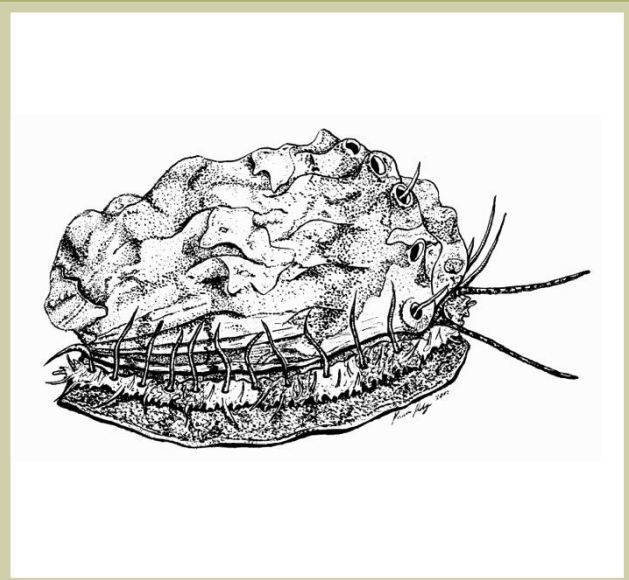# Report on the Progress of Recovery Strategy and Action Plan Implementation for the Northern Abalone (*Haliotis kamtschatkana*) in Canada for the Period 2013 to 2021

Northern Abalone

2024

Canada

Recommended citation:

Fisheries and Oceans Canada. 2024. Report on the Progress of Recovery Strategy and Action Plan Implementation for the Northern Abalone (*Haliotis kamtschatkana*) in Canada for the period 2013 to 2021. *Species at Risk Act* Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. iv + 55 pp.

For copies of the progress report, or for additional information on species at risk, including COSEWIC Status Reports, recovery strategies, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry.

Cover illustration: Pauline Ridings, Fisheries and Oceans Canada

Également disponible en français sous le titre
«Rapport sur les progrès de la mise en œuvre du programme de rétablissement et du plan d'action visant l'ormeau nordique (*Haliotis kamtschatkana*) au Canada pour la période 2013 à 2021»

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for the protection of species at risk throughout Canada. Under section 46 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the competent minister is responsible for reporting on the implementation of the recovery strategy for a species at risk, and on the progress towards meeting its objectives within 5 years of the date when the final recovery strategy was placed on the Species at Risk Public Registry, and in every subsequent 5-year period until its objectives have been achieved or the species' recovery is no longer feasible. Under section 55 of SARA, the competent minister must monitor the implementation of an action plan and the progress towards meeting its objectives and assess and report on its implementation and its ecological and socio-economic impacts 5 years after the plan comes into effect.

Reporting on the progress of recovery strategy and action plan implementation requires reporting on the collective efforts of the competent ministers, provincial and territorial governments, and all other parties involved in conducting activities that contribute to the species' recovery. Recovery strategies identify broad strategies that will provide the best chance of ensuring the survival and recovery of species at risk. Some of the identified broad strategies are sequential to the progress or completion of others and not all may be undertaken or show significant progress during the timeframe of a report on the progress of recovery strategy and action plan implementation (progress report).

The Minister of Fisheries and Oceans and the Minister responsible for Parks Canada are the competent ministers under SARA for the Northern Abalone and have prepared this progress report.

As stated in the preamble to SARA, success in the protection and recovery of species at risk depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in the recovery strategy and action plan, and will not be achieved by Fisheries and Oceans Canada (DFO), Parks Canada (PC) or any other jurisdiction alone. The cost of recovering and conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing the recovery strategy and action plan for the Northern Abalone for the benefit of the species and Canadian society as a whole.

Acknowledgments

Executive summary

The Northern Abalone (*Haliotis kamtschatkana*) was listed as threatened in 2003, and then as endangered in 2011 under the *Species at Risk Act* (SARA), following an updated status report and reassessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in April 2009. The "Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada" was finalized and published on the Species at Risk Public Registry in 2007. The "Action Plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada" was subsequently finalized and published on the Species at Risk Public Registry in 2012. The Report on the "Progress of Recovery Strategy Implementation for Northern Abalone (*Haliotis kamtschatkana*)" in Canada for the Period 2007 to 2012 was published on the Species at Risk Public Registry in 2015.

The main threats identified for Northern Abalone include: illegal harvest; low recruitment; habitat loss or degradation stemming from works on, in, and under water; and Sea Otter (*Enhydra lutris*) predation. The key factors limiting the survival and recovery of Northern Abalone are their patchy distribution, short larval period, slow growth, relatively long lifespan, and lowered or sporadic recruitment. Also, mature individuals, which tend to accumulate in shallow water, are easily accessible to illegal harvesters.

The population and distribution objectives for Northern Abalone are:

1) to observe that mean densities of large adult (> 100 mm shell length [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 with large adult (> 100 mm SL) Northern Abalone does not decrease below 40%
2) to observe that the mean total density estimates at newly established index sites in the Queen Charlotte and Johnstone Straits do not decline below the level observed in 2004 (0.06 Northern Abalone per m^2 and 0.02 Northern Abalone per m^2, respectively), and the mean total density estimates for the West Coast of Vancouver Island do not decline below the level observed in 2003 (0.09 Northern Abalone per m^2)
3) to observe at the index sites (in areas without Sea Otters) that the annual estimated mortality rate for mature (≥ 70 mm SL) Northern Abalone is reduced to < 0.20 and the mean densities of mature (≥ 70 mm SL) Northern Abalone are increased to > 0.32 per m^2
4) to observe at the index sites (in areas without Sea Otters) that the proportion of quadrats (m^2) with Northern Abalone is increased to > 40%

The Report on the Progress of Recovery Strategy and Action Plan Implementation for the Northern Abalone (*Haliotis kamtschatkana*) in Canada for the Period 2013 to 2021 (progress report) reports on the progress made by DFO, PC, and partners towards implementing the recovery strategy and the action plan and achieving the objectives therein. Due to delays in completing the report on a 5-year cycle, the reporting period was extended in order to capture the most up-to-date information. During this time period, progress has been made, notably:

- partially fulfilling population and distribution objectives #2 and #3, and fulfilling population and distribution objective #4
- continued long-term monitoring (beginning in 1978 for parts of the coast) of Northern Abalone abundance, distribution, size, mortality, and density at index sites in 5 biogeographical zones

- enforcement of SARA and of *Fisheries Act* regulations to address illegal harvest and trade
- First Nations and coastal community involvement in enforcement of fisheries closures through local vessel patrols and Abalone Coast Watch or similar guardian programs, both through independently organized approaches as well as collaborations with DFO
- protection of critical habitat for Northern Abalone in 4 geographical areas through a Critical Habitat Order
- addressing information gaps for Northern Abalone and standardizing sampling techniques, including:
  o publication of a key paper on stock status and re-analysis of index site surveys
  o publication of research which identifies variables for standardization of the DFO Northern Abalone Index Site Survey data
  o development of a knowledge-based habitat suitability index to predict the probability of occurrence for Northern Abalone in the North Central Coast area
  o reporting on juvenile sampling techniques for Northern Abalone
  o publication of updated DFO data on Northern Abalone for use by COSEWIC to update the status of Northern Abalone in future reassessments

While notable progress has been made over the reporting period towards the recovery of Northern Abalone through the implementation of the activities identified in the recovery strategy and action plan, additional effort is required to achieve the population and distribution objectives to recover Northern Abalone in British Columbia (BC). Positive trends in some population indicators have been observed at some index sites in several regions of the BC coast but further work is needed to understand short- and long-term population implications of these trends. Continued work is also necessary to further our understanding of the relationships between Northern Abalone and Sea Otters in BC, as evidence suggests that while recovery of abalone remains feasible in the presence of Sea Otters, abalone populations may stabilize at lower densities than in the absence of Sea Otters.

Achieving population and distribution objectives will require additional research and monitoring to improve our understanding of Northern Abalone in BC, for example, by increasing the number of index sites surveyed to provide greater precision in our estimates of Northern Abalone density. In addition, achieving population and distribution objectives will also require efforts to mitigate anthropogenic threats, including through continuing to address illegal harvest, and continued review of development proposals in Northern Abalone habitat in accordance with the Northern Abalone impact assessment protocol.

Table of contents

1 Introduction

The "Report on the Progress of Recovery Strategy and Action Plan Implementation for the Northern Abalone in Canada for the Period of 2013 to 2021" outlines the progress made towards meeting the objectives listed in the "Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada" (Fisheries and Oceans Canada [DFO] 2007) and the "Action Plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada" (DFO 2012) during the indicated time period. This progress report is part of a series of documents for this species that are linked and should be taken into consideration together; including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports (COSEWIC 2000, 2009), the recovery potential assessment (RPA; Lessard et al. 2007), and the "Report on the Progress of Recovery Strategy Implementation for Northern Abalone (*Haliotis kamtschatkana*) in Canada for the Period 2007 to 2012" (progress report, DFO 2015a). This report serves as the second progress report for the Northern Abalone recovery strategy and the first progress report for the Northern Abalone action plan.

Section 2 of the progress report provides a summary of the threats to the species, population and distribution objectives for achieving its recovery, approaches to meeting the objectives, and performance measures to assess the progress of recovery. For more details, readers should refer back to the recovery strategy (DFO 2007) and the action plan (DFO 2012) as well as the first progress report (DFO 2015a). Section 3 reports on the progress of activities identified in the recovery strategy and action plan, to support achieving the population and distribution objectives. Section 4 summarizes the progress towards achieving these objectives.

2 Background

2.1 COSEWIC assessment summary and threats to the species and its critical habitat

Assessment summary: April 2009

Common name: Northern Abalone

Scientific name: *Haliotis kamtschatkana*

Status: Endangered

Reason for designation:
Highly valued for its meat, this marine mollusc is patchily distributed along the west coast of Canada. Despite a total moratorium on harvest in 1990, the species was designated as Threatened in 2000. Poaching is the most serious threat and continues to reduce population abundance, particularly the larger, more fecund component; however, all size classes have declined significantly over the past 3 generations (that is, since 1978) with mature individuals declining an estimated 88-89%. Low densities may further exacerbate the problem by reducing fertilization success in this broadcast spawner (the Allee effect). Although predators such as the recovering Sea Otter population are not responsible for recently observed declines, they may ultimately influence future abundance of abalone populations.

Occurrence: Pacific Ocean

Status history: Designated threatened in April 1999. Status re-examined and confirmed in May 2000. Status re-examined and designated endangered in April 2009. Last assessment based on an update status report.

The listing of Northern Abalone under the *Species at Risk Act* (SARA) in 2003 led to the development and publication of the Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada in 2007 (recovery strategy; DFO 2007). The recovery strategy is consistent with the information provided in the COSEWIC Status Report (COSEWIC 2000).

In 2009, COSEWIC re-examined and changed the status of Northern Abalone from threatened to endangered in the COSEWIC Status Report (COSEWIC 2009) due to continued illegal harvest and low recruitment. Subsequently, the SARA status of Northern Abalone was uplisted to endangered in 2011.

The Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada and the Action Plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada identify the threats to survival and recovery of the Northern Abalone and threats to its critical habitat.

Section 1.6 of the recovery strategy, section 1.7 of the action plan, and section 1.2 of the first progress report provide information on the threats to the species (DFO 2007, 2012, 2015a). These threats include: illegal harvest; low recruitment; habitat loss or degradation stemming from works on, in, and under water; and Sea Otter (*Enhydra lutris*) predation.

Critical habitat for Northern Abalone has been identified in the action plan (DFO 2012) to the extent possible, within 4 geographical areas on the coast of British Columbia (BC; figure 3 in DFO 2012). The action plan also provides examples of activities that are likely to result in the destruction of critical habitat (that is, threats to critical habitat). The list of activities provided in table 3 of the action plan is neither exhaustive nor exclusive, and the inclusion of activities has been guided by the relevant threats to habitat described in the action plan. For more details on the activities likely to result in the destruction of critical habitat, consult section 2.3 of the action plan.

2.2 Recovery

This section summarizes the information, found in both the recovery strategy (DFO 2007) and action plan (DFO 2012), on the recovery goals and population and distribution objectives necessary for the recovery of the Northern Abalone, and on the performance measures that are used to define and measure progress towards achieving the population and distribution objectives.

Recovery goals
Section 2.1 of the recovery strategy (DFO 2007) identified 2 goals necessary for the recovery of the species:

Immediate goal over the next 5 years: halt the decline of the existing wild Northern Abalone population in BC in order to reduce the risk of this species becoming endangered.[1]

---

[1] Northern Abalone was assigned a threatened status by COSEWIC in 1999. The status was changed to endangered following an updated status report by COSEWIC. As such, the 2007 recovery strategy references the 1999 status of the species, not the current endangered status.

