Before the Secretary of Commerce

Petition to List the Pinto Abalone (*Haliotis kamtschatkana*) as Endangered under the Endangered Species Act

(Photo by ADFG)

June 27, 2013

Executive Summary

The pinto abalone is a marine gastropod in the family Haliotidae (abalones). It is both the northernmost and the smallest of eight abalone species found on the west coast of North America. The pinto abalone (*Haliotis kamtschatkana*) has a patchy distribution ranging from Sitka, Alaska (AK), to Baja, Mexico, and is the only abalone species commonly found in Washington (WA), British Columbia, and AK. The pinto abalone occupies relatively shallow coastal areas (from shorelines exposed by low-low tides to a depth of 30-40 feet) that are exposed to ocean currents. Such habitats (*e.g.*, kelp beds and rocky areas with coralline algae) are both easily accessible to humans and vulnerable to natural and anthropogenic disturbances. The pinto abalone, like other species of abalones, has been harvested for centuries, prized for its beautiful mother-of-pearl shell, which is used for decorative purposes, and its large muscular foot, which is considered a culinary delicacy.

Wild abalone populations worldwide have been decimated by predation, disease, loss of habitat and overfishing. Most abalone species on the west coast of North America are facing widespread declines and ongoing population threats. In 2001, the white abalone (*H. sorenseni*) was the first marine invertebrate to be listed as endangered under the U.S. Endangered Species Act (ESA). Black abalone (*H. cracherodii*) was listed as endangered under the ESA in 2009. The green (*H. fulgens*), pink (*H. corrugata*) and pinto abalone have been identified as Species of Concern (SOC) since 2004.

The pinto abalone is now in imminent peril as spawning aggregations throughout its range have been experiencing recruitment failures due to low population densities that fall below the threshold for successful reproduction. The pinto abalone should be listed as endangered under the ESA as it is in danger of extinction within the foreseeable future for the following reasons:

(1) The pinto abalone is in severe decline throughout its range in the northeast Pacific Ocean. Monitoring at survey stations in the San Juan Islands, Washington; Alaska; and in British Columbia, Canada, have shown > 80% declines in abundance since the early 1990s, despite prohibitions on commercial and recreational harvest and the conservation listings of this species in both Canada and the United States (U.S.). Populations of the northern subspecies of pinto abalone in California were estimated to have declined to 11% of historic levels by 2001, with declines continuing since then. The southern subspecies of pinto abalone in California is estimated to have declined by more than 99% since the 1970s. Data suggest that this subspecies may now number in just the hundreds. Populations of pinto abalone in many areas throughout its range are presently below threshold densities required for successful reproduction.

(2) While overharvest by both commercial and recreational fisheries has historically contributed to population declines, current threats are largely from illegal poaching and increased predation mortality on populations that are near or already below the density threshold required to replenish themselves, and from climate change, ocean acidification, and disease.

(3) In some areas (like the coastal waters of the State of Washington), scientists have declared the species "functionally extinct" and believe that the species will have no hope of recovering without immediate and active intervention. Likewise, in southern California, scientists suggest that captive breeding may be the only option for recovery of the southern subspecies of pinto abalone, because of the extent of population declines. Without additional conservation measures, like establishment of marine reserves to protect spawning aggregations, better enforcement of harvest bans, and even translocation of wild individuals to increase local densities (create aggregations) within protected areas, the species faces serious risk of local to complete extirpation throughout its range and continued decline is likely.

In light of its very low population level, the ongoing threats, and the insufficiency of current management and conservation measures, the National Marine Fisheries Service (NMFS) should designate the pinto abalone as endangered under the ESA. In the alternative, NMFS should list the pinto abalone as threatened. In the further alternative, NMFS should list the southern subspecies of pinto abalone as endangered, and identify distinct population segments (DPSs) of the northern subspecies of pinto abalone and list such DPSs as endangered or threatened.

Notice of Petition

The Natural Resources Defense Council (NRDC) hereby petitions the Secretary of Commerce, through NMFS, to list the pinto abalone (*Haliotis kamtschatkana*) as endangered under the ESA, or, in the alternative, as threatened; and to designate critical habitat to ensure its recovery pursuant to Section 4(b) of the ESA, 16 U.S.C. § 1533(b), section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 533(e), and 50 C.F.R. § 424.14(a).

NRDC is a national not-for-profit conservation organization with approximately 1.3 million members and activists. One of NRDC's organizational goals is to further the ESA's purpose by preserving our national biodiversity. NRDC's members have a direct interest in ensuring the survival and recovery of pinto abalone and in conserving the unique marine communities on which they rely and which they benefit.

NMFS has jurisdiction over this petition. This petition sets in motion a specific process, requiring NMFS to make an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533 (b)(3)(A). NMFS must make this initial finding "(t)o the maximum extent practicable, within 90 days after receiving the petition." *Id*. A petitioner need not demonstrate that listing is warranted, but rather present information demonstrating that such a listing *may* be warranted. While NRDC believes that the best available science demonstrates that listing the pinto abalone as endangered (or, in the alternative, as threatened) is in fact warranted, the available information clearly indicates that listing the species may be warranted. As such, NMFS must promptly make a positive finding on this petition and commence a status review as required by 16 U.S.C. § 1533 (b)(3)(B).

Respectfully submitted this 27th day of June, 2013.

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I. Species Account

A. Species Information

1. Taxonomy and description

The pinto abalone, *Haliotis kamtschatkana*, is a gastropod mollusk in the Family Haliotidae (abalones). It is both the northernmost abalone species in the eastern Pacific Ocean and the smallest of the abalone species, with a maximum length of approximately 15 centimeters (cm). One of eight abalone species that occur on the west coast of North America, the pinto abalone can be distinguished by a lumpy and raised oval shell with 3 to 6 open flush (respiratory) pores and a narrow and somewhat scalloped shell margin (NOAA 2007; CDFW 2013a). The outer shell has a wide range of coloring including red, pink, tan, greenish-brown, or mottled, while the inside of the shell is mother-of-pearl (NOAA 2007; CDFW 2013a).

2. Diet

The pinto abalone is a grazer, using its file-like tongue (radula) to feed mainly on marine algae ranging in size from microscopic diatoms to large kelp.

3. Life history, longevity, and growth

Like many invertebrates, pinto abalones are broadcast spawners, with males and females releasing gametes into the water simultaneously (COSEWIC 2009). In broadcast-spawning invertebrates like abalone, minimum density thresholds of 0.15 to 0.33 individuals per m^2 are necessary for successful fertilization (Rothhaus *et al.* 2008). To aid reproductive success, sexually mature pinto abalones cluster in spawning aggregations, typically in shallower water (COSEWIC 2009). Spawning typically occurs from the spring through the summer and early fall (NOAA 2007; Pritchett and Hoyt 2008), but abalones with ripe gonads have been found at all times of the year (COSEWIC 2009).

After fertilization, the planktonic stage lasts from five to thirteen days (depending on water temperature; Rothaus *et al.* 2008). There is expected to be some small degree of larval exchange, although larval dispersal is believed to be limited (Jamieson 1999; Bouma 2007). Larvae settle in relatively deeper areas with coralline algae. After settling, these larvae undergo metamorphosis into the post-larval/early juvenile stage. Once the larvae reach five millimeters (mm) shell length (SL), they are considered juvenile abalone (Hester *et al*. 2011). It takes the pinto abalone from two to up to eight years to reach sexual maturity, which is typically associated with a threshold shell size (*e.g.*, 50-70 mm SL in British Columbia; COSEWIC 2009). As they grow, abalones tend to move to shallower habitat (Muse 1998). Although pinto abalones are relatively slow growing, they can reach sizes of around 15 cm (up to 16.5 cm, COSEWIC 2009) over their lifespan of at least 13-20 years (Shepherd *et al.* 2000; Paul and Paul 2000).

4. Habitat

Pinto abalones occupy relatively shallow coastal areas (from shorelines exposed by low-low tides to a depth of 30-40 feet) that are exposed to ocean currents (Pritchett and Hoyt 2008). They are found on rocky substrate, and prefer kelp beds and areas of high coralline algae coverage (COSEWIC 2009; Rogers-Bennett 2011). The presence of coralline algae is particularly important during early life as it is thought to trigger settlement of larvae (COSEWIC 2009). Pinto juveniles are cryptic, blending in with their habitat and remaining in crevices or under rocks typically in the deeper coralline algae habitat. Mature pinto abalone become emergent and typically move to kelp forests to feed (Hester *et al*. 2011). Abalones are also often associated with red urchins and urchin habitat, though interactions differ by geographic area (Tomascik and Holmes 2003; Rogers-Bennett 2011).

5. Geographic range

Pinto, or northern, abalone is the northernmost abalone species to occur in the eastern Pacific Ocean, and the only abalone species commonly found in Washington, British Columbia and Alaska. There are two subspecies of pinto abalone: a “northern” and “southern” form. The “northern” subspecies of pinto abalone (*H. k. kamtschatkana*) is patchily distributed and reported to range from Sitka, Alaska, to Point Conception, California, with its core abundance distributed in northern Washington (inland waters), British Columbia, and southeast Alaska (**Figure 1**; McDougall *et al.* 2006; COSEWIC 2009; NMFS 2009). This subspecies of pinto abalone is also found in Oregon (NOAA 2009) and northern California (Rogers-Bennett *et al.* 2002). The range of the “southern” subspecies, the threaded abalone (*H. k. assimilis*), extends from Point Conception in central California to Baja, Mexico (McDougall 2006; NMFS 2009; COSEWIC 2009: 8; **Figure 1**).

