

Abalone (GalGahlyang) and Sea Otter (Kuu) Interaction: Are sea otters the most important threat to a potential abalone harvest in Haida Gwaii?

Introduction

The marine ecosystems of the Pacific Northwest are characterized by complex predator-prey relationships, which regulate the state of an ecosystem. Sea otters (*Enhydra lutris*) are small marine carnivores whose presence can determine the state of near-shore systems (Paine 1969, Watson 2000). Once common throughout the North Pacific, sea otters were hunted near extinction in the mid-1700s until 1911 when they were protected from further hunting (Estes 1990). Due to sea otters reintroduction, the population is expanding its historic range (Estes 1990). As a major predator of Northern abalone (*Haliotis kamtschatkana*), sea otters are known to effect population dynamics and abalone habitat (Watson 2000). Northern abalone was an important marine resource historically for both First Nations and the former commercial fishery throughout British Columbia (Sloan 2005). Since the severe population decline and closure of the commercial fishery in 1990, rehabilitation efforts, abalone population and life history research, as well as public awareness of the marine invertebrate have escalated. The current threats to abalone have been expressed as, illegal harvest, low recruitment, sea otter predation and habitat degradation. Haida Gwaii, British Columbia, once supported healthy populations of both abalone and sea otter species (Fisheries and Oceans Canada 2007). However, since the sea otters extirpation, abalone populations have fluctuated independently of sea otter predation levels (Watson 2000). As the current population of

sea otters expands, sea otter predation on the currently depressed abalone stock has been expressed as an important potential threat to the future of a viable abalone fishery in Haida Gwaii. Discussion of pertinent topics will be performed in order to answer the question: Are sea otters the most important threat to a potential abalone harvest in Haida Gwaii? In this study, I will explore the potential for a future abalone harvest in Haida Gwaii by examining the current threats to healthy abalone populations, with special emphasis on sea otter predation. The life history of Northern abalone and its importance as a marine resource to the Haida Nation will also be examined.

Methods

I performed a literature review of relevant academic literature including peer-reviewed journals and grey literature such as DFO reports, consultation summaries and Species at Risk (SARA) recovery strategies. I collected available information concerning both abalone and sea otter species in order to perform a comprehensive literature review. The information accumulated represents research performed throughout British Columbia, Alaska and California that will enable me to discuss these findings in the context of Haida Gwaii. There are several unpublished studies and long-term research projects currently proceeding throughout Haida Gwaii and BC. Therefore, information collected was limited to the available research database and may not reflect recent research efforts.

Brief History of Sea Otter and Abalone Utilization

Haida Gwaii is an archipelago with a terrestrial landmass of 10,190km² on the

North Coast of British Columbia. The Haida Nation have laid claim through occupation and resource use of the lands and oceans surrounding Haida Gwaii for time immemorial (Josenhans et al. 1997). The current population of the Haida Nation is 4,164 (registered band members), while the pre-contact population is estimated to be 14,500 people (Fedje and Mathewes 2005, BC GOV 2011). Traditionally, The Haida people used Northern Abalone (GalGahlyang in Haida) and Sea otter (Kuu in Haida) as well as many other marine organisms as important resources (Sloan 2004). Abalone is utilized in art and jewelry, as well as providing a valuable food source, while sea otters provided resources for clothing and regalia (Sloan 2004). In 1774, European contact with the Haida Nation started the sea otter pelt trade with eventually caused extirpation of sea otter populations from Haida Gwaii (Horwood 2009). The Haida Nation became extremely wealthy from sea otter pelt trade dealings until the populations were overexploited by hunting (Horwood 2009). Table 1 illustrates a chronology of important historical events concerning abalone, sea otter and human interactions pertinent to Haida Gwaii. The Haida Nation continue to utilize these marine resources, however, due to depressed population levels of abalone and the extirpation of sea otters, resource use is limited (Sloan 2004).