Long-term goal over the next 30 years[2]: increase number and densities of wild Northern
   Abalone to self-sustainable levels in each bio-geographic zone of BC[3] (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 (SARA)
   status.[1]

Population and distribution objectives

Section 2.3 of the recovery strategy (DFO 2007) identified the following population and
distribution objectives necessary for the recovery of the species:

1) to observe that mean densities of large adult (> 100 mm shell length [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 with large
   adult (> 100 mm SL) Northern Abalone does not decrease below 40%

2) to observe that the mean total density estimates at newly established index sites in the
   Queen Charlotte and Johnstone Straits do not decline below the level observed in 2004
   (0.06 Northern Abalone per m^2 and 0.02 Northern Abalone per m^2, respectively), and the
   mean total density estimates for the West Coast of Vancouver Island do not decline
   below the level observed in 2003 (0.09 Northern Abalone per m^2)

3) to observe at the index sites (in areas without Sea Otters) that the annual estimated
   mortality rate for mature (≥ 70 mm SL) Northern Abalone is reduced to < 0.20 and the
   mean densities of mature (≥ 70 mm SL) Northern Abalone are increased to > 0.32 per
   m^2

4) to observe at the index sites (in areas without Sea Otters) that the proportion of quadrats
   (m^2) with Northern Abalone is increased to > 40%

Performance measures

Section 2.5 of the recovery strategy and 2.5.2 of the action plan (DFO 2007, 2012) includes
performance measures to define and evaluate progress toward achieving the population and
distribution objectives. Some of the performance measures from the 2007 recovery strategy
were either re-framed or additional clarifying questions were added in the 2012 action plan, to
focus and support future analyses of performance and progress towards achieving the stated
objectives. Northern Abalone performance measures are summarized in table 1 and the
clarifications between the recovery strategy and action plan are shown in **bold**.

This progress report further notes specific assumptions built into 3 of the objective-based
performance measures in order to align with their corresponding population and distribution
objectives. These assumptions are shown in **[bracketed bold]**. Additionally, 2 sub-measures
have been included to facilitate reporting on the progress made towards population and
distribution goal #2 regarding Queen Charlotte and Johnstone Straits (assumptions also shown
in **[bracketed bold]**). For more information see section 3.3.1 of this report.

---

[2] 30 years from the publication of the recovery strategy puts this timeline into 2037.
[3] Refer to page 27 of the recovery strategy (DFO 2007) for a map depicting the bio-geographic zones.

Table 1: Performance measures for Northern Abalone from the recovery strategy (Fisheries and Oceans Canada [DFO] 2007) and action plan (DFO 2012).

Type of measure	Performance measures

Objective-based	1. Did the mean densities of large adult (> 100 mm shell length [SL]) Northern Abalone decline below 0.1/m^2 at surveyed index sites in Haida Gwaii and North and Central Coast? Or did it increase?
	2. Did the percentage of surveyed index sites with large adult (> 100 mm SL) Northern Abalone decrease (<40%) **[in Haida Gwaii and the North and Central Coast]**? Or did it increase (>40%)?
	    a. **[Did the mean total densities of Northern Abalone in the Queen Charlotte Strait decline below 0.06 Northern Abalone per m^2 or in the Johnstone Strait did it decline below 0.02 Northern Abalone per m^2? Or did one or both increase?]**
	    b. **[Did the mean total densities of Northern Abalone in the West Coast of Vancouver Island decline below 0.09 Northern Abalone per m^2? Or did it increase?]**
	3. **[In areas without Sea Otters,]** did the annual estimated mortality rate for mature (≥ 70 mm SL) abalone drop to < 0.20, and the mean densities of mature (≥ 70 mm SL) abalone increase to greater than 0.32/m^2?
	4. **[In areas without Sea Otters,]** were more than 40% of the quadrats (m^2) occupied by abalone?

Action-based: management	5. Was the coast-wide closure to Northern Abalone harvesting maintained and enforced? **6. Is there evidence for success in detecting and apprehending illegal harvesters?**
Action-based: protection	7. Was a proactive protective enforcement plan implemented? 8. How many reports relating to abalone harvesting were provided to enforcement officers and the toll free enforcement line (Observe-Record-Report)? 9. To what degree were these reports investigated and resulted in charges and convictions? 10. How much effort has been spent on enforcing abalone closures (for example, how many, months, hours)? 11. What were the trends in enforcement hours and resulting charges and convictions over the period before and during implementation of the recovery strategy? **12. Has the impact of the illegal harvest been studied further?**
Action-based: education and awareness	13. Was a long-term communications strategy implemented? 14. How many and what kind of communication materials and/or actions were produced and/or undertaken? 15. How many people, and where, did the communications activities reach? 16. What indications for increased awareness (for example, did visits to the abalone website increase, what level of participation at workshops?) were a result of communications efforts?

Type of measure	Performance measures
Action-based: research and population rebuilding	17. What significant new knowledge was gained through research that would directly contribute to the rebuilding of the Northern Abalone population? 18. How many population rebuilding initiatives were undertaken? 19. Was there an observed increase in juvenile abundance and/or recruitment as a result of rebuilding experiments? 20. Does rebuilding appear to be a viable or promising strategy to recover the wild abalone population? 21. What reports (technical or primary publications) were prepared that provided results of surveys and biological studies?
Action-based: population monitoring	22. Were regular surveys continued in each of the biogeographic zones?

3   Progress towards recovery

This section updates and summarizes the achievements towards recovery strategy goals and objectives, as well as the progress achieved when working towards the more detailed goals and objectives that were clarified in the action plan within the 2013 to 2021 period. Refer to DFO 2015a for work that occurred prior to 2013.

The recovery strategy groups the recovery approaches into 5 broad strategies:
1) management
2) protection
3) education and awareness
4) research
5) monitoring

The recovery strategy also divides the recovery effort into 5 broad recovery approaches:
1) undertake research and rebuilding experiments for Northern Abalone
2) monitor the population status of Northern Abalone
3) maintain fisheries closures
4) implement a proactive protection plan for the recovery of Northern Abalone
5) implement a communications campaign to stop illegal harvest and raise public awareness for Northern Abalone

The action plan also categorizes the recovery effort activities into 5 broad strategies that are similar to the recovery strategy:

1) management
2) protection
3) education and awareness
4) research and population rebuilding
5) population monitoring

Progress in carrying out these broad strategies in the recovery strategy and the action plan are reported in section 3.1. Section 3.2 reports on the activities identified in the schedule of studies to identify critical habitat. Section 3.3 reports on the progress made towards meeting the

performance measures and other commitments identified in both the recovery strategy and the action plan, and information obtained through implementing both documents.

3.1 Activities supporting recovery

Table 2 provides information on the implementation of activities undertaken to address the broad strategies identified in the recovery planning table of the recovery strategy (DFO 2007) between 2013 to 2021.

Broad Strategy 1: Management and research[4]
- Approach 1-1: Undertake research and rebuilding experiments for Northern Abalone

Broad Strategy 2: Protection
- Approach 2-1: Maintain fisheries closure
- Approach 2-2: Implement a proactive protection plan for the recovery of Northern Abalone
- Approach 2-3: Use protocols for authorizing works or development on, in and under water

Broad Strategy 3: Education and awareness
- Approach 3-1: Implement a communications campaign to stop illegal harvest and raise public awareness for Northern Abalone

Broad Strategy 4: Monitoring
- Approach 4-1: Monitor the population (surveys)

Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Each activity has been assigned 1 of 5 statuses:

1) completed: the activity has been carried out and concluded
2) completed, ongoing: activity has been completed, but efforts will continue as needed to achieve the objectives outlined in the species recovery strategy/action plan
3) in progress: the planned activity is underway and has not concluded
4) not started: the activity has been planned but has yet to start
5) cancelled: the planned activity will not be started or completed

---

[4]Although the recovery strategy and the action plan list "management" and "research" as 2 distinct broad strategies, these have been combined into one "management and research" strategy in this progress report.

Table 2: Details of activities identified in the recovery strategy supporting the recovery of Northern Abalone from 2013 to 2021.

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
1-1a	Establish experimental pilot research areas and test rebuilding methods by aggregating reproductive adults.	In progress	The review and synthesis of aggregation work completed from 2002 until 2007 (in collaboration with Parks Canada [PC]) in the Broken Group Islands, within Pacific Rim National Park Reserve, in Barkley Sound, British Columbia is currently underway. Recently, Curtis et al. (2021) published a report on "Northern Abalone, *Haliotis kamtschatkana*, juvenile sampling techniques: A summary of methods tested in the Broken Group Islands, Barkley Sound, British Columbia". The Washington Department of Fish and Wildlife (WDFW) artificially aggregated abalone adults to help bolster the reproductive potential of spatially isolated adults that currently have a low chance of successful reproduction (Vadopalas and Watson 2014).	Fisheries and Oceans Canada (DFO), PC, WDFW
1-1b	Establish experimental pilot research areas and test enhancement through outplanting the hatchery-raised abalone to the wild. Investigate the effects of size, habitat type, season, presence/absenc	Cancelled	DFO (2015a) describes work completed between 2001 and 2011 by the Bamfield Huu-ay-aht Community Abalone Project. The hatchery has been closed since 2011 and there are no current facilities culturing Northern Abalone in British Columbia (BC). Given this closure, the experimental pilot projects to test enhancement through outplanting (that is, releasing hatchery-raised Northern Abalone to the wild) have been cancelled. However, related studies, described below, were conducted during the period of this progress report. Hansen and Gosselin (2013, 2016) researched the magnitude, timing, and causes of post-outplanting mortality of hatchery-reared late-juvenile Northern Abalone. Their results found that Northern Abalone survivorship declined precipitously following outplanting,	**DFO**, Academia, WDFW

---

[5] Lead participant(s), where applicable, is/are listed on top and in bold; other participants are listed alphabetically.

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
	e of predators, and site exposure on enhancement success by assessing the survival and growth of released juvenile and larval hatchery raised abalone in small experimental plots of known habitat and species complex.		with 83% of abalone surviving 24 hours after release and only 34% surviving 2 weeks in the wild. The primary cause of these declines in survivorship was predation. Read et al. (2013) conducted 2 experiments to assess the effectiveness of different methods of reducing predation on outplanted Northern Abalone: • The first experiment found that the survival rates of juveniles were greater in cages from which sea stars and other predators were removed periodically, than in control cages • The second experiment found that plots with complex substrate provided crypsis from large predators but also resulted in significantly higher densities of small predators. Outplanting lower densities of abalone into larger plots of natural high-substrate complexity might attract fewer predatory sea stars and crabs, and thus result in higher survival rates The WDFW and the Puget Sound Restoration Fund support the rotation of hatchery broodstock into wild spawning aggregations of Northern Abalone (Vadopalas and Watson 2014). A pilot program placed over 11,000 hatchery-origin juveniles at 10 sites in the San Juan Islands. Year 1 survival averaged 10.2% and was most influenced by site compared to lineage or size-at-outplant; 3.4% of detected outplants across all sites had reached reproductive success in 2017 (Carson et al. 2019).	
1-1c	Test the application of recruitment modules to sample and/or protect early life-stages.	In progress	Artificial habitats for juvenile abalone were built by the Kitasoo Abalone Stewardship Program (KASP) at several sites from 1999 until 2004 and were monitored and maintained annually from 1999 until 2014. These recruitment modules have been successful, with juvenile abalone documented inhabiting these structures for the past 15 years (Hankewich 2017). From 2018 to 2020, KASP received funding from the DFO Aboriginal fund for Species at Risk	DFO, HGMSG, KASP

Approach and activity #	Activity	Status	Descriptions and results	Participants[5]
			(AFSAR) to continue surveying and repairing artificial habitats for juvenile abalone. The Haida Fisheries Program, supported by the Haida Gwaii Marine Stewardship Group (HGMSG) continues to maintain and annually survey a network of Northern Abalone recruitment modules[6] that were established throughout Haida Gwaii waters in the early 2000s. The majority of the abalone measured within these modules through the years were in the early life stage (juveniles; < 50 mm shell length [SL]).	
1-1d	Establish pilot research areas to determine effect of Sea Otter recovery on abalone population parameters and determine Northern Abalone population and distribution objectives in the presence of Sea Otters.	In progress	Northern Abalone population and distribution objectives in the presence of Sea Otters have not yet been determined. Lee et al. (2016) researched the effects of Sea Otters on Northern Abalone and found that sites occupied by Sea Otters for over 30 years had 16 times lower densities of exposed abalone than sites where otters have yet to recover, but also had higher densities of cryptic (or hidden) abalone. Sea Otter impacts on exposed abalone density were 3 times greater in magnitude than those of any other factor (for example, wave exposure and substrate complexity). DFO Northern Abalone index sites in the West Coast of Vancouver Island (WCVI) survey region were surveyed in 2003, 2008, 2013 and 2018 (Curtis and Zhang 2018, Obradovich et al. 2021). The WCVI survey region overlaps with some of the largest Sea Otter populations in BC. This region was observed to have declining numbers of Northern Abalone between 2003 and 2013, but subsequently showed increases in abalone density in 2018. Some	DFO, KASP, Parks Canada

---

[6] These recruitment modules are also called artificial habitats or "condos"; these units consist of concrete bricks housed in a modified commercial crab trap and provide suitable habitat for Northern Abalone.

