

Northern Abalone

Background

The northern abalone (*Haliotis kamtschatkana*) is found from Alaska to Baja California and is the only species occurring in British Columbia (BC). Most adult abalone occur in near shore, exposed or semi-exposed coastal waters at <10 m depth. Abalone are aggregating synchronous broadcast spawners and fertilization success depends on the local density of adults and dilution of gametes.

Surveys at index sites have provided a time series of abalone densities and size frequencies from the south-east Queen Charlotte Islands (QCI) and the central coast of BC (CC) every 3-5 years during 1978-2002 (Fig. 1). Abundance of northern abalone in these areas declined more than 75% between 1978 and 1989-90. DFO banned the harvest of northern abalone in December of 1990 due to concerns of low population numbers. Despite the harvest closure, numbers remained low and in 1999 northern abalone was listed as 'threatened' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

As a result of the official listing, a National Recovery Strategy for the Northern Abalone was prepared. The short-term measurable objective set out in the recovery strategy is: "[to] ensure that mean densities of large (≥ 100 mm shell length (SL)) northern abalone do not decline below $0.1/m^2$ at surveyed index sites in Haida Gwaii and North and Central Coast, and that the percentage of surveyed index sites without large (≥ 100 mm SL) northern abalone does not increase to greater than 60%". In other words, the percentage of index sites with large abalone should not fall below 40% (Fig.4).

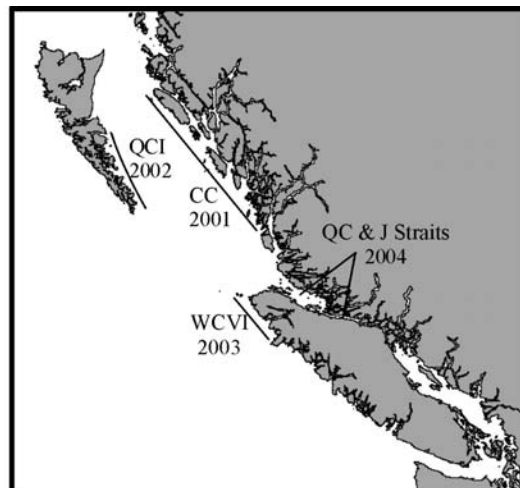


Figure 1. Index site survey locations in BC and year of the last survey.

Summary

- Densities of northern abalone have continued to decrease despite a total ban on harvest since 1990. There is no current evidence of population recovery in BC.
- Low recruitment levels and continued harvest despite the fisheries closure are considered to be the most significant threats to northern abalone recovery. Expansion of the sea otter population and near shore marine development may also contribute to the decline of abalone in BC.

Species Biology

Northern abalone are found in shallow subtidal waters along exposed and semi-exposed rocky coastlines from Yakutat, Alaska, to Turtle Bay, Baja California. In BC, abalone occur in patchy distribution on hard substrate in the intertidal and shallow subtidal zones.

Northern abalone are considered mature at a size of 50-64 mm SL, depending on local habitat conditions. Large female

northern abalone (e.g., >100 mm SL) are more fecund than small mature abalone. Spawning generally occurs between April and July. Abalone spawn synchronously, with groups of males and females gathering in shallow waters, broadcasting their gametes into the water column. Cues that initiate mass spawning in abalone can include environmental factors such as temperature changes and minor storms. Recent studies on abalone and sea urchins have documented reduced fertilization success caused by dilution of gametes due to reduced adult spawner densities. Since fertilization success depends on the aggregation density of abalone, exploitation rates and high natural mortality on abalone aggregations may be important in influencing juvenile recruitment.

Within 48 hours after fertilization, trochophore larvae emerge from the eggs. This planktonic phase of northern abalone is short and temperature dependent (10-14 days at 14-10°C). 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).

Very little is known about the early juvenile stages (1-3 years) of northern abalone in BC and further study is required. Small juveniles (<10 mm SL) are hard to find, but are usually associated with crustose algae. 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 juveniles develop to maturity, their diets change from benthic diatoms and micro-algae to drift macro-algae.

Northern abalone growth can vary considerably between areas depending on the extent of exposure to wave action and availability and quality of food.

