and strategies.

1) Was the coast-wide closure to northern abalone harvesting maintained and enforced? Was the coast-wide closure an effective measure contributing in halting the population decline?

2) Was a proactive protective enforcement plan implemented? How many reports relating to abalone harvesting were provided to enforcement officers and the toll free enforcement line (Observe-Record-Report). To what degree were these reports investigated and resulted in charges and convictions? How many hours were spent on enforcing abalone closures? What were the trends in enforcement hours and resulting charges and convictions over the period before and during implementation of the recovery strategy? What were the trends in ratios between enforcement effort and the quantity of illegally harvested abalone seized and what were the biological characteristics of the animals seized (e.g., sizes)?

3) Was a long-term communications strategy developed? How many and what kind of communications materials and/or actions were produced and/or undertaken? How many people, and where, did the communications activities reach? What indications for increased awareness (e.g., did visits to the abalone web site increase, what level of participation at workshops?)

and/or reductions in illegal harvest were a result of communications efforts?

4) Did research activities fill some of the knowledge gaps about abalone, its biology and ecology? What significant new knowledge was gained through research that would directly contribute to the rebuilding of the northern abalone population? How many population rebuilding initiatives were undertaken? Was there an observed increase in juvenile abundance and/or recruitment as a result of rebuilding experiments (e.g., as seen through periodic and long-term diver based surveys)? Does rebuilding appear to be a viable, or promising strategy to recover the wild abalone population?

5) Was baseline abundance data established in each of the biogeographic zones? What were the findings of population monitoring? How did index surveys relate to the recovery objective (increase or decrease in the population)? How effective are baseline index sites in monitoring the changes in population abundance? What reports (technical or primary publications) were prepared that provide results of surveys and biological studies?

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V. APPENDIX I - Glossary of Terms

ABALONE: marine gastropod snail of the Family Haliotidae; for the purposes of this document, northern abalone or pinto abalone, *Haliotis kamtschatkana*. This species is the most common and abundant abalone in B.C. *Note*: A mature red abalone, *H. rufescens* was recently found in the central coast of B.C. There are numerous unsubstantiated reports of the flat abalone, *H. wallalensis* in the literature with a northern distribution to B.C.

AQUACULTURE: as defined by the UN Food and Agriculture Organization (FAO) is the culture of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Aquaculture implies some form of intervention in the rearing process to increase production, such as regular stocking, feeding, and protection from predators.

B.C.: British Columbia, Canada.

BIOGEOGRAPHIC ZONES IN B.C. - based on environmental, management and/or biological considerations for northern abalone, includes intertidal and sub-tidal waters surrounding the following land areas:

Haida Gwaii (Queen Charlotte Islands): Queen Charlotte Islands.

Queen Charlotte and Johnstone Straits: Quadra Island (Seymour Narrows) north to Cape Caution.

North and Central Coast: Cape Caution north to and including Prince Rupert.

Georgia Basin: San Juan Point to Seymour Narrows near Quadra Island.

West Coast of Vancouver Island: the west coast of Vancouver Island from San Juan Point north to the Scott Islands.

BROODSTOCK: mature adults that are able to produce young.

CULTURE: Culture is used to define a variety of techniques or interventions used to assist in an animal's survival and growth. The term "culture" is generic and can be used in the context of either "aquaculture" or "enhancement", and includes use of hatchery technologies and grow-out technologies.

DFO: Fisheries and Oceans Canada.

POPULATION REBUILDING (OR REHABILITATION): describes the activities undertaken to restore populations to desired levels of strength or number, and can involve culture, habitat modification, experimental manipulations and aggregating reproductive adults.

PREVENTATIVE ENFORCEMENT: active patrols, education and investigations into illegal activity in order to prevent the loss of or illegal harvest of abalone and other species; all of which is done on a continuous and frequent basis throughout the year.

PROACTIVE ENFORCEMENT: enforcement initiatives undertaken (as for Preventative above) with a long-term view (e.g., education, community development, stewardship and similar effort) aimed at protecting the resource; long-term efforts.

REACTIVE ENFORCEMENT: enforcement initiatives undertaken immediately as a result of reported active theft of the resource, happening real time and addressed real time.

RECOVERY: the act of bringing a species back from the risk of extinction to a self-sustainable population level, able to withstand stochastic (random) events and other environmental variables.

RECOVERY ACTION GROUPS: group of people working on specific actions or projects under the umbrella of a national recovery team.

RECRUITMENT: for this document, the number of juvenile abalone that enter into the adult population.

RENEW: acronym for **Re**covery of **N**ationally **E**ndangered **W**ildlife.

