United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

APR 17 2012

Dear Interested Party,

In October 2011, the U.S. Fish and Wildlife Service (Service) formed a Recovery Implementation Team (RIT) to assist us in recovering the marbled murrelet (*Brachyramphus marmoratus*) throughout its listed range in Washington, Oregon, and California. The RIT was comprised of scientific experts from a breadth of fields relevant to murrelet conservation. We also held a stakeholder's workshop in conjunction with the RIT's meeting. The objective of the RIT and stakeholder's workshop was to evaluate the specific causes of the continued murrelet population decline in this area, determine the relative importance (weight) of threats/causes of the decline, and develop a prioritized list of implementable actions to be taken in the short-term to stem the population decline.

The attached report documents the process, discussions, and results of the RIT meeting and stakeholder workshop. The RIT concluded that sustained low recruitment is the most likely overarching cause of the continued population decline, and identified five major mechanisms that appear to be contributing to this decline. These are:

- Ongoing and historic loss of terrestrial (forest) nesting habitat
- Predation on murrelet eggs and chicks in their nests
- Changes in marine forage conditions, affecting the abundance, distribution and quality of murrelet prey
- Post-fledging mortality
- Cumulative and interactive effects of factors on individuals, populations, and the species

The stakeholder group used the RIT's mechanisms and factors impacting murrelet populations to develop a list of 151 actions that could be taken to address those factors and help restore healthy murrelet populations and habitat. The RIT evaluated these 151 actions in terms of importance for implementing over the next 5 to 10 years, and identified 13 highest-ranked actions. These, plus the complete list of actions, are provided in the attached report.

The Service encourages proponents of actions within the listed range of the marbled murrelet to consider the cause of the decline and the mechanisms affecting the population when developing projects, and where feasible, to implement the actions identified as most beneficial for stemming the population decline. Your local Service field office looks forward to assisting you with this process.

To further our commitment to recovery of the murrelet, the Service has formed a marbled murrelet coordination team. The team is comprised of Service biologists from several of our field offices. One of the goals of this team will be to ensure the highest priority actions identified in the report are implemented.

The Service appreciates your interest in the recovery of the marbled murrelet. If you have any questions regarding the RIT and stakeholder process or information contained in the attached report, please contact Deanna Lynch at (360) 753-9545 or deanna_lynch@fws.gov or Jodi Bush at (360) 753-6046 or jodi_bush@fws.gov.

Sincerely,

Ken S. Berg

Ken S. Berg, Manager
Washington Fish and Wildlife Office

Attachment

Report on Marbled Murrelet Recovery Implementation Team Meeting and Stakeholder Workshop

Introduction

The U.S. Fish and Wildlife Service (Service) convened the Marbled Murrelet Recovery Implementation Team (RIT) and held a Stakeholder Workshop during the week of October 17-21, 2011. A recent (2009) 5-year status review by the Service concluded that the marbled murrelet (*Brachyramphus marmoratus)* (murrelet) population had declined significantly since 2002 within its federally-listed range, which is from Washington to California. The objective of the RIT and Stakeholder Workshop was to evaluate the specific causes of the continued murrelet population decline in this area, determine the relative importance (weight) of threats/causes of the decline, and develop a prioritized list of implementable actions to be taken in the short-term to stem the population decline. This purpose of this report is to document the process, discussions, and results of the RIT meeting and stakeholder workshop.

Recovery Implementation Team:
The RIT was convened at the U.S. Fish and Wildlife's Washington Fish and Wildlife Office in Lacey, Washington from October 17-21, 2011. Members of the RIT are:

Martin Raphael, US Forest Service, Pacific Northwest Research Station : Areas of expertise include murrelets in general, terrestrial habitat, population trend, and the Northwest Forest Plan.

Nate Mantua, University of Washington, Climate Impacts Group: Areas of expertise includes climate change and variability, and El Niño/Southern Oscillation and other forms of ocean-atmosphere climate variability.

Kim Nelson, Oregon State University: Areas of expertise include murrelets in general, terrestrial habitat, and the Northwest Forest Plan.

Zach Peery, University of Wisconsin, Department of Forest and Wildlife Ecology: Areas of expertise include murrelets in the marine environment and murrelet population ecology.

David Ainley, H.T. Harvey and Associates: Areas of expertise include marine ecology, focusing on seabirds and the California Current System.

Jeanette E. Zamon, NOAA Fisheries Service, Northwest Fisheries Science Center: Areas of expertise include seabirds and marine forage fish in the California Current System.

Craig Johnson, NOAA Fisheries Service, National Office of Protected Resources: Areas of expertise includes population ecology and the process of extinction.

Andrew Gray, US Forest Service, Pacific Northwest Research Station: Areas of expertise include Pacific Northwest forest dynamics and monitoring, and disturbance ecology.

Christine Fiorello, University of California-Davis, Wildlife Health Center: Areas of expertise include veterinary science, wildlife health and marine oil spill impacts on seabirds.

The Service established the objectives for the RIT to develop the following products:

a) A prioritized list of the most important mechanisms causing the continued population decline, including levels of uncertainty and rationale supporting prioritization.
b) A list of the data gaps that limit our ability to identify the most important mechanisms for the population decline, and which could be addressed quickly and effectively in order to stem the population decline and begin to achieve recovery.
c) A list of data sets that are readily available from other sources that may assist in identifying factors for the murrelet's decline.
d) A list of implementable actions to be taken in the short-term to stem the population decline

Stakeholder Workshop:

On October 20, 2011, the Service convened a Stakeholder's Workshop. The purpose of the Stakeholder's Workshop was to develop a list of actions that could be taken to reduce impacts to the species and contribute to recovery of the murrelet. Invitations were sent to over 100 entities that have an interest in murrelets, including Federal, state, and Tribal agency experts, non-governmental organizations, private sector businesses, and species experts not on the RIT (See Appendix A for a list of invitees and final attendees). A teleconference session was held simultaneously to accommodate stakeholders who were not able to attend in-person.

Ken Berg, manager of the Service's Washington Fish and Wildlife Office, started the workshop with opening remarks, and then Service staff and RIT members provided stakeholders with the most recent status of the species information, an overview of the RIT's process and the top five mechanisms they identified, and held a question/answer session. The RIT members and stakeholders then worked in smaller groups to brainstorm lists of actions. In order to be consistent with the Federal Advisory Committee Act, the Service did not seek agreement or consensus from the stakeholders; rather, the session focused strictly on gaining input and brainstorming actions.

Service Staff:

Lena Chang, USFWS, Ventura Fish and Wildlife Office
Gary Falxa, USFWS, Arcata Fish and Wildlife Office
Kim Flotlin, USFWS, Washington Fish and Wildlife Office
Deanna Lynch, USFWS, Washington Fish and Wildlife Office
Kevin Maurice, USFWS, Oregon Fish and Wildlife Office
Lynn Roberts, USFWS, Arcata Fish and Wildlife Office
Emily Teachout, USFWS, Washington Fish and Wildlife Office
Bridgette Tuerler, USFWS, Oregon Fish and Wildlife Office

Facilitator:

Both the RIT and Stakeholder Workshop were facilitated by Jamie Riche of PSDA Consulting, Inc. The facilitator guided the RIT through discussions to reach consensus on a prioritized list of the most important mechanisms of continued marbled murrelet population decline (including rationale to support prioritization), a list of the knowledge gaps that need to be filled in order to stem the population decline and begin to achieve recovery, as well as level of uncertainties in the

mechanisms. The facilitator, in coordination with Service staff, guided the stakeholders in development of actions aimed at addressing specific mechanisms of decline.

Process

RECOVERY IMPLEMENTATION TEAM

The following sections outline the process the RIT undertook to reach the final prioritized list of implementable actions to be taken in the short-term to stem the population decline. Figure 1 provides an outline of the process.

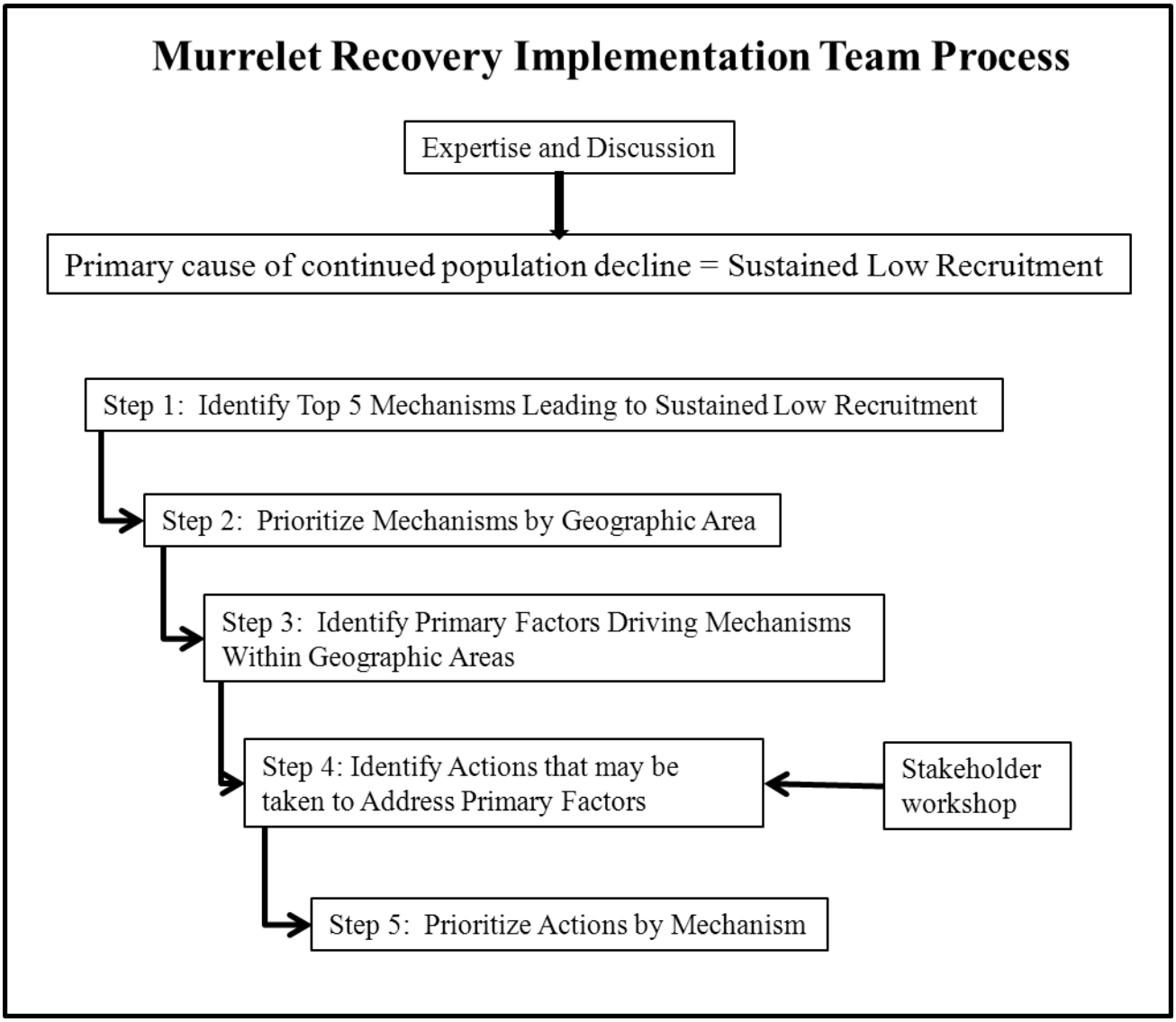


Figure 1. RIT process outline.