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
			of the current DFO index sites in the Central Coast region are in areas where Sea Otters are more recently recovering. Hansen et al. (2020) identified variables to standardize the DFO Northern Abalone Index Site Survey data (1978 to 2018) to estimate trends in Northern Abalone densities in BC. Sea Otter occupancy (presence/absence) at DFO index sites was found to be an important environmental variable for survey regions in Southern BC (WCVI, Queen Charlotte Strait [QCS] and Georgia Basin [GB]). This may be because Sea Otters are present in both the WCVI and QCS regions. The presence of Sea Otters in Southern BC regions positively correlated with Northern Abalone density, possibly due to the co-occurrence of good Sea Otter and Northern Abalone habitat. Further work is needed to clarify the contribution of Sea Otters and other Northern Abalone predators to Northern Abalone abundance estimates and trends. Sea Otter occupancy (presence/absence over time) was estimated for every index site in the DFO index site surveys. Total mortality of Northern Abalone was found to vary by region and with the presence/absence of Sea Otters (Obradovich et al. 2021). KASP has undertaken long-term population monitoring in the central coast Northern Abalone, in an area that is also seeing recovery of Sea Otters. They have been monitoring Sea Otter sightings in their traditional territory since 2010. Further research into the impacts of Sea Otters on Northern Abalone in all these areas over the long-term is necessary to be able to fully understand the effects.	
1-1e	Research the effects of disease and/or parasites.	In progress	DFO has not conducted disease research on Northern Abalone during the reporting period.	DFO, Academia

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
			Crosson and Friedman (2017) found that abalone species in the northeastern Pacific and in warmer waters are more susceptible to withering syndrome and that closely related species will have a similar host response to withering syndrome. They also found that Northern Abalone have a high susceptibility and low resistance to withering syndrome when water temperatures increase. Crosson et al. (2014) found that some populations of abalone which have suffered catastrophic losses due to withering syndrome have then developed resistance to the disease.	
1-1f	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 the abalone population, project goals, rebuilding techniques, impacts, etc.	In progress	DFO frequently coordinates joint Northern Abalone index site surveys with First Nations when working in the First Nation's traditional territory. DFO, First Nations, and other government agencies continue to share information about surveys, population estimates, rebuilding techniques and goals related to recovery of Northern Abalone, primarily through the bi-annual Abalone Recovery Implementation Group (AbRIG) meetings. PC, Haida Nation and DFO, in collaboration with academia and the Pacific Urchin Harvesters Association, have implemented a pilot kelp forest restoration project in Gwaii Haanas to improve abalone habitat quality by increasing the area and depth of kelp at the site. Initial results have demonstrated significant increases in areal coverage of bull kelp canopy from pre- to post-restoration periods in 2018 (Lee pers. comm. 2021).	AbRIG, Coastal First Nations (FN), DFO, PC
1-1g	Work co-operatively with coastal communities to	In progress	Information about the Northern Abalone population and developing rebuilding techniques was shared with members of coastal communities at bi-annual AbRIG meetings throughout the reporting period.	AbRIG, Coastal FN, DFO, Non-governmenta

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
	share information on the local abalone population and develop rebuilding techniques.		PC promotes abalone population rebuilding initiatives in collaboration with the Haida Nation throughout the Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site. The Haida Gwaii Marine Stewardship Group led by the Haida Nation in partnership with Gwaii Haanas PC, DFO, Skidegate Band Council, Old Masset Village Council, and Laskeek Bay Conservation Society, promotes abalone recovery initiatives throughout Haida Gwaii.	l Organizations (NGOs), PC
1-1h	Incorporate information on abalone from other jurisdictions where appropriate	In progress	DFO participated in an international environmental crimes investigation group aimed at reducing poaching and illegal harvesting of Northern Abalone between 2013 and 2017. Although DFO no longer participates in the investigation group, international relationships are maintained (Demsky pers. comm. 2021). DFO's work on Northern Abalone continues to be informed by research on Northern Abalone and other abalone species from the United States (U.S.) and internationally, as demonstrated in the pre-Committee on the Status of Endangered Wildlife in Canada (COSEWIC) review of DFO information on Northern Abalone (Obradovich et al. 2021).	DFO, U.S. Fish and Wildlife Service (USFWS), U.S. National Marine Fisheries Service (USNMFS), WDFW
1-1i	Consider a broad ecosystem approach in the research of Northern Abalone.	In progress	DFO considers a broad ecosystem approach in the research of benthic invertebrates (including Northern Abalone) in its annual multispecies survey. Data on abundance, size, habitat, substrate and algae are collected (Lochead et al. 2023). DFO brought multiple sources of data together including DFO index site surveys and other abalone surveys, along with environmental data on sea otter occupancy time, in the	**DFO**, HGMSG, Heiltsuk Integrated Resource Management Department (HIRMD),

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
			development of the pre-COSEWIC review of DFO information on Northern Abalone (Obradovich et al. 2021). Northern Abalone research conducted by Lee et al. (2016) focused on modelling the effects of Sea Otters and other biotic and abiotic factors on Northern Abalone population and distribution using empirical data. Wherever possible, PC takes a broad ecosystem approach in Gwaii Haanas, prioritizing actions that benefit numerous species at once to effectively and efficiently protect and recover populations of species at risk, including Northern Abalone (Parks Canada 2016). More recent work brought multiple sources of data together, including Indigenous knowledge and DFO index site surveys from the BC central coast, as well as many other knowledge sources to reconstruct the Northern Abalone historical social-ecological system from the Holocene to the present (Lee et al. 2018).	PC, Academia
2-1	Maintain fisheries closure	Completed, ongoing	The complete closure of all Northern Abalone fisheries (including commercial, recreational, and Food, Social, and Ceremonial fisheries) has been maintained since 1990. Fishery notices are released annually in order to reiterate the coast-wide closure to all harvest of Northern Abalone.	DFO
2-2a	Use reactive, preventative, and proactive enforcement to curtail illegal harvest and	In progress	DFO continues to take reactive, preventative, and proactive actions to curtail illegal harvest and trafficking of Northern Abalone. Activities within the reporting period include: • Education and stewardship: media releases, school programs, and social media are used to increase awareness of the threats of harvest and sale to Northern Abalone, promoting the	**DFO**, Coastal FN, BC Coastal Communities (BCCC), PC

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
	trafficking of Northern Abalone.		Observe-Record-Report (ORR) toll-free telephone number, and drawing attention to convictions. The most recent media release occurred in August 2016 • A species at risk signage campaign was initiated in 2020. These signs, which include Northern Abalone information, are designed to increase public awareness and contain biological information and a summary of prohibitions under the *Species at Risk Act*, and the ORR number. Versions of the signs were produced in First Nations languages (Bettger pers. comm. 2021) • Regular vessel patrols and flights, inspections at airports and borders, and inspections of points of sale have been ongoing that focus on monitoring, compliance, and surveillance. • Inspections training for Fishery Officers has been a priority area of focus. Inspections at the Vancouver International Airport have also been highlighted to monitor the import and export of seafood products, in which Northern Abalone can be intermixed (Bettger pers. comm. 2021) • DFO has increased its effectiveness at conducting field inspections in locations where Northern Abalone is located, through the use of the Pacific Region dive team. Fishery Officers on the dive team have been trained and certified to perform underwater inspections of fishing activity, extending DFO's ability to detect signs of illegal Northern Abalone harvesting (Bettger pers. comm. 2021) • Fishery Officers are using their inspection authorities under the *Fisheries Act* to collect swabs during compliance checks. This allows DFO to identify resource users who may have Northern Abalone DNA on their boats or fishing gear, building intel that leads to more focused monitoring of targets or clients of concern (Bettger pers. comm. 2021)	

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
			• A 3-year intelligence-based operation concluded in 2018, informing subsequent enforcement planning PC park wardens conducted regular patrols to monitor compliance with Northern Abalone harvest closure in Pacific Rim National Park Reserve and Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site.	
2-2b	Continue to identify illegal abalone in the marketplace using genetic markers.	In progress	Since 2002, DFO has been using molecular genetic testing to support all investigations into abalone sales to identify illegal abalone in the marketplace and differentiate between legally imported species (for example cultured Red Abalone *(Haliotis rufescens)* and Northern Abalone). In 2016, DNA testing done by DFO confirmed the presence of Northern Abalone in possession of a food wholesaler.	DFO
2-2c	Promote communication, awareness, stewardship and policing (for example, First Nations guardians).	In progress	From 2013 to 2021, DFO Habitat Stewardship Program for Aquatic Species at Risk (HSP) and AFSAR funding has been provided to multiple First Nations to help with education and mitigation of threats to Northern Abalone within their traditional territories, including for: • Communication activities and products: newsletters, websites, brochures, and radio and TV spots • Outreach: created and delivered school curricula, participated in community events and meetings, and printed and distributed materials featuring the ORR phone number • Stewardship activities including: fishers and community members participating in Abalone Coast Watch programs and dedicated and opportunistic patrols within their respective territories to watch for and report any signs of illegal abalone harvest	AbRIG, Coastal FN, DFO

Approach and activity #	Activity	Status	Descriptions and results	Participants 5
			The bi-annual AbRIG meetings provide a platform to promote and discuss communication, awareness, stewardship activities and policing centred around Northern Abalone.	
2-2d	Promote coastal watch programs ("Abalone Coast Watch") to involve communities in protecting the abalone population.	In progress	Multiple Northern Abalone projects have been funded between 2013 and 2021 that included Abalone Coast Watch or similar guardian programs. These programs involve: • Community-based stewardship program that supports public education, awareness, and abalone patrols to reduce illegal harvest • Watching for suspicious activity and reporting signs of illegal harvest to the DFO ORR line from on-water or shore-based platforms • Workshops, outreach events, posters, brochures, community meetings, and community presentations used to engage and recruit Coast Watch volunteers from these communities	AbRIG, Coastal FN, DFO, PC
2-2e	Use 'traceability' protocols to distinguish legally obtained cultured Northern Abalone from illegally obtained wild Northern Abalone.	Completed	Since the closure of the Bamfield Huu-ay-aht Community Abalone Project hatchery in 2011, there is a limited need to use the traceability protocols. The traceability protocols would be used if cultured Northern Abalone from outside of Canada were found locally.	DFO
2-2f	Foster public support of court imposed sentencing that is appropriate to the [endangered]	In progress	Public support of court imposed sentencing has been fostered to the extent of DFO-developed media releases, following charges and convictions for illegal activity involving Northern Abalone, that contribute towards a positive public relations campaign. The most recent media release occurred in August 2016.	DFO

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
	status of Northern Abalone.			
2-2g	Continue to apply precautionary protocols (Lessard et al. 2007) for authorizing works or developments on, in and under the water.	In progress	The precautionary protocols developed by Lessard et al. (2007) continue to be used as a reference for any developments proposed in abalone habitat and to provide information on the extent that these developments may affect abalone recovery. These protocols can be found in appendix 4 of the action plan (DFO 2012).	**DFO**, Proponents
3-1a	Promote Northern Abalone stewardship projects.	In progress	Northern Abalone stewardship projects have been promoted through the distribution of brochures, posters, and newsletters through DFO offices and small harbours throughout the coast. HSP- and AFSAR-funded stewardship groups used traditional media and social media to promote Northern Abalone awareness and to highlight the coast-wide harvest closure.	AbRIG, DFO, Coastal FN, PC
3-1b	Continue to update a Northern Abalone website and newsletter(s) for interested parties and the general public.	In progress	The DFO Northern Abalone species profile is regularly updated, and other Northern Abalone web resources are available through the DFO website. The Haida Gwaii Marine Stewardship Group (HGMSG) maintains a Northern Abalone website. Newsletters are developed and distributed regularly within communities by various abalone stewardship groups. Topics include abalone biology, population-level threats, and programs aimed at mitigating these threats.	**DFO**, Coastal FN, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants[5]
3-1c	Work with First Nations, interested local parties, stakeholders and international agencies.	In progress	Abalone Recovery Implementation Group (AbRIG) meetings are held twice per year (with additional bi-lateral meetings held as necessary). DFO continues to partner with First Nations stewardship groups and PC to conduct research, education, monitoring, and patrolling activities for Northern Abalone. See activities 2-2c and 2-2d for more detail. Throughout the reporting period, community outreach and education about the endangered status of Abalone, and regular patrols were undertaken by DFO in communities near Northern Abalone habitat. Collaboration with international agencies occurs regarding illegal harvest or sale. See activity 1-1h in this table and activity 2-1-3a in table 3 for more detail and examples.	AbRIG, California Department of Fish and Wildlife (CDFW), Coastal FN, DFO, PC, USFWS, USNMFS, U.S. Customs, Authorities in Mexico
3-1d	Produce communication materials (for example, posters, stickers, and brochures) aimed at stopping illegal harvest.	In progress	Various communication materials have been produced in the reporting period aimed at stopping illegal harvest. HSP and AFSAR funds have been used to create and distribute various materials aimed at raising awareness about the threats to Northern Abalone, and how to report suspected or witnessed incidents of illegal harvest. These include: • newsletters • brochures/pamphlets • posters including the ORR line information (distributed to small craft harbours) • various other communication materials, including: stickers, tee shirts, hats, temporary tattoos, buttons, canvas totes, coffee mugs and backpacks	Coastal FN, DFO, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants [5]
			DFO has produced and distributed stickers and an informational brochure aimed at stopping illegal harvest and increasing awareness of Northern Abalone.	
3-1e	Initiate a proactive media relations campaign, and identify and co-ordinate media opportunities.	In progress	No formal media relations campaign has been initiated at this time. DFO uses a wide set of tools for media and the public to learn about Northern Abalone biology, conservation, and stopping illegal harvesting available on the DFO abalone webpage. DFO's regional and national social media accounts have shared information about Northern Abalone via: • Twitter in 2017, 2018, 2019 and 2020 • Facebook in 2017 and 2019 • Instagram in 2019	DFO
4-1a	Continue index site surveys (every 5 years).	In progress	DFO, along with members from several local First Nations, surveys Northern Abalone index sites on a rotating basis every 5 years. During the reporting period, index site surveys occurred in 2013 and 2018 on the West Coast of Vancouver Island and West Coast of Haida Gwaii, in 2014 and 2019 in the Queen Charlotte Strait, in 2016 on the Central Coast, in 2017 on the East Coast Haida Gwaii, and Georgia Basin in 2019. See table 5 in section 3.3.1 of this report for all Northern Abalone survey regions and the years they have been surveyed.	**DFO**, Coastal FN
4-1b	Establish index sites in Georgia Basin.	Completed	No further updates for this reporting period	DFO
4-1c	Develop an improved measure for 'patch' size.	Not started	Work on this measure has not yet begun.	DFO

