DRAFT Abalone Recovery Plan Goals and Objectives
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The following goals and objectives are in DRAFT form, and have not been reviewed or endorsed by other ADFG staff (e.g., researchers, managers, or biometricians) at this time. They are presented here merely as a starting point for discussion and represent a first cut at outlining what research and monitoring field surveys and associated analyses could be done to reach the larger goal of abalone recovery. Note that Objective a) and b) may be combined to save money and time, but potentially at the cost of statistical "inference space", or in other words, generalization of the results from a large-scale population survey. This is an important decision that should be weighed carefully, with input from biometricians.

Vision: Wild abalone stocks in Southeast Alaska that are, in order of priority, abundant enough to be 1) self-sustaining (i.e., not dependent upon hatcheries), 2) harvested for subsistence, 3) harvested for personal use, 4) harvested for sport/recreational use, and 5) harvested commercially.

Study Goals

a) Determine whether extant abalone stocks in Southeast Alaska appear to be self-sustaining or need active intervention (e.g., policy changes, restoration aquaculture) by December 2016
    i) Strategy: Determine current population status of abalone stocks by conducting fishery-independent surveys throughout the historical geographic range of abalone and measure key population metrics during one 9-day cruise aboard ADFG's R/V Kestrel in summer 2016
        (1) Objectives
            (a) Reduce and refine the geographic inference space to survey by:
                (i) Acquiring spatial data from resource managers and users (e.g., former commercial fishermen, subsistence and personal use users), then compiling and aggregating the data into maps (i.e., "knowledge mapping")
                1. Tactical options for achieving objective:
                    a. Contract with Ecotrust (Portland, OR), a private firm specializing in this type of data collection and analysis (e.g., State of California Marine Life Protection Act initiative, State of Oregon's Territorial Sea Marine Spatial Planning initiative); note: Ecotrust's PIs on these projects (Astrid Scholtz, John Steinback) are no longer with Ecotrust, and I am unsure if current staff are experts in the process
                    b. Fund a graduate student to do the work; literature is available to permit reconstruction of knowledge mapping exercise
                        i. Pros: local AK sourcing possible, potential for greater rapport between interviewer and interviewees, cheaper than contracting Ecotrust
                        ii. Cons: no prior knowledge/experience with analysis, more mistakes/inefficiencies/sub-optimal results possible when using inexperienced PI, longer timeline for results likely
                    c. Fund ADFG subsistence and commercial fisheries divisions to do project
                        i. Pros: project is consistent with mission of Subsistence program, social networking infrastructure already exists, cheaper than contracting Ecotrust, raw data stays in-house/confidential, funding could fill gap in forthcoming General Fund cuts

ii. Cons: no prior knowledge/experience with analysis, staff time may be limited, timeline could be extended if workloads conflict

(ii) Develop a predictive species-habitat model (aka habitat suitability model) using inputs including knowledge mapping result map, biological shoreline exposure (from Shorezone database), distance from open ocean, kelp canopy cover; Test the model and knowledge map using ADFG's relative density data from 130+ sites in 1979-81, and a subset of the knowledge mapping spatial data that was withheld from incorporation into the model

1. Tactical options for achieving objective:
   a. Contract with outside entity to conduct analysis; Oregon Department of Fish and Wildlife contracted The Nature Conservancy (Portland) for Territorial Sea Marine Spatial Planning; Oregon also had an MOU with NOAA's Center for Coastal Monitoring and Assessment (http://ccma.nos.noaa.gov/, http://ccma.nos.noaa.gov/about/biogeography/) to do similar work, and it was FREE
   b. Fund graduate student
      i. Pros/Cons: see above
   c. Fund ADFG Commercial Fisheries
      i. Pros/Cons: see above

(b) Design survey

(i) Use the habitat suitability model to stratify survey sites into low, medium, and high abalone density areas

(ii) Stratify the study area geographically (e.g., Sitka Sound, Outer Baranof, Kuiu/POW Barrier Islands/ W Coast Dall Isl, W Coast POW/Cordova Bay, Dixon Entrance/Ketchikan/Nakat)

(iii) Randomly allocate survey sites within each geographic and density strata, using an optimal sampling strategy (i.e., maximizing sampling effort in high-density areas, and minimizing effort in low-density areas)

(iv) Select key population metrics including absolute density, nearest-neighbor distances, size frequencies, and habitat associations, using methods refined from Sitka Sound surveys in 2015

1. Tactical options to achieve objective:
   a. Fund ADFG Commercial Fisheries division staff
      i. Pros: Staff are experienced in abalone survey design and logistical operations/constraints of diving fieldwork in AK
      ii. Cons: Possible workload conflicts
   b. Fund outside entity
      i. Pros: Staff may be experienced in abalone survey design
      ii. Cons: Staff probably not experienced with logistical operations/constraints of diving in remote locations in Alaska
   c. Fund graduate student
      i. Pros: Student may have thesis advisor that is experienced in abalone survey design
      ii. Cons: Student and/or advisor probably not experienced with logistical operations/constraints of diving in remote locations in Alaska