SELF-SUSTAINABLE POPULATION: a population having a <5% probability of becoming extinct over the next 100 years. According to COSEWIC this requires:

a) enough breeding adults to be considered sustainable in the long-term;
b) sufficient quality habitat to available or potentially available to maintain sustainable population numbers;
c) adequate or improving demographic parameters (eg: sex ratio, birth and death rates); and
d) mitigation/control of threats to the population, particularly those that initially caused the species decline.

VI. Appendix II Schedule of Studies[11]

SARA allows for a schedule of studies to be developed to identify critical habitat where available information is inadequate [*SARA* s.41(1)(*c.1*)]. Further research is needed before critical habitat for northern abalone can be identified. The following schedule outlines the activities required over the next 5 years (2002-2007) for habitat identification and threat clarification that will yield information towards identifying critical habitat for northern abalone in B.C. The activities outlined in this schedule are recommendations that are subject to priorities and budgetary constraints of the participating jurisdictions and organizations. Some studies may take longer than 5 years to complete. In particular, developing measurable indices for a sustainable population is expected to take 10 -15 years.

Recovery Activities	Date
Research	
Examine growth, survival and distribution of early benthic stages in relation to local habitat, algal, predator and competitor species interactions	2002 - 2007
Develop measurable objectives that define a "self-sustaining" abalone population 1) in different benthic communities, 2) in different habitat types, and 3) in the presence and absence of sea otters	2002 - 2007
Examine abalone distribution in relation to local seawater current patterns and computer simulations to determine potential larval	2002 - 2005

[11] *SARA* s.41(1)(*c*).

Recovery Activities	Date
dispersal mechanisms	
Investigate the effect of 1) size, 2) habitat type, 3) season, 4) presence/absence of predators and 5) site exposure, on wild stock enhancement success by assessing the survival and growth of released juvenile and larval abalone in small experimental plots of known habitat and species complex	2003 - 2007
Investigate the extent to which works and developments on, in and under the water may impact on abalone habitat and recovery	2004 - 2007
Population Rebuilding	
Aggregate reproductive adult abalone to increase density and improve reproductive success and transplant "surf" abalone to calmer, kelp abundant habitats to improve growth rates	2002 - 2007
Conduct small scale enhancement of habitat[12] to monitor and increase survival of early benthic life-stages	2002 - 2007

VII. ADDITIONAL INFORMATION

1. **Prepared by:** Prepared under the lead of Fisheries and Oceans Canada in cooperation with the Abalone Recovery Team.
2. **Date Completed:** March 28, 2002. Updated August 17, 2004 to meet requirements of *SARA*.
3. **Recommended Citation:** Fisheries and Oceans Canada and the Abalone Recovery Team. 2004. National Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada. 22 pp.
4. **Lead Jurisdiction / Other Responsible Jurisdictions / Wildlife Management Boards with authority for the species under a settled land claims agreement / Key Contacts:**

   The lead jurisdiction for the protection of northern abalone and its habitat is Fisheries and Oceans Canada, under the *Canada Fisheries Act*. The Province of British Columbia has jurisdiction over the use of seabed and foreshore under the *BC Land Act*, which will be considered in cases of the need for habitat modifications or the development of refugia. In such cases, these projects may also be subject to review under the *Navigable Waters Protection Act* and the *Canadian Environmental Assessment Act*. Aquaculture facilities are subject to licensing under the *BC Fisheries Act.* Artificial movements of northern abalone into and within coastal waters are subject to review by the federal-provincial Introductions and Transfers Committee. Parks Canada Agency has involvement in abalone management and protection in Marine Conservation Areas.

[12] Abalone, especially juveniles, are cryptic and hide in rocks and crevices, which makes monitoring of juvenile survivorship difficult. Currently, contained units (e.g., crab traps) are being used to increase rugosity (i.e., hiding crevices), to monitor juvenile survival and species interactions, and to allow efficient sampling without disrupting the natural environment.

Although abalone were not specifically identified within the Nisga'a Treaty process and no specific surveys have been conducted within the area, the Nisga'a Fisheries Program has an interest in abalone recovery and will be reviewing their current program commitments and available resources. In the meantime, they are kept abreast of abalone recovery initiatives.