3.1.1 Activities supporting recovery from the action plan

Table 3 provides information on the implementation of the recovery activities identified in the action plan (DFO 2012) from 2013 to 2021.

Broad Strategy 1: Management
- Approach 1-1: Maintain the fisheries closures for Northern Abalone

Broad Strategy 2: Protection
- Approach 2-1: Implement a compliance promotion and enforcement (proactive and reactive) plan for the recovery of Northern Abalone
    - Initiative 2-1-1: Education and shared stewardship activities
    - Initiative 2-1-2: Activities to monitor, detect and respond to cases of non-compliance
    - Initiative 2-1-3: Develop major cases and intelligence-based investigations on illegal abalone trade

Broad Strategy 3: Education and awareness
- Approach 3-1: Implement a communications campaign to stop illegal harvest and raise public awareness of Northern Abalone
    - Initiative 3-1-1: Continue to raise awareness of the plight of the abalone and the threats to their survival
    - Initiative 3-1-2: Stop or discourage illegal harvesting activities
    - Initiative 3-1-3: Significantly reduce demand for (illegal) Northern Abalone by targeting sales and consumption of Northern Abalone

Broad Strategy 4: Research and population rebuilding
- Approach 4-1: Research on Northern Abalone to improve understanding of abalone recruitment and species interactions
- Approach 4-2: Continue to promote abalone population rebuilding initiatives in collaboration with First Nations and other coastal communities

Broad Strategy 5: Population monitoring
- Approach 5-1: Monitor population status of Northern Abalone

Table 3: Details of activities identified in the action plan supporting the recovery of the Northern Abalone from 2013 to 2021.

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
1-1a	Maintain fisheries closures under the *Fisheries Act* and Regulations (1993) to recreational, commercial and First Nations' food, social and ceremonial abalone fisheries to limit mortalities and declines in abundance.	Completed, ongoing	Refer to measure 2-1 in table 2.	**Fisheries and Oceans Canada (DFO)**, Canadian Coast Guard (CCG)
1-1b	Restrict release of detailed data on abalone distribution and occurrence collected as a result of monitoring surveys, or proposal reviews conducted under the *Fisheries Act*, *Canadian Environmental Assessment Act*[8] or the *Species at Risk Act* (SARA), in order to mitigate threats to both individual abalone (illegal harvest) and willful destruction of critical habitat for abalone.	Completed, ongoing	Detailed data on Northern Abalone distribution, occurrence and critical habitat is considered highly sensitive and was not made public during the reporting period. As illegal harvest significant threat to Northern Abalone recovery, detailed geospatial information is not included in the SARA public registry pursuant to SARA section 124.	ALL
1-1c	Continue to employ the monitoring requirements in the impact assessment protocol (Lessard et al. 2007) for works and development in abalone habitat and critical habitat.	In progress	Refer to measure 2-2g in table 2. The protocol can be found in appendix 4 of the action plan (DFO 2012).	**DFO**, Parks Canada (PC), Proponents

---

[7] Lead participant(s), where applicable, is/are listed on top and in bold; other participants are listed alphabetically.
[8] The *Canadian Environmental Assessment Act* was repealed with the coming into force of the *Impact Assessment Act* in August 2019.

Approach and activity #	Activity	Status	Descriptions and results	Participants[7]
2-1-1a	Engage clients, stakeholders and First Nations in compliance decision-making, monitoring agreements, and activities.	In progress	DFO and stewardship groups supported through the Aboriginal Fund for Species at Risk (AFSAR) and the Habitat Stewardship Program (HSP) have prioritized engaging with key parties regarding compliance with SARA, monitoring of Northern Abalone at First Nations index sites, and general compliance promotion. The Northern Abalone Recovery Implementation Group (AbRIG) is a forum for engaging around compliance, research, monitoring and other/all topics related to Northern Abalone. The terms of reference for AbRIG were finalized in February 2018 and include guidance for long-term continued engagement on Northern Abalone recovery.	**DFO,** AbRIG, British Columbia Coastal Communities (BCCC), Coastal First Nations (FN), PC
2-1-1b	Discuss abalone protection with individuals at wharves, on general patrols, at community events, and at schools.	Completed, ongoing	Over 30 Northern Abalone projects were funded through HSP and AFSAR between 2013 and 2021, all of which have supported general outreach regarding Northern Abalone protection. These have taken place: • at wharves and docks • at community events (for example, the All Native Basketball Tournament) • at schools (see activity 3-1-1 of this table)	**DFO,** Coastal FN, PC
2-1-1c	Interact with clients and stakeholder groups, First Nations, industry and interested parties on the importance of abalone protection.	Completed, ongoing	AbRIG is the primary forum for interaction and engagement with stakeholder groups and First Nations regarding the importance of Northern Abalone recovery and protection.	AbRIG
2-1-1d	Promote abalone protection and the Observe-Record-Report	Completed, ongoing	Abalone protection and the ORR line has been promoted by DFO, First Nations, and other	**DFO,** Coastal FN,

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
	(ORR) toll-free reporting line (1-800-465-4336).		stewardship groups through: posters, pamphlets, stickers and magnets, community outreach, print and social media, newsletters, the DFO Northern Abalone website, recovery documents, public notices, Coast Watch funding, training, and workshops.	Non-governmental Organizations (NGOs), PC
2-1-2a	Surveillance of port and offloading sites	In progress	DFO uses surveillance to gather information on potential illegal harvest, as well inspections and patrols at common sites that abalone may be shipped and received through, such as airports and shipping ports.	**DFO**, CCG
2-1-2b	Conduct extensive on-the-water patrols, dive patrols and air patrols (including covert operations) to monitor areas, vessels and persons of interest.	In progress	DFO, PC and partners continue to conduct on-the-water, dive, and air patrols to monitor for any illegal harvest of Northern Abalone.	**DFO**, CCG, PC, FN partners
2-1-2c	Build partnerships with other Canadian and international agencies (for example, Department of Justice [DOJ], Royal Canadian Mounted Police [RCMP], Environment and Climate Change Canada [ECCC], and Canadian Food Inspection Agency [CFIA]).	In progress	DFO has ongoing partnerships with other Canadian and international agencies both for enforcement of the SARA prohibitions (for example, harvest, transport, or sale of Northern Abalone) and for ongoing research efforts. Agencies involved include the United States National Marine Fisheries Service (USNMFS), the State of California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (USFWS), U.S. Customs, and authorities in Mexico.	**DFO**, CDFW, Canadian Border Services Agency (CBSA), CFIA, DOJ, ECCC, PC, British Columbia Government (BC Gov.), RCMP, USNMFS, USFWS,

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
				U.S. Customs, Authorities in Mexico
2-1-2d	Respond to cases of non-compliance (for example, warnings, alternative measures, orders, prosecutions, community-based justice processes).	In progress	All cases of non-compliance are reviewed and responded to by DFO Fisheries Officers on a case-by-case basis. These include situations on the shores and the water, and in urban locations including ports of entry, air cargo, brokers, wholesale shellfish distributers, cold storages, fish processing plants, restaurants, and apothecaries. These are responded to and charges are laid as appropriate. These may include fines, community justice, confiscations, and warnings (Demsky pers. comm. 2021).	**DFO**, DOJ, Public Prosecution Service of Canada (PPSC)
2-1-3a	Build intelligence to disrupt the illegal supply-demand chain.	In progress	DFO continues to build intelligence to disrupt the illegal Northern Abalone supply-demand chain through monitoring and surveillance, including regular vessel patrols and flights in collaboration with other national and international agencies. Intelligence-based investigations have led to convictions. In 2016, DFO concluded a several-year operation involving the sale and possession of Northern Abalone. Consequently, a Richmond food wholesaler was fined $77,500.	**DFO**, RCMP
2-1-3b	Follow up on tips received from the public, informants and partners.	In progress	Tips from the public are an important source of information for DFO in the long-term protection of Northern Abalone. All information regarding potential illegal occurrences is reviewed and followed up on a case-by-case basis. All	**DFO**, CDFW, CBSA, CFIA, ECCC, PC, BC Gov., RCMP,

Approach and activity #	Activity	Status	Descriptions and results	Participants 7
			occurrences are logged into a database (Demsky pers. comm. 2021). DFO has long-standing relationships with partners across jurisdictions and international borders, including with the National Marine Fisheries Service, the State of California Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, U.S. Customs, and authorities in Mexico. Tips shared by these partners are an important part of DFO's targeted investigations and inspections.	USNMFS, USFWS, U.S. Customs, Authorities in Mexico
2-1-3c	Work with national and international enforcement agencies to share intelligence and disrupt movement of abalone	In progress	DFO continues to work together with national and international enforcement agencies to share intelligence and disrupt the possession and sale of Northern Abalone. For example, in 2018, DFO concluded a 3-year operation involving the sale and possession of Northern Abalone (Demsky pers. comm. 2021). The operation involved collaborating with other Canadian agencies.	**DFO**, CDFW, CBSA, CFIA, ECCC, BC Gov., RCMP, USNMFS, USFWS, U.S. Customs, and authorities in Mexico
2-1-3d	Continue to review development proposals under the *Fisheries Act* following the Northern Abalone impact assessment protocol (Lessard et al. 2007) to mitigate harmful alteration, disruption or destruction of abalone habitat and critical habitat.	In progress	Refer to approach and activity 2-2g in table 2.	**DFO**, PC, Proponents