(c) Conduct field surveys

(i) Tactical options to achieve objective:

1. Fund ADFG dive team to do survey

a. Pros: very experienced divers familiar with AK diving and abalone survey techniques, existing infrastructure, funding could fill gap in General Fund budget shortfall
b. Cons: expensive (~$10k/day, ~$90k total for 9 day cruise), may cause schedule conflicts with ADFG's primary mission (i.e. surveys of commercially important invertebrates)

2. Fund outside dive team
   a. Pros: may be cheaper than ADFG dive team (but not likely), but ≥$4k/day vessel charter probably needed
   b. Cons: no existing infrastructure, limited (if any) experience with diving in Alaska
3. Fund graduate student
   a. Pros: may be cheaper than other options, but ≥$4k/day vessel charter probably needed unless University vessel used; could dedicate more time to project
   b. Cons: probably limited if any Alaska diving experience, no existing infrastructure, project would likely take longer because lesser staffing, successful outcome less certain, timeline to completion could be extended
4. Some combination of the above (ADFG/ graduate student may be ideal)

(d) Analyze data and determine the extent to which:
   (i) adult densities and nearest-neighbor distances are sufficient for successful fertilization (0.15-0.2 abs / m^{-2} , <2.5m separation distance, respectively)
   (ii) the stock's size structure is "healthy" (i.e., includes small, intermediate, and large size classes, per California's Abalone Recovery and Management Plan)
   (iii) metrics differ as a function of geographic sub-region, estimated sea otter predation intensity, estimated human harvest intensity
   (iv) Using same structure of predictive habitat suitability model developed earlier in Objective A, replace knowledge mapping input with actual extant absolute densities and compare results [as a sensitivity test of the model to determine reliability]
      1. Tactical options to achieve objective
         a. ADFG Commercial Fisheries staff
            i. Pros: will be familiar with abalone data analysis
            ii. Cons: possible workload conflicts
         b. Graduate student
            i. Pros/Cons: see above
         c. Contract outside entity
            i. Pros: outside entities may be more experienced with abalone analyses
            ii. Cons: probably more expensive
         d. Some combination of the above (ADFG/ graduate student may be ideal)

(e) Based on results from (d), interpret data and, if warranted, make policy recommendations, e.g., bag limit reduction or elimination, size limit increase, protected area establishment, or initiate active intervention (e.g., propagation/outplanting or transplanting), by geographic subregion

b) Determine magnitude of abalone population decline from historical levels and identify probable causation for decline (e.g., sea otters, human harvest, Allee effects) by geographic subregion, to guide future recovery efforts (if applicable)

i) Strategy: Re-survey 130+ sites throughout Southeast that were originally surveyed by ADFG (Larson and Blankenbeckler) in 1976 – 1982, using the same methods for direct backwards

comparability (i.e. relative density), as well as modern methods for forward comparability with new surveys (i.e. absolute density, nearest neighbor distances) during one 9-day cruise aboard ADFG's RV Kestrel in summer 2017; estimate magnitude of subregion-specific population decline and geographic contraction, and analyze data as a function of estimated sea otter predation intensity and human harvest intensity)

(1) Objectives:
  (a) Locate and compile hardcopies of all historical survey data and enter into electronic relational database; convert hardcopy maps to GIS data; re-create survey methodology via interviews with original data collectors; re-calculate relative density metrics (# abalone per minute of search time)
    (i) Tactical options for achieving objective:
      1. Fund ADFG
        a. Pros: data currently reside with ADFG, retired ADFG staff that worked on project still available for consultation
        b. Cons: Potential workload conflicts
      2. Fund graduate student
        a. Pros: cheaper than funding ADFG
        b. Cons: Work would need to be done in ADFG facility (original datasheets may not leave building), possible mistakes by someone inexperienced in dealing with data
      3. Combination of above, e.g., graduate student with ADFG oversight, may be ideal
  (b) Design survey
    (i) Tactical options for achieving objective:
      1. Fund ADFG
        a. Pros/Cons: see Pros/Cons listed for survey design in Objective A
      2. Fund graduate student
        a. Pros/Cons: see Pros/Cons listed for survey design in Objective A; note: this survey would be much easier to design than the one in Objective A, because site selection step would not be necessary, and methods are mostly worked out
      3. Fund outside entity
        a. Pros/Cons: see Pros/Cons listed for survey design in Objective A; note: this survey would be much easier to design than the one in Objective A, because site selection step would not be necessary, and methods are mostly worked out
  (c) Conduct field surveys
    (i) Tactical options to achieve objective:
      1. Fund ADFG dive team to do survey
        a. Pros: very experienced divers familiar with AK diving and abalone survey techniques, existing infrastructure, funding could fill gap in General Fund budget shortfall
        b. Cons: expensive (~$10k/day, ~$80k total for 8 day cruise), may cause schedule conflicts with ADFG's primary mission (i.e. surveys of commercially important invertebrates)
      2. Fund outside dive team
        a. Pros: may be cheaper than ADFG dive team, but ≥$4k/day vessel charter probably needed

b. Cons: no existing infrastructure, limited (if any) experience with diving in Alaska