Background and Assumptions

Several weeks prior to the meeting, the Service provided the following background documents to the RIT.

Falxa, G., J. Baldwin, D. Lynch, S.L. Miller, S.K. Nelson, S.F. Pearson, M.G. Raphael, C. Strong, T. Bloxton, B. Galleher, B. Hogoboom, M. Lance, and R. Young. 2011. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2009 and 2010 summary report. 26 p. Available at: http://www.reo.gov/monitoring/reports/marbled-murrelet-reports-publications.shtml.

Falxa, G. 2010. Northwest forest plan interagency regional monitoring 15 year report, status and trend of marbled murrelet population and habitat. Briefing paper submitted to Northwest Forest Plan Effectiveness Monitoring Interagency Working Group. Available at: http://reo.gov/monitoring/reports/15yr-%20report/MAMU%202%20pg%20brief%20042111.pdf

McShane, C.; T. Hamer; H. Carter; G. Swartzman; V. Friesen; D. Ainley; R. Tressler; K. Nelson; A. Burger; L. Spear; T. Mohagen; R. Martin; L. Henkel; K. Prindle; C. Strong; and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report. EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, Oregon.

Peery, M.Z. and R.W. Henry. 2010. Abundance and productivity of marbled murrelets off central California during the 2009 breeding season. Final report submitted to California Stat Parks. 16 pp.

Raphael, M.G.; G.A. Falxa; K.M. Dugger; B.M. Galleher; D. Lynch; S.L. Miller; S.K. Nelson and R.D. Young. 2010. Northwest Forest Plan—the first 15 years (1994-2008): Status and trend of nesting habitat for the Marbled Murrelet. Gen. Tech. Rep. PNW-GTR-848. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available at http://www.reo.gov/monitoring/reports/15yr-report/marbled-murrelet/index.shtml

U.S. Department of Interior, Fish and Wildlife Service. 2009. Marbled murrelet (*Brachyramphus marmoratus*) 5-year Review. Final. June 12, 2009. 85. pp.

In addition, the Service provided a preliminary list of mechanisms that could potentially be causing the continued population decline. Potential mechanisms included activities that could result in injury or mortality of individual murrelets or that might affect the quantity and/or quality of terrestrial or marine habitat. The Service also asked the RIT to consider the following four preliminary questions during their deliberation process.

- Are there additional potential mechanisms of population decline that are not included in the list?
- Are there mechanisms on the list that are not or are no longer a source of decline?
- What are the most important mechanisms of continued population decline?
- How would the importance of mechanisms differ by conservation zone?

At the outset of the RIT meeting, the Service gave a presentation on the state of the species based on information in the background documents. In addition, there was a question/answer session that enabled all members of the RIT to be "on the same page" regarding the status of the listed population.

The basic premises and assumptions the RIT used for their deliberations are provided in the following bullets.

- Strategies, threats, and actions should be focused on what can be done in the next 5-10 years to address the decline and conserve the species.
- Conservation Zones 1-5 have experienced a population decline of 3.8 percent since 2001, the trend is unclear for the Conservation Zone 6 population (very low reproductive success).
- The 1997 Service recovery plan calls for 4 of 6 conservation zones to be stable or increasing. Currently Conservation Zones 5 and 6 contribute very few murrelets to the listed population. There is no evidence of a population decline in Conservation Zones 3 and 4 (based on a regression of numbers by year, with a significance level set at $p \sim< 0.05$); however, there is evidence murrelet populations in Conservation Zones 1 and 2 are declining.
- The documented trends do not appear to be explained by movement of murrelets from one zone to another or between Canada and Washington. Breeding murrelets exhibit site fidelity. Radio-telemetry indicates they have been observed to nest on the same branch, within the same tree and/or within the same habitat patch from one year to the next. Birds observed moving up and down the coast may have had early nest failures or were moving to winter foraging locations, but by the next season all indications are that they go back to where they nested the previous year. If a nesting stand is cut, those birds or pair of birds may never breed again. Also, genetic-based research in Conservation Zone 6 indicated that a substantial number of immigrants are from populations to the north, particularly in the winter; however, few of these birds are actual immigrants, but rather are visitors, as few appear to be nesting in Conservation Zone 6.
- Nesting habitat continues to be harvested in Oregon and Washington, primarily on non-federal lands. Very little nesting habitat remains in California and removal of habitat there appears to be minimal.
- In order to have a stable population, the ratio of juveniles to adults in the population should be about 0.2 or greater. The ratios observed in coastal waters within the listed range are between about 0.03 (California) and 0.08 (Washington).
- Increasing populations of predators are believed to be impacting murrelet populations. Predators include avian predators (corvids and raptors) and mammals (e.g. squirrels, mice), which probably prey on chicks and eggs. Avian predators appear to have the greater impact. Crows, jays, and ravens are nest predators known to prey on eggs but also take chicks; raptors (primarily peregrine falcons and bald eagles) prey on adult birds, both in flight and on the water. Peregrine falcon and bald eagle numbers are increasing as these species recover from once being endangered. Corvid (jays, ravens, crows) populations are increasing in many areas, particularly where humans are present. The ratio of edge to interior forest changes the risk of nest predation, especially from corvids where the risk increases with more edge (this risk is unclear for

mammals). In addition, the increased presence of predators may alter adult murrelet nest attendance, resulting in increased amount of disturbance and changes in energetics.

- Factors that subsidize predator food resources, leading to increased abundance of predators, include altering habitat structure to benefit predators, such as converting forest to shrubby habitats with greater food sources for jays (e.g. berries); recreation sites in forests; landfills/garbage dumps; rural development; agriculture and feedlots; and road corridors in and near nesting habitat, which provide road kill that feeds ravens and crows.
- There are weaknesses in the best available information. For example, the radio-telemetry data may have skewed reproductive rates downward due to radio effects on adult behavior and survival; observed juvenile-to-adult ratios may be skewed low if juveniles are missed during offshore surveys because they are not within surveyed areas or they use different areas than adults.
- Population growth has been identified as most sensitive to adult survival rates in population viability models for murrelets, but reproduction is probably driving the current population trend. Where estimated, survival rates were in the range expected for a stable population. However, reproductive rates are difficult to observe and reproductive rates in many areas are simply unknown, and survival rates have been estimated only in Conservation Zone 6 and in British Columbia.
- Potential prey species include juvenile rockfish, smelt, herring, anchovies, sardines, sandlance, squid, juvenile salmon, and krill.

Identification of Mechanisms Leading to Population Decline

The RIT began their initial deliberative process by reviewing, adding, deleting, and combining activities provided in the preliminary list of potential mechanisms of continued population decline (See Appendix B for the revised list of preliminary mechanisms). However, after a night's rest, all members of the RIT were uncomfortable with the revised list of mechanisms and sought another way to provide a conceptual structure for organizing information on mechanisms of decline. Craig Johnson developed a PowerPoint presentation that provided a structured way of thinking about how stressors affect the different life history stages of vertebrates, including murrelets. For example, stressors on the egg stage might include predation or timber harvest of a nest tree during incubation (see Appendix C for presentation). In addition, some RIT members had been thinking about the issue of "legacy effects" of past impacts and how this might be contributing to the current population decline. The quick population model Peery developed indicated that the population is likely to experience impacts from nesting habitat loss for as long as 20 years.

After this discussion, each of the RIT members were asked to list their top five causes of decline, their confidence in this cause, and any comments. The top 5 causes from each of the RIT members shared common themes. The RIT then discussed what is known and not known regarding ties between marine and terrestrial habitat, and whether there could be a spatial disconnect between where high quality marine foraging areas occur and where nesting habitat remains.

The RIT concluded that the primary cause of the continued population decline is sustained low recruitment. Sustained low recruitment can be caused by nest failure, low numbers of nesting attempts, and/or low juvenile survival rates. The RIT determined sustained low recruitment is caused by the following four sources: 1) terrestrial habitat loss, 2) nest predation, 3) changes in marine forage base which reduce prey resources, and 4) cumulative effects of multiple smaller impacts.

The RIT then returned to the basic life cycle and used the following structure to guide their deliberations. Each question is followed by key factors for that stage of reproduction.

1. Do they attempt to nest?
   -Nest habitat availability
   -Forage conditions
2. Do they lay an egg?
   -Forage conditions
   -Habitat disturbance
3. Does the egg hatch?
   -Predation on eggs & adults
   -Forage conditions
   -Disturbance, including loss of nest site
4. Does the chick fledge?
   -Forage conditions
   -Predation on chicks and adults
   -Disturbance
5. Does the fledgling survive to breed?
   -Forage conditions
   -Predation
   -Cumulative effects

The RIT then went back to their four sources of sustained low recruitment and began fleshing out the details of each one. After considerable discussion regarding predation beyond the nest, the RIT added another source: post-fledging mortality, which included mortality of juveniles subsequent to their first flight and mortality of adults.