Estimates of the age at which northern abalone reach 100 mm SL range from 6 to 8 years in BC. 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 are less able to catch and hold on to drift algae. Abalone growth is more rapid in moderately exposed areas with giant kelp, *Macrocystis integrifolia*, or bull kelp, *Nereocystis luetkeana*, forests than in highly exposed areas with walking kelp, *Pterygophora californica*, forests.

Major natural predators of northern abalone include sea otters, crabs, octopus, some fishes, and sea stars (especially *Pycnopodia helianthoides*).

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

The Fishery

Traditional harvesting of abalone by First Nations along the north west coast of North America occurred at low tide where exposed abalone were picked by hand and subtidally where abalone were harvested with a long pole terminating in a hook. The first non-aboriginal harvest of abalone began in the early 1900s using long poles armed with hooks or by diving. By the 1950s, the introduction of SCUBA allowed small recreational and commercial fisheries to begin. Commercial landings were low (the mean annual landing was 7.7t during 1952-71) until the early 1970s when total annual landings increased dramatically due to increases in market demand and technological improvements enabling exploitation in remote areas. Landings reached a maximum of 481.4 t in 1977. Harvesting was concentrated in the Queen Charlotte Islands and along the

central coast of BC. With evidence of resource depletion, landings were reduced under a quota management system to 47 t during 1985-1990.

A minimum size limit was enforced, with some changes, for all abalone fisheries from 1908 until the closure. The minimum size limit was 100 mm SL during 1981-1990. Harvest for all northern abalone fisheries was officially closed in BC in December 1990, and has remained closed, due to conservation concerns.

Resource Status

In BC, northern abalone populations have been assessed since 1978 through surveys of index sites using a standard survey design. Much of the commercial fishery for northern abalone was conducted in the QCI and CC areas during 1978-90 (Fig. 1). Although there were a few surveys of southern BC, they did not afford the extended coverage provided by the northern surveys. Surveys at index sites in south east QCI and CC have provided general time-series trends indicating that the abundance of northern abalone declined more than 75% between the period of 1977-1989/90 and remained low and/or continued to decrease through 2002.

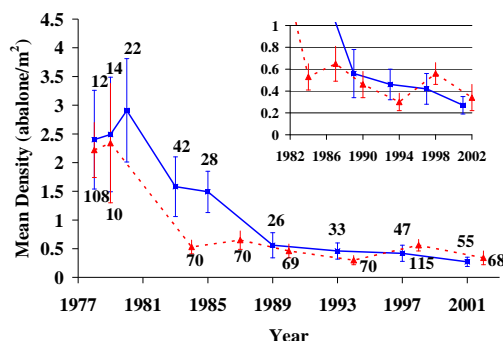


Figure 2. Mean total density of abalone from all surveys in the CC (solid blue line) and the QCI (dashed red line). Numbers are sample sizes. Error bars represent two standard errors. Inset graph displays greater resolution

of densities for survey years after 1982.

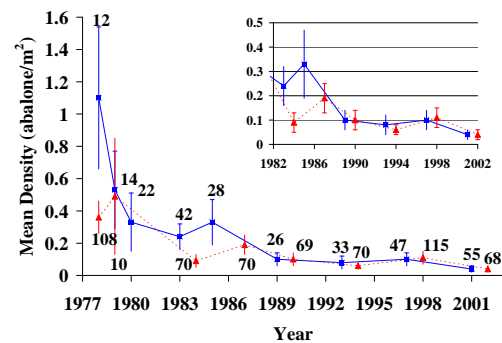


Figure 3. Mean density of large (≥ 100 mm SL) abalone from all surveys in the CC (solid blue line) and the QCI (dashed red line). Numbers are sample sizes. Error bars represent two standard errors. Inset graph displays greater resolution of densities for survey years after 1982.

The mean total northern abalone density at comparable index sites decreased from 2.40 to 0.27 abalone/m² for CC during 1978-2001, and from 2.22 to 0.34 abalone/m² for QCI during 1978-2002 (Fig. 2). During the same periods, the mean large (≥ 100 mm SL) density decreased from 1.10 to 0.04 abalone/m² for CC and from 0.36 to 0.04 for QCI (Fig. 3). The mean size of abalone surveyed significantly dropped from 76.4 mm SL in 1998 to 67.0 mm SL in 2002 in QCI and from 80.7 mm SL in 1997 to 77.6 mm SL in 2001 in CC. These decreases were partly due to a greater proportion of small individuals (< 70 mm SL). While there were significant declines in total densities compared to previous surveys in both QCI and CC, proportionally, the density of large abalone decreased more rapidly than that for small individuals.