3. Fund graduate student

a. Pros: may be cheaper than other options, but ≥$4k/day vessel charter probably needed unless University vessel used; could dedicate more time to project

b. Cons: probably limited if any Alaska diving experience, no existing infrastructure, project would likely take longer because lesser staffing, successful outcome less certain, timeline to completion could be extended

4. Some combination of the above (ADFG/ graduate student may be ideal)

(d) Analyze data:

(i) Directly compare historical vs extant relative density estimates (e.g., ANOVA with factors of geographic subregion, sea otter predation intensity/duration, human harvest intensity; pool data if factors are non-significant and run paired t-test, with site as replicate)

(ii) Estimate site-specific historical absolute density and nearest neighbor distances by back-calculation via relationship between extant and historical relative density estimates; compare historical vs extant absolute density estimates to estimate site-specific and subregion-specific magnitude of abalone population decline and range contraction

(e) Based on results from (d), interpret data and determine probable causation for population decline (if applicable), by comparing population trajectories by geographic subregion

c) Guide recovery efforts, if necessary, by determining whether recovery of abalone stocks is presently occurring or not by December 2018

i) Strategy: Determine short-term population trajectories of abalone stocks by conducting follow-up fishery-independent surveys using the same methods at the same sites visited in Objective A or B during one 9-day cruises aboard ADFG's R/V Kestrel in summer 2018

(1) Objectives

(a) Design survey

(i) Tactical options for achieving objective:

1. Fund ADFG

a. Pros/Cons: see Pros/Cons listed for survey design in Objective A

2. Fund graduate student

a. Pros/Cons: see Pros/Cons listed for survey design in Objective A; note: this survey would be much easier to design than the one in Objective A, because site selection step would not be necessary, and methods are mostly worked out

3. Fund outside entity

a. Pros/Cons: see Pros/Cons listed for survey design in Objective A; note: this survey would be much easier to design than the one in Objective A, because site selection step would not be necessary, and methods are mostly worked out

(b) Conduct field surveys

(i) Tactical options to achieve objective:

1. Fund ADFG dive team to do survey

a. Pros: very experienced divers familiar with AK diving and abalone survey techniques, existing infrastructure, funding could fill gap in General Fund budget shortfall

b. Cons: expensive (~$10k/day, ~$90k total for 9 day cruise), may cause schedule conflicts with ADFG's primary mission (i.e. surveys of commercially important invertebrates)

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b. Cons: probably imited if any Alaska diving experience, no existing infrastructure, project would likely take longer because lesser staffing, successful outcome less certain, timeline to completion could be extended

4. Some combination of the above (ADFG/ graduate student may be ideal)

(c) Analyze data:

(i) Compare all metrics (e.g., absolute density, nearest neighbor distances, aggregation size) with values from previous survey, and estimate direction and magnitude of short-term changes (if any) as a function of geographic subregion, sea otter predation intensity, human harvest intensity

(d) Based on results from (c), interpret data and determine probable causation for population decline (if applicable), by comparing population trajectories by geographic subregion

(e) Identify optimal geographic subregions for focusing restoration efforts (e.g., propagation.outplanting, adult transplanting)

d) Develop and refine restoration aquaculture and outplanting techniques,

e) Determine best approach for large-scale outplanting/transplanting recovery efforts by 2020

i) Strategy: Experimentally determine optimal approach by field studies comparing survival and growth of hatchery outplants and wild transplants using best practices techniques from the literature, and testing for differences among release locations (e.g., otter or non-otter, proximity to population centers, micro-habitats [e.g., boulders, cracks/crevices]), size/age of outplants, season, and absolute density) and monitor over time

(1) Objectives:

(a) Identify most promising areas for transplanting/outplanting at multiple spatial scales (e.g., subregion, areas within subregion, site, habitat type, depth); use data obtained from previous objectives to guide site selection, including small-scale species-habitat association analysis for within-site placement

(i) Tactical options for achieving objective:

1. ADFG
2. Graduate student
3. Outside entity

(b) Conduct outplanting/transplanting fieldwork

(i) Tactical options for achieving objective:

1. ADFG

2. Graduate student
3. Outside entity

(c) Perform cost-benefit analysis of propagation/outplanting vs adult transplants, and develop plan for implement the optimal strategy at large spatial scale

(i) Tactical options for achieving objective:

1. ADFG
2. Graduate student
3. Outside entity