The decline in abalone stocks over the last century is due to a variety of characteristics that make abalone vulnerable to overexploitation. Northern abalone are found in patchy distributions on hard substrate in intertidal and shallow subtidal off the west coast of North America from Yakutat, Alaska south to Turtle Bay, Baja California (Fisheries and Oceans Canada 2007). Habitat characteristics defined by shallow waters in close proximity to shoreline settlements have allowed abalone to become an important

marine resource (Campbell 2000). Traditionally, harvest of abalone by First Nations was carried out at low tide by hand collection of exposed individuals as well as some subtidal harvest by means of hooked poles (Campbell 1997, Campbell 2000). The importance of abalone is demonstrated in the quote, “The Haida people appreciate abalone and over the past few years of the closure, I heard elders regretfully say they might never taste abalone again in their lifetime” (Jones 2000). The early 1900s marked an era of technology advancements that progressed from early diving to SCUBA in the 1950s (Table 1) (Fisheries and Oceans Canada 2007). During this time recreational and commercial fishing for abalone began harvesting at levels well above previous traditional gathering (Campbell 2000, Sloan 2005). High market demand, an easily accessible species and more advancement in transportation, SCUBA and fuel technology allowed for exploitation in remote areas and the development of a relatively lucrative fishery (Campbell, 2000). The commercial fishery in 1978 peaked at \$1.8 Million (landed value) and the majority of harvest occurred across the central coast of B.C. and in Haida Gwaii (Sloan 2005). Northern abalone abundance declined more than 75% in Haida Gwaii from the period of 1978-1984 until the closure of the fishery to first nations, recreational and commercial fishers across BC in December of 1990 (Fisheries and Oceans Canada 2007). Despite the ban on harvest, Northern abalone populations continue to decline and have been listed as endangered under COSEWIC, April 2009, and threatened under the Species at Risk Act June, 2003 (Table 1)(Fisheries and Oceans Canada 2007). Population monitoring for abalone in Haida Gwaii, illustrates that there is no clear evidence of a recovery of the Northern abalone population since the fishery’s closure in 1990 (Hankewich et al. 2007).

The sea otter was reduced by means of hunting to fewer than 1000 individuals located in 12 remnant population on the Pacific Northwest (Kenyon 1969). In BC, sea otters are classified as species under species concern with COSEWIC and threatened under the SARA (Table 1). Successful reintroduction throughout Alaska, BC, Washington and Oregon have resulted in range expansion and well-established sea otter populations in certain areas (Watson 2000). Figure 1, adapted from the Recovery Strategy for the Sea Otter illustrates the historical and current population range (Fisheries and Oceans Canada 2007).

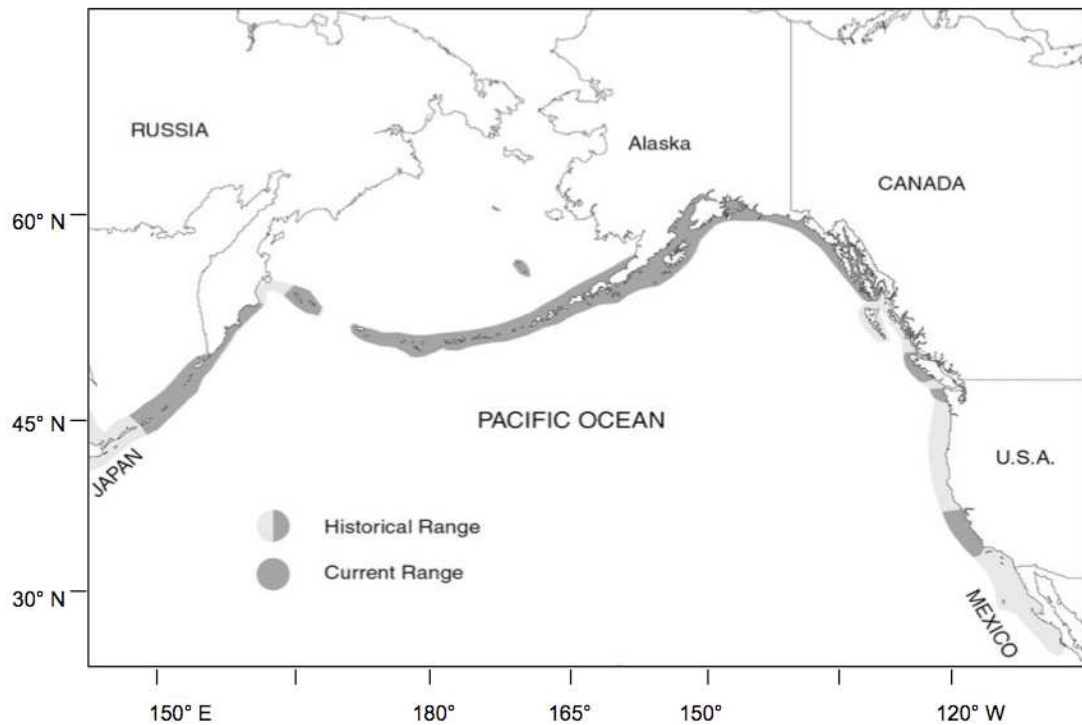


Figure 1. Historical and current range of sea otter populations globally, adapted from Recovery Strategy for the Sea Otter (Fisheries and Oceans Canada 2007).