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
3-1-1a	Continue to provide communications support to stewardship activities to further the First Nations and community involvement in the abalone action plan.	In progress	Refer to approach and activity 2-2c in table 2 for more detail on the communications support and stewardship activities.	**DFO**, AbRIG, BCCC, Coastal FN, NGOs, PC
3-1-1b	Promote delivery of the education tool kit through distribution and use within the public education system.	Completed	Through HSP, AFSAR, and AbRIG and the work of DFO and stewardship partners several different educational programs have been developed for students from grade 1 through 10. These educational programs include traditional classroom learning as well as learning in the field and through traditional knowledge. Northern Abalone and other species at risk are also included in the curriculum for Adventure Camps in Gwaii Haanas. These education programs have reached over 700 students since 2013. Further, in 2015 DFO developed a free and publicly available Northern Abalone lesson-plan and tool-kit for teachers of grade 8 students. These Northern Abalone lesson plans and materials are based in the core units of science, math, and social studies (DFO 2015b).	**DFO**, AbRIG, Coastal FN, NGOs, PC
3-1-1c	Continue to use abalone displays at public events and in public areas, and identify new and upcoming events at which to promote abalone information.	In progress	DFO and partners have promoted the dissemination of Northern Abalone information at public events and through signage and posters in public areas during the reporting period. Refer to measures 2-2d and 3-1a in table 2 for more information.	**DFO**, AbRIG, Coastal FN, NGOs, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants[7]
3-1-1d	Engage in media relations to highlight abalone issues, status and stewardship successes.	In progress	DFO ensures that there is media available to: • learn about Northern Abalone biology, conservation, and stopping illegal harvesting • increase awareness of the threats of harvest and sale to Northern Abalone • promote the ORR telephone number • draw attention to convictions DFO, through HSP and AFSAR funding programs, has supported the use of traditional media and social media by stewardship groups to promote Northern Abalone awareness and to highlight the coast-wide harvest closure. DFO's regional and national social media accounts promoted information about Northern Abalone biology, threats, fisheries closures, resources, and successes within the reporting period.	**DFO**, AbRIG, Coastal FN, NGOs, PC
3-1-2a	Continue to promote the Abalone Coast Watch Program and the ORR phone number (for example, sticker/card with reporting information and phone number).	In progress	Refer to measure 2-2d in table 2 for details on the promotion of the Abalone Coast Watch program. Refer to approaches 2-1-1 of this table to see how the ORR phone number was promoted.	**DFO**, AbRIG, Coastal FN, NGOs, PC
3-1-2b	Continue to involve First Nations and other coastal communities in monitoring and reporting poaching activities.	In progress	Indigenous-led Northern Abalone Coast Watch programs are in place throughout the majority of coastal BC, which include monitoring and reporting of suspicious activities to the DFO ORR line.	**DFO**, AbRIG, BCCC, Coastal FN, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants 7
			The Watchmen of Haida Gwaii also monitor and report any suspicious activities to responsible authorities.	
3-1-2c	Engage in media relations to deter illegal harvest, and raise awareness of enforcement actions and results (for example, arrests, convictions, fines).	In progress	Refer to approaches and activities 2-2a and 2-2f in table 2.	DFO
3-1-2d	Where possible, foster public support of court-imposed sentencing that is appropriate to the 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.	In progress	DFO issued a press release available to the general public in August of 2016 that focused on a wholesaler that was fined for illegal possession of Northern Abalone. This release included details of the sentencing and investigation, quick facts on Northern Abalone and its endangered status, and the ORR line information. There has been no other court-imposed sentencing during the reporting period.	DFO
3-1-3a	Engage in media and public relations to explain the distinction between illegal and legal types of abalone in the marketplace.	Not started	Work has not commenced by DFO on this activity.	DFO
3-1-3b	Foster restaurant (for example, "We only use legal abalone" sticker) and consumer-directed awareness programs (for example, Marine Stewardship Council, Seafood Watch).	Not started	Work has not commenced by DFO on this activity.	**DFO**, NGOs

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
4-1a	If a disease is detected, conduct examinations to identify the cause of disease(s). If the disease is determined to be infectious, investigate the etiological agent to identify the pathogen and determine the biology of the pathogen to find methods of prevention or control.	In progress	No Northern Abalone from BC have been submitted for disease examination since 2010 (Meyer pers. comm. 2021). Refer to activity 1-1e in table 2 for more information.	DFO
4-1b	Conduct computer simulations to determine potential larval dispersal mechanisms.	Not started	No computer simulations of potential larval dispersal mechanisms have been conducted since 2008.	DFO, PC
4-1c	Kinship analyses may be conducted to identify adults to their progeny in support of linking the source of adult concentrations with the proportion of their recruited progeny in an area in (i) wild adult aggregation studies, and (ii) hatchery-raised abalone outplanting studies.	Not started	No research on kinship analysis was conducted during the reporting period.	**Academia**, DFO, PC
4-1d	Investigate ecological interactions with Sea Otters and their role in the recovery of Northern Abalone by establishing pilot research areas where Sea Otters occur to determine abalone population parameters under the effects of Sea Otters and to determine	In progress	From 2013 to 2021, several studies have investigated ecological interactions between Sea Otter and Northern Abalone. Lee et al. (2016) researched the impacts of Sea Otters on Northern Abalone by surveying subtidal rocky reef sites varying in Sea Otter occupation time in 3 regions of BC and found that:	**DFO, PC**, FN, NGOs, Academia

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
	population and distribution objectives in the presence of Sea Otters.		• sites occupied by Sea Otters for over 30 years had 16 times lower densities of exposed abalone than sites where otters have yet to recover, but higher densities of cryptic abalone • Sea Otter occupancy was the best predictor of exposed abalone density among all of the environmental factors considered in the analysis • Abalone densities were higher in deeper parts of sites occupied by Sea Otters compared to sites where otters have yet to recover Curtis and Zhang (2018) analyzed DFO Northern Abalone index site survey data from 2000 to 2016 and found that in contrast to the other survey regions, Northern Abalone at index sites in the West Coast Vancouver Island (WCVI) region, which is occupied by Sea Otters, appear to be in decline and are moving away from the population and distribution objectives outlined in the action plan. Obradovich et al. (2021) also evaluated DFO Northern Abalone index site survey data up to and including 2019 surveys and reported an increase in abalone density at WCVI index sites in 2018 surveys relative to all previous surveys in the WCVI region. Obradovich et al. (2021) also concluded that there remains uncertainty about the causal relationship between Sea Otter occupancy and abalone population parameters. In contrast to the conclusions described above, Hansen et al. (2020) found a positive correlation	

Approach and activity #	Activity	Status	Descriptions and results	Participants[7]
			between Sea Otter occupancy and Northern Abalone density in Southern BC regions. For more information see activity 1-1d in table 2. Since 1999, the Kitasoo Abalone Stewardship Program has undertaken long-term population monitoring on a central coast Northern Abalone population in an area that is also seeing recovery of Sea Otters. This research will be important to help increase understanding of the dynamic impacts of Sea Otters on Northern Abalone in particular and ecosystems more generally. Taken together, these studies provide insight into the role of Sea Otter in the recovery of Northern Abalone, but highlight remaining knowledge gaps. Updated population and distribution objectives that account for Sea Otter and Northern Abalone ecological interactions have not been established and further research is required to determine if conservation targets that do not account for Sea Otter are achievable (Obradovich et al. 2021). See activity 1-1d in table 2 for more information on Sea Otter foraging behaviour. See activity 1-1i in table 2 for related research.	
4-1e	Evaluate feasibility and effectiveness of pilot aggregation and translocation projects.	In progress	Refer to activity 1-1a in table 2.	**DFO**, Coastal FN

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
4-1f	Evaluate the feasibility and effectiveness of outplanting using data from pilot projects conducted between 2000 and 2010.	Cancelled	Refer to activity 1-1b in table 2.	**DFO**, Academia, Washington Department of Fish and Wildlife (WDFW)
4-1g	Promote additional traditional knowledge research, using appropriate and respectful methods (for example, HMTK Study Participants et al. 2008).	In progress	Haida and Heiltsuk First Nations each undertook work to facilitate contribution of their traditional knowledge and experiential (local) knowledge to advance Northern Abalone and Sea Otter recovery and conservation in northern BC. This work was prior to this reporting period, but the confidential reports were made available to DFO in 2014. An Abalone Traditional Knowledge Project was initiated in October 2019, involving interviews with Haida Knowledge Holders. This project is an ongoing collaboration between University of Victoria (UVic), the Council of the Haida Nation and DFO (Rooper pers. comm. 2021).	**FN**, DFO, PC, UVic
4-2a	Conduct small scale enhancement of habitat to monitor and increase survival of early abalone benthic stages.	In progress	See activity 1-1f in table 2 for a summary of the pilot kelp forest restoration project between PC, Haida Nation and DFO. The intent of this project is to significantly reduce urchin abundance and, in turn, enhance marine health of kelp forests and rocky reefs and create more kelp forest habitat for Northern Abalone and other species at risk.	DFO, Haida Gwaii Marine Stewardship Group (HGMSG), PC, Council of the Haida Nation
4-2b	Examine growth, survival and distribution of early benthic	In progress	Research to improve our understanding of growth, survival, and distribution of early benthic stages of	Academia, DFO, FN, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
	stages in relation to local habitat, algal, predator and competitor species, in order to determine the parameters that contribute to higher juvenile densities (recruitment). Promote the participation of First Nations in identification of habitat requirements for the rebuilding program.		Northern Abalone in relation to predator and competitor species is ongoing. Participation of First Nations is supported through AbRIG and the DFO index site surveys. It has been found that the addition of complex substrate of any size, from thin layers of cobbles to thick layers of boulders, led to increased survival of juvenile abalone (Read et al. 2013). Increases in the density of size classes is potentially due to favourable settlement conditions beginning in about 2006, as evidenced by an increase in 1 to 2 year old individuals at each subsequent survey point (Curtis and Zhang 2018). This scenario has possibly been further enhanced by reduced predation pressure due to a near coast-wide absence of Sunflower Stars because of mass mortalities from sea star wasting disease beginning in 2012 (Hewson et al. 2014).	
5-1a	Continue index site surveys every 4–5 years (started 1978) in the North and Central Coast and Haida Gwaii, which includes the collection of habitat information.	In progress	Regions are surveyed on a 5-year rotation, with one region surveyed each year; the exception being West Coast Haida Gwaii (WCHG) and West Coast Vancouver Island (WCVI) which are surveyed in the same year. Refer to activity 4-1a in table 2, and table 5 for more information.	**DFO**, AbRIG, BCCC, FN
5-1b	Continue more recently established index surveys every 4–5 years (started 2003) on the	In progress	Refer to activity 4-1a in table 2, and table 5 for information on when these surveys occurred.	**DFO**, BCCC, FN

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
	West Coast of Vancouver Island, Georgia Basin, and in Queen Charlotte Strait, which includes the collection of habitat information.		Curtis and Zhang (2018) provides detail on site locations and the type of habitat information collected on these surveys.	
5-1c	Test new or modifications of existing survey methods to estimate the abundance of abalone of different life stages, aggregation size (patchiness), suitable habitat and habitat mapping.	In progress	DFO published "A Review of Dive Survey Methods for Northern Abalone in BC" (DFO 2016), in response to requested guidance on the selection and use of appropriate survey methods for Northern Abalone. This report is intended to support First Nations, proponents, and stakeholders in ensuring surveys are executed consistently coast-wide and in a manner such that data can be used to reliably assess population densities and monitor species recovery. Hansen et al. (2020) identified variables for standardization of the DFO Northern Abalone Index Site Survey data (1978 to 2018) based on survey methods and environmental variability to estimate trends in Northern Abalone densities in BC. Curtis et al. (2021) reported on juvenile sampling techniques for Northern Abalone based on research conducted in the Broken Group Islands within Pacific Rim National Park Reserve in the Barkley Sound, BC from 2002 until 2007. Nephin et al. (2020) developed a knowledge-based habitat suitability index to predict the probability of occurrence for Northern Abalone in the North and Central Coast areas. This model was extrapolated	DFO, PC

Approach and activity #	Activity	Status	Descriptions and results	Participants [7]
			to the rest of the BC coast by Obradovich et al. (2021), generating a new estimate of 6,985 km^2 for the extent of occurrence of Northern Abalone in BC waters.	

3.2 Activities supporting identification of critical habitat

Table 4 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat within the recovery strategy (DFO 2007). Each study has been assigned 1 of 4 statuses:

1) completed: the study has been carried out and concluded
2) in progress: the study is underway and has not concluded
3) not started: the study has been planned but has yet to start
4) cancelled: the study will not be started or completed

Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically.

Table 4: Status and details of the implementation of the schedule of studies to identify Northern Abalone critical habitat outlined in the recovery strategy.

	Study	Status	Descriptions and results	Participants[9]
1	Survey juvenile abalone to improve the 'cryptic model' (estimate of the portion of the population that remains cryptic and unavailable to survey).	Completed	Research that improves the 'cryptic model' for Northern Abalone was carried out and completed during the previous reporting period (DFO 2015a).	Fisheries and Oceans Canada (DFO), First Nations (FN)
2	Compare field observations from known abalone habitat to a predicted abalone habitat suitability model (Jamieson et al. 2004).	Not started	No new research has been completed within the reporting period. The habitat suitability index model used by Obradovich et al. (2021) has not yet been compared to field observations.	DFO
3	Determine the habitat characteristics that improve growth rates.	Not Started	No dedicated studies to identify the habitat characteristics that contribute to higher growth rates of Northern Abalone occurred within the reporting period. Refer to activity 1-1f in table 2 for information on the kelp forest restoration project between Parks Canada (PC), Haida Nation and DFO. The results of this could be used to	**DFO**, FN, PC

---

[9] Lead participant(s), where applicable, is/are listed on top and in bold; other participants are listed alphabetically.