The similarity in northern abalone density between recent surveys at new, randomly chosen sites and historic, non-random index sites, indicated that the mean densities from all index sites were reasonably representative of adult northern abalone sampled in areas of CC in 1997 and QCI in 1998. Other surveys

using different sampling designs also confirmed the low densities of northern abalone found by index surveys in the same areas.

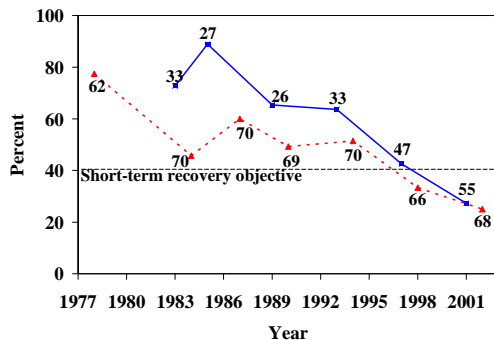


Figure 4. Percent of repeated index sites with large abalone (≥ 100 mm SL) from surveys in the CC (solid blue line) and the QCI (dashed red line) (some years were excluded due to small number of 'index sites' in those years). Numbers are sample sizes.

Index site surveys were initiated on the west coast of Vancouver Island (WCVI) in 2003 and in Queen Charlotte and Johnstone Straits (QC&J Straits) in 2004 (Fig. 1). Mean total density estimates were 0.06 abalone/m² in Queen Charlotte Strait and 0.02 abalone/m² in Johnstone Strait. The mean total density was 0.09 abalone/m² on WCVI from all sites sampled, but 0.21 abalone/m² in Quatsino Sound where more sheltered abalone habitat was present. Sea otters, *Enhydra lutris*, have inhabited the surveyed area of WCVI since 1989 and more specifically since 1991 in Quatsino Sound. Studies have shown that abalone, in areas where sea otters are present, are restricted to crevices and other cryptic habitats where they are inaccessible or hidden from sea otters.

Index sites with large abalone (> 100 mm SL) decreased from 89% and 77% to 27% and 25% for the CC and QCI, respectively (Fig. 4). Decreases in density and declines in number of sites with large northern abalone suggested serial depletion of large abalone during most of the 1990s.

Outlook

It is unclear what the natural state of northern abalone populations may have been historically. Abalone populations probably fluctuated even in the absence of commercial fishing. Exploratory surveys conducted in south-east QCI during 1955 suggested that northern abalone were less abundant in 1955 than in both 1914 and in the late 1970s. The extirpation of sea otters had an effect on all invertebrate populations, including northern abalone. With the re-introduction and recent expansion of sea otter populations, restoration of northern abalone populations to the levels seen in the late 1970s may not be possible.

The mean densities of large abalone (≥ 100 mm SL) were only at 0.04/m² in both CC and QCI in 2001 and 2002 respectively, well below the short-term recovery objective of maintaining densities at or above 0.1/m². The percentage of sites with large sized abalone was also below the short-term recovery target of 40%.

There has been no evidence of abalone populations rebuilding in QCI and CC since abalone were protected by harvest closures in late 1990. Although other factors, e.g. natural predation, have played a role, low recruitment levels and continued harvest despite the fisheries closure probably have had predominant and widespread effects, and are considered to be the most significant threats to northern abalone recovery. Poachers target larger individuals, which have the highest reproductive potential, thereby compounding the impact of their removal on the surrounding population by contributing to lower future recruitment. 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 has mature individuals which tend to accumulate in shallow

water where they are easily accessible to harvesters.

Despite recovery efforts, abalone densities continue to decline. There is a need now, more than ever, to continue with population rebuilding studies in key areas, enhance public education, and increase enforcement on poaching, to reduce the impact of low recruitment on northern abalone populations in BC.

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ISSN 1480-4913 (Printed)

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***Correct Citation for this
publication***

DFO, 2008. Northern Abalone. DFO
Science Stock Status Report
2004/053.