Currently, there is no permanent sea otter population in Haida Gwaii, and there have been 8 sightings of independent males from 1972-2002 (Raum-Suryan et al. 2004). However, there is general consensus that with the current increase in growth rate of sea otters populations in BC (18.6% per year), sea otters will likely expand into the

ecosystems of Haida Gwaii (Watson 2000). Before extirpation, sea otters limited the size, abundance and distribution of many invertebrate populations, including Northern Abalone (Fishers and Oceans 2007). The resulting abundant populations coupled with high demand across developing international markets contributed to the growth of the commercial and recreational fisheries and thus the eventually overexploitation (Hankewich et al. 2007). Sea otters are seen as keystone species; defined as a species which are ‘keystone to the communities structure and integrity’ by strongly influencing communities and ecosystems relative to their biomass (Paine 1969, Power et al. 1996). By limiting grazing pressure, kelp abundance is enhanced, thus creating more complex habitat for fish and invertebrate recruitment (Power et al. 1996). In California, sea otters have been shown to contribute to the decline of the commercial fisheries, however, the crash in abalone populations found in BC and Haida Gwaii (where sea otters have been extirpated) were not effected by sea otter predation (Fanshawe 2003) However, as abalone populations attempt to recover and sea otter expansion is immanent, concern over the effect of sea otter predation in Haida Gwaii has arisen.

Table 1. Chronology of events relating to abalone and sea otter exploitation.

Date	Event
1774	European contact: Spanish explorer Captain Juan Perez first contact with the Haida Nation (Horwood 2009). Captain Cook initiated sea otter trade: Sea otter trade began and extirpation of sea otters by way of hunting (Horwood 2009). Sea otter populations reduced to fewer than 1000 individuals located in 12 remnant populations (Watson 2000)
1778	International Fur Seal Treaty: Protection of sea otters from hunting (Fisheries and Oceans Canada 2007)
1911	Introduction of diving techniques: Increased exploitation of abalone (Watson 2000)
1900s	SCUBA technology: Increased rate of abalone exploitation (Watson 2000)
1950s	
1978	Peak in Commercial Abalone fishery: \$1.8 million harvest of abalone

	from areas of central BC and Haida Gwaii (Sloan 2004)
	Sea otters designated as endangered (COSEWIC)
1978-1984	75% of stocks decline in Haida Gwaii: Major stock depletion in a limited time period (Sloan 2004)
1990	Closure of Abalone Fishery: Closure to First Nations, recreational and commercial fisheries due to severely depleted stock (Sloan 2004)
1999	Abalone listed federally as threatened (COSEWIC): First marine invertebrate to be federally listed (Fisheries and Oceans Canada 2007)
	Haida Gwaii Abalone Stewardship Program initiated: Funded by Environment Canada/DFO/Parks Canada and chaired by Haida Fisheries program. Initiated to restore abalone populations to level sufficient to support subsistence and recreational fisheries (Sloan 2004).
2000	
2003	Abalone listed as threatened with Species at Risk Act (Fisheries and Oceans Canada 2007)
	Sea otters listed as threatened with Species at Risk Act (Fisheries and Oceans Canada 2003)
2007	Sea Otter listing demoted to Special Concern (COSEWIC): High rate of growth is causing population expansion across BC, Washington and Alaska (Fisheries and Oceans Canada 2007).
2009	Abalone listed as endangered (COSEWIC): Heightened listing for Northern abalone due to continued population decline (Fisheries and Oceans Canada 2007)

Threats to Abalone

Several biological factors contribute to the slow recovery and overexploitation of Northern abalone. Life history characteristics, including a sensitivity to environmental factors, as well as the effect of natural predation contribute to this slow recovery.