Prioritization of Mechanisms by Geographic Area

The next step was for the RIT members to prioritize the top five mechanisms specific to geographic areas. The RIT subdivided the murrelet's listed range into four main geographic areas, based on underlying ecological marine and terrestrial patterns and differences. These areas differ in some cases from the six Conservation Zones used in the Service's Recovery Plan for the Marbled Murrelet. The four areas were:

1. Puget Sound (Conservation Zone 1 excluding the Strait of Juan de Fuca),
2. The Strait of Juan de Fuca (Conservation Zone 1 in part) plus the outer Washington coast north of Grays Harbor (Conservation Zone 2 in part)
3. The Washington coast from Grays Harbor south to the Oregon/California border (Conservation Zone 2 in part, all of Conservation Zone 3, and Zone 4 in part),
4. California (Conservation Zones 4 (in part), 5, and 6).

Three sub-groups were formed based on the four geographic areas and RIT member's expertise. One subgroup covered both the Puget Sound and Strait of Juan de Fuca/northern Washington coast geographic areas. The southern Washington/Oregon coast and California coast geographic areas were each covered by one subgroup.

Each of the subgroups first prioritized among the final five mechanisms based on their likely importance within their geographic area, and then brainstormed the primary factors driving these mechanisms in their area, including where possible, the importance of the factor and their confidence level in that importance ranking.

RIT Ranking of Actions Identified during Stakeholder Workshop

On the day following the Stakeholder Workshop, the RIT ranked the list of actions developed during the Stakeholder Workshop. Within each of the four geographic areas identified earlier by the RIT, each RIT member assigned an importance score to each action (score of 1=most important action to take, 5=least important action to take, 6=not ranked or not applicable). The RIT was instructed not to consider the feasibility of implementing an action or agency jurisdiction issues in the scoring. Service staff compiled the rankings and the RIT considered whether the actions that were ranked as most important overall were what they expected.

The list of actions collated from the Stakeholder Workshop contained some duplicates and the RIT members wanted more time to carefully consider their scoring. Therefore, subsequent to the RIT meeting, the Service staff amended the list of actions to remove duplicates and provided a revised list to the RIT for a second round of scoring. The same instructions/considerations from the first round of scoring were to be applied to the second round of ranking. Six of the nine RIT members provided new scorings. In order to have a complete action ranking, Service staff applied the first round scores for the three RIT members that did not re-score. For the actions that were combined or removed for the revised list, the lowest score given during the first round by these three RIT members was applied for the second round scoring.

Using the scores from the RIT's second round, Service staff averaged the individual team member's scores by action and the four geographic areas. This produced a list for each geographic area, in which all the actions were ranked based on the average scores (see Appendix E and Results below).

Data Sets and Data Gaps

As the meeting progressed, the RIT identified data gaps. On the final day of the meeting, the RIT generated a list of data sets that might be of use to the Service. In addition, the RIT compiled and added to the list of data gaps that should be filled in order to further murrelet recovery.

STAKEHOLDER WORKSHOP

The Stakeholder Workshop included two components, in-person and teleconference. A total of 51 stakeholders participated in the workshop, including 42 in-person and 9 via teleconference. In addition, 12 Service staff participated. All attendees, whether in person or teleconference, received the introduction, overview, and questions/answer session simultaneously. The attendees were invited to develop a list of actions that might be taken to address the mechanisms

of decline developed by the RIT. Each action was to include a rationale, pros, and cons. The guidelines below were provided to the stakeholders for the brainstorming session. Proposed actions needed to be realistic and achievable.

- The Service is not seeking consensus or agreement from the stakeholders with the expert panel findings nor with the list of potential actions.
- Stakeholders will not be "voting on" or "prioritizing" the list of actions.
- Each stakeholder has an equal voice/opinion. Discussion of all suggestions is welcomed.

After receiving the task guidelines, the in-person and teleconference sessions used different steps to complete their respective brainstorming sessions, as outlined in the following sections.

In-person session

The in-person session consisted of five sequential sub-sessions. Stakeholders were divided into five subgroups, one subgroup per mechanism. At the end of each sub-session, stakeholders moved from the subgroup they were in to another mechanism. The first session was 1 hour long, then each subsequent sub-session was shorter. Each subgroup was comprised of stakeholders, RIT members, and Service staff. Service staff took the official notes for each subgroup and other members of the subgroup were asked to serve as time-keepers and poster note-takers.

Each subgroup was provided with a list of contributing factors for their specific mechanism (see Appendix D). At the beginning of the sub-session, the subgroups reviewed the mechanism's factors and the list of actions developed by any prior subgroups. The subgroup members then added new items to the actions, rationale, pros, or cons. All suggested actions, rationales, pros, and cons were captured by the official note taker.

Teleconference session

The teleconference session consisted of one group that went through the five mechanisms. The group was comprised of stakeholders and Service staff. Service staff facilitated the meeting, ran a WebEx application to share written material and took the official notes.

Through the WebEx application the group was provided with a list of contributing factors for each specific mechanism (see Appendix E). At the beginning of each mechanism, the subgroups reviewed the mechanism's factors. The teleconference members then brainstormed actions, including rationales, pros, and cons. Progression to next mechanism occurred when the group had exhausted actions on previous mechanism. All suggested actions, rationales, pros, and cons were captured by the official note taker.

Collation of actions

Service staff combined the lists of actions from the in-person and teleconference sessions and refined the lists to reduce obvious duplications within each mechanism. These lists were used by the RIT for their action scoring.

Results

MECHANISMS OF POPULATION DECLINE

The RIT determined the primary cause of the continued population decline is sustained low recruitment, i.e. the birds are not replacing themselves. The mechanisms causing sustained low recruitment were determined to include the following five mechanisms. Bullets under each mechanism include the RIT's rationale.

Loss of Terrestrial (Forest) Habitat: Historic and Ongoing:

- High quality forest habitat includes large diameter trees with large limbs and multi-layered canopy. Larger patches are better than smaller patches.
- Legacy effects of historic harvest may be contributing to the current population decline.
- Timber harvest, fire, and other disturbances contribute to ongoing habitat losses and degradation, fragmentation, and continued population decline.

Nest Predation (Eggs and Chicks)

- There are documented increases in populations of corvids (crows, ravens, and jays).
- Human activity both within and around habitat patches (recreation sites, roads, landfills/dumps, agriculture, rural development) contributes to increased predator populations.
- Habitat fragmentation and degradation contributes to increased predation due to increased forest edges and increased predator access to nests (e.g. by corvids).
- Energetic stress on individual birds is also a factor in chick mortality.
    - chicks: increased likelihood of being preyed upon, for example, reduced chick vigor due to reduced prey delivery and lowered ability to defend themselves
    - adults: attendance at nest could be affected by foraging conditions, which in turn could affect predation risk for eggs and chicks

Changes in Marine Forage (Abundance, Distribution, and Quality of Prey)

- Effects of historic fisheries and changes in aquatic ecosystems have impacted the abundance and distribution of potential prey. While murrelets seem to be resilient in terms of prey choice, their choices have become fewer.
- There is evidence that murrelet food webs are sensitive to climate variability. There is uncertainty about how future changes will impact these webs.
- Loss and degradation of estuarine ecosystems' function has impacted spawning and rearing habitat for forage fish.

Post-fledging Mortality

- Increasing abundance of known predators may be resulting in increased predation on murrelets
    - Bald eagle and peregrine falcon populations have recovered to the degree that both of these species were removed from the Endangered Species List
    - Reintroduction (e.g. hack sites) of peregrine falcons is a recent activity, therefore data are limited regarding adult and subadult predation. However,

extrapolations of effects on other seabirds and shorebirds can be made to suggest increasing predation events on murrelets.

- Murrelets are known to be entangled in nets and other marine gear.
- Oil spills and other catastrophic events have resulted in murrelet mortality.
- Juveniles and subadults have a higher mortality rate than adults, which is normal for birds. Data related to age-specific mortality and how mortality rates at this stage impact overall population are limited. .

Cumulative and Interactive Effects (Individual Birds, Populations, and Species)

- Effects of past declines can alter population dynamics and population resiliency (e.g. legacy effects).
- There is a potential disconnect between quality marine and terrestrial habitats. The best foraging habitat may not be near best nesting habitat, due to nesting habitat losses.
- Longer commuting times between nesting and foraging habitats can increase both energetic costs of reproduction and exposure to predators.
- Repeated or sustained disturbances increase murrelet fight/flight responses, which carries an energetic cost (increased metabolic rate, chronic elevation of stress hormones).
- Energy deficits increase vulnerability to predators and disease, and/or affect reproductive success.
- The impact of pollutants, toxins, pathogens, or disease is more severe if murrelets are chronically stressed.
- The cumulative effect of factors affecting adult energetics may limit murrelet reproductive success.

PRIORITIZATION OF MECHANISMS BY GEOGRAPHIC AREA

Each of the RIT subgroups approached the task of prioritizing the mechanisms differently, but each subgroup was able to come to agreement on which mechanisms were the most important cause of sustained low recruitment within their geographic area (Table 1). In addition, the subgroups recorded their confidence associated with the ranking and noted differences if the prioritization was not the same throughout their geographic area. Thus the results in Table 1 subdivide some of the initial 4 geographic areas.

Table 1. Mechanisms of Sustained Low Recruitment Prioritized by Area/Conservation Zone.

Geographic Area	Loss of Terrestrial Habitat	Nest Predation	Changes in Marine Forage	Post Fledging Mortality	Cumulative & Interactive Effects
Area 1: Puget Sound (Zone 1 except SJDF)**	2H*	2H	3H	4L	1H
Area 2: SJDF + WA coast north of Grays Harbor (Zones 1 and 2, in part)	1H	2H	4H	5L	3L
Area 3: Oregon + WA coast south of Grays Harbor (Zone 3 + Zones 2 and 4 in part)	1H	2H	3H	5L	4M
Area 4: California Zone 4	4H	1H	2M-L	3H/M	5L
Zones 5 and 6	4H	1H	2M-L	3H/M	5H

*Priority of mechanism as cause of continued population decline and Confidence in ranking. Example: 1H = Most important mechanism in continued population decline in that geographic area and subgroup has a high confidence in this ranking.
**Strait of Juan de Fuca = SJDF

The following sections include the RIT's final lists of factors affecting low recruitment by geographic area and mechanism. Also listed are the RIT members and the Service staff that participated in each subgroup.