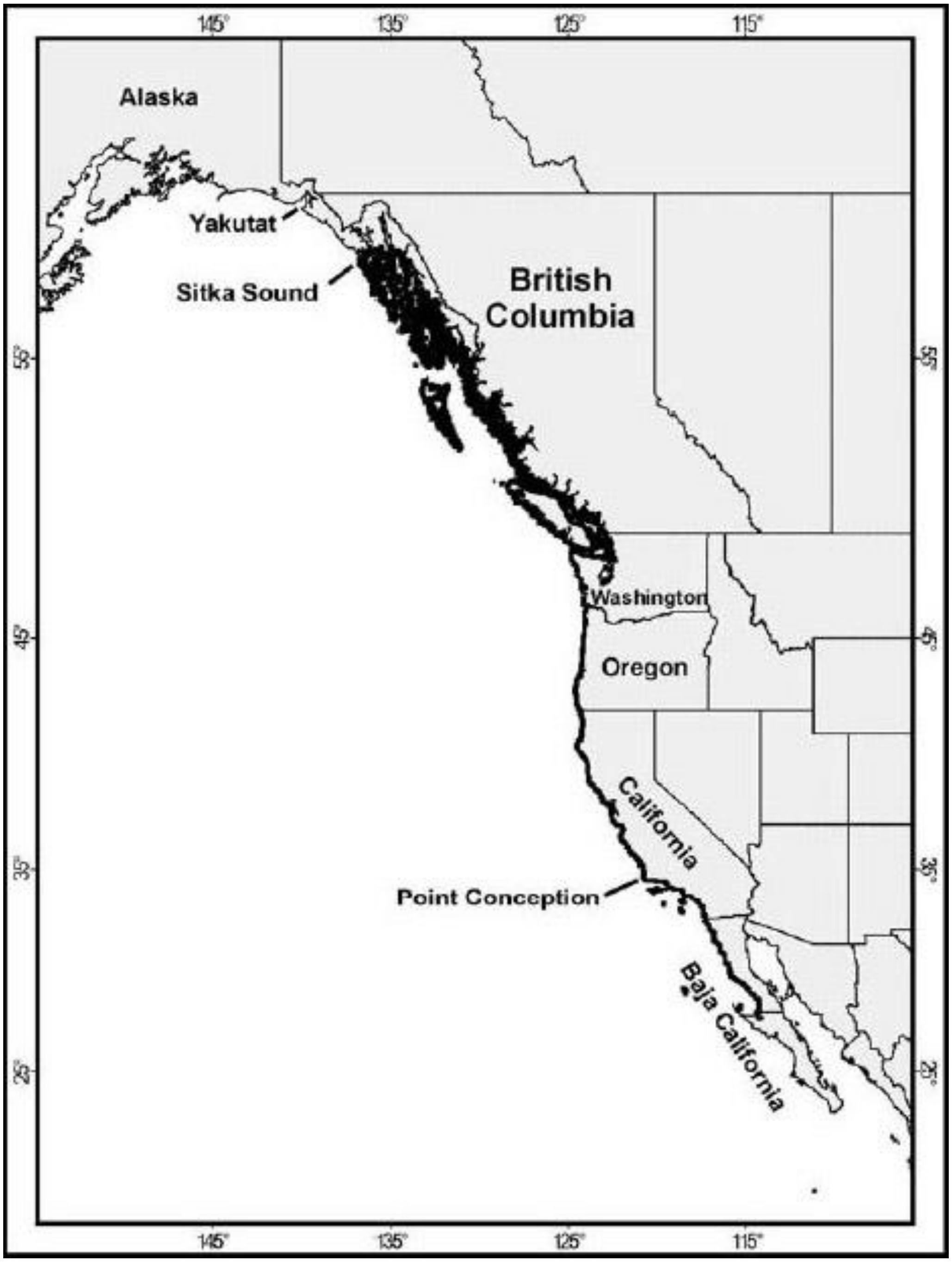

Figure 1: The core geographic distribution (shaded in black) of the northern subspecies of pinto abalone (*H. kamtschatkana kamtschatkana*) includes coastal waters of Washington, British Columbia, and southeast Alaska. Historically, the distribution of pinto abalone extended as far south as Point Conception, in central California (bold coastline). The southern subspecies, the threaded abalone (*H. kamtschatkana assimilis*), occupies the southern part of the range, from Point Conception to Baja, Mexico. (Figure 4 from COSEWIC 2009: 9).

III. Population status and abundance trends of pinto abalone

A. Population trends

Pinto abalone is in severe decline throughout its range in the northeast Pacific Ocean, and declines have been evident since at least the early 1990s. While pinto abalone populations have suffered declines due to direct sources of mortality including harvest and predation, they are also vulnerable to recruitment failure if their densities drop below a threshold level, a process known as the "Allee effect" (Allee *et al.* 1949). In broadcast-spawning invertebrates like abalone, successful fertilization has been linked to Allee minimum density thresholds of 0.15 to 0.33 individuals per m^2, although specific thresholds have not been determined for pinto abalone (Rothhaus *et al.* 2008). Based on the lack of recovery and continued decline of unfished abalone populations in the San Juan Islands that were at or above the Allee threshold of 0.15 individuals per m^2, it is thought that this threshold may be higher for pinto abalone, at least in the San Juan Islands (Rothaus *et al.* 2008: 2708). Throughout its range, densities of pinto abalone have been measured at or below this threshold since at least the 1990s. Given the limited larval dispersal and patchy distribution of pinto abalone populations, it is likely that there is population structure distinguishing at least some individual populations (spawning aggregations) while connectivity may be an important feature for others. Therefore, the loss of even one spawning aggregation could result in a loss of genetic diversity (Naish 2006; Straus *et al.* 2007; NMFS 2009) and connectivity for the species as well as cause a significant gap in its range. Population trends by state/province are outlined below.

Alaska

Since there has been little to no population monitoring of pinto abalone in Alaska (no index sites), the only available measures of abundance come from the commercial fishery and limited dive surveys (Woodby *et al*. 2000). Based on fisheries data, the abundance of pinto abalone in Alaska declined sharply from 1982 to 1995. There was a 90% decline in catch per unit effort (CPUE) between the peak of the commercial fishery in 1979 and 1995, the last year of the fishery (**Figure 2**; Woodby *et al*. 2000; McDougall *et al*. 2006). This was largely due to unrestricted commercial harvests that peaked in the late 1970s and early 1980s, followed by the collapse of the stock (**Figure** 2; Woodby *et al*. 2000). Stock declines continued into the 1990s until the commercial fishery was closed at the end of 1995 (Woodby *et al*. 2000; Pritchett and Hoyt 2008).

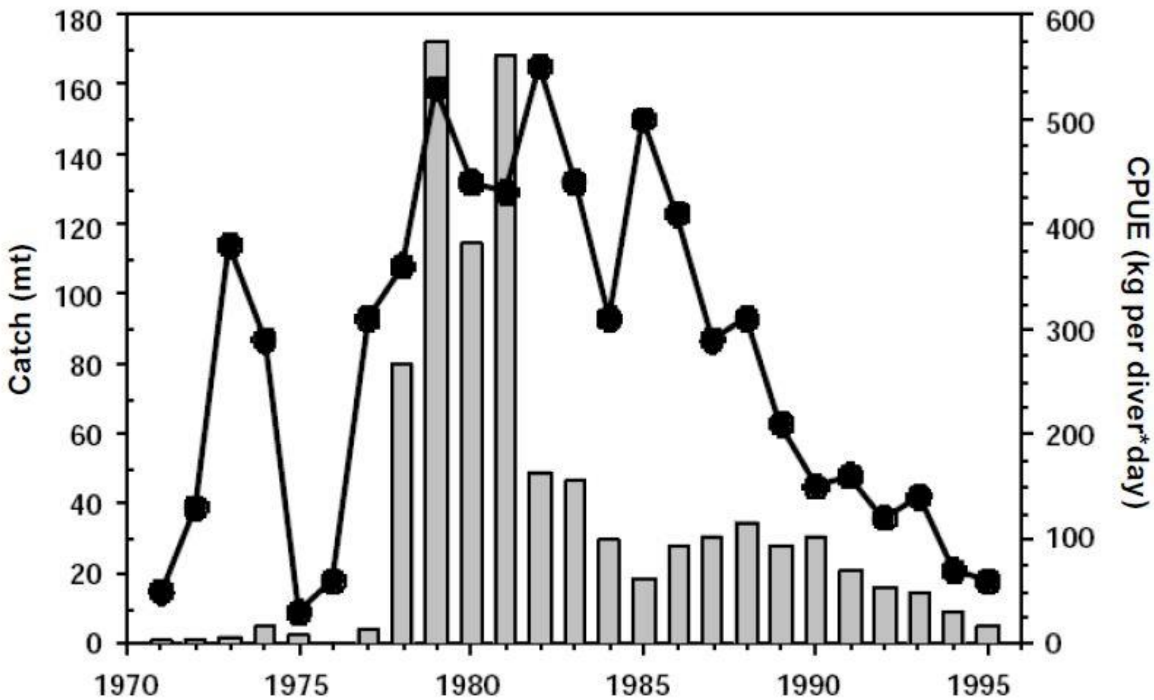

Figure 2: Catch (metric tons) and catch per unit effort (kilograms (kg) per diver day) for the southeast Alaska abalone fishery, 1971-1995. Shaded bars represent total catch (metric tons (mt)) and the dotted line represents CPUE (Woodby *et al*. 2000: 26).

In dive surveys, Woodby *et al*. (2000) recorded a considerable decrease in Alaska abalone densities in the decade between 1988 and 1999. Observations over an extensive area of Southeastern Alaska made by Alaska Department of Fish and Game (ADFG) divers during stock assessment surveys for other species that are commercially harvested clearly indicate a continued steady decline in abalone populations (Alaska Board of Fisheries 2012a: Proposal 195; *see also* Pritchett and Hoyt 2008: 5).

British Columbia

Total and mature densities of pinto abalone at index sites have declined by 83% and 89% on the central coast of British Columbia (**Figure 3**, upper panel) and by 81% and 88% in the Queen Charlotte Islands (**Figure 3**, lower panel) since 1978, or approximately three generations (COSEWIC 2009).

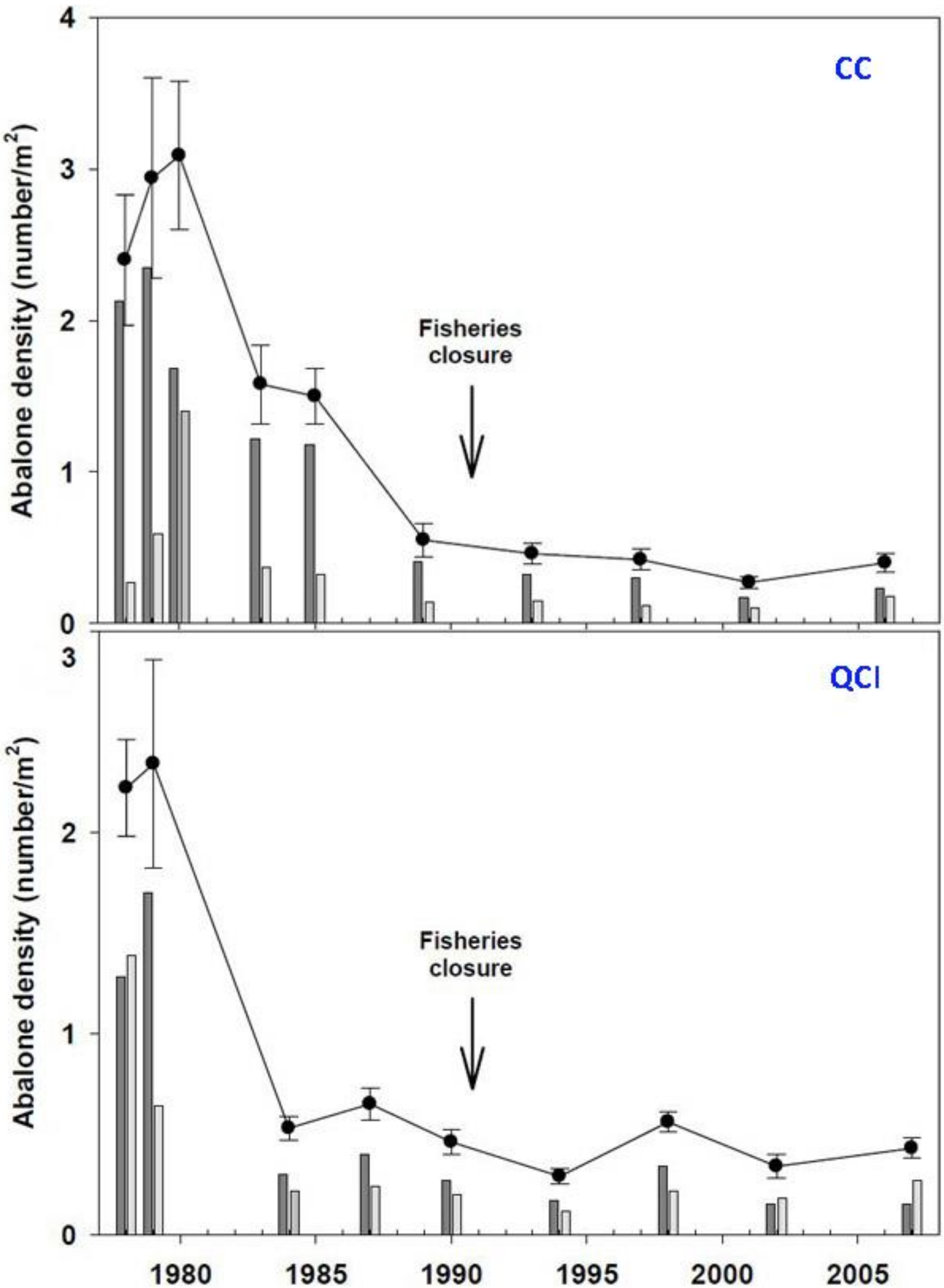

Figure 3: Total (circle and line), mature (≥ 70mm SL, dark grey bars) and immature (< 70mm SL, light grey bars) density estimates of pinto abalone in the central coast (CC, top panel) and Queen Charlotte Islands (QCI, lower panel) survey areas, British Columbia (adapted from Figures 7 and 8; COSEWIC 2009).