	Study	Status	Descriptions and results	Participants[9]
			determine how beneficial the enhancement of kelp forests are to Northern Abalone survival and density.	
4	Examine growth, survival and distribution of early benthic stages in relation to local habitat, algal, predator and competitor species. Determine the parameters that contribute to higher juvenile densities (recruitment).	In progress	Research to improve our understanding of growth, survival, and distribution of early benthic stages of Northern Abalone in relation to predator and competitor species is ongoing. Refer to activity 4-2b in table 3 for more information.	**DFO**, FN, PC
5	As part of the protocol (Lessard et al. 2007), monitor the extent to which works and developments on, in and under the water may impact on abalone habitat and recovery.	In progress	The protocol includes monitoring approaches that allow for the determination of the impacts of projects, works, or developments on abalone abundance and density. It includes: • surveys at 1 to 3 plot sites within the area of impact plus a control site • follow-up surveys after 5 years These protocols continue to be used for any developments proposed in Northern Abalone habitat and continue to provide information on the extent that these developments may affect abalone recovery. Refer to measure 2-2g in table 2 for more information on the protocol.	**DFO**, PC, Proponents
6	Refine the predicted abalone habitat suitability model based on field observations.	In progress	The predicted Northern Abalone habitat suitability model developed by Jamieson et al. (2004) has not been refined based on field observations. However, other work to improve Northern Abalone habitat suitability modelling has occurred during the reporting period. A knowledge-based habitat suitability index model was developed by Nephin et al. (2020) for the North and Central Coast area and was used to estimate the extent of occurrence of Northern Abalone in all British Columbia (BC) waters (Obradovich et al. 2021). This model has not yet been compared to field observations.	**DFO**, PC

	Study	Status	Descriptions and results	Participants[9]
7	Examine abalone distribution in relation to local seawater current patterns and computer simulations to determine potential larval dispersal mechanisms.	Not started	No dedicated studies of Northern Abalone distribution in relation to local seawater current patterns have been conducted in this reporting period.	DFO

3.3 Summary of progress towards recovery

3.3.1 Status of performance measures

The following is a summary of the progress made towards the recovery of Northern Abalone as outlined in the updated performance measures from the action plan. Some of the questions from the 2007 recovery strategy were re-framed in the 2012 action plan to focus and support future analyses of performance and progress towards achieving the stated objectives (shown in **bold**). This progress report further notes specific assumptions built into 3 of the objective-based performance measures to better reflect their correlated population and distribution objectives and how they have been interpreted in practice (shown in **[bracketed bold]**). Additionally, 2 sub-measures have been included to facilitate reporting on the progress made towards population and distribution objective #2 regarding Queen Charlotte and Johnstone Straits (also shown in **[bracketed bold]**). Population and distribution objectives relating to the objective-based performance measures are stated in section 2.2 of this report.

Objective-based performance measures[10]:

The Haida Gwaii biogeographic zone referenced in the recovery strategy (DFO 2007) and the action plan (DFO 2012) corresponds with both the East Coast Haida Gwaii (ECHG) and West Coast Haida Gwaii (WCHG) Northern Abalone index site survey regions. Likewise, the North and Central Coast biogeographic zone corresponds with the Central Coast (CC) survey region.

Two main publications have been used to address and answer the objective-based performance measures. Obradovich et al. (2021) presents updated DFO data on Northern Abalone with the purpose of informing an upcoming COSEWIC status re-assessment. Curtis and Zhang (2018) presents survey data collected by DFO at the Northern Abalone index sites from 2000 to 2016.

1) Did the mean density of large adult (> 100 mm SL) Northern Abalone decline below 0.1 per m^2 at surveyed index sites in Haida Gwaii and North and Central Coast? Or did it increase?

    This objective has not been fulfilled. Obradovich et al. (2021) reported observed and estimated posterior mean densities (Abalone per m^2) for the index site survey regions by size category based on SL.

    - In the CC survey region, the observed mean density of large adult Northern Abalone increased slightly from 0.07 individuals per m^2 in 2011 to 0.08 individuals per m^2 in 2016
    - In the ECHG survey region, the observed mean density of large adult Northern Abalone remained the same at 0.05 individuals per m^2 in 2012 and 2017
    - In the WCHG survey region, the observed mean density of large adult Northern Abalone increased from 0.02 individuals per m^2 in 2013 to 0.04 individuals per m^2 in 2018

    Curtis and Zhang (2018) analyzed Northern Abalone index site surveys in BC from 2000 to 2016. They found that:

---

[10] Survey data presented here are specific to the index sites surveyed and may not reflect the greater population of Northern Abalone within a region or the entire BC coast.

- by 2016, the estimated mean density for large Northern Abalone for CC survey region had continued to increase from 0.043 ± 0.015 (standard error) in 2001 to 0.085 ± 0.029 in 2016, with a decline below the 2001 value observed only in 2006
- the estimated mean density of large Northern Abalone adults in the ECHG survey region increased from 0.026 ± 0.008 individuals per m^2 in 2007 to 0.051 ± 0.014 individuals per m^2 in 2012
- in the WCHG survey region, large Northern Abalone adults were absent in 2008, and the observed mean density for this size class in 2013 was 0.018 ± 0.010 individuals per m^2

2) Did the percentage of surveyed index sites with large adult (> 100 mm SL) Northern Abalone decrease (< 40%) at surveyed index sites **[in Haida Gwaii and the North and Central Coast]**)? Or did it increase (> 40%)?

This objective has been partially fulfilled. The percentage of sites on the ECHG survey region as well as CC survey region with large adult Northern Abalone has begun to increase. Results of the 2012 survey of the ECHG index sites showed that the percentage of sites with large Northern Abalone increased to 30.2% ± 17.4% (mean ± 95% confidence interval) and was no longer significantly below 40% (Curtis and Zhang 2018). A similar pattern has been observed for the CC survey region, with survey results in 2011 and 2016 showing that the percentage of sites with large Northern Abalone has increased to approximately 40% (Curtis and Zhang 2018).

[2a. Did the mean total densities of Northern Abalone in the Queen Charlotte Strait[11] decline below 0.06 Northern Abalone per m^2 or in the Johnstone Strait did it decline below 0.02 Northern Abalone per m^2? Or did one or both increase?]

This objective has been partially fulfilled. Curtis and Zhang (2018) reported on the results of the index site surveys of the Queen Charlotte Strait (QCS) survey region, which are divided into 2 areas[12]: Gordon Channel (GC; established in 2004) and North Queen Charlotte Strait (NQCS; added in 2009). Index Sites in the GC Area provide the most relevant comparisons to the population and distribution objectives outlined in the action plan since the NQCS Area was not added until 2009, after the objectives in the action plan were developed. The estimated mean total density for all size classes of Northern Abalone in GC increased between 2004 and 2009, and then remained relatively stable between 2009 and 2014 at 0.164 ± 0.061 (standard error) and 0.147 ± 0.046 individuals per m^2 respectively (Curtis and Zhang 2018). 2014 surveys of index sites in NQCS indicate that the estimated mean total density in this area was 0.051 ± 0.026 individuals per m^2. This is not significantly less than the observed 2009 density of 0.063 individuals per m^2 (Curtis and Zhang 2018). Johnstone Strait was not resurveyed based on the recommendation of Davies et al. (2006), given the limited suitable abalone habitat in the area.

Obradovich et al. (2021) reported observed and estimated posterior mean densities by size category for the QCS survey region. In this analysis, the QCS survey region was not divided into the 2 areas. The observed mean total density increased from 0.04 individuals per m^2 in 2004 to 0.11 individuals per m^2 in 2009, dropping to 0.09 individuals

[11] The QCS survey region corresponds to the "Queen Charlotte and Johnstone Straits" biogeographic zone referenced in the recovery strategy (DFO 2007) and the action plan (DFO 2012).
[12] The site selection criteria used prevents direct comparisons between density estimates from GC and NQCS.

per m^2 in 2014 (Obradovich et al. 2021). Survey data from Johnstone Strait (surveyed in 1986 and 2004) was not included in this analysis as these sites contained limited abalone habitat and are no longer surveyed as part of the index site surveys.

[2b. Did the mean total densities of Northern Abalone in the West Coast of Vancouver Island decline below 0.09 Northern Abalone per m^2? Or did it increase?]

Analysis of 2018 index site survey data indicates that Objective 2(b) was fulfilled during that survey year (Obradovich et al. 2021). The West Coast Vancouver Island (WCVI) region was most recently surveyed in 2013 and 2018. From the establishment of this region's index sites in 2003 until 2013, a decline was observed in the densities of each size category (Curtis and Zhang 2018). This decline was most pronounced for the adult size class where the observed density was 9 times lower in 2013 than in 2003. The 2013 index site survey results in the WCVI region showed a mean total density of 0.063 ± 0.019 (standard error) Northern Abalone per m^2. In the Obradovich et al. (2021) analysis, the observed mean total density for the WCVI decreased from 0.16 individuals per m^2 in 2003 to 0.09 individuals per m^2 in 2013; however, it then increased to 0.26 individuals per m^2 in 2018.

Larger abalone (> 100 mm SL) were noticeably absent from the WCVI survey region where Sea Otters have been present at the index sites for up to 42 years in some areas. See table 2, activity 1-1d, and table 3, activity 4-1d, for more detail on ecological interactions between Northern Abalone and Sea Otter, and remaining knowledge gaps around the role of Sea Otter in Northern Abalone recovery.

3) At index sites **[In areas without Sea Otters]** was the annual estimated mortality rate for mature (≥ 70 mm SL) abalone reduced to < 0.20, and the mean densities of mature (≥ 70 mm SL) abalone increase to greater than 0.32/m^2?

This objective has been partially fulfilled. The annual estimated mortality rate for mature abalone was not reduced to < 0.20 in localised areas where site index data was collected within the period of this progress report (Curtis and Zhang 2018; Obradovich et al. 2021). The mortality rate was estimated to be 0.252 ± 0.016 (standard error) within the ECHG region from 1990 to 2012 (Curtis and Zhang 2018). For mature Northern Abalone in the CC region, the mortality rate was estimated to be 0.295 ± 0.023 from 1993 to 2016 (Curtis and Zhang 2018).

The estimates of annual mortality rates provided by Curtis and Zhang (2018) are lower than those by Obradovich et al. (2021) for the ECHG survey region and the CC survey region in areas with Sea Otters present, but higher than the estimate for the CC survey region in areas where Sea Otters are absent. Obradovich et al. (2021) estimates of annual mortality rates by survey region are as follows:
- 0.60 ± 0.05 per year in the ECHG survey region (2012 to 2017, sea otters absent)
- 0.42 ± 0.07 per year in the CC survey region (1993 to 2016) in areas where Sea Otters were present
- 0.20 ± 0.02 per year in the CC survey region (1993 to 2016) in areas where Sea Otters were absent (Obradovich et al. 2021)

While mortality rates were higher in areas of Sea Otter presence, further work is needed to understand the specific contributions of Sea Otter predation, illegal harvest and other factors to total Northern Abalone mortality (Obradovich et al. 2021).

The estimated mean densities of mature abalone increased to be greater than 0.32 per m² for 2 of the 3 bio-regions where this recovery target applies (ECHG, WCHG CC) and where index site data was collected within the period of this progress report. Densities for Northern Abalone have been slowly increasing in areas without Sea Otters, though there is a high degree of variability in adult density between and within regions and areas. Curtis and Zhang (2018) reported that the mean density of mature abalone was 0.353 ± 0.084 in 2012 for the ECHG region, noting that given the standard error, the possible mean density of mature abalone could be below 0.32 individuals per m². Obradovich et al. (2021) reported that the estimated observed mean density of mature Northern Abalone was 0.37 individuals per m² during the 2012 surveys of ECHG, which then decreased slightly to 0.36 individuals per m² in 2017. Observed mean densities of Northern Abalone in the CC were estimated at 0.44 individuals per m² in 2011, and increased to 0.60 individuals per m² during the 2016 surveys in that region (Obradovich et al. 2021). In the WCHG region, between 2008 and 2018, mature Northern Abalone observed mean density increased from 0.06 to 0.49 individuals per m² (Obradovich et al. 2021).

4) At index sites **[In areas without Sea Otters]** were more than 40% of the quadrats (m²) occupied by abalone?

This objective has been fulfilled. Within the period of 2013 to 2018, more than 40% of the quadrats were occupied by abalone in index sites without Sea Otters (Curtis and Zhang 2018). This target was met on the ECHG as of 2012, WCHG as of 2013, and CC as of 2016, though there are sea otters present at the southern end of the CC index area. The percentage of quadrats with Northern Abalone amalgamates both density and dispersion, providing a coarse scale view of aggregative behaviour.

Action-based performance measures:

Management

5) Was the coast-wide closure to Northern Abalone harvesting maintained and enforced?

The coast-wide closure to harvesting of Northern Abalone has remained in place since 1990 and has been enforced. There are ongoing patrols for, and investigations into, potential illegal harvests, possession, and sales of Northern Abalone (Demsky pers. comm. 2021). The majority of the efforts to curtail the threat of illegal harvest on Northern Abalone are concentrated on the sale and transport of illegally obtained abalone. While efforts to monitor for illegal harvest continue, it is also of great importance to disrupt the market demand for Northern Abalone by apprehending individuals and organizations that are purchasing, possessing, and/or selling it.

6) Is there evidence for success in detecting and apprehending illegal harvesters?

Up until 2018, there were several multi-year investigations into illegal harvest, possession, and sale of Northern Abalone (Demsky pers. comm. 2021) that have led to charges being approved to proceed to court. The amount of calls to the Observe-Record-Report (ORR) line received by enforcement officers has declined since the last reporting period (77 calls between 2007 and 2012, and 40 between 2013 and December 31, 2021).