5. Recovery Team Members and Associated Specialists

The Abalone Recovery Team (2002)

Bruce Adkins, Fisheries and Oceans Canada

Elizabeth Bornhold, Fisheries and Oceans Canada

James Boutillier, Fisheries and Oceans Canada

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Al Castledine, Government of British Columbia, Ministry of Agriculture, Food and Fisheries

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Michele Patterson, World Wildlife Fund Canada,

Scoresby Shepherd, South Australian Research and Development Institute

Norm Sloan, Parks Canada Agency, Gwaii Haanas National Park Reserve

Ann Stewart, Bamfield Huu-ay-aht Community Abalone Project Society

Jane Watson, Malaspina University-College

Abalone Recovery Action Groups (2002)

The following stewardship groups have actively participated in the northern abalone research and rebuilding programs:

Bamfield Huu-ay-aht Community Abalone Project

Haida Fisheries Program

Kitasoo Fisheries Program

Kitkatla Indian Band

Ethelda Bay Ventures

Community Futures Development Corporation of the Powell River Region

Malcolm Island Shellfish Cooperative

6. Record of Cooperation & Consultation[13]

Northern abalone are an aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada: 200-401 Burrard St., Vancouver, B.C. V6C 3S4.

Fisheries and Oceans Canada engaged an Abalone Recovery Team in November 2001 to work cooperatively on drafting this recovery strategy (completed March 2002) based on *A Strategy for Rebuilding Abalone Populations in British Columbia* (www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Abalone/default_e.htm) that was developed cooperatively by First Nations, international researchers, aquaculturists, local communities, non-government organizations and federal and provincial governments in 1999. The membership of the Recovery Team and a list of stewardship groups that have worked co-operatively in the development and implementation of recovery programs ('abalone recovery action groups') are provided above. The list of participants and the thirteen peer-reviewed papers from the 1999 workshop are available in Campbell (2000a).

In addition, consultations were also undertaken with First Nations and all those interested in the recovery of northern abalone to gain input and advice on an early draft of the recovery strategy through a series of coastal workshops. All coastal First Nations, participants from the 1999 workshop, abalone recovery action groups, commercial fishing representatives and the general public were invited to participate. Over the course of eight workshops held February 1 2002 in Bella Bella; February 5 2002 in Port McNeil; February 8 2002 in Powell River; February 11 2002 in Port Alberni; February 12 2002 in Victoria; February 13 2002 in Nanaimo; February 19 2002 in Prince Rupert; and February 22 2002 in Skidegate, B.C., input on the draft Abalone Recovery Strategy was provided by representatives from: abalone commercial licence holders, Ahousat First Nation, Archipelago Marine Research Ltd., A-tlegay Fisheries Society, Bamfield Huu-ay-aht Community Abalone Project Society, Bamfield Marine Station, BC Ministry of Assets and Lands, BC Ministry of Agriculture, Food, and Fish, Combined North Island Fisheries Center, commercial fishers, Community Futures Development Corporation of the Powell River Region, Council of Haida Nations, Cowichan Tribes, G-N Fisheries, Groundfish Hook and Line Advisory Committee, Haida Fisheries Commission, Haida Gwaii Marine Resources Group Assn., Heiltsuk First Nations, Hemas Council, Kitasoo Fisheries Program, Kitkatla First Nation, Kwakiutl Band, Kwakiutl Nation Development Corp., Lax Kw'alaams Band Council, Living Oceans Society, Malcolm Island Shellfish Cooperative, Metlakatla Band Council, nearshore rockfish fishers, Nuchatlaht Band, Nuu chah

[13] *SARA* s.39.

nulth Tribal Council, Outer Coast Oysters, Oweekeno First Nations, Parks Canada Gwaii Haanas, Parks Canada Pacific Rim National Parks Reserve, Penelakut Tribes, Prince Rupert Chamber of Commerce, Quatsino Seafood, shellfish biologists, shellfish growers, Sub Sea Products, Tseshaht Band, Tsimshian Allied Tribes, University of Victoria, World Wildlife Canada (marine program), and other interested parties. Written submissions were also provided by Lorne Clayton, IEC International Collaborative Marine Research and Development Ltd.; Erica Boulter, World Wildlife Fund; Larry Golden, Prince Rupert; John Shepherd, Northwest Community College; Stefan Ochman, Fisheries Manager, Huu-ay-aht First Nation, Fred Hawkshaw, nearshore rockfish; Michele James, Underwater Harvesters' Association; Robert DeVault, Outer Coast Oysters; Mike Featherstone, Pacific Urchin Harvesters' Association; Dawn Renfrew, Bamfield Marine Sciences Center; and Mark Biagi, Community Futures Development Corporation. Meeting records are available at www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Abalone/default_e.htm.

Input from the workshops and written submissions encouraged the importance of enforcement and deterrents to illegal harvest, adopting an ecosystem approach, consideration for the role of culture and commercial aquaculture, co-operation from commercial urchin and geoduck and horseclam dive fishery associations, research to fill knowledge gaps, incentives for First Nations, and community involvement and education in abalone recovery. In re-drafting the Abalone Recovery Strategy input from public workshops, written submissions and external reviews was adopted wherever possible.