The entire coast of British Columbia has been closed to harvest of abalone since 1991 (COSEWIC 2009). The large decreases in densities of mature abalones combined with the decrease in average size (SLs) of populations since the fisheries closures point to the size-selective mortality that is characteristic of poaching (COSEWIC 2009). In 2009, pinto abalone in Canada was designated as Endangered (COSEWIC 2009).

Washington

In Washington, there has been concern over declines in the population of pinto abalone since at least the early 1990s; this prompted the closure of the recreational fishery after 1994 (Rothaus *et al*. 2008; Essington *et al*. 2011). In 1998, pinto abalone was designated as a Candidate Species in Washington (Gaydos 2007). Beginning in 1992, the Washington Department of Fish and Wildlife (WDFW) has been regularly monitoring the abundance of pinto abalone at ten index stations throughout the San Juan Archipelago (Rothaus *et a1*. 2008; Essington *et al*. 2011). Since they were initiated, these surveys have indicated a steady declining trend. By 2006, the mean density of pinto abalone at these index sites had fallen to 0.04 abalone/m^2 (0.000 to 0.082 abalone/m^2), and abalone had been extirpated from two of the sites (**Figure 4**; Rothaus *et al.* 2008).

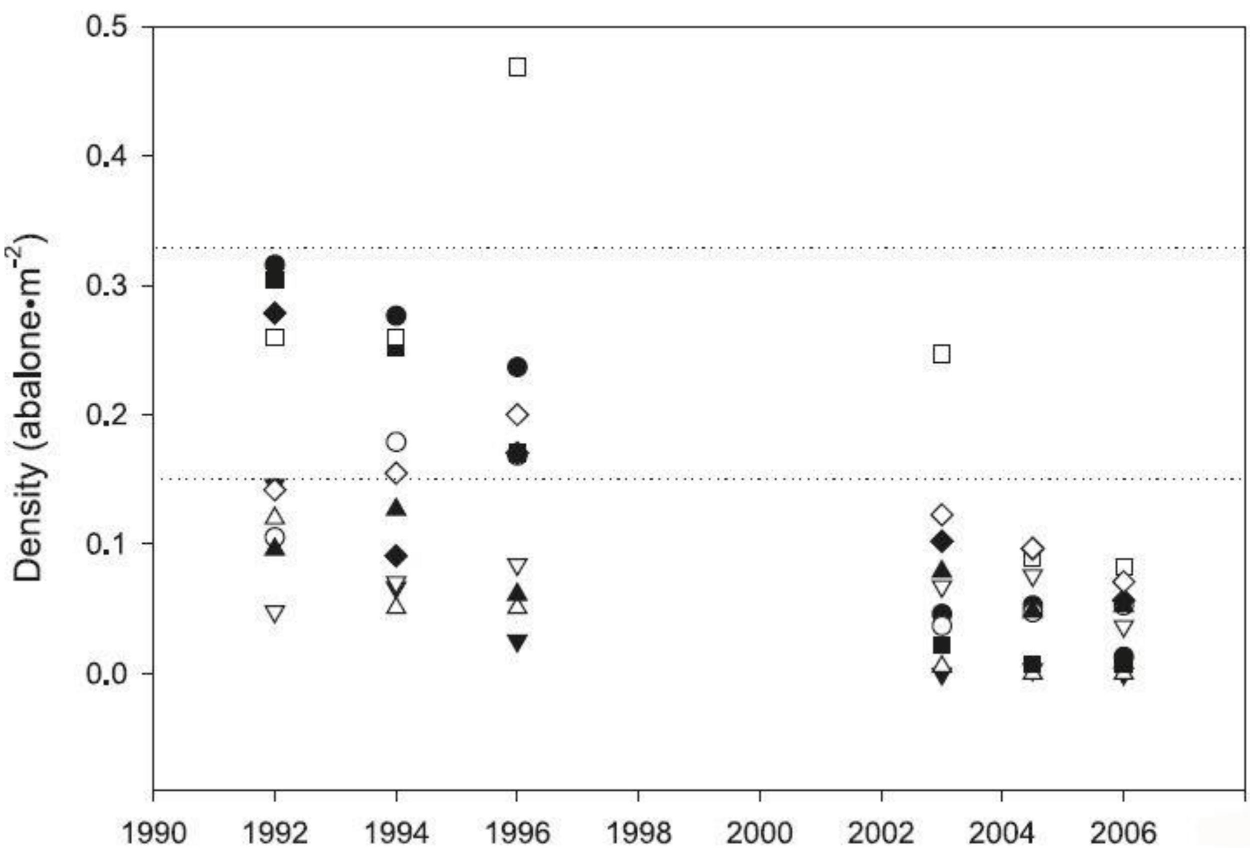

Figure 4: Densities of pinto abalone at ten index stations in the San Juan Island Archipelago, Washington, 1992-2006. Horizontal broken lines indicate the Allee threshold of 0.33 to 0.15 abalone per m^2. WDFW closed the fishery following the 1994 survey (Figure 3 from Rothaus *et al*. 2008).

The average abundance trend of pinto abalone at these index sites has continued to decline (**Figure 5**; Essington *et al*. 2011). Between 1992 and 2009, the average abundance (number) of abalone at these index sites declined by 83% (Essington *et al.* 2011).

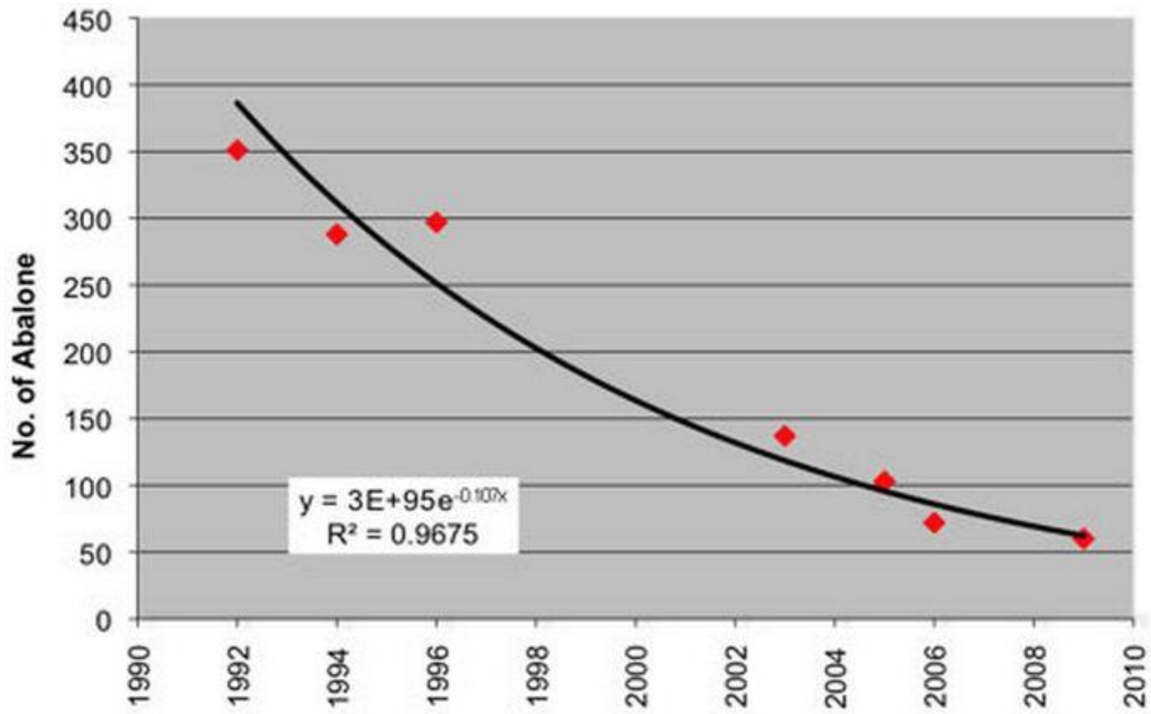

Figure 5: Trends in pinto abalone abundance at ten index stations in the San Juan archipelago, 1992-2009 (methods according to Rothaus *et al*. 2008; Figure 2 in Essington *et al*. 2011).

In addition, the size distribution of abalone at these sites has shifted since 1992 (**Figure 6**), due to both the complete absence of juvenile (< 70 mm) abalone and the aging (growth) of the population. This is a strong indication of recruitment failure as well as some indication that poaching and predation by otters (both of which select the largest individuals) is not the largest threat at these sites (Rothaus *et al*. 2008; Essington *et al*. 2011). In Washington, the pinto abalone is considered "functionally extinct" and many scientists believe that the species will have no hope of recovering without immediate and active intervention (Puget Sound Restoration Fund 2013).

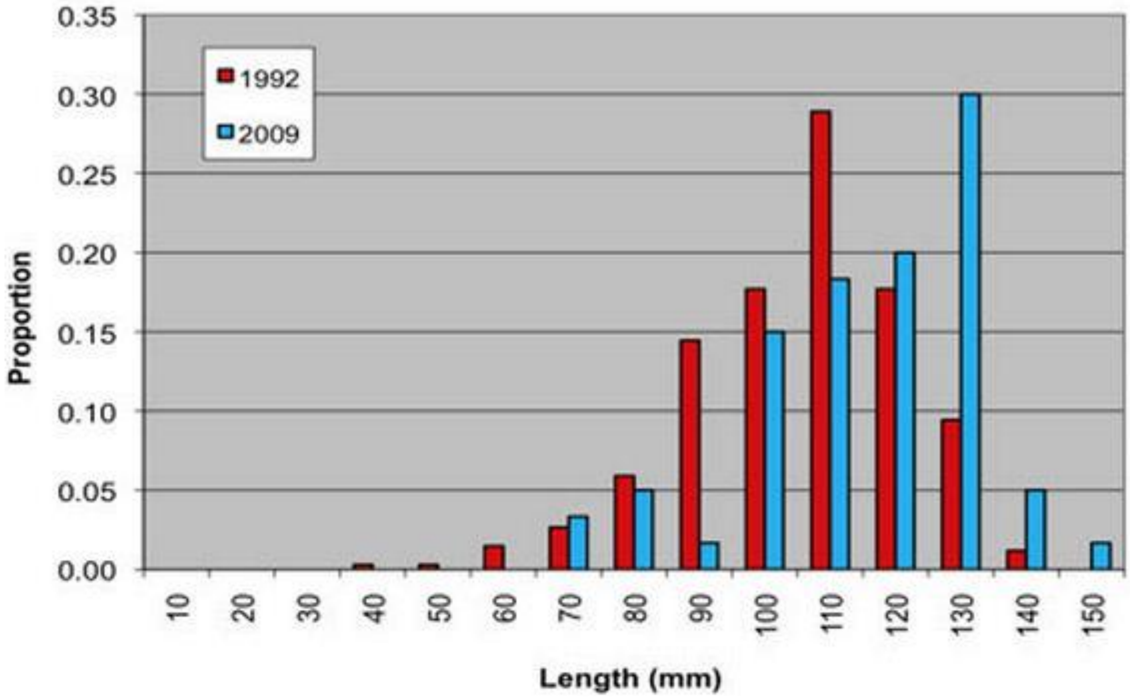

Figure 6: Pinto abalone SL frequency from ten index sites in the San Juan archipelago, 1992-2009 (methods according to Rothaus *et al.* 2008; Figure 3 in Essington *et al*. 2011).

Oregon
Information on the population status of pinto abalone in Oregon is limited (Rogers-Bennett 2007). There have been isolated reports of pinto abalone in Oregon (NOAA 2009), however never in abundances large enough to support fishing activity.