Protection

7) Was a proactive protective enforcement plan implemented?

A proactive enforcement plan for Northern Abalone has been in place since the species was listed under SARA in 2003. Annual compliance promotion work plans are prepared for all abalone-related activities. Coast-wide proactive protection measures included preventative enforcement patrols, intelligence gathering, and community stewardship and conservation activities such as community-based Coast Watch programs.

8) How many reports relating to abalone harvesting were provided to enforcement officers and the toll free enforcement line (Observe-Record-Report [ORR])?

Enforcement officers at the ORR line received a total of 40 reports related to Northern Abalone between 2013 and 2021. In addition to these reports, information from the public is often communicated to DFO during patrols and public visits to DFO detachments. Abalone patrols by stewardship groups have also directly resulted in several reports, both to regional DFO staff and/or to the ORR line.

9) To what degree were these reports investigated and resulted in charges and convictions?

All reports to the ORR are reviewed by an official and recorded. Responses vary depending on the severity and reliability of the report and are responded to as appropriate. All violations are entered into a database. Many of these reports led to investigations by fishery officers to determine whether a violation had occurred and charges were laid for confirmed violations.

10) How many hours were spent on enforcing abalone closures?

DFO has dedicated thousands of hours to enforcing Northern Abalone closures. This includes patrols, inspections, and long-term and covert investigations. DFO-funded Northern Abalone Stewardship groups and Coast Watch members have dedicated over 3,150 days to at-sea monitoring patrols (dedicated and opportunistic) since 2013.

11) What were the trends in enforcement hours and resulting charges and convictions over the period before and during implementation of the recovery strategy?

Illegal possession and sale of Northern Abalone has resulted in fines as high as $77,500 as well as the confiscation of vehicles and vessels. This is an increase from smaller fines imposed in the past, both before and after the assent of SARA.

12) Has the impact of the illegal harvest been studied further?

Camaclang et al. (2017) developed a spatially explicit simulation model of poaching behaviour to estimate the influence of the intensity, frequency, and spatial distribution of poaching on the population viability of Northern Abalone in Barkley Sound, BC. They integrated this model of poaching with a stochastic, habitat-based, spatially explicit population model and applied it to examine the impact of poaching on metapopulation dynamics in Barkley Sound. They found that while demographic parameters remained important in predicting extinction probabilities for Northern Abalone, simulations indicate that the odds of extinction are twice as high when populations are subjected to poaching.

Education and awareness

13) Was a long-term communications strategy implemented?

A long-term communications strategy has been in place for Northern Abalone since the development of the recovery strategy in 2007. Multiple communications activities were undertaken within the reporting period, both by DFO and Northern Abalone stewardship groups. Refer to activities 2-2c and 3-1d in table 2 for a summary of communications materials that were created and how they were promoted.

14) How many and what kind of communication materials and/or actions were produced and/or undertaken?

A wide variety of materials and approaches have been used to help raise awareness about the threats to Northern Abalone, and how to report suspected or witnessed incidents of illegal harvest. These included:
- newsletters (7 distributed)
- brochures/pamphlets (over 3100 distributed)
- posters (100+ distributed to small craft harbours)
- various other communication materials including: stickers and magnets, tee shirts, hats, temporary tattoos, buttons, canvas totes, coffee mugs, backpacks
- Coast Watch training and workshops
- community outreach
- print and social media
- stewardship group participation in community events including the All Native Basketball Tournament and Community days
- website maintained by Haida Gwaii Marine Stewardship Group (HGMSG)
- DFO Northern Abalone website including links to Northern Abalone video clips, publications, and lesson plans

15) How many people, and where, did the communications activities reach?

Results from Aboriginal Fund for Species at Risk (AFSAR) and Habitat Stewardship Program (HSP) final project reports submitted within the reporting period indicate that over 19,000 people were reached through communication and outreach efforts. These outreach materials reached people in the Gitga'at, Heiltsuk, Kitasoo, Metlakatla, Huu-ay-aht, Nisga'a, and Haida territories, as well as members of coastal communities around these territories. Communications activities conducted by DFO through the use of social media (including Facebook and Twitter) were targeted to the general public.

16) What indications for increased awareness and/or reductions in illegal harvest were a result of communication efforts?

Indications for increased awareness of threats to Northern Abalone and efforts to mitigate these threats include participation in Northern Abalone Coast Watch programs, attendance at community meetings, workshops, and Abalone Recovery Implementation Group (AbRIG) meetings, as well as use of the DFO ORR line. The number of volunteers participating in Coast Watch activities has continued to increase. Based on HSP and AFSAR reports, at least 650 people attended community meetings and/or workshops related to abalone conservation in the Haida, Kitasoo, Heiltsuk, and Metlakatla territories. AbRIG meetings, led by DFO, continue to be attended by representatives from First Nations and Parks Canada (PC). Several reports of suspected

illegal activity have been provided to DFO during the reporting period. An increase in
awareness is apparent, given the large number of people who attended various
workshops and have been involved in communication efforts.

Research and population rebuilding

17) What significant new knowledge was gained through research that would directly
contribute to the rebuilding of the Northern Abalone population?

There has been significant research completed between 2013 and 2021, both in BC and
internationally, that has contributed to the overall knowledge of Northern Abalone and
other abalone species (that may be applied to Northern Abalone as well) including:
- a greater understanding of the impacts of Sea Otters on Northern Abalone
  abundance, size, and behaviour (Lee 2016; Lee et al. 2018)
- research on the potential impacts of climate change on abalone species, which
  may assist in adaptively managing Northern Abalone (Boch et al. 2018)
- a stock status and re-analysis of index site surveys in BC. (Curtis and Zhang
  2018)
- identification of variables for standardization of the DFO Northern Abalone Index
  Site Survey data (1978 to 2018) based on survey methodology and environmental
  variability to estimate trends in Northern Abalone densities in BC (Hansen et al.
  2020)
- a knowledge-based habitat suitability index to predict the probability of occurrence
  for Northern Abalone in the North and Central Coast area (Nephin et al. 2020)
- an updated summary of DFO information on Northern Abalone in Canadian
  Pacific waters for use in the upcoming abalone status re-assessment by the
  Committee on the Status of Endangered Wildlife in Canada (Obradovich et al.
  2021)
- a report on juvenile sampling techniques for Northern Abalone based on research
  conducted in the Broken Group Islands in the Barkley Sound, BC from 2002 until
  2007 (Curtis et al. 2021)

18) How many population rebuilding initiatives were undertaken?

There were no new outplanting or aggregation population rebuilding initiatives
undertaken during the reporting period, though results based on previous population
rebuilding initiatives outside of this reporting period have now been published. See
activities 1-1a and 1-1c in table 2.

19) Was there an observed increase in juvenile abundance and/or recruitment as a result of
rebuilding experiments?

There have been observed increases in juvenile abundance; however, this is likely the
result of many contributing factors and not primarily due to rebuilding experiments. A
more thorough understanding of this will be available when the review and synthesis of
aggregation work is completed (activity 1-1a in table 2).

20) Does rebuilding appear to be a viable or promising strategy to recover the wild abalone
population?

An understanding of this linkage is dependent on the ongoing work in activity 1-1a (table 2) and will be reported on in a subsequent progress report.

21) What reports were prepared which provide results of surveys and biological studies?

In November, 2018, DFO published the manuscript "Northern Abalone, *Haliotis kamtschatkana*, Stock Status and Re-analysis of Index Site Surveys in BC., 2000–2016" (Curtis and Zhang 2018). This report presents data collected for each of the biogeographic regions since either 2000 or the initiation of the survey and includes an analysis using a zero-inflated Bayesian model. Much of the data presented in this report has not been previously published, including surveys from 2008 to 2016. For more details see section 3.3.1.1.

In 2021, DFO published the research document "Pre-COSEWIC review of DFO information on Northern Abalone (*Haliotis kamtschatkana*) along the Pacific Coast of Canada" (Obradovich et al. 2021). This report assessed index site survey data from 1978 to present and used the Bayesian hurdle model standardized by environmental variables at the index sites to estimate posterior mean densities. For more details see section 3.3.1.1.

Also in 2021, Curtis et al. (2021) reported on juvenile sampling techniques for Northern Abalone based on research conducted in the Broken Group Islands in the Barkley Sound, BC from 2002 until 2007.

22) Were regular surveys continued in each of the biogeographic zones?[13]

Yes, ongoing Northern Abalone index site surveys are conducted in 6 survey regions in BC, which correspond to 5 biogeographic zones referenced in the recovery strategy (DFO 2007) and the action plan (DFO 2012). The survey regions, biogeographic zones and years each region was sampled can be found in table 1 of Obradovich et al. (2021) and have been included in table 5 below. No surveys were conducted in 2020 and 2021 due constraints resulting from the COVID-19 pandemic.

Table 5: Northern Abalone Index Site Survey regions, years each region was sampled and corresponding *Species at Risk Act* Recovery Strategy (DFO 2007) biogeographic zones (Obradovich et al. 2021).

Survey region	Years	Biogeographic zone
East Coast Haida Gwaii (ECHG)	1978,1979,1984, 1987, 1990, 1994, 1998, 2002, 2007, 2012, 2017	Haida Gwaii
Central Coast (CC)	1978, 1979, 1980, 1983, 1985, 1989, 1993, 1997, 2001, 2006, 2011, 2016	North and Central Coast
Queen Charlotte Strait (QCS)	2004, 2009, 2014, 2019	Queen Charlotte and Johnstone Straits
Georgia Basin (GB)	1982, 1985, 2005, 2009, 2019	Georgia Basin

---

[13] This was updated in the action plan from 'was baseline abundance established in each of the biogeographic zones?' That action has been completed.

| West Coast Vancouver Island (WCVI) | 2003, 2008, 2013, 2018 | West Coast Vancouver Island |
| West Coast Haida Gwaii (WCHG) | 2008, 2013, 2018 | Haida Gwaii |

3.3.2 Critical habitat identification and protection

Critical habitat for the Northern Abalone was identified in the action plan. The critical habitat identified in the action plan describes the geographical area that contains habitat necessary for the survival or recovery of the species. The critical habitat for Northern Abalone has been identified within 4 distinct geospatial areas: West Coast Haida Gwaii, East Coast Haida Gwaii, North and Central Coast, and Barkley Sound (figure 2 in DFO 2012). The current area identified is deemed to be sufficient to achieve the population and distribution objectives for the species. As illegal harvest is the most significant threat to Northern Abalone recovery, detailed geospatial information is not included in the SARA public registry pursuant to SARA section 124. The critical habitat for Northern Abalone has been protected against destruction under a SARA Critical Habitat Order made under subsections 58(4) and 58(5) in December 2017.

3.3.3 Socio-economic impact

As per section 49(1) (e) of SARA, the action plan included a socio-economic evaluation of the costs of the action plan and the benefits to be derived from its implementation (section 4 of the action plan). This section updates the socio-economic impacts associated with the implementation of the action plan between 2013 and 2021.

Many of the economic costs associated with implementation of recovery actions have been, and will continue to be, borne by government agencies (for example, DFO and PC). These were evaluated as a reallocation of existing government funds and are not considered additional costs to society. These government-funded actions have also had opportunity costs (which are the loss of any potential gain from activities that have not occurred as a result of action plan implementation); however, these are not easily quantified.

Actions to recover Northern Abalone, such as coast-wide fisheries closures, pre-date the listing of the species under SARA in 2003. This evaluation considers the economic costs and benefits of the recovery activities that have taken place over the reporting period of 2013 to 2021.

A large part of the economic costs that are borne by the federal government for Northern Abalone recovery are provided via the AFSAR and HSP funding programs, which represent a key approach to achieving recovery actions for Northern Abalone. Between 2013 and 2021, 34 projects that included Northern Abalone have received funding through these programs. These projects are vital to the recovery of Northern Abalone and fulfilling the performance measures from the action plan. Projects funded by HSP must have dollar and in-kind costs matched by the recipients receiving the funding, and for every $1 provided by AFSAR at least $0.20 is raised by project recipients.

Socio-economic benefits have arisen from the implementation of the recovery strategy and action plan, including positive impacts on biodiversity and the value individuals place on preserving biodiversity (Federal, Provincial, Territorial Governments of Canada 2014). These recovery actions have provided broader ecosystem and non-market benefits.

3.3.4 Recovery feasibility

Based on the best current available information, recovery of Northern Abalone is determined to be feasible (DFO 2007). No new information has been gathered that would suggest that Northern Abalone in BC no longer meets the feasibility criteria laid out in the recovery strategy.