The Northern abalone is vulnerable to population decline as the species has short-larval period, is slow-growing, relatively long-lived and sedentary, as well as low and sporadic recruitment (Campbell 2000) Successful recruitment is achieved through a critical mass of male and female individuals in close vicinity as gametes are broadcasted into the water column (Sloan and Breen 1988). A population of over 800 individuals may be required to ensure this success (Shepherd et al. 1996). During the commercial fisheries, harvesting occurred during these spawning seasons, targeting aggregations vulnerable to exploitation

and causing serial depletion (Campbell 2000). Due to the large population decline in BC, populations are small and thus reproductive success is limited due to the dilution of gametes through the reduced adult spawner densities. (Shepherd et al. 1996). After fertilization, the planktonic phase of approximately 5 days is followed by the early juvenile stage lasting 1-3 years. (Sloan and Breen 1988). A research gap exists in the dynamics of the juvenile stage and could provide further clues into the decreasing populations (Sloan and Breen 1988). Adult abalone must reach a size of 100mm (6-10 years of growth) before they can be harvested and can live to approximately 15 years (Campbell 2000). Environmental factors such as exposure can limit the size and frequency of populations and create further difficulty in population determination (Campbell 2000) The long life history demonstrated by abalone as well as aggregated population dynamics cause slow population growth and accessibility for exploitation.

Non-anthropogenic causes of mortality include environmental factors such as high temperature, low salinity and storms; natural predators including the sea otter, crab (*Cancer productus*), sea stars (*Pycnopodia helianthoides*) and octopus (*Octopus dofleini*); starvation through competition with other invertebrates such as the red sea urchin (*Strongylocentrotus franciscanus*) (Fisheries and Oceans Canada 2007). Furthermore, The expansion of sea otter populations across BC and into Haida Gwaii has caused concern about the future of anthropogenic harvest of Northern Abalone.

In general, there is consensus that a viable commercial abalone fishery and a stable sea otter population cannot co-exist in the same area (Sloan 2004). In addition, a sea otter population may heavily affect areas that are already seriously depleted or

contain fragmented Abalone populations (Fisheries and Oceans Canada 2007) Although this is not an imminent concern in Haida Gwaii due to a sea otter absence, it may threaten the future of a potential recreational or traditional harvest (Sloan 2004). Sea otter and Northern Abalone have co-existed in the past, although there is no historical knowledge on the Abalone or sea otter populations before the commercial fisheries (Watson 2000). It has been demonstrated that in the presence of sea otters abalone populations become more stable, albeit smaller and reduced to surviving in small sheltered cavities (Watson 2000, Fisheries and Oceans Canada 2007). It is thought that in the absence of sea otters, abalone developed a pattern of grazing in open areas. Alternatively, in the presence of sea otters, abalone return to opportunistic feeding on broken or fragmented kelp. It is possible that sea otter introduction could aid abalone recovery in the long-term. Sea otters increase kelp and algae biomass and control red urchin populations, providing an available food supply to feeding abalone, controlling competition with red urchin populations by limiting urchin barrens. This long-term interaction represents an important knowledge gap in the literature and should be considered in abalone population recovery attempts (Fisheries and Oceans Canada 2007).

Studies demonstrate different levels relationship between sea otter presence and abalone abundance. For example, Lee and Salomon (2010), demonstrate no clear trend related to sea otter occupation time for biomass and density of abalone. Whereas, Fanshaw et al. (2003), illustrates a negative effect of sea otters on the abalone populations and thus the recreational harvest of red abalone (*Haliotis rufescen*) in California. This study indicated that sea otters and recreational harvesters had similar effects on abalone populations by reducing density and truncation of size classes on the population, structure

and microhabitat use by red abalones. The implications of this study indicate that marine protected areas with sea otters restored as top-level carnivore cannot serve the dual purposes of biodiversity enhancement (through sea otters as a key stone species) and abalone fishery conservation in California. Perhaps a recreational fishery and a sea otter population in Haida Gwaii could co-exist, or perhaps multiple categories of marine protected areas are needed to meet multiple conservation goals. The marine protected area planned for Gwaii Haanas National Park/Reserve is considering a multi-species ecosystem-based management perspective which is unique in British Columbia (Sloan 2004). This innovative planning process may have the capacity to plan and address these management issues.