California
In northern California, the northern subspecies of pinto abalone (*H. k. kamtschatkana*) was more common in the 1970s, when it made up an estimated 13% of the abalone population (California Department of Fish and Game (CDFG) 2005: 2-20) and Cox (1962) reported that large numbers could occasionally be found in deeper waters. Pinto abalone is now estimated to make up less than 1% of the abalone population in northern California (CDFG 2005: 2-20). Using survey data, baseline abundance for pinto abalone in northern California was estimated to be 156,000 in 1971 (Rogers-Bennett *et al.* 2002a: 106). Comparisons with abundance estimates made in 1999-2001 showed pinto abalone populations declining precipitously in northern California, dropping nearly ten-fold to 18,000 (Rogers-Bennett *et al.* 2002a: 106). More recently, Rogers-Bennett *et al.* (2007: Table 3) showed declines of more than 99% at three sites in northern California from the early 1970s to 1999-2003. The range of the northern subspecies in California also appears to have contracted, with no observations of the subspecies in the northern Channel Islands for the past two decades, nor in central California for at least 30 years (Rogers-Bennett *et al.* 2002a: 108).

In southern California, baseline abundance for the southern subspecies of pinto abalone, the threaded abalone (*H. k. assimilis*), was estimated at 21,000 in 1971 based on peak commercial landings from 1971-80 (Rogers-Bennett *et al.* 2002a: 97, 101 (Table 1), 105). The ten-year period, 1971 to 1980, is responsible for 99.6% of threaded abalone landings over the entire course of the fishery's history. After 1980 only 66 threaded abalone were landed (Rogers-Bennett *et al.* 2002a: 105). The southern subspecies of pinto abalone is now extremely rare, with numbers at less than 1% of the estimated baseline (Rogers-Bennett *et al.* 2002a: 98). None have been found in surveys of the northern Channel Islands since 1982, and only a handful of threaded abalone have been documented in scattered reports since 2000 (Rogers-Bennett 2007: 286). Data suggest that this subspecies may now number in the hundreds and may be at least as rare as the ESA-listed endangered white abalone, if not more so (Rogers-Bennett *et al.* 2002a: 105). In light of such extremely low numbers, Rogers-Bennett *et al.* (2002a: 108) suggest that captive breeding may be the only option for recovery of this subspecies.

B. Conservation status

Concerns over population trends for pinto abalone prompted a Threatened listing under the Canadian Federal Species at Risk Act (SARA) in 1999. As noted above, the status was changed to Endangered in 2009. In 2004, NOAA identified pinto abalone as a Species of Concern due to substantial population declines, limited larval dispersal, and continued threats including illegal harvest and predation (NOAA 2007). Following an assessment in 2006, the IUCN designated the pinto abalone as endangered.

IV. Identified threats to the species: criteria for listing

A species is endangered under the ESA if it "is in danger of extinction throughout all or a significant portion of its range." *See* 16 U.S.C. § 1532(6). A species is threatened under the ESA if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *See id.* at § 1532(20). To determine whether a species is endangered or threatened, NMFS must consider five statutorily prescribed factors:

- The present or threatened destruction, modification, or curtailment of its habitat or range;
- Overutilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- The inadequacy of existing regulatory mechanisms; and
- Other natural or manmade factors affecting its continued existence.

See 16 U.S.C. § 1533(1)(a). The agency must consider each of the listing factors singularly and in combination with the other factors. *See Carlton v. Babbitt*, 900 F. Supp. 526, 530 (D.D.C. 1995). Each factor is equally important and a finding by the Secretary that a species is negatively affected by just one of the factors warrants a non-discretionary listing as either endangered or threatened. *See Nat'l Wildlife Fed. v. Norton*, 386 F. Supp. 2d. 553, 558 (D. Vt. 2005) (citing 50 C.F.R. § 424.11(c)). Likewise, a species must be listed if it is endangered or threatened because of a combination of factors. *See, e.g.*, 50 C.F.R. § 424.11(c).

In choosing a time frame, *e.g.*, what is the "foreseeable future" in which a species is likely to become endangered for classification purposes, the U.S. Fish and Wildlife Service (FWS) must choose a time frame that is reasonable, given the species' characteristics and the nature of the threats. *Cf.* Black's Law Dictionary, 8th ed. 2004 (definition of foreseeable is "reasonably anticipatable"). The time frame should also ensure protection of the petitioned species, and give the benefit of the doubt regarding any scientific uncertainty to the species.

The time frame for pinto abalone should be similar to that used for other marine invertebrate species. Because ocean acidification and global warming are significant threats to pinto abalone, NMFS should also use a time frame that is appropriate for such impacts. The minimum time period that meets these criteria is 100 years. Most recently, NMFS defined the year 2100 as the foreseeable future in proposed listing determinations for 82 candidate coral species (77 Fed. Reg. 73220: 73226). This was based on NMFS agreement with a scientific review committee's "judgment that the threats related to global climate change (*e.g.*, bleaching from ocean warming, ocean acidification) pose the greatest potential extinction risk to corals and have been assessed with sufficient certainty out to the year 2100." (77 Fed. Reg. 73220: 73226). The 100 year time frame has also been used for fish species such as Columbia River steelhead, Chinook salmon, and the Gulf of Maine DPS of Atlantic Salmon (NMFS 2009: 74 Fed. Reg. 29344, 29356). Courts have approved the use of the 100 year time frame for multiple other species as well. *See Western Watersheds Project v. United States Fish and Wildlife Service*, 535 F. Supp. 2d 1173, 1184 (D. Id. 2007) (To be a "threatened species under the ESA, the sage-grouse must be likely 'to be in danger of extinction' within 100 years"); *Southwest Center for Biological Diversity v. Norton*, 2002 WL 1733618, at *12 (D.D.C. July 29, 2002) (for the Queen Charlotte goshawk, the FWS determined that the goshawk would be "threatened" if at any point in the next 100 years there is a 20% chance that the species would become extinct); *Western Watersheds Project v. Foss*, 2005 WL 2002473, at *15 (D. Id., Aug. 19, 2005) (court ruled that FWS's decision not to list a plant with 64 percent chance of extinction within 100 years as threatened was untenable).

The IUCN species classification system also uses a time frame of 100 years. For example, a species must be classified as "vulnerable" under the IUCN system if there is a probability of extinction of at least 10% within 100 years. Further, a species must be listed as "endangered" if the probability of extinction is at least 20% within 20 years or five generations, whichever is the longer, up to a maximum of 100 years.

Moreover, in planning for species recovery, agencies routinely consider a 75-200 year foreseeable future threshold (Suckling 2006). For example, the FWS used 100 years in connection with recovery of the Steller's Eider (*e.g.*, the Alaska-breeding population of the species will be considered for delisting from threatened status when it has <1% probability of extinction in the next 100 years, and certain populations have <10% probability of extinction in 100 years and are stable or increasing) and 200 years in connection with recovery of the Utah prairie dog, and NMFS used 150 years in connection with the recovery of the Northern right whale (Suckling 2006).

Perhaps most importantly, the time period that FWS uses in its listing decision must be long enough so that actions can be taken to ameliorate the threats to the petitioned species and prevent extinction. For all these reasons, Petitioner recommends a minimum of 100 years, or until at least the year 2113, as the time frame for analyzing the threats to the continued survival of pinto abalone.

As discussed below, the pinto abalone is in danger of extinction throughout all or a significant portion of its range as a result of at least three of the statutorily-prescribed factors.

A. Overutilization for commercial, recreational, scientific, or educational purposes

1. Directed fisheries

Alaska

In Alaska, there was a commercial fishery for pinto abalone from the mid-1960s until the fishery was closed in 1996 (Pritchett and Hoyt 2008). This fishery operated entirely subtidally using compressed air (SCUBA and umbilical diving gear). The commercial abalone fishery went through a "boom and bust history" characterized by an initial period of unrestricted access (requiring only interim permits) and harvests followed by stock crash (Woodby *et al*. 2000). Harvests peaked at 172 tons in the 1979-80 season, at around the same time that the value of pinto abalone started its steady increase (**Figure 7**; Pritchett and Hoyt 2008). Despite increasingly-stringent catch guidelines and minimum size limits (increasing from three inches to four inches), the stock failed to recover and the commercial fishery was closed by emergency order after October 1995 (Woodby *et al*. 2000; Pritchett and Hoyt 2008). Subsistence and personal use fisheries continue, with fishers limited to 5 abalone per day (reduced from 50 per day in 2012), with a minimum size of three and a one half inches (5 A.A.C. 02-135, 77-670). As noted above, observations by both ADFG and commercial divers indicate a continued decline in abalone populations (Alaska Board of Fisheries 2012a: Proposal 195; Pritchett and Hoyt 2008: 5).

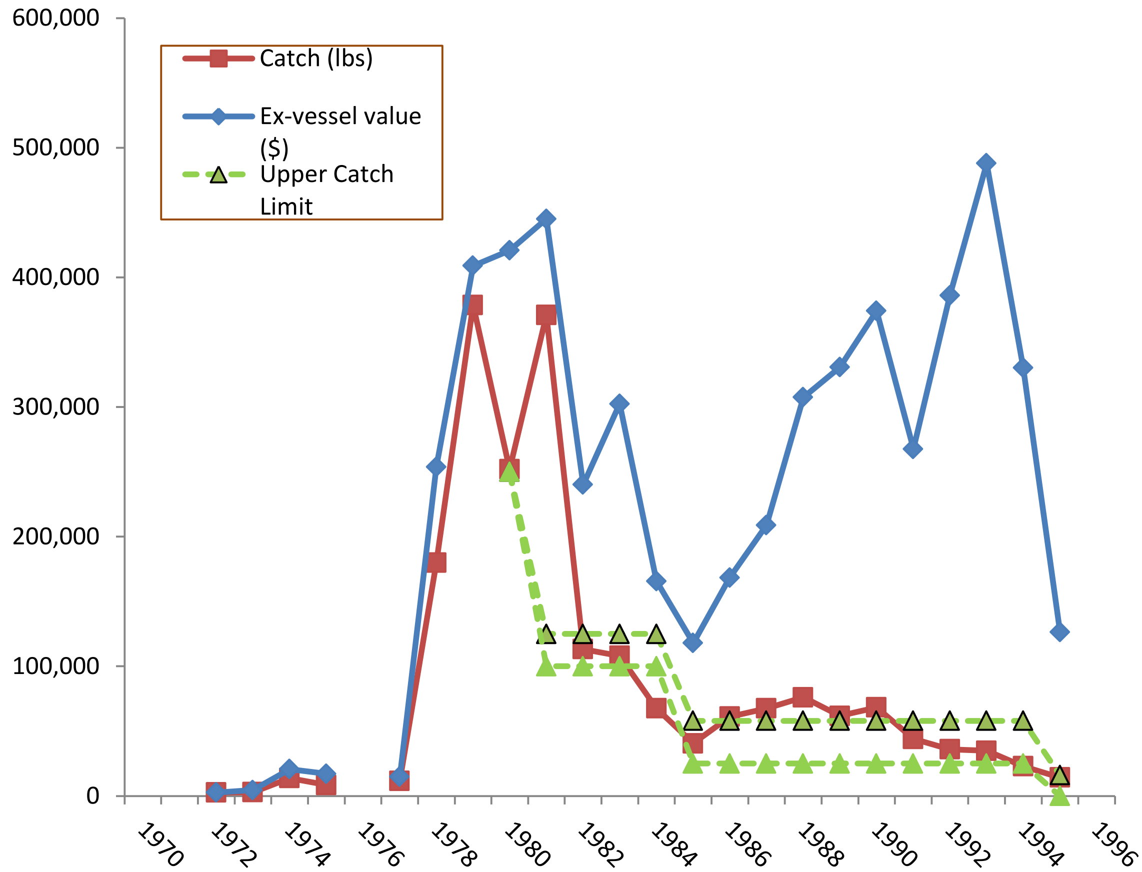

Figure 7: Total landings (pounds (lbs)), catch limits (upper and lower harvest guidelines, lbs) and total ex-vessel value ($USD) of pinto abalone in the southeast Alaska commercial abalone fishery (adapted from Table 1 in Pritchett and Hoyt 2008). The commercial fishery was closed after 1995.