4   Concluding statement

In the period of 2013 to 2021, through the implementation of the activities identified in the
Recovery Strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada and in the
Action Plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada, notable progress has
been made in recovering Northern Abalone, including:

- continued long-term population monitoring of Northern Abalone index sites along the BC
  coast
- continued enforcement of SARA and of *Fisheries Act* regulations to address illegal
  harvest and trade
- involvement of First Nations and coastal communities in Northern Abalone stewardship
  through local vessel patrols and Abalone Coast Watch or similar guardian programs,
  both through independently organized approaches and collaborations with DFO
- protection of critical habitat for Northern Abalone in 4 geographical areas through a
  Critical Habitat Order

While positive trends in Northern Abalone abundances and densities have been observed in
some survey regions, additional effort is required to understand underlying drivers and short and
long-term population implications of these trends, and to achieve all population and distribution
objectives. As stated in the action plan (DFO 2012), achieving long-term recovery goals is
expected to take several decades, given the species is slow-growing, has low and sporadic
recruitment, and reduced fertilization success at low densities. Priority next steps include:
increasing the number of index sites in Northern Abalone surveys, improving our understanding
of the relationships between Northern Abalone and Sea Otters in BC, continuing efforts to
address illegal harvest, and continued reviewing of development proposals in Northern Abalone
habitat in accordance with the established impact assessment protocol (see appendix 4 in the
action plan).

The Government of Canada remains committed to the recovery of the Northern Abalone. The
work started and completed to date has built a strong foundation for continued research and
management of this species over the next reporting period. Progress made to date would not
have been achieved without the contribution from our partners. The Government of Canada is
looking forward to continuing this successful collaboration and welcomes the participation of
additional partners.

5   References

Bettger, H., pers. comm. 2021. Email communication with J. Banning, April 2021. Senior
Compliance Program Officer, Fisheries and Oceans Canada. Tofino, British Columbia.

Boch, C.A., F. Micheli, M. AlNajjar, S.G. Monismith, J.M. Beers, J.C. Bonilla, A.M. Espinoza, L.
Vazquez-Vera, and C.B. Woodson. 2018. Local oceanographic variability influences the
performance of juvenile abalone under climate change. Sci Rep. 8: 5501-5512.

Camaclang, A.E., J.M.R. Curtis, I. Naujokaitis-Lewis, M.S. Poesch, and M.A. Koops. 2017.
Modelling the impact of poaching on metapopulation viability for data-limited species. Can. J.
Fish. Aquat. Sci. 74: 894-906.

Carson, H.S., D.J. Morin, J.V. Bouma, M. Ulrich, and R. Sizemore. 2019. The survival of
hatchery-origin pinto abalone *Haliotis kamtschatkana* released into Washington waters. Aquatic
Conser: Mar Freshw Ecosyst. 1-18.

COSEWIC. 2000. COSEWIC assessment and status report on the Northern Abalone *Haliotis
kamtschatkana* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
vi + 20 pp.

COSEWIC. 2009. COSEWIC assessment and update status report on the Northern Abalone
(*Haliotis kamtschatkana*) in Canada. Committee on the Status of Endangered Wildlife in
Canada. Ottawa. vii + 48 pp.

Crosson, L.M., N. Wight, G.R. VanBlaricom, I. Kiryu, J.D. Moore, and C.S. Friedman. 2014.
Abalone withering syndrome: distribution, impacts, current diagnostic methods and new
findings. Dis. Aquat. Organ. 108: 261-270.

Crosson, L.M., and C.S. Friedman. 2017. Withering syndrome susceptibility of northeastern
Pacific abalones: A complex relationship with phylogeny and thermal experience. J. Invertebr.
Pathol. 151: 91-101.

Curtis, D.L. and Z. Zhang. 2018. Northern Abalone, *Haliotis kamtschatkana*, stock status and re-
analysis of index site surveys in British Columbia, 2000–2016. Can. Man. Rep. Fish. Aquat. Sci
3162 vi + 164 pp.

Curtis, L.F., K.D. Swan, and J. Lessard. 2021. Northern Abalone, *Haliotis kamtschatkana*,
juvenile sampling techniques: A summary of methods tested in the Broken Group Islands,
Barkley Sound, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 3420: vi + 53 p.

Davies, K., M. Atkins, and J. Lessard. 2006. Survey of Northern Abalone, *Haliotis
kamtschatkana,* populations in Queen Charlotte and Johnstone Straits, British Columbia, May
2004. Ca. Manuscr. Rep. Fish. Aquat. Sci. 2743. 16 p.

Demsky, A., pers. comm. 2021. Telephone conversation with J. Banning. February, 2021.
Conservation and Protection Detachment Supervisor, Fisheries and Oceans Canada. Langley,
British Columbia.

DFO. 2007. Recovery strategy for the Northern Abalone (*Haliotis kamtschatkana*) in Canada. *Species at Risk Act* recovery strategy series. Fisheries and Oceans Canada, Vancouver. vi + 31 pp.

DFO. 2012. Action plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada. *Species at Risk Act* action plan series. Fisheries and Oceans Canada, Ottawa. vii + 65 pp.

DFO. 2015a. Report on the progress of recovery strategy implementation for Northern Abalone (*Haliotis kamtschatkana*) in Canada for the period 2007–2012. *Species at Risk Act* recovery strategy report series. Fisheries and Oceans Canada, Ottawa. v + 28 pp.

DFO. 2015b. Lesson plan - The Northern Abalone - species at risk.

DFO. 2016. Review of dive survey methods for Northern Abalone in British Columbia. Can. Sci. Advis. Sec. Sci. Resp. 2016/044. 28 pp.

Federal, Provincial, and Territorial Governments of Canada. 2014. 2012 Canadian nature survey: Awareness, participation, and expenditures in nature-based recreation, conservation, and subsistence activities. Ottawa, ON: Canadian Councils of Resource Ministers. 188 pp.

Hankewich, S. 2017. Kitasoo Abalone Stewardship Program. Kitasoo Abalone Stewardship Project Report. Kitasoo Fisheries Program. Klemtu. 15 pp.

Hansen, S.C., and L.A. Gosselin. 2013. Do predators, handling stress or field acclimation periods influence the survivorship of hatchery-reared abalone *Haliotis kamtschatkana* outplanted into natural habitats? AQUAT CONSERV. 23(2): 246-253.

Hansen, S.C., and L.A. Gosselin. 2016. Are hatchery-reared abalone naïve of predators? Comparing the behaviours of wild and hatchery reared Northern Abalone, *Haliotis kamtschatkana* (Jonas, 1845). Aquacult. Res. 47: 1727-1736.

Hansen, S.C., S.G. Obradovich, C.N. Rooper, B.J. Waddell, L.M. Nichol, S. MacNeill, and L.L. Barton. 2020. Identifying variables for standardization of the Northern Abalone (*Haliotis kamtschatkana*) Index Site Surveys time series (1978-2018) based on survey methodology and environmental variability. Can. Tech. Rep. Fish. Aquat. Sci. 3330: vii + 110p.

Hewson, I., J.B. Button, B.M. Gudenkauf, B. Miner, A.L. Newton, J.K. Gaydos, J. Wynne, C.L. Groves, G. Hendler, M. Murray, S. Fradkin, M. Breitbart, E. Fahsbender, K.D. Lafferty, A.M. Kilpatrick, C.M. Miner, P. Raimondi, L. Lahner, C.S. Friedman, S. Daniels, M. Haulena, J. Marliave, C.A. Burge, M.E. Eisenlord, and C.D. Harvell. 2014. Densovirus associated with sea-star wasting disease and mass mortality. PNAS. 111(48): 17278-17283.

Jamieson, G.S., E.J. Gregr, and C. Robinson. 2004. Northern Abalone case study for the determination of SARA Critical Habitat. Can. Sci. Adv. Sec. Res. Doc. 2004/117. 63 pp.

Lee. L.C., J.C. Watson, R. Trebilco, and A.K. Salomon. 2016. Indirect effects and prey behavior mediate interactions between an endangered prey and recovering predator. Ecosphere 7(12): 1-26.

Lee, L.C., J. Thorley, J. Watson, M. Reid, and A.K. Salomon. 2018. Diverse knowledge systems reveal social-ecological dynamics that inform species conservation status. Conservation Letters e12613. 11pp.

Lee, L., pers. comm. 2021. Correspondence with J. Banning, March 2021. Marine Ecologist, Parks Canada. Queen Charlotte, British Columbia.

Lessard, J., A. Campbell, Z. Zhang, L. MacDougall, and S. Hankewich. 2007. Recovery potential assessment for the Northern Abalone, (*Haliotis kamtschatkana*) in Canada. Can. Sci. Adv. Sec. Res. Doc. 2007/061. 107 pp.

Lochead, J., C.J. Schwarz, C. Rooper, and D. Bureau. 2023. Recommendations on the design of a multispecies benthic marine invertebrate dive survey program for stock monitoring in British Columbia. Can. Sci. Advis. Sec. Res. Doc. 2023/031. ix + 99 p.

Meyer, G., pers. comm. 2021 Correspondence with J.Banning, March 2021. Technician, Fisheries and Oceans Canada, Nanaimo British Columbia.

Nephin, J., E.J. Gregr, C. St. Germain, C. Fields, and J.L. Finney. 2020. Development of a Species Distribution Modelling Framework and its Application to Twelve Species on Canada's Pacific Coast. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/004. xii + 107 p.

Obradovich, S.G., S.C. Hansen, Z. Zhang, S. MacNeill, L.M. Nichol, C.N. Rooper, C. St. Germain, D.L. Curtis, B.J. Waddell, and L.L. Barton. 2021. Pre-COSEWIC review of DFO information on Northern Abalone (*Haliotis kamtschatkana*) along the Pacific Coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2021/001. v + 70 p.

Parks Canada. 2016. Multi-species action plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site. *Species at Risk Act* action plan series. Parks Canada, Ottawa. vi + 25 pp.

Read, K.D., J. Lessard, and E.G. Boulding. 2013. Improving outplanting designs for Northern Abalone (*Haliotis kamtschatkana*): The addition of complex substrate increases survival. J. Shellfish Res. 32(1): 171-180.

Rooper, C. pers. comm. 2021. Correspondence with J. Banning, March 2021. Research Scientist, Fisheries and Oceans Canada. Nanaimo, British Columbia.

The Haida Gwaii Marine Stewardship Group. Marine Matters Org.

Vadopalas, B., and J. Watson. 2014. Recovery plan for Pinto Abalone (*Haliotis kamtschatkana*) in Washington state (using a collaborative management approach). Puget Sound Restoration Fund for the Washington Department of Fish and Wildlife. iv + 50 pp.

Appendix A: key to abbreviations

AbRIG	Abalone Recovery Implementation Group
AFSAR	Aboriginal Fund for Species at Risk
BC	British Columbia
BCCC	BC coastal communities
BC Gov.	Government of BC. Ministry of Environment and Climate Change Strategy, BC Ministry of Water, Land and Resource Stewardship, BC Conservation Officer Service
CBSA	Canadian Border Service Agency
CC	Central Coast
CCG	Canadian Coast Guard
CDFW	California Department of Fish and Wildlife
CFIA	Canadian Food Inspection Agency
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
DOJ	Department of Justice
ECCC	Environment and Climate Change Canada
ECHG	East Coast Haida Gwaii
FN	First Nations
GB	Georgia Basin
HGMSG	Haida Gwaii Marine Stewardship Group, formally known as the Haida Gwaii Abalone Stewards - a partnership of the Haida Fisheries Program, Skidegate Band Council, Old Massett Village Council, Laskeek Bay Conservation Society, Gwaii Haanas National Park Reserve and Haida Heritage Site, World Wildlife Fund Canada, Simon Fraser University Centre for Wildlife Ecology, SFU School of Resource and Environmental Management, Environment Canada and Fisheries and Oceans Canada.
HIRMD	Heiltsuk Integrated Resource Management Department
HSP	Habitat Stewardship Program for Species at Risk
KASP	Kitasoo Abalone Stewardship Program (Kitasoo Fisheries Program)
NGOs	Non-governmental Organizations
ORR	Observe-Record-Report
PC	Parks Canada
PPSC	Public Prosecution Service of Canada
Proponent	Proponent for the works or developments on, in, or under the water
QCS	Queen Charlotte Strait
RCMP	Royal Canadian Mounted Police
SARA	*Species at Risk Act*
SL	Shell Length
U.S.	United States
USFWS	United States Fish and Wildlife Service
USNMFS	United States National Marine Fisheries Service
WCHG	West Coast Haida Gwaii

WCVI   West Coast Vancouver Island
WDFW   Washington Department of Fish and Wildlife

Appendix B: associated plans

For ease of reference, provided below is a list of recovery strategies, action plans, and progress reports in which information on Northern Abalone recovery in Canada can be found.

Recovery strategy for Northern Abalone (*Haliotis kamtschatkana*) in Canada (2007)

Haida Gwaii Northern Abalone community action plan (2008)

Action Plan for the Northern Abalone (*Haliotis kamtschatkana*) in Canada (2012)

Management plan for the Sea Otter (*Enhydra lutris*) in Canada (2014)

Report on the progress of recovery strategy implementation for Northern Abalone (*Haliotis kamtschatkana*) in Canada for the period 2007 to 2012 (2015)

Multi-species action plan for Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site (2016)

Multi-species action plan for Pacific Rim National Park Reserve of Canada (2017)