Because each subgroup undertook this task in a different manner, the results are not presented in a similar manner. For example, the subgroup for Zone 2 (SW Washington), Zone 3 (N and Central Oregon), and Zone 4 north (southern Oregon) used numbers to represent their prioritization, whereas, the subgroup for Zone 1 (Puget Sound, except the Strait of Juan de Fuca) denoted priority and confidence levels in parentheticals.

Area 1: Puget Sound and San Juan Islands
Participants: RIT: Martin Raphael, Nathan Mantua, Craig Johnson. Service staff: Deanna Lynch, Emily Teachout, Kim Flotlin

Loss of Terrestrial Habitat:

- Doubling of housing density and high human footprint index (high priority, high confidence).
- High human population growth – increase predation, loss of habitat lead to reduced productivity (high priority).

- Large federal reserve system (e.g. Northwest Forest Plan, Wilderness, National Parks).
- Habitat losses are closer to marine habitat (most low elevation habitat gone, most remaining habitat is far from the coast and has high predator densities).

Nest Predation:

- High predator levels (high priority, high confidence).
    - Resulting from high urbanization and reserves perforated by roads, trails, and intense recreation (i.e. human footprint index).

Changes in Marine Forage:

- Forage fish are depleted (high priority, low confidence due to poor data quality). Rockfish have been heavily impacted. Murrelets have shifted foraging to lower trophic levels, maybe in competition with harbor seals, where seal populations have increased.
- High contaminant loads (high priority): specifically documented in other top-level predators such as pinnipeds and orcas (PCBs).
- Significant amounts of shoreline alteration, such as armoring, that degrades forage fish spawning and rearing habitat.
- Increased harmful algal blooms.
- Other marine risks: derelict fishing gear and gill net fisheries.

Post-Fledging Mortality:

- Most of these are known sources of mortality but population impacts are unknown (low confidence).
    - Nets (gillnets, purse seines, derelict gear)
    - Avian predation
    - Collision with moving or stationary objects (e.g. vehicles, powerlines, etc.)
    - Oil spills
    - Underwater sound (impulsive)
        - Impact pile driving, detonations, etc.

Cumulative and Interactive Effects:

- Historic loss of habitat + ongoing loss of habitat: Marine and terrestrial coupling (high priority).
- Acute mortality events (e.g. oil spills, harmful algal blooms) (high priority).
- Chronic impacts related to population dynamics (high priority).
- Disturbance due to boat traffic (ferry system, commercial freight, recreational, military).
- Stress level increases from varieties of sources of disturbances.
- Significant distance between marine area and remaining nesting habitat; energetic costs of commute probably highest in this Zone.
- High contaminant loads in marine systems and in monitored vertebrate species.
- Harmful algal blooms-e.g. Hood Canal anoxia

- Feeding area displacements (lost productivity zones in estuaries): Elliot Bay, Commencement Bay, Hood Canal, etc.
- Reduced forage fish availability.

Area 2: Strait of Juan de Fuca and Washington coast south to Grays Harbor
Participants: RIT: Martin Raphael, Nathan Mantua, Craig Johnson. Service staff: Deanna Lynch, Emily Teachout, Kim Flotlin

Loss of Terrestrial Habitat:

- Lower elevation habitat heavily impacted (high priority).
- Much of ongoing loss is harvest on non-federal lands (high priority).
- Nest predation is associated with recreation on protected federal lands (high priority).
- Higher elevation in reserves.
- Lower risk of catastrophic loss from fire compared to other areas within murrelet listed range.
- Windthrow is a known risk.
- Fragmentation due to transportation corridors.

Nest Predation:

- High predator levels (medium confidence)
- Lowest human footprint index – compared to other zones (highest confidence).

Changes in Marine Forage:

- Large climate-driven variations between years.
- Highly productive system – driven by upwelling and upwellings are highly variable and may have changed in space and timing.
- Limited fisheries for forage fish (limited data); herring stocks that spawn in N Puget Sound and SJDF will move to outer coast (NW WA and Vancouver Island) to grow up more, these stocks are not doing well.
- Disease and harmful algal blooms are already an issue and are anticipated to increase in frequency.
- Shorelines are relatively pristine from Tatoosh area south to Kalaloch, however SJDF and south of Kalaloch are impacted by beach housing and recreation which likely impacts forage fish spawning beaches.
- Presence and impacts from derelict gear and nets is unknown along the outer coast. This gear is documented to impact seabirds in the SJDF.

Post-Fledging Mortality:

- Most of these are known sources of mortality but population impacts are unknown (low confidence).
    - Nets (less prevalent than in Zone 1)
    - Avian predation: bald eagles, peregrines
    - Catastrophic events, with long lasting effects (mortality) such as oil spills (*Tenyo Maru*, *Nestucca*)

Cumulative and Interactive Effects:

- Terrestrial effects
    - Recreation
    - Habitat Loss

    - Development
    - Transportation corridors (e.g. Highway 101)
- Marine effects
    - Algal Blooms
    - Domoic Acid

Area 3: Oregon and SW Washington (south of Grays Harbor)
Participants: RIT: Kim Nelson, Andrew Gray, Jen Zamon. Service staff: Bridgette Tuerler, Kevin Maurice

<u>Loss of Terrestrial Habitat:</u>

1) Past and ongoing removal of occupied and unoccupied suitable habitat (high confidence)
    - Past habitat removal has created three large gaps: SW Washington, NW Oregon, and coastal strip habitat between Reedsport and the Siskiyou Province. These gaps fragment the population distribution and may reduce population's robustness and/or resilience to stressors.

2) No functioning habitat reserve programs outside of the Northwest Forest Plan (high confidence).
    - All Zones

3) No incentives to protect or restore habitat on private, state and county lands (high confidence).
    - All Zones

4) Limited protection on non-federal lands (high confidence).
    - All Zones

5) Climate change effects on fire dynamics (frequency and magnitude) (low confidence).
    - Potentially higher in SW Oregon (e.g. Biscuit Fire).

<u>Nest Predation</u>

1) Fragmentation of occupied habitat and unoccupied habitat and adjacent forest which leads to increased predator numbers and nest predation rates.

2a) Increased recreation use of forested areas leading to increased nest predator abundance (e.g. camp grounds, trailheads, roads).

2b) Increased development or agriculture use of adjacent habitat leading to increase in nest predator populations.

<u>Changes in Marine Forage;</u>

1) Existing and proposed removal of foraging fish also used by murrelets.
    - Especially Zone 2 south, Zone 3 north (Columbia River Plume) due to existing sardine fishery

2) Past and ongoing removal of spawning and rearing habitat for fish (e.g. estuaries, reefs, eelgrass beds).

3) Climate variability effects on food webs in murrelet marine habitat (e.g. HABs, dead zones, El Nino).

<u>Post-fledging mortality:</u>

1) Oil spills and other catastrophic events

- Highest risk in Columbia River area due to higher vessel traffic, larger commercial shipping volume.

2) Raptor predation increasing with recovering raptor populations (e.g. bald eagles, peregrine falcons).
3) Wind farm collision.

Cumulative and Interactive Effects:

1) Increased extinction risk due to small population size (high confidence).
2) Disconnect between high quality terrestrial and marine habitat (moderate confidence).
   - Possibly of more concern in SW Washington/NW Oregon due to very limited terrestrial habitat.
3) Energetic, predation risk associated with commute between nesting and ocean habitat (moderate confidence).
4) Increased disturbance leads to increased physiological stress and reduced performance (moderate confidence).
5) Contaminant loading increases vulnerability to disease, decreases fitness (low confidence).
   - Columbia River may be source of higher concern.

Area 4: California

Participants: RIT: Zach Peery, David Ainley, Christine Fiorello. Service staff: Lynn Roberts, Gary Falxa

Threats ranked in order of their likelihood of explaining the "current population decline" in Zones 4-6. There has not been a statistical decline in the past 10 years detected for these zones based on at-sea data, possibly due to emigration/immigration. There is greater confidence that reproduction and recruitment are low, and the threats listed and ranked below could all impact these vital rates.

Loss of terrestrial habitat:

- Discussion: Historic loss of habitat has been severe and is very likely responsible for large historic declines (high confidence). Ongoing loss of habitat is likely not responsible for current declines in populations with the caveat that remaining habitat may not be adjacent to high quality foraging (low confidence).

Nest predation:

Nest monitoring indicates that nest predation is occurring in California at an elevated rate, with corvids being the primary predator. Most remaining habitat is highly fragmented and is impacted by people and associated predators, as most remaining habitat is within public parks where recreational use is heavy. Corvid populations have increased dramatically and continue to increase in these areas. (reasonably high confidence).

1a) Human related impacts and resultant food subsidies increase nest predator (corvid) populations within parks (campgrounds and picnic areas).
1b) Remaining habitat is in small patches with large amounts of edge and surrounded by urban areas, agriculture, dumps etc. There are synergistic effects between habitat loss, fragmentation and increased nest predation.

Changes in Marine Forage:

High level of uncertainty. However, based on Becker's trophic level work in Conservation Zone 6, and fishery impacts (e.g., loss of rockfish – showing signs of recovery, but still low), likely continuing to impact populations through energetics.

1) Commercial fishing: Historic loss of rockfish has been most severe south of Oregon border. Even though commercial fisheries are now highly regulated, recreational fisheries may continue to have small impacts.
2) Degradation of spawning grounds of herring and smelt has affected these potentially important prey populations.
3) Increasing frequency of El Nino events have the potential to affect primary productivity resulting in more difficult foraging and leading to lower murrelet reproduction. Becker found that reproduction is lower in warm-water years, when upwelling tends to be less or less effective, which leads to more dispersed forage fish/krill.
4) Anchovy populations abundance patterns tend to act opposite those of sardines. Not sure what current population numbers are, but anchovy are a known food source for murrelet.