British Columbia

Pinto abalone was harvested commercially in British Columbia starting in the early twentieth century, and the fishery was unregulated for much of its history. Harvest levels were relatively small and sporadic for the first 50 years. A 31 mt harvest in 1928 was the peak landing for this time period (Muse 1998). With the introduction of SCUBA gear in the 1950s, harvests became more consistent and began to increase (Muse 1998). Harvest increased dramatically in the 1970s, hitting its peak in the late 1970s, presumably in response to the increase in price and advances in freezing technology (**Figure 8**; Muse 1998). In response to the dramatic increase in effort, regulations (with limited entry, quotas, size limits, and total allowable catch (TAC)) were put in place to try to manage the stock (**Figure 8**; Muse 1998). While the commercial fishery continued to be active through the 1980s, depletion of the abalone stocks became increasingly evident, and the fishery was closed in 1990 (Muse 1998).

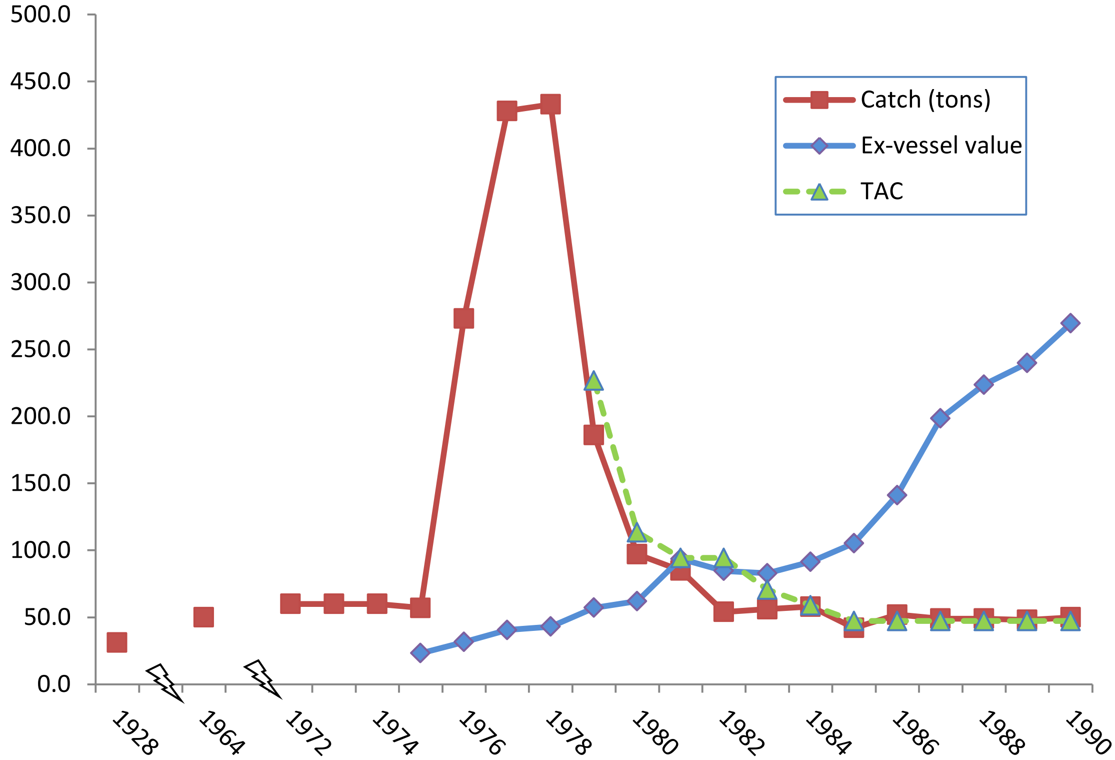

Figure 8: Landings (tons), catch limits (TAC in tons) and ex-vessel price ($CND * 100 per ton) of pinto abalone in the British Columbia commercial abalone fishery (adapted from appendix and data in Muse 1998). Data are primarily from the Department of Fisheries and Oceans Canada (DFO). There was heavy illegal fishing during at least some of this time, especially as price increased, which undermines the accuracy of these numbers, especially as prices increased in later years. The fishery closed after 1990.

During the same time period (1976-90) that the commercial harvest of abalone increased and began to be regulated, there was also substantial harvest of abalone by recreational and native fisheries, as well as an extremely high amount of illegal harvest. Throughout the last decade of the fishery, illegal and unreported harvest was estimated to range from 100-400% the amount of legal harvest (Muse 1998).

<u>Washington</u>

While commercial fishing for abalone has never been allowed in Washington, recreational (sport) and subsistence harvest has been popular in the past (pinto abalones have been an important part of the subsistence diet and culture of native peoples of the Pacific Northwest (Bouma 2007; COSEWIC 2009)). Unfortunately subsistence harvest has only been minimally documented. According to data from creel surveys and charter boat captains, annual sport harvest was approximately 38,200 individuals in the early 1980s and 40,934 individuals in the early 1990s, before a moratorium on recreational harvest was implemented in 1994 (Bouma 2007: 2).

California

California has a long history of abalone harvest. While pinto abalone (*H. kamtschatkana*) are believed to have occurred in numbers too low to support targeted fishing (CDFW 2013c: 3-1), the species was landed in abalone fisheries (Rogers-Bennett et al. 2002a: 105, 108).

Archaeological evidence indicates that Native Americans fished extensively for abalone from coastal areas and island areas prior to European settlement of California (CDFW 2004: 8-1). Between 1850 and 1900, Chinese-Americans had an intensive commercial fishery for intertidal abalones, and in the early 1900s, Japanese-American divers began fishing virgin stocks of subtidal abalone (CDFW 2004: 8-1). Commercial abalone fishing continued with substantial and relatively stable landings until rapid declines began in 1969 (CDFW 2004: 8-1). By 1996, the last full year the commercial fishery was open, landings had fallen to about 229,500 lb, only 4% of the fishery's peak landings of 5.4 million lb (CDFW 2004: 8-1). Low population numbers and disease triggered the closure of the commercial black abalone fishery in 1993 and was followed by closures of the commercial pink, green, and white abalone fisheries in 1996 (CDFW 2013c: 3-1). The northern California recreational red abalone fishery is the only abalone fishery currently open in California (CDFW 2013c: 3-2).

The commercial abalone fishery removed 21,000 threaded abalone (the southern subspecies of pinto abalone) from 1969 to 1995, apparently the bulk of the population in southern California (Rogers-Bennett *et al.* 2002a: 108). In 2002, only 16 threaded abalone were documented in California, all at depths greater than 20 meters (Rogers-Bennett *et al.* 2002a: 108).

Rogers-Bennett *et al.* (2002a: 108) suggest that the relatively light fishing pressure on the northern subspecies of pinto abalone in northern California may have led to declines in abundance, as the species was not effectively excluded from the recreational fishery until 1999 (as the result of an increase in minimum harvest size limits).

2. Illegal fisheries

Illegal harvest (poaching) is considered to be the most significant short-term threat to pinto abalone in Canada, and a major source of mortality for pinto abalone since the closure of the fisheries (Muse 1998; COSEWIC 2009). In British Columbia, around 30 abalone poaching convictions were made from 1997 to 2006, and this is estimated to represent only 10-20% of poaching activity (COSEWIC 2009). As recently as December 2010, authorities in British Columbia seized 280 kg of illegal pinto abalone, worth anywhere from $30,000 to $100,000, from a local seafood importer, indicating that the black market for pinto abalone is still active (V'Inkin Lee 2012). Pinto abalones are particularly susceptible to poaching because 1) they are easily accessible to harvesters when they aggregate in relatively shallow waters, 2) they have a wide distribution on largely uninhabited and minimally patrolled coastlines, and 3) their high market value makes them an attractive target to poachers (Muse 1998; COSEWIC 2009; McDougall *et al*. 2006). Though there is less documentation of illegal harvest in other areas, poaching has been identified as a threat to the pinto abalone in Alaska and throughout its range.

Poachers represent a double threat to abalone populations. Not only do they directly reduce population numbers through removals, but they preferentially select the larger, more reproductively valuable abalone, further reducing the reproductive potential and resiliency of the population (COSEWIC 2009). In Canada, approximately 85% of the abalones recovered from poachers were well above the size limits that had been in place when commercial fisheries were active (COSEWIC 2009).

3. Discard Mortality

Because the largest abalone are the most prized (and in some cases, fishers are restricted by size limits), abalone fishers will often discard smaller pinto abalone. When abalones are harvested, they must be pried from the rocky substrates to which they adhere tightly with their strong, muscular foot. Typically, this requires the use a tool to quickly "pop" the abalone off the rock and to help remove the meat from the shell. The accepted tool is called an abalone iron, a flat metal spatula-type instrument with rounded edges designed to protect the abalone's sensitive skin from lacerations. However, due to improper use, abalone irons often produce fatal cuts. When they are damaged and cut during harvesting, abalone tend to keep bleeding (Fedorenko and Sprout 1982; Muse 1998). Even if they are not damaged, unless abalones are returned to suitable habitat (which often means the same spot they were removed from), abalones will face increased risk of natural mortality from predation and/or starvation (CDFW 2013b). Discard mortality rates for the pinto abalone have been measured at 50-100% (Fedorenko and Sprout 1982).

B. Predation

Major predators of juvenile and adult abalone are crabs, octopus, and various sea stars (Griffiths and Gosselin 2008). Adult abalones are also a favorite prey item of sea otters (*Enhydra lutis*), a predator whose population has been recovering and increasing in many areas occupied by pinto abalone (Pritchett and Hoyt 2008). Alaskan abalone populations took a significant dip following reintroduction of sea otters in southeast Alaska (Woodby *et al*. 2000), and continue to face high levels of predation from an abundant sea otter population (ADFG 2013). However, evidence from other locations suggests that sea otter predation is not the main cause of the pinto abalone's decline. Sea otters are not present in many abalone communities in Canada in which both reduction in densities of mature individuals and reductions in maximum size of individuals have continued to occur (which suggests poaching as the cause of harm) (COSEWIC 2009: 22). In Washington, the size distribution of abalone has shifted since 1992 (**Figure 6**), due to both the complete absence of juvenile (< 70 mm) abalone and the aging (growth) of the population, indicating that neither poaching nor predation by otters (both of which select the largest individuals) is the largest threat at these sites (Rothaus *et al*. 2008; Essington *et al*. 2011).

C. The inadequacy of existing regulatory mechanisms

1. Inadequate state regulations

Alaska, Washington, Oregon and California have long regulated the harvest of abalone, and pinto abalone in particular. Pinto abalone aggregations have failed to recover and have continued to decline under these regulations and management plans.

Alaska

The Alaska commercial fishery for pinto abalone was closed in 1996 (Pritchett and Hoyt 2008). Alaska's recreational fishery for pinto abalone is managed using bag and size limits (Pritchett and Hoyt 2008). The size limit (89 mm, or 3.5 inches) is similar to size limits used during the commercial fishery (three to four inches), and this size limited is believed to provide protection to abalone for at least three years after the average age of reproductive maturity (Woodby *et al*. 2000). However, this size limit failed to prevent stock collapse in the commercial fishery and may be too low to ensure sufficient reproductive output to sustain populations in face of recreational fishing pressure (Woodby *et al*. 2000). In addition, size limits are frequently associated with high discard rates due to ineligible sizes and high-grading, and the pinto abalone has a high (50-100%, Fedorenko and Sprout 1982) discard mortality rate.

In early 2012, the Alaska Board of Fisheries closed the sport fishery and reduced possession limits for personal use and subsistence abalone fisheries in Alaska (Alaska Board of Fisheries 2012b: discussing Proposals 195, 196).[1] Personal use and subsistence fishers are now limited to five abalone per day (Alaska Board of Fisheries 2012a: Proposal 195; Alaska Board of Fisheries 2012b (discussing Proposals 195, 196)).[2] Allowed collection methods include by hand, using snorkel gear, and using abalone irons (Alaska Board of Fisheries 2012a); the use of compressed air has been prohibited since at least 2008 (Pritchett and Hoyt 2008).