The most severe threat to abalone harvest outlined by the literature is illegal harvest (Fisheries and Oceans Canada 2007, Lessard *et al.* 2007). The high market value (recent unconfirmed reports of >Can \$45/ kg) and ease of harvest make abalone populations vulnerable to illegal harvest across the large, mostly uninhabited BC coastal area, which makes enforcing the fishery closure difficult (Campbell 1997). Unregulated harvesting reduces already declining populations and significantly decreased reproductive potential by removing the largest individuals (greater than 100mm SL) and fragmenting populations (Fisheries and Oceans Canada 2007). For example, 11,000 abalone individuals were seized in 2006 from three poaching events (Fisheries and Oceans Canada 2007). Although fines and penalties are in place for illegal harvest, enforcement is difficult and mortality due to poaching is estimated to be substantial but problematic to document (Campbell 1997). First nations abalone coast watch initiatives are being developed to encourage multi-party cooperation. These initiatives are being created by

organizations such as Bamfield Huu-ay-aht Community Abalone Project, Gwa'sala-
'Nakwaxda'xw Fisheries, Kitasoo Abalone Stewardship Program and the The Haida
Gwaii Marine Stewardship Group (Fisheries and Oceans 2007). Difficulties exist in
identifying illegal abalone individuals and an abalone DNA bank has been suggested to
identify abalone origins has been identified as a possible solution. This solution is costly
and has not been implemented but could provide relief to the threat of abalone poaching
in the future (Fisheries and Oceans 2007). Poaching is a serious pressure to northern
abalone stock and consensus indicated that public education and information on poaching
problems should be created.

Current Initiatives in Haida Gwaii

In Haida Gwaii, efforts such as the The Haida Gwaii Marine Stewardship Group are
focused on researching abalone populations so that traditional and recreational fisheries
may be established (Sloan 2005). Critical research is currently being performed to close
important knowledge gaps concerning abalone populations and habitat on Haida Gwaii.
The Haida Gwaii Marine Stewardship Group and the DFO in Haida Gwaii have focused
on determining critical abalone habitat, determining existing populations and installing
abalone condos. Abalone condos are made from crab traps filled with concrete blocks and
provides critical habitat for juvenile abalone in order to perform abalone research (DFO
2010). Hankewich et al. (2008), determined that abalone stocks throughout Haida Gwaii
have not significantly increased to a level that can be sustainably harvested. Thus, the
depressed stocks could potentially be vulnerable in the future to expanding sea otter
populations. Increased efforts in Haida Gwaii should focus on actively re-establishing

abalone populations through the research of out-planting of abalone stocks and the identification of critical habitat.

The Bamfield Huu-ay-aht Community Abalone Project was formed to address the national abalone recovery strategies while building community capacity through a multi-stakeholder process involving the Huu-ay-aht First Nation, community organizations and research groups. Abalones raised in a hatchery (\$5 million individuals in total) were out-planted as juveniles to increase local abalone populations (John Richards 2010, pers. comm.) The out-planting conducted by the Bamfield Huu-ay-aht Community Abalone Project is speculated to have been effective, although long-term monitoring and proper scientific methods have not been applied to these populations (John Richards 2010, pers. comm.) A large knowledge gap exists on the success of out-planting methods to increase abalone stock, however, it could represent an important strategy for future abalone recovery (Fisheries and Oceans Canada 2007).

The goals of Haida Gwaii and the rest of British Columbia represent different scales of recovery (Sloan 2004). The degree of population recovery for enabling a Haida and recreation fishery may be different than that for the delisting of the species as part of the national recovery strategy (Sloan 2004). This may cause future legal conflict and could pose as a barricade to a future abalone fishery. In addition, criteria for a suitable abalone fishery need to be developed and further research is required to determine the 'optimal distribution and density of spawners and recruits, distance of larval transport, genetic stock discreteness and how these factors would effect the geographic scale of fisheries management' (Campbell 2000).

Conclusion

The main threats to abalone have been identified as low recruitment of individuals, illegal harvesting and sea otter predation. Although sea otter predation is a possible threat to a future sustainable abalone fishery, the illegal harvest of abalone is currently identified as the significant threat. Biological factors such as low-recruitment rate, aggregated and localized populations as well as natural predation contribute to the continued population instability. Thus, it is unlikely that a commercial fishery will re-emerge in the presence or absence of sea otters, as Abalone populations have yet to demonstrate any significant population rebound. However, abalone populations on Haida Gwaii could reach sustainable population levels in the future in order to allow a recreational or subsistence fishery. It seems likely that sea otter populations could stabilize and diversify marine ecosystems, contributing positively to abalone populations in the long run. The effects of sea otter predation on abalone population dynamics are unclear and efforts should continue to focus on actively rebuilding abalone populations. In conclusion, Northern Abalone represents part of the diverse marine legacy in Haida Gwaii and should be a priority for conservation.

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