Post-fledging mortality:

After-hatch-year survival rates appear "normal" in Zone 6, but mortality has been observed due to several causes, some of which appear to be increasing.

1a) Zone 4 and 6 are most vulnerable to catastrophic loss due to oil spills- data exist to support this (high confidence).

1b) Sub-adults and adults – peregrines and eagles are numerous and increasing and may be resulting in increased predation – (less confidence).
   - Zone 4 – not much information on incidence of predation by peregrines and eagles.
   - Zone 5 – no information on mortality sources
   - Zone 6 – active hacking of peregrines in murrelet flyways; predation events have been observed in Santa Cruz mountains.

1c) Zone 6 is a hot spot for domoic acid events, likely due to agricultural runoff, specifically phosphorus. Known murrelet mortality from domoic acid, but population effect not known.

Cumulative and Interactive Effects:

Conservation Zones 5 and 6 are at such low population levels that they may be experiencing negative demographic effects of small population size, maybe even be in an extinction vortex, in which multiple factors can interact to drive a small population size further downward to extinction (e.g. Allee effect). Extent of such problems in Conservation Zone 5 depends on connectivity with other populations. Extent of problems in Conservation Zone 6 depends on current size of the *resident* population, which is uncertain.

- Behavioral/social stimuli may be needed for recruitment into population (versus dispersing out of the zone).
- Demographic heterogeneity/stochasticity

RANKING OF ACTIONS IDENTIFIED BY STAKEHOLDERS

The Stakeholder Workshop produced 151 actions that might be taken to address the mechanisms of decline identified by the RIT. The RIT scoring of these actions produced a ranked list of these actions by mechanism and geographic area. The full list of actions identified by the stakeholders and their average RIT rank by geographic area can be found in Appendix E. The top ten ranked actions for the geographic areas are presented in Table 2.

DATA SETS AND DATA GAPS

The data sets compiled by the RIT can be found in Appendix F. The following data gaps were identified by the RIT as being necessary to fill in order to further murrelet recovery.

- What are murrelets eating? What and where are the most important prey in different zones? One idea for obtaining this information was to analyze murrelet feces using genetic methods to identify prey. Alternately, one could study what fish species are in habitats where murrelets are feeding.
- Determine impacts of thinning forests adjacent to murrelet occupied sites, e.g. relationship to density of nest predators (corvids). Longer term: Assess thinning methodology to create murrelet habitat. Conduct before/after comparisons?
- Need to understand corvid ecology, territoriality, and behavior in order to assess corvid control methodologies.
- Look at wintering areas – murrelet forage locations, movement patterns, and target species.
- Need information about contaminant loading in murrelets. Is this a problem? If so, at what level?
- Related to above, sample forage fish for contaminants (could help to estimate potential murrelet contaminant load).
- Regular coast-wide forage fish surveys.
- Investigate the impact of apex predators (e.g. peregrine falcons) have on mortality, distribution and time/activity budgets of murrelets.
- An analysis of murrelet energetics/energy requirements. There was a mixed sense of the priority for this one among RIT members.

Explore effects of radio telemetry on murrelets. Explore collaborations with the military and universities. Could use proxy species such as dovekie or diving petrels to test methods.

Table 2. The top actions to address mechanisms of decline, among the 151 actions identified by the stakeholders, as ranked by the RIT. This cumulative list includes the top 10 actions as identified by the RIT for each of the 4 geographic areas.

Mechanism(s) and Specific Factors (in bullets) Identified by RIT	**Actions Identified by Stakeholders**	**RIT Ranking of Actions by Geographic Area**
Marine Forage • Existing and proposed removal of foraging fish also used by murrelet • Degradation of spawning grounds of herring and smelt which has reduced populations of forage fish for murrelet. • Climate variability effects on food webs in murrelet marine habitat (e.g., HABs, dead zones, El Nino)	State and Federal resource agencies can write letters to NOAA Science Center directors for NW and SW Fisheries Science Centers and the Pacific Fisheries Management Council supporting forage fish surveys and/or research	In the top 10 range-wide. Ranked within top 3 for all 4 geographic areas. Ranked #2 in Washington and California
Marine Forage • All Factors	Revise Marbled Murrelet Critical Habitat to include marine habitat.	In the top 10 range-wide. Ranked within top 4 for all geographic areas.
Loss Terrestrial Habitat • Past habitat removal has created large gaps • Few/no functioning habitat reserve programs outside of the Northwest Forest Plan areas Nest Predation • Fragmentation	Develop landscape-scale strategy that blocks up protected habitat. Identify gaps (assess the current landscape) to focus the resources / restorations / easements. Protect blocks of habitat from harvest. If the murrelet population continues to crash, may be time to revisit current reserve system on federal lands.	In the top 10 range-wide. Ranked #1 for Washington's Zone 1 and northern portion of Zone 2
Nest Predation • Recreation	Better/more effective outreach to visitors to encourage appropriate behavior and educate about consequences of people's actions-pet food, bird feeders	In the top 10 range-wide. Ranked #1 in California

Mechanism(s) and Specific Factors (in bullets) Identified by RIT	Actions Identified by Stakeholders	RIT Ranking of Actions by Geographic Area
Post-Fledging Mortality • Collision	Design renewable energy structures to minimize impacts	In the top 10 range-wide. Ranked in the top 5 in Washington's Zone 1 and northern portion of Zone 2, as well as California.
Marine Forage • Existing and proposed removal of foraging fish also used by murrelet. • Commercial fishing: Loss of rock fish historic has been most severe south of OR border. Even though no current commercial fishery, recreational fishery may continue to have small impact. • Degradation of spawning grounds of herring and smelt which has reduced populations of forage fish for murrelet. • Large loss in natural shorelines, estuaries; High contaminant loads; Reduced herring abundance and reduced age structure in herring; Depleted rockfish populations; Large increases in pinnipeds; Other marine risks: derelict fishing gear, gill net fisheries, HABs. • Climate variability effects on food webs in murrelet marine habitat (e.g., HABs, dead zones, El Nino).	Assess populations and identify limiting factors on forage fish populations.	In the top 10 range-wide.
Nest Predation • Recreation	Planning for new campgrounds/day-use areas should take into account effects on murrelets	In the top 10 range-wide.

Mechanism(s) and Specific Factors (in bullets) Identified by RIT	Actions Identified by Stakeholders	RIT Ranking of Actions by Geographic Area
Nest Predation • Recreation/corvids	More trash management; Improve dump technology; Put into county zoning laws – trash regulation/dump location, recycling to ultimately reduce dump; Promote composting; Make county dumps free	In the top 10 range-wide.
Loss Terrestrial Habitat • No incentives to protect or restore habitat on private, state, and county lands	Maintain/create incentives for protecting best habitat, in size of blocks that work for murrelets. For nonfederal lands, focus on and prioritize best remaining habitat blocks.	Washington and Oregon
Loss Terrestrial Habitat • No incentives to protect or restore habitat on private, state, and county lands	Modify forest practice rules to better protect higher value habitat	Washington's Straits of Juan de Fuca and outer coast, and Oregon
Marine Forage • All Factors	Tighten and enforce current laws to protect and recover forage fish habitat.	Washington – Puget Sound
Marine Forage • All Factors	Establish Marine Protected Areas. Include offshore forage fish production, nearshore foraging, and nesting habitat.	California
Cumulative • Disconnect between high quality terrestrial and marine habitat in terms of location/adjacency(lost productivity zones in some major estuaries). • Energetic, predation risk associated with commute between nesting and ocean habitat. • Energetic income" probably decreasing due to reduced forage fish availability.	Reduce predation in Zone 6, or anywhere there are small populations.	California

Summary

The Service convened a Recovery Implementation Team comprised of scientific experts from a breadth of fields relevant to murrelet conservation. The RIT identified sustained low recruitment as the most likely cause of the continued population decline. The team then identified five major mechanisms that appear to be affecting the murrelet population. The RIT used the structure of the five major mechanisms to identify dominant factors most likely to be causing low recruitment and population trends in different geographic areas within the listed range.

The five major mechanisms the team identified are:

- Ongoing and historic loss of terrestrial (forest) habitat
- Nest predation, on murrelet eggs and chicks
- Changes in marine forage conditions, affecting the abundance, distribution and quality of murrelet prey
- Post-fledging mortality of murrelets
- Cumulative and interactive effects of factors on individuals, populations, and the species

A stakeholder group used the RIT's mechanisms and factors impacting murrelet populations to develop a list of 151 actions that could be taken to address those factors and help restore healthy murrelet populations and habitat.

Finally, the RIT evaluated the 151 actions identified by stakeholders and produced four lists, one for each of 4 geographic areas, of the potential actions ranked in terms of importance for implementing over the next 5 to 10 years. The cumulative set of actions from this list includes 13 different actions. Eight of these actions were ranked within the top 10 for all geographic areas within the murrelet's listed range, while the remaining 5 actions were high-ranked for specific areas.