Washington

Commercial and recreational fisheries are closed to allow recovery of stocks (Washington Department of Fish and Wildlife (WDFW) UDa; WDFW UDb). In 1998, pinto abalone was designated as a Candidate Species in Washington (Gaydos 2007). Neither regulatory action has stopped the decline of pinto abalone in the state.

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[1] All (and only) Alaska residents are eligible to participate in both Subsistence and Personal Use fisheries, while nonresidents harvest shellfish in the sport fishery. Details available through Alaska Department of Fish and Game website at http://www.adfg.alaska.gov/.

[2] The Alaska Department of Fish and Game recommended reductions in allowable harvest of pinto abalone after recognizing that previous harvest rates were resulting in population depletion (Alaska Board of Fisheries 2012a: Proposal 195 and 196). A proposal was also made to reduce not only the harvest level but also to increase the size limit and increase education for the fishers on conservation and proper harvest techniques in particular, to address the high discard mortality rates associated with high-grading and size limits (Alaska Board of Fisheries 2012a: Proposal 196). A temporary moratorium was also considered but was rejected out of concern that enforcement resources were inadequate to prevent an increase in poaching.

Oregon
Although there is no commercial fishery for abalone in Oregon (Oregon Department of Fish and Wildlife (ODFW) UDb), there remains a recreational fishery with limits of one abalone per day per person, and five per year (ODFW UDa).

California
Because of declines in many abalone populations, in 1997, California passed a moratorium on taking, possessing, or landing abalone for commercial or recreational purposes in ocean waters south of San Francisco, including all offshore islands and mandated the creation of an Abalone Recovery and Management Plan (ARMP) (CDFG 2005: i). The Abalone Recovery and Management Plan, which was finalized in 2005, included the recovery of at-risk abalone species and management of abalone fisheries as plan goals; pinto abalones were included in the recovery portion of the plan (CDFG 2005: 5-1; Table 6-1; 6-30).

2. Inadequate federal protections

In 2004, NOAA identified pinto abalone as a Species of Concern due to substantial population declines, limited larval dispersal, and continued threats including illegal harvest and predation (NOAA 2007). Species of Concern are those species that do not have endangered, threatened, or candidate species status under the ESA and have not been petitioned for listing but have been identified as important to monitor (FWS UD).

3. Lack of enforcement

A major impediment to the management of abalone populations in the northeast Pacific is the lack of enforcement (NMFS 2009; COSEWIC 2009). As poaching remains a lucrative and low risk activity, it remains a major threat to pinto abalone. Alaska and British Columbia, in particular, have large and relatively uninhabited coastlines and minimal enforcement activity (NMFS 2009; COSEWIC 2009). The ability to enforce the no-take restrictions in any marine protected areas will also directly determine the efficacy of such areas as refugia and recovery measures for pinto abalone (McDougall *et al*. 2006).

D. Other natural or manmade factors affecting the pinto abalone's continued existence

1. Impacts of greenhouse gas pollution, including climate change and ocean acidification

The impacts of carbon dioxide (CO_2) and other "greenhouse gas" pollutants pose a serious and increasing threat to the pinto abalone. For more than two and a half centuries (since the industrial revolution), humans have discharged vast quantities of CO_2 into the earth's atmosphere through the burning of fossil fuels and land use changes (Feely *et al*. 2012: xi). Since the pre-industrial era (early 1700s), global atmospheric CO_2 levels have risen from approximately 280 parts per million (ppm) to 400 ppm, higher than they have been at any time over the past 800,000 years (Intergovernmental Panel on Climate Change (IPCC) 2007; Scripps Institution of Oceanography 2013). The substantial increase in atmospheric CO_2 levels (as well as other greenhouse gases) to date has led to climate warming, sea level rise, and related impacts as evidenced by increases in global average air and ocean temperatures, widespread melting of snow and ice cover, and rising global average sea level (IPCC 2007). Climate warming has also led to changes in precipitation patterns, river discharges, wind patterns, and other effects (Greene *et al.* 2008). Such changes are occurring faster than scientists had previously predicted (Boesch *et al.* 2007) and are impacting species and their habitats worldwide (IPCC 2007). With rates of CO_2 emissions accelerating and atmospheric levels of CO_2 expected to increase to 800-1000 ppm by the end of the century, such impacts are expected to increase in rate and magnitude (IPCC 2007; 77 Fed. Reg. 73220). NMFS has stated that "at our current emissions rate, the earth's atmosphere is expected to warm 4 °C (likely range 2.4 °C-6.4 °C), and [ocean temperature is] expected to warm 2.8 °C-3.6 °C by the year 2100 (77 Fed. Reg. 73220: 73227).

For marine species, increased atmospheric CO_2 levels presents an especially dire threat since approximately one quarter of the anthropogenic, or human generated, CO_2 has been absorbed by the ocean (Feely *et al*. 2012). This has resulted in increased ocean water acidity (lower pH). Since the mid-1700s, pH in the upper ocean has decreased by about 0.1 pH units (~30%) in a process known as "ocean acidification" (OA). By the end of this century, surface ocean pH is expected to decline by another 0.3–0.4 pH units, with aragonite saturation state decreasing below the current range of annual variability within 12–40 years (Feely *et al*. 2012). Aragonite saturation levels are critical for calcifying organisms like abalone, with OA likely to cause water conditions that are both corrosive to existing shells and unfavorable for shell formation and normal larval development (Crim *et al*. 2011; Feely *et al*. 2012).

As further discussed below, direct impacts of greenhouse gas pollution on the pinto abalone will include disruption of normal larval development caused by exposure to water that is warmer, less saline, and increasingly acidic. Indirect impacts of greenhouse gas pollution on the species will include changes in the distribution and availability of preferred habitat and food sources, specifically kelp beds and coralline algae (Tomascik and Holmes 2003; Rogers-Bennett 2007; COSEWIC 2009; Rogers-Bennett *et al*. 2011).

a. Impaired water quality: temperature and salinity

Larval stages of pinto abalone are particularly susceptible to environmental conditions, including decreased salinities (such as caused by increased inputs of freshwater) and higher water temperatures. In controlled lab experiments, larval abalone exposed to water below 23 practical salinity units (psu) experienced total mortality, while larvae in controls (in water of 30-32 psu) experienced little mortality (**Figure 9**, Bouma 2007). Bouma (2007) concluded that exposure to water of depressed salinity (< 26 psu) during early life stages negatively impacts the survival of pinto abalone. Pinto abalone larvae were also increasingly sensitive to temperatures above 21ºC, and 24ºC was the lethal limit (Bouma 2007).

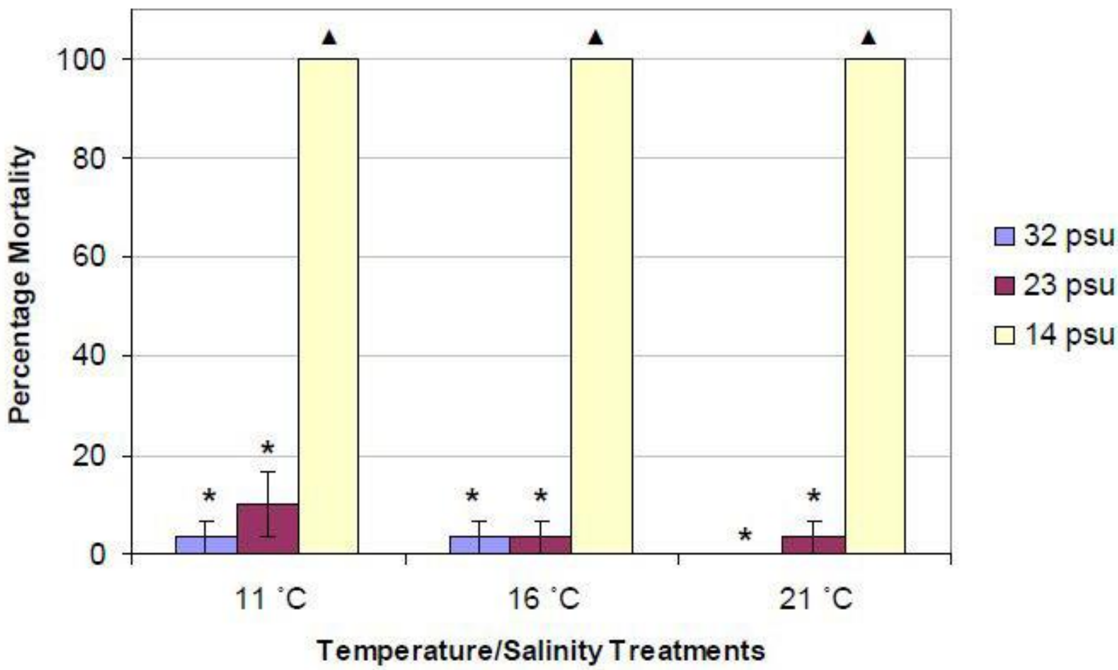

Figure 9: Temperature and salinity effects on survival of post-larval pinto abalone (mean SL = 4.0 mm) after 14 days of exposure to treatments. Salinity effects were highly significant ($p<0.0005$), while there were no significant temperature ($p=0.715$) or interaction effects ($p=0.373$). Error bars indicate standard error of the mean of five replicates. Symbols indicate multiple comparison groupings between treatments. (Figure 2.5, Bouma 2007.)

Bouma (2007) likely understates the threat posed to the pinto abalone from greenhouse gas-induced changes in water temperature and salinities. The study used temperature and salinity parameters intended to bracket the range of conditions juvenile abalone experienced at that time (2007) during short-term and seasonal fluctuations, and did not reflect changes likely in the future as a result of continuing greenhouse gas pollution. According to the IPCC (2007), climate change is predicted to increase the temperature of open ocean waters adjacent to the Pacific Northwest coast between 0 and 1°C from 2015 to 2025, and between 1 and 2°C from 2045 to 2055.[3] In addition, climate change is predicted to affect the hydrology (flow rates, timing, and patterns of water movement) of coastal ecosystems, likely causing increased heavy precipitation events that will lead to increased incursions of low salinity water into coastal waters (Essington *et al.* 2011).

b. Impaired water quality: ocean acidification

The IPCC defines OA as "a reduction in the pH of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of CO_2 from the atmosphere, but can also be caused by other chemical additions or subtractions from the ocean" (IPCC 2011: 37). Ocean

[3] NMFS has noted that global warming is and will continue to cause increased stratification of the upper ocean, because water density decreases with increasing temperature. Increased stratification results in decreased vertical mixing of both heat and nutrients, leaving surface waters warmer and nutrient-poor (77 Fed. Reg. 73220: 73229).

pH is directly linked to dissolved levels of seawater CO_2, which is directly linked to atmospheric CO_2 levels (**Figure 10**).

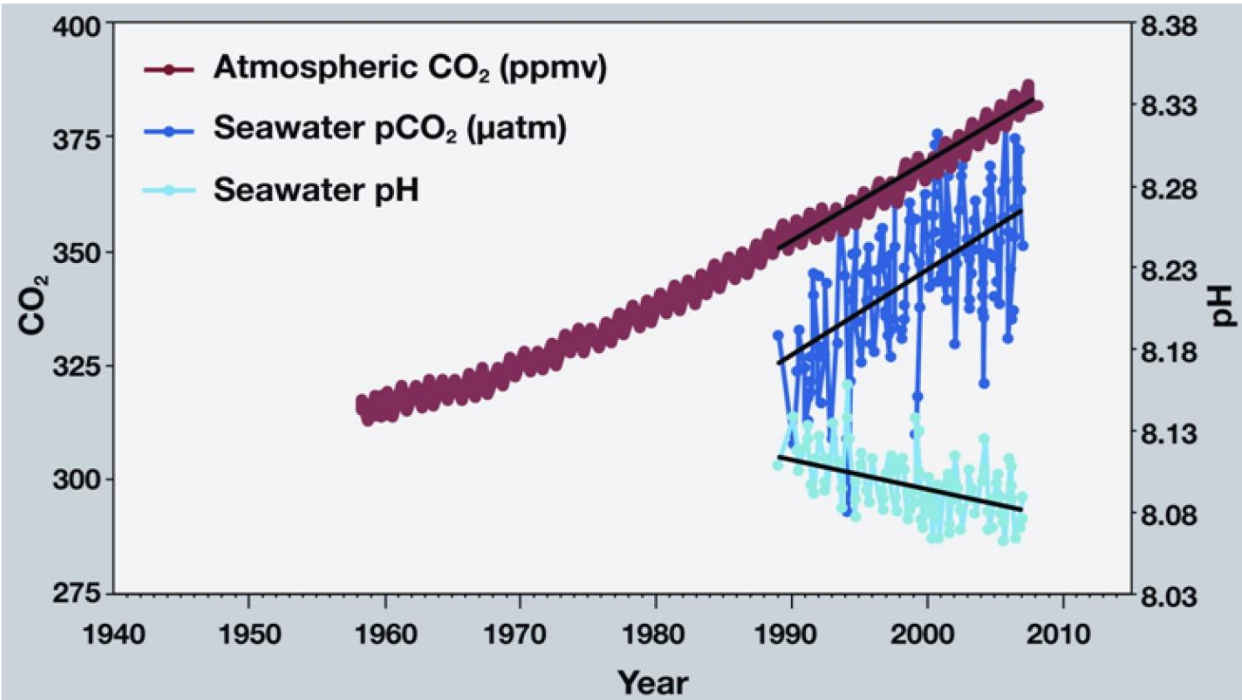

Figure 10: Time series of atmospheric CO_2 at the Mauna Loa station (in ppm; mole fraction in dry air) and surface ocean pH and the partial pressure of CO_2 dissolved in seawater (pCO_2) in microatmospheres (μatm) at the nearby Ocean Station Aloha in the subtropical North Pacific Ocean. As more CO_2 accumulates in the ocean, the pH of the ocean decreases. Available at: http://www.pmel.noaa.gov/co2/file/Hawaii+Carbon+Dioxide+Time-Series.

Recent studies indicate that ocean acidification presents an imminent threat to pinto abalone populations. Crim *et al.* (2011) exposed larvae to different levels of CO_2 (400 ppm (ambient), 800 ppm, and 1800 ppm CO_2). Larval development was found to be very sensitive to CO_2, with negative impacts on both shell development and normal larval development with increasing pCO_2 (**Figure 11**; Crim *et al*. 2011). Larval shell abnormalities became apparent in approximately 40% of larvae reared at 800 ppm $CO_{2;}$ almost all larvae reared at 1800 ppm CO_2 either developed an abnormal shell or lacked a shell completely (**Figure 12**; Crim *et al*. 2011). Overall, larval survival decreased by around 40% in elevated CO_2 treatments relative to the 400 ppm control.

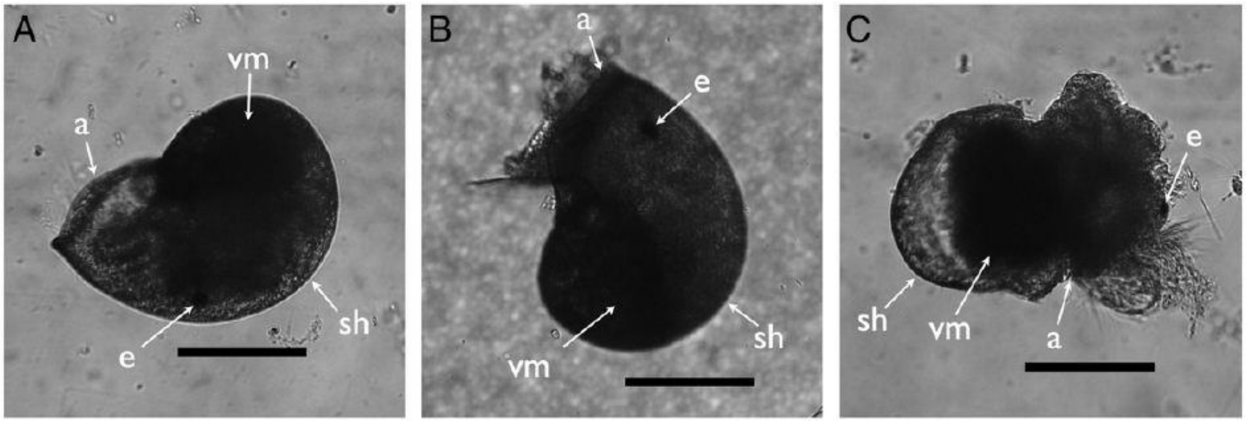

Figure 11: Pinto abalone larvae exposed to elevated CO_2 levels (A: 400 ppm (ambient); B: 800 ppm; and C: 1800 ppm) for 8 days, and showing increasing impacts on calcification and larval development. a = aperture, e = eye spot, vm = visceral mass, sh = shell. Scale bar = 100 micrometers (µm). (Figure 1, Crim *et al*. 2011)

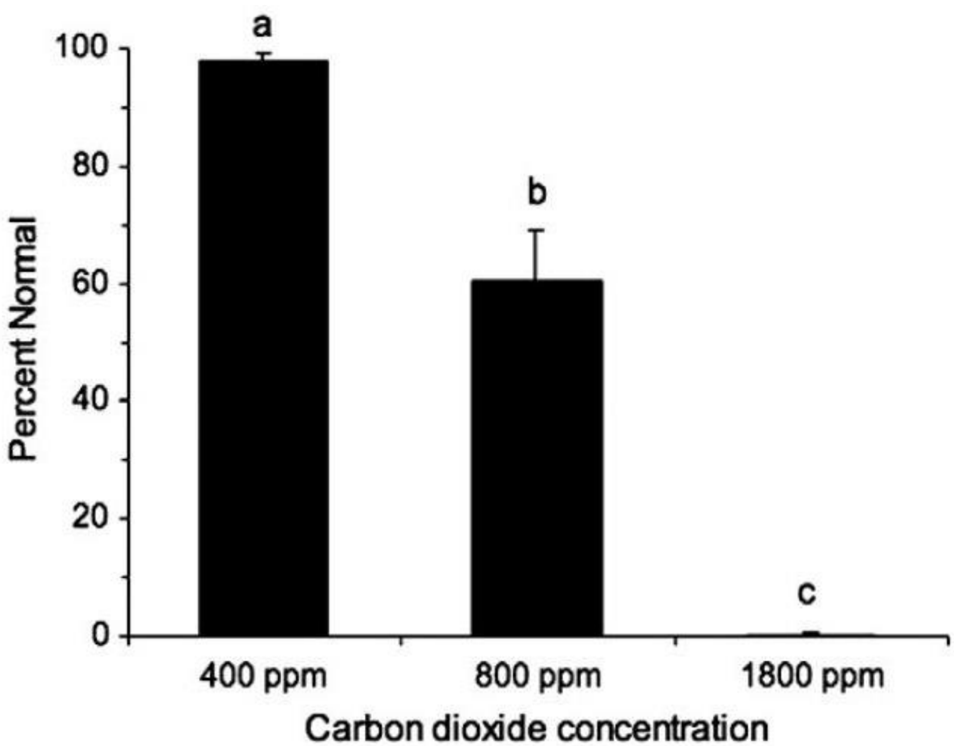

Figure 12: Mean (+ 1 standard error) percent of pinto abalone larvae that developed normal shell morphology after exposure to elevated CO_2 levels (400 ppm [ambient]; 800 ppm; and 1800 ppm) for 8 days, Small letters denote significant differences assessed by a non-parametric Kruskal Wallis and post-hoc Tukey HSD comparison. (Figure 4 in Crim *et al*. 2011)

Friedman *et al*. (2012) examined impacts of increased CO_2 on pinto abalone larval survival. In this study, reduced survival of day 6 pinto abalone larvae was observed in larvae exposed to 750 µatm CO_2 relative to controls (400 µatm) after 48 hour ($p < 0.01$) and 72 hour ($p < 0.001$) exposures.

Spikes in dissolved CO_2 are already being observed along the coasts of British Columbia (UBC Science 2011) and Washington due to seasonal coastal upwelling (Feely *et al*. 2012), particularly in late spring and early summer when northern abalone populations are spawning. The coastal waters of the Pacific Northwest are particularly susceptible to ocean acidification due to a combination of regional factors, including oceanography (upwelling), riverine input, and bathymetry (Feely *et al.* 2008; Feely *et al*. 2012). Seawater pH as low as 7.3 pH units has been observed in some parts of Puget Sound, Washington, and as low as 7.6 in Washington and Oregon coastal waters (Friedman *et al*. 2012), suggesting that ocean acidification could already be affecting pinto abalone populations.

c. Impaired water quality: multiple stressors

Pinto abalone are threatened by the above-discussed changes to ocean water pH, temperature, and salinity resulting from greenhouse gas emissions acting in concert, including together with other impacts of greenhouse gas emissions, like reduced dissolved oxygen, nutrient concentration changes, and increased water pollution, and other threats like fishing and habitat modification and loss (Feely *et al*. 2012: 79). In general, research suggests that the response to multiple simultaneous stressors is often larger and potentially of a different nature than the additive response to each stressor considered in isolation (Feely *et al*. 2012). Specifically, the nature and magnitude of the impacts from ocean acidification on marine organisms and ecosystems may be different (exaggerated or modulated) when coupled with these other changes (IPCC 2011: 26).

Byrne *et al*. (2011) examined the effects of both warming and acidification on the reddish-rayed abalone (*Haliotis coccoradiata*) reared from fertilization in different temperature and pH/pCO_2 treatments. Larval development of this abalone was negatively impacted both by increased temperatures (**Figure 13** (b)) and acidification (pH 7.6-7.8; **Figure 13** (c-d)) (Byrne *et al.* 2011).

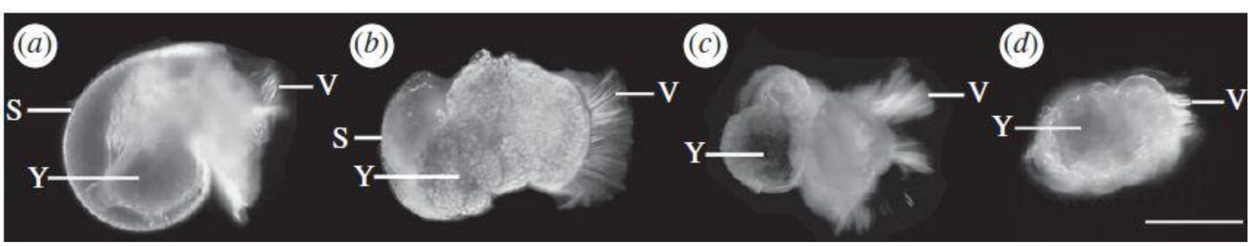

Figure 13: Effects of increased temperature and reduced pH on larval development in the reddish-rayed abalone, *Haliotis coccoradiata.* Larvae shown after 21 hours in an experimental treatment: (a) veliger from control treatments, (b) larvae from control pH/+2°C and (c,d) larvae from pH 7.8 treatments. S, veliger shell; V, velum; Y, yolk mass in developing digestive tract. Scale bar: 100 mm. (Figure 1a-d in Byrne *et al*. 2011).

Larval calcification rates specifically were substantially reduced with increasing temperature and acidification, with negligible calcification occurring in the lowest pH treatment (7.6; **Figure 14**).