Appendices

Appendix A: Stakeholder Workshop Invitees and Final Attendees
Appendix B: List of Preliminary Mechanisms Provided to RIT
Appendix C: Endogenous Sources of Extinction Risk presentation
Appendix D: Mechanism Details Provided to Stakeholders for Brainstorming Sessions
Appendix E: Complete List of Actions and Rankings by Geographic Area
Appendix F: Data Sets

Appendix A

Marbled Murrelet Stakeholder Workshop Invitation and Final Attendee List

Agency/Company	Number of Attendees	
American Bird Conservancy		
American Forest Resources Council	1	
Audubon California		
Audubon Society of Portland		
Audubon Washington		
Big Creek Lumber Co		
Bureau of Land Management	2	1 via Teleconference
Bureau of Land Management-Oregon State Office	1	
Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE)	1	
California Dept. of Fish and Game	1	
California Dept. of Forestry and Fire Protection		
California Dept. of Forestry and Fire Protection (CalFire)		
California Dept. of Spill Prevention and Response (OSPR)		
California State Parks	2	Teleconference
Campbell Group LLC		
Cascade Land Conservancy		
Center for Biological Diversity	1	
City of Tacoma, Attention: Greg Volkhardt	1	
Confederated Tribes of Siletz Indians		
Conservation Northwest	1	
Coos Bay District, Bureau of Land Management		
Coquille Indian Tribe		
Elk River Land Trust, Attn: Jerry Becker		
Environmental Protection Information Center (EPIC)		
Eugene District, Bureau of Land Management		
Federal Highway Administration		
Green Crow Timber Company	1	
Green Diamond		
Green Diamond Resource Company	1	
Hancock Timber Resource Group		
Hoh River Trust		
Hoopa Valley Tribe		
Humboldt Redwood Company		
Land Trust of Santa Cruz County		
Makah Indian Tribal Council	1	
Medford District, Bureau of Land Management	1	
Mendocino Redwood Company		
Merrill & Ring Timber Company		
Natural Resources Division, Confederated Tribes of Grand Ronde		
Nisqually Land Trust		
NOAA Fisheries Service, Southwest Fisheries Science Center		
North Coast Land Conservancy, Attn: Katie Voelke		
North Olympic Land Trust		
Northcoast Environmental Center (NEC)		
Northwest Indian Fisheries Commission		
Northwest Straits Foundation		
NPS - Region		
ODOT Technical Leadership Center, Geo-Environmental Section		
Olympic Coast National Marine Sanctuary		
Olympic Forest Coalition	1	
Oregon Department of Fish and Wildlife		
Oregon Department of Forestry		
Oregon Parks & Recreation Dept.	1	
Pacific Seabird Group		
People for Puget Sound		
Plum Creek Timber Company		

Marbled Murrelet Stakeholder Workshop Invitation and Final Attendee List

Agency/Company	Number of Attendees	
Port Blakely Tree Farms	1	
PRBO Science		
Puget Sound Partnership		
Quinault Indian Nation		
Rayonier Timber Company	1	
Redwood Forest Foundation, INC		
Redwood National and State Parks	1	Teleconference
Resource Conservation District of Santa Cruz County	1	
Rogue River-Siskiyou National Forest		
Roseburg District, Bureau of Land Management	1	
Salem District, Bureau of Land Management		
Save the Redwoods League		
Seattle City Light		
Seattle District Corps of Engineers, CENWS-OD-RG, Attention Michelle Walker		
Sempervirens Fund	1	
Skagit Land Trust		
Stimson Lumber Company		
The Nature Conservancy		
The Wetlands Conservancy, attn: Paul Engelmeyer	1	
US Navy Naval Facilities Engineering Command, NAVFAC Northwest	1	
US Navy Region Northwest, Commander	1	
US Forest Service Pacific Southwest Research Station : Redwood Sciences Lab		
US National Park Service Mount Ranier National Park	1	
US National Park Service North Cascades National Park		
US National Park Service Olympic National Park	1	
USACE Regulatory	1	Teleconference
USFS - Region 6		
USFS Gifford Pinchot National Forest		
USFS - Mt. Baker-Snoqualmie National Forest	1	
USFS Olympic National Forest	1	
USFS Siuslaw		
USFS Sx Rivers	1	Teleconference
USFWS - Nisqually National Wildlife Refuge	1	
USFWS - Washington Maritime National Wildlife Refuge Complex		
USFWS - Willapa National Wildlife Refuge	1	
Washington Department of Fish and Wildlife	2	
Washington Department of Natural Resources	2	
Washington Forest Law Center	1	
West Fork Timber Company		
Weyerhaeuser Company, Timberlands Technology		
Weyerhaeuser Timber Company		
WSDOT Environmental Services Office		
Yurok Tribe		

Marbled Murrelet Stakeholder Workshop Invitation and Final Attendee List

Agency/Company	Number of Attendees	
Recovery Implementation Team candidates (not chosen for team and not represented in agency list)		
John Marzluff, University of Washington		
Doug Bertram, Environment Canada	1	Teleconference
Ben Becker		
Joe Gaydos, SeaDoc Society		
Rick Golightly, Humboldt State University	1	Teleconference
Laird Henkel, OSPR		
Tom Hamer		
Craig Strong	1	Teleconference
Bill Sydeman, Point Reyes Bird Observatory		
Michelle Kissling, US Fish and Wildlife Service		
Recovery Implementation Team		
Marty Raphael	1	
Nate Mantua	1	
Kim Nelson	1	
Zach Peery	1	
David Ainley	1	
Jen Zamon	1	
Craig Johnson	1	
Andrew Gray	1	
Christine Fiorello	1	
FWS Managers/Staff & Facilitator		
Jamie Riche, Facilitator	1	
Ken Berg	1	
Jodi Bush	1	
Paul Henson		
Lena Chang	1	
Lynn Roberts	1	
Gary Falxa	1	
Bridgette Tuerler	1	
Kevin Maurice	1	
Deanna Lynch	1	
Emily Teachout	1	
Kim Flotlin	1	
Carolyn Scafidi	1	
Total Attendees - In Person	**54**	
Total Attendees - Teleconference	**9**	

Appendix B

Marbled Murrelet Recovery Implementation Team
Potential Mechanisms of Continued Population Decline
Work Product from October 17, 2011

Conservation Issue		Mechanism(s)
Injury/Mortality	Sustained reproductive failure, loss of lifetime reproduction success,	Predation on egg/chick resulting in nest failure
Injury/Mortality	peregrine falcon and bald eagle recovery	Predation resulting in adult mortality
Injury/Mortality		Derelict net entanglement
Injury/Mortality		Active gillnet fishery entanglement
Injury/Mortality	Mortality of murrelets (adult or young-of-year)	Harmful underwater sound pressure levels (underwater detonations, pile-driving, etc.)
Injury/Mortality	Non-serious injury not resulting in reproductive loss	Harmful underwater sound pressure levels (underwater detonations, pile-driving, etc.)
Injury/Mortality		Collision stationary objects (powerlines, above/underwater alt energy structures)
Injury/Mortality		Collision moving objects (wind turbines, vehicles, above/underwater alt energy structures)
Injury/Mortality		Oil spills and seeps
Injury/Mortality		timber harvest during breeding season, Harvest of suitable habitat without surveys or insufficient surveys (lack of detections, presence only)
Injury/Mortality	Disease	Avian influenza, west nile virus, etc.
Injury/Mortality	Energetics, stress, allostatic loading	Including overwintering effects
Terrestrial Habitat - Quantity	Habitat loss	Legacy effects of historic (pre-1990's/pre-listing) harvest; creates a surplus breeding population (i.e. not enough habitat for breeding mamu); reduced population abundance
Terrestrial Habitat - Quantity	Habitat loss	Recent/ongoing harvest (occupied or not); Long linear energy projects (roads/hwys, powerlines, natural gas)
Terrestrial Habitat - Quantity	Habitat loss	Fire
Terrestrial Habitat - Quantity	Amount of remaining habitat	Not enough habitat in correct configuration across range
Terrestrial Habitat - Quantity	Habitat loss	Windthrow and other natural habitat loss (e.g. insects, disease)
Terrestrial Habitat - Quantity	Habitat loss	Climate change effects on nesting habitat quantity (e.g. changes in fire regime) and/or nesting habitat quality (e.g. changes in temperature, moisture, etc that impact moss growth) ENSO, PDO
Terrestrial Habitat - Quantity	Habitat loss	Development of dense younger stands around nest trees
Terrestrial Habitat - Quality	Disturbance/masking/allostatic loading/invisible predators = energetics	Human-caused noise near nests
Terrestrial Habitat - Quality	Disturbance	Visual disturbance of adults and/or chicks due to human activity
Terrestrial Habitat - Quality	Fragmentation (stand and landscape)	Legacy and ongoing harvest (tree removal, roads, corridors)
Terrestrial Habitat - Quality	Fragmentation (stand and landscape)	Windthrow and other natural habitat loss (e.g. insects, disease)

Marbled Murrelet Recovery Implementation Team
Potential Mechanisms of Continued Population Decline
Work Product from October 17, 2011

Conservation Issue		Mechanism(s)
Terrestrial Habitat - Quality	Fragmentation (stand and landscape)	Development (general, energy, gravel pits, roads)
Terrestrial Habitat - Quality	Habitat degradation and fragmentation (landscape)	Loss or degradation of forested buffer
Terrestrial Habitat - Quality	Platform abundance	Nest site carrying capacity
Terrestrial Habitat - Quality	Habitat degradation and fragmentation (landscape)	Higher abundance of nest predators resulting in more nest failures, reduced fecundity. Higher predator (e.g., corvid/small mammals) abundance due to multiple factors. Shifts in predator distribution due to humans. Recreational sites
Terrestrial Habitat - Quality	Habitat degradation and fragmentation (landscape)	Increased abundance of predators resulting in elevated adult murrelet mortality.
Terrestrial Habitat - Quality	Forest health/regeneration processes	
Marine Habitat	Alternative Energy (wave, tidal, and offshore wind)	Loss and/or degradation of foraging and/or resting habitat in area of projects. Indirect/Direct effects, Future effects unknown
Marine Habitat	altered food webs (community or carrying capacity)	Climate change (e.g. ENSO, PDO, upwelling changes)
Marine Habitat	altered food webs/carrying capacity	depletion of fish stocks
Marine Habitat-Quantity	Loss or reduction of forage fish habitat availability	Loss of spawning/holding areas (e.g. loss of eelgrass beds, shoreline modification, dredging)
Marine Habitat-Quantity	Loss, reduction, or changed distribution/abundance in age & size in forage fish species	Direct and indirect effects of harvest of prey by fisheries (human fisheries compete with mamu for prey); non-target fish
Marine Habitat-Quantity	Loss or reduction of forage fish/euphasid species	Ocean acidification associated with increased carbon dioxide in atmosphere
Marine Habitat-Quantity	Loss or reduction in prey population and/or their habitat	Harmful Algal Blooms (food poisoning, dead zones)
Marine Habitat-Quantity	Reduction of prey populations	Food competition with non-human predators (e.g. other seabirds and marine mammals) reduces prey availability (esp. where other seabird species are increasing)
Marine Habitat-Quantity	Foraging/resting habitat fragmentation; Disturbance behavior	Disturbance by high vessel activity/other anthropogenic presence in marine waters; underwater and above water sound
Marine Habitat Quantity	Reduced prey abundance/distribution?	Invasion of nearshore waters by jellyfish
Marine Habitat-Quality	Water quality	Point/Non Point Pollution Sources resulting in potential uptake of heavy metals, hormones, etc. - bioaccumulation on mamu, water pollution effects on prey
Marine Habitat-Quality	Water quality	Harmful Algal Blooms (loss of feather waterproofing)
Population dynamics		Legacy effects of past population decline