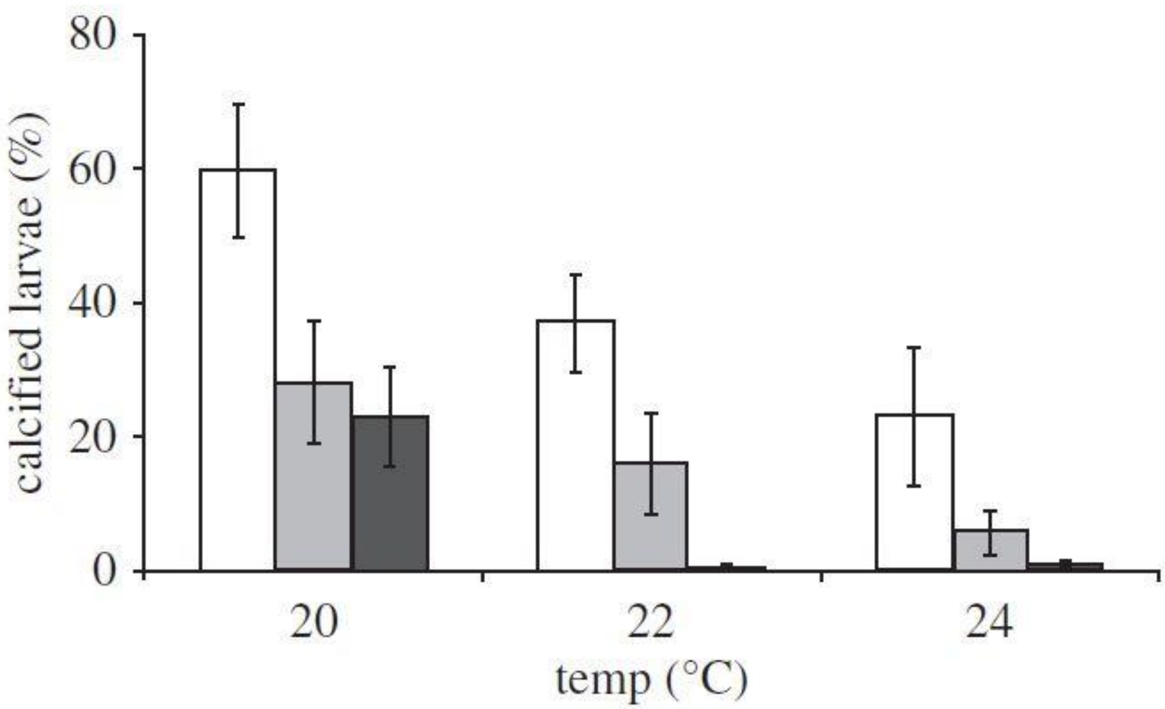

Figure 14: Mean percentage (± s.e.) of calcified *H. coccoradiata* veliger larvae (21 h) in nine treatments (three pH x three temperature). Temperature and pH both significantly affected calcification. White bars, pH 8.2; grey bars, pH 7.8; black bars, pH 7.6. (Figure 2 in Byrne *et al*. 2011)

d. Climate-mediated habitat shifts

Climate change is predicted to have indirect negative effects on pinto abalone through the changing distribution and availability of critical food sources and habitats, specifically kelp (especially bull kelp, *Nereocystis luetkeana)* beds and coralline algae (Tomascik and Holmes 2003; Rogers-Bennett 2007; COSEWIC 2009; Rogers-Bennett *et al*. 2011). Kelp forest communities are complex, productive and vital habitats for abalones, providing food and shelter from predators throughout multiple life stages (CDFG 2005; Rogers-Bennett *et al*. 2011). Kelp (and other algal food sources) may be particularly sensitive to increased sea surface temperatures (and the nutrient depletion that often accompanies warmer waters), with negative impacts on growth and productivity (CDFG 2005: 2-11; Rogers-Bennett *et al*. 2011: 579). Reduced kelp resources may lead to increased competition for food between abalones and major competitors like the adult sea urchin, with negative effects on the growth and survival of abalone (CDFG 2005: 2-10). Coralline algae may also experience decreased growth with increasing temperatures (CDFG 2005: 2-11; Rogers-Bennett *et al*. 2011), which could limit juvenile recruitment by reducing the amount of suitable juvenile abalone habitat and food sources.

V. Requested Listing

NMFS must list a species as "endangered" under the ESA if the species is "in danger of extinction throughout all or a significant portion of its range." See 16 U.S.C. § 1532(6). NMFS must list a species as "threatened" under the ESA if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *See id.* at § 1532(20).

A. NMFS should list the pinto abalone as an endangered species or, in the alternative, as a threatened species

For the reasons set forth in this petition, NMFS must list the pinto abalone as an endangered species because it is in danger of extinction in the foreseeable future throughout all or a significant portion of its range. The precipitous and sustained decline of pinto abalone despite efforts to stabilize and rebuild this population, as well as widespread reproductive failures due to unsustainably low population densities, indicate that it is necessary to use the protections available under the ESA to save and recover this population. In the alternative, for these same reasons, NMFS should list the pinto abalone as a threatened species because it is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

B. In the further alternative, NMFS should list the southern subspecies of pinto abalone as endangered, and identify distinct population segments (DPSs) of the northern subspecies of pinto abalone and list such DPSs as endangered or threatened

In the further alternative, we request that NMFS both (1) list the southern subspecies of pinto abalone (threaded abalone) as endangered, and (2) segregate the northern subspecies of pinto abalone into separate populations that are discrete (because of their limited larval dispersal and patchy distribution) and significant (in terms of the ecosystems that they occupy and the range of the species) and list these DPSs as either endangered or threatened.[4] The southern subspecies was long considered a separate species of abalone until recent evaluations defined it as a subspecies based on some areas of limited divergence (Rogers-Bennett 2007: 284). Pinto abalone found in and around Puget Sound in Washington merit particular consideration as a DPS. Studies have identified genetic variation among Washington's pinto abalone population and other pinto abalone populations, including significant differences between pinto abalone along the interior coast (including Washington) and the outer coast (British Columbia and parts of Alaska) (*e.g.*, Straus et al. 2007).

The southern subspecies of pinto abalone and the Washington State DPS clearly meet the criteria for an endangered listing. The limited geographic range of the southern subspecies puts it at particular risk of extinction (Rogers-Bennett 2007: 291). The Washington population of pinto abalone is considered functionally extinct, and both the Washington population and the southern

[4] The loss of even one spawning aggregation could result in a loss of genetic diversity in pinto abalones (Naish 2006; Straus *et al.* 2007; NMFS 2009).

subspecies likely require immediate and active interventions (such as captive breeding) to survive (Rogers-Bennett *et al.* 2002a: 108; Puget Sound Restoration Fund 2013).

VI. Recovery plan elements

NMFS should establish a recovery plan for pinto abalone that addresses critically reduced population densities, unsustainable (and largely illegal) harvest, inadequacy of existing regulatory mechanisms, climate change, and other key threats.

A key component of a successful recovery strategy for pinto abalone will be habitat protection. Habitat areas where spawning aggregations of the pinto abalone occur must be protected, monitored, and potentially supplemented. Throughout the northeast Pacific, densities of pinto abalones have been measured at or below the minimum threshold for successful reproduction since at least the 1990s, and there is widespread evidence that recruitment failure is one of the major impediments to recovery of pinto abalone populations (Rothaus *et al.* 2008; COSEWIC 2009; Essington *et al.* 2011). Establishing and maintaining spawning populations of pinto abalones that are above the threshold to sustain their replenishment and recovery will be key to the continued existence of this species.

Adequately protected habitat areas are considered important potential recovery tools for depleted abalone populations both throughout the northeast Pacific and globally (Edgar and Barrett 1999; Wallace 1999; Davis 2000; Rogers-Bennett *et al.* 2002b; Bouma 2007; Micheli *et al.* 2008). In British Columbia, Wallace (1999) found that population abundances of pinto abalone were consistently greater at protected than at unprotected sites (**Table 1**). In addition, protected sites often had a greater proportion of larger individuals which, combined with higher abundances, translated into greater reproductive potential for those populations (Wallace 1999). The site with the greatest reproductive potential per individual was a prison reserve, an unintentional marine reserve due to access restrictions provided by the operation of a prison on that land for nearly 40 years, effectively protecting this population from harvest.[5] The study found that coast-wide sites had been heavily harvested by legal fisheries and poachers, and densities were critically low (**Table 1**; Wallace 1999). Wallace (1999) indicates that closed areas that are completely protected from harvest can produce significantly healthier populations than neighboring open access shorelines.

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[5] A more recent survey (in 2005) of the populations around this reserve indicated that this population may be disappearing (COSEWIC 2009). Although the reasons are unknown, it appears that this area is suffering recruitment failure, as poaching at this location is not thought to be a problem (COSEWIC 2009).

Table 1: Comparison of pinto abalone abundance (abalone per minute diving (APMD)) and size based on data from three forms of marine reserve (prison, ecological, military), and a historical government study on unprotected shorelines (government data and five coast-wide sites). This study was conducted during March 1996 and February 1997, at locations in the Strait of Juan de Fuca off the southern end of Vancouver Island. (Adapted from Table 1, Wallace 1999).

Location	**# of abalone**	**APMD (n/min.)**	**Average size/range (mm)**	**> 130 mm (%)**
Prison reserve	211	0.77	115.6 (62-154)	26.5
Ecological reserve	241	0.70	99.7 (40-148)	8.8
Military site	163	1.22	100.4 (40-152)	6.1
Government data	298	-	98.1 (50-142)	3.4
Five coast-wide sites	9	0.05	109.4 (72-127)	0

Measures should also be put in place to protect spawning aggregations, including potentially are supplementing such aggregations by transplanting existing wild stock to achieve critical, above-threshold densities, or even transplanting wild individuals to create aggregations in preferred habitat. In southern California, the former technique was successful in creating and sustaining increased densities of green abalones in a protected location (Bouma 2007). It is important to recognize that aggregations of abalone are highly vulnerable to poaching, so this recovery strategy will be only as effective as the enforcement of harvest regulations (*i.e.*, preventing poaching; Bouma 2007).

Other components of a recovery plan for pinto abalone include:

- Measures to address the current and future effects of global warming on pinto abalone, including measures to protect water quality (ocean acidity level and temperature) and essential coastal habitats (including kelp beds and rocky areas with coralline algae coverage); and

- Increased support for active restoration and recovery techniques.

VII. Critical habitat designation

Petitioner requests the designation of critical habitat for pinto abalone on the northwestern Pacific coast of the U.S. concurrent with the requested listings, as required by 16 U.S.C. § 1533(b)(6)(C). *See also* 16 U.S.C. § 1533(a)(3)(A). Critical habitat should encompass all coastal and marine habitats where all stages of pinto abalone (larval to adult) are known to reside.

Critical habitat is defined by Section 3 of the ESA as:

> (i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found

> those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species.

See 16 U.S.C. § 1532(5).

The designation and protection of critical habitat is one of the primary ways to achieve the fundamental purpose of the ESA, "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." *See* 16 U.S.C. § 1531(b). In adding the critical habitat provision to the ESA, Congress clearly saw that species-based conservation efforts must be augmented with habitat-based measures:

> It is the Committee's view that classifying a species as endangered or threatened is only the first step in insuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence . . . If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the [ESA] will depend on the designation of critical habitat."

See House Committee on Merchant Marine and Fisheries, H.R. Rep. No. 887, 94th Cong. 2nd Sess. at 3 (1976).

The pinto abalone will benefit from the designation of critical habitat in all of the ways described above. Designated critical habitat will allow FWS to designate reasonable and prudent alternatives to activities that are impeding recovery but not necessarily causing immediate jeopardy to the continued survival of the species. For these reasons and as already stated, we request critical habitat designation concurrent with species listing.

VIII. Conclusion

For all of the reasons discussed in this petition, NMFS should list the pinto abalone as an endangered species under the ESA, or, in the alternative, as threatened. In the further alternative, NMFS should list the southern subspecies of pinto abalone as endangered, and identify distinct population segments (DPSs) of the northern subspecies of pinto abalone and list such DPSs as endangered or threatened.

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