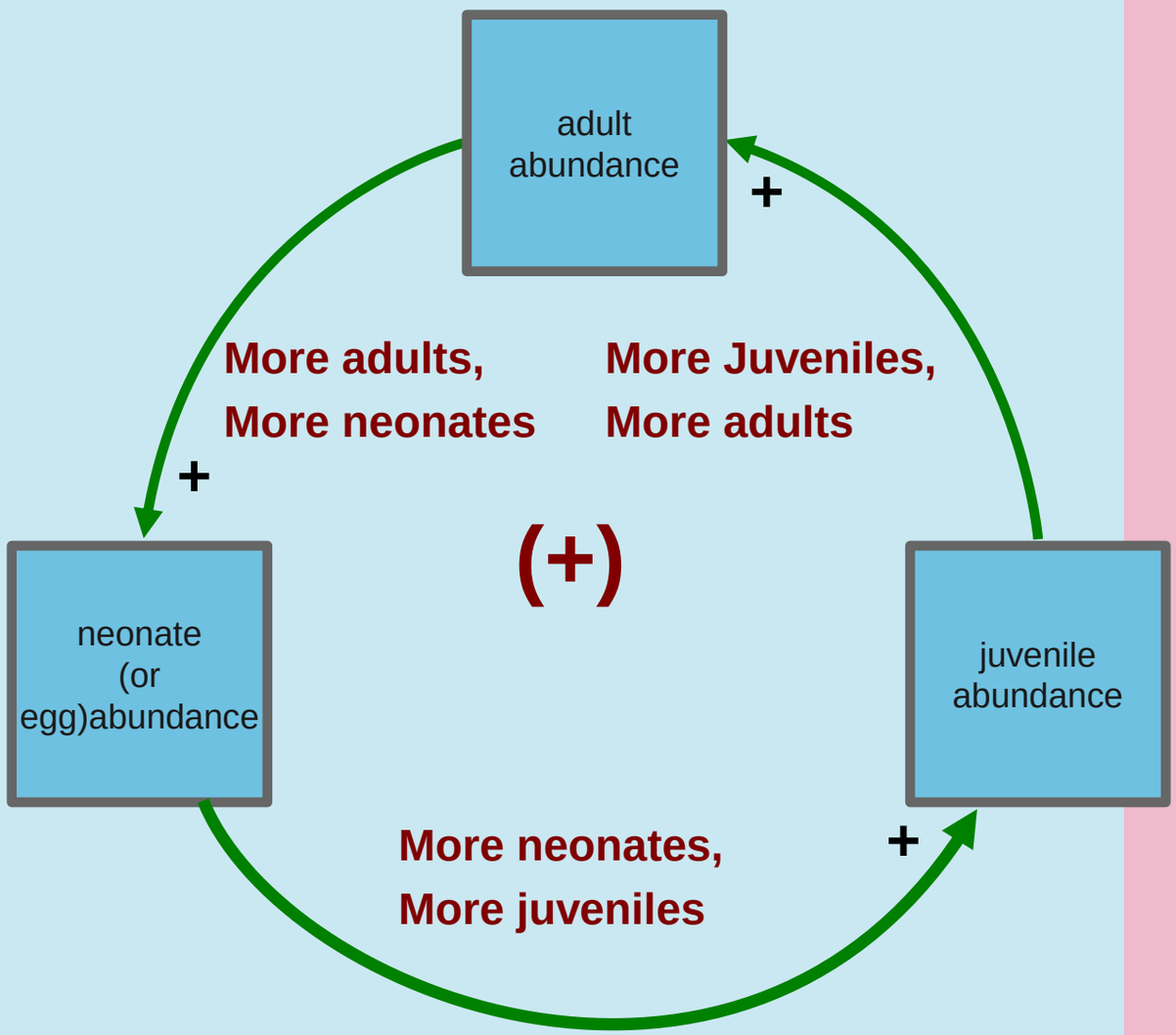
Marbled Murrelet Recovery Implementation Team
Potential Mechanisms of Continued Population Decline
Work Product from October 17, 2011

Conservation Issue		Mechanism(s)
Cumulative impacts from all above		Time-crowded, space-crowded, nibbling
Marine & Terrestrial Habitat Connections		Displacement, disconnect between foraging and nesting habitat; synergy between marine and terrestrial habitat

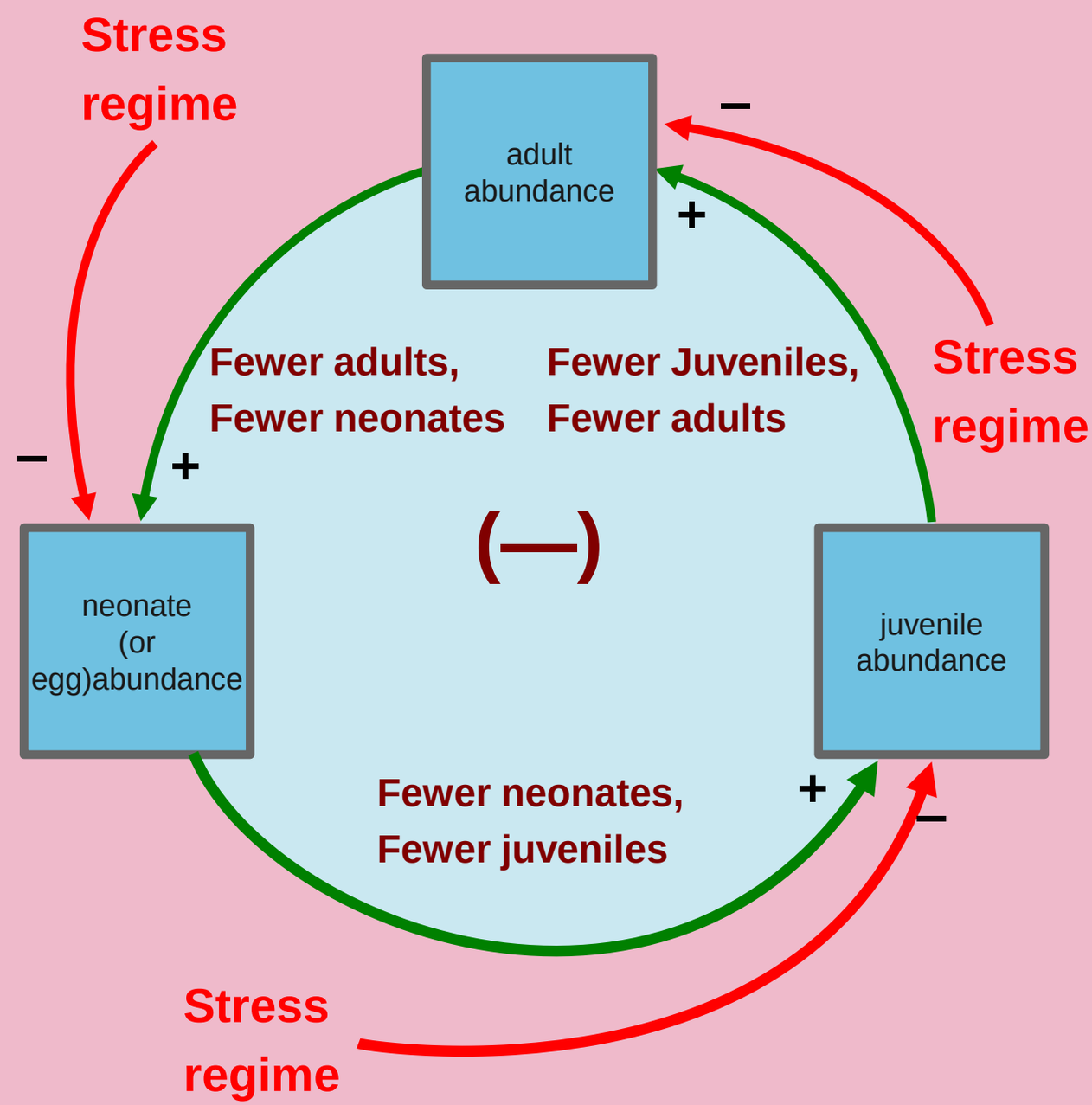
Appendix C

Endogenous Sources of Extinction Risk

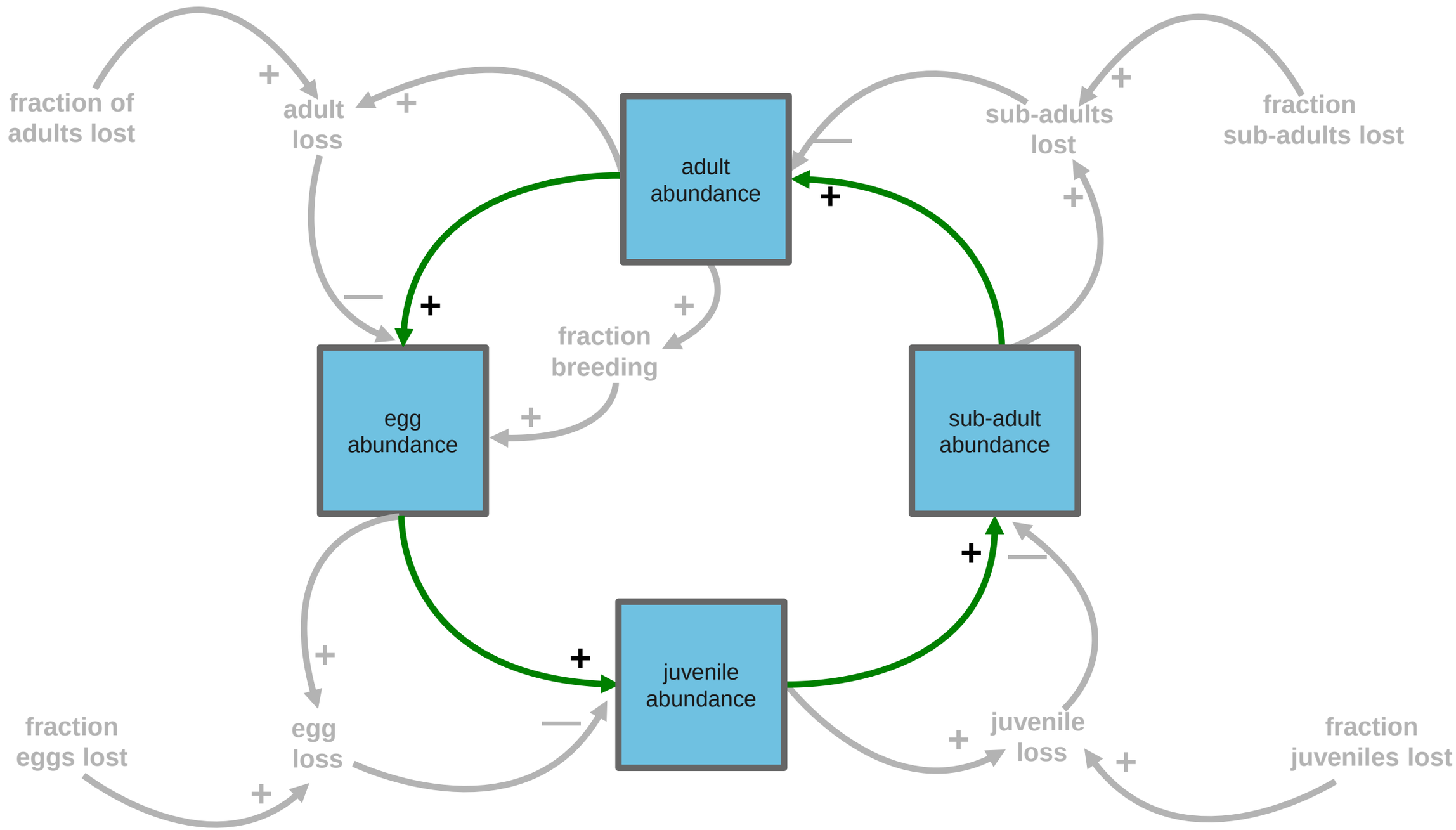
Normally, this reinforcing loop would cause a population to grow exponentially



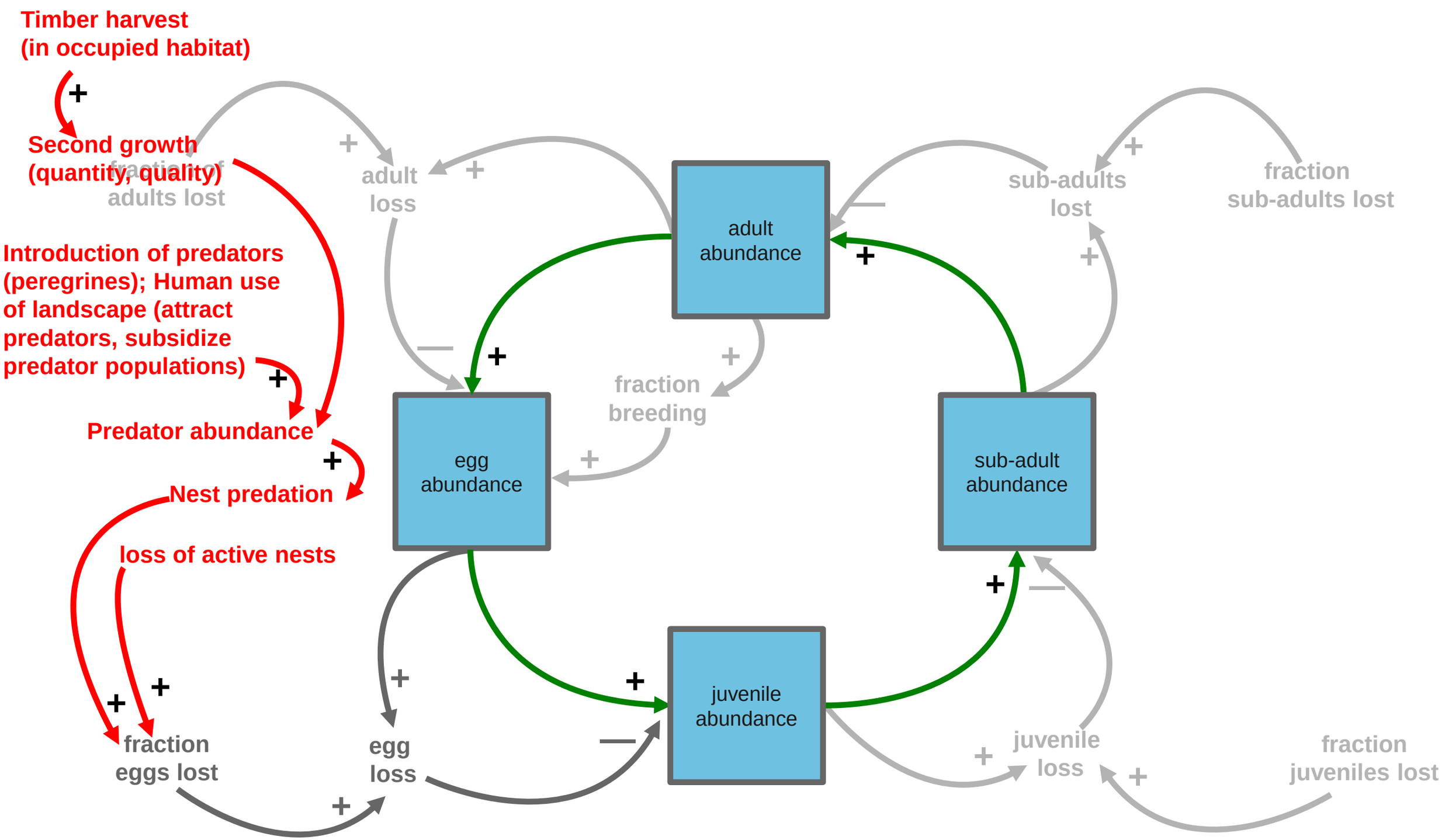
However, stress regimes acting on the population can create exponential decline



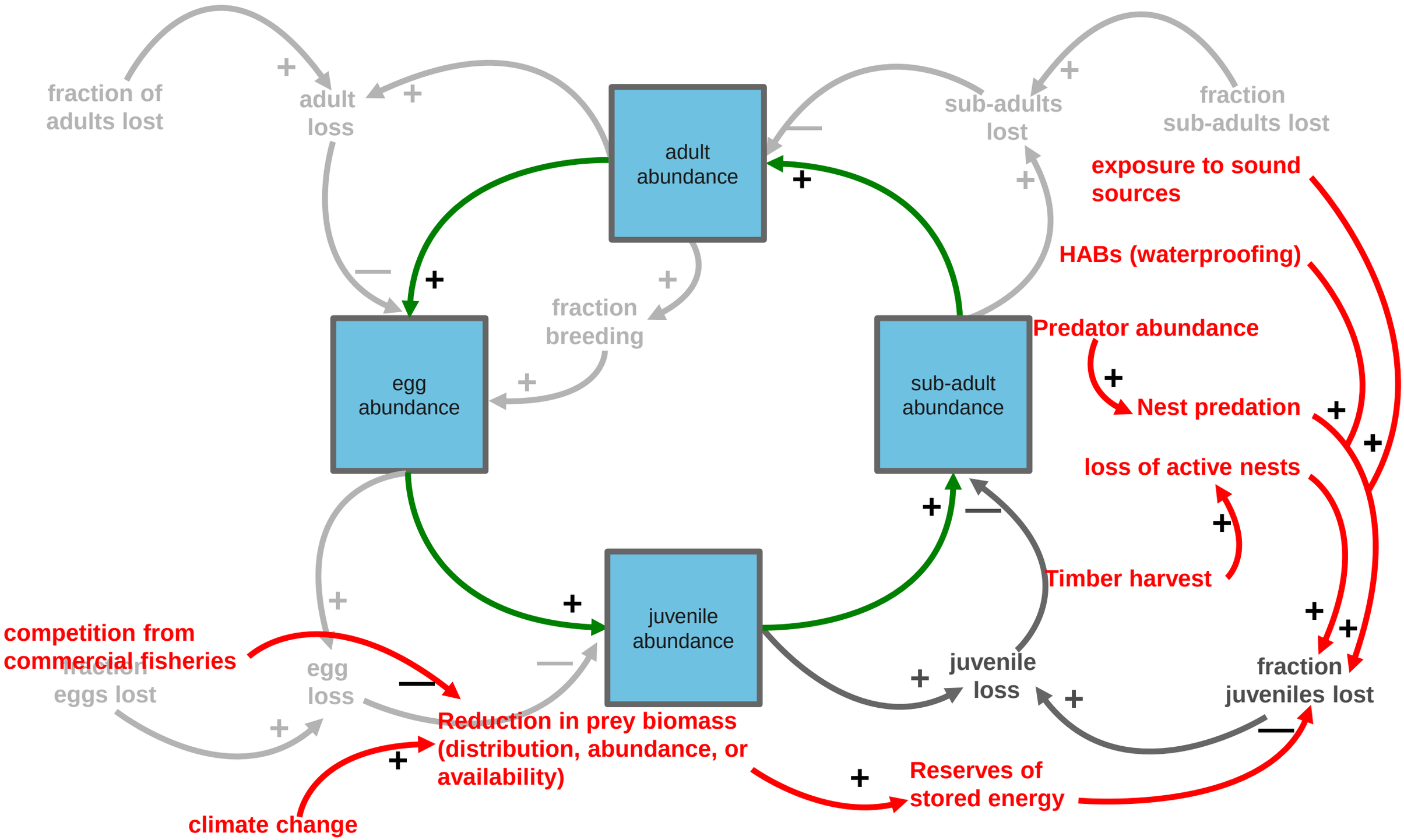
Stressors Acting on Mamu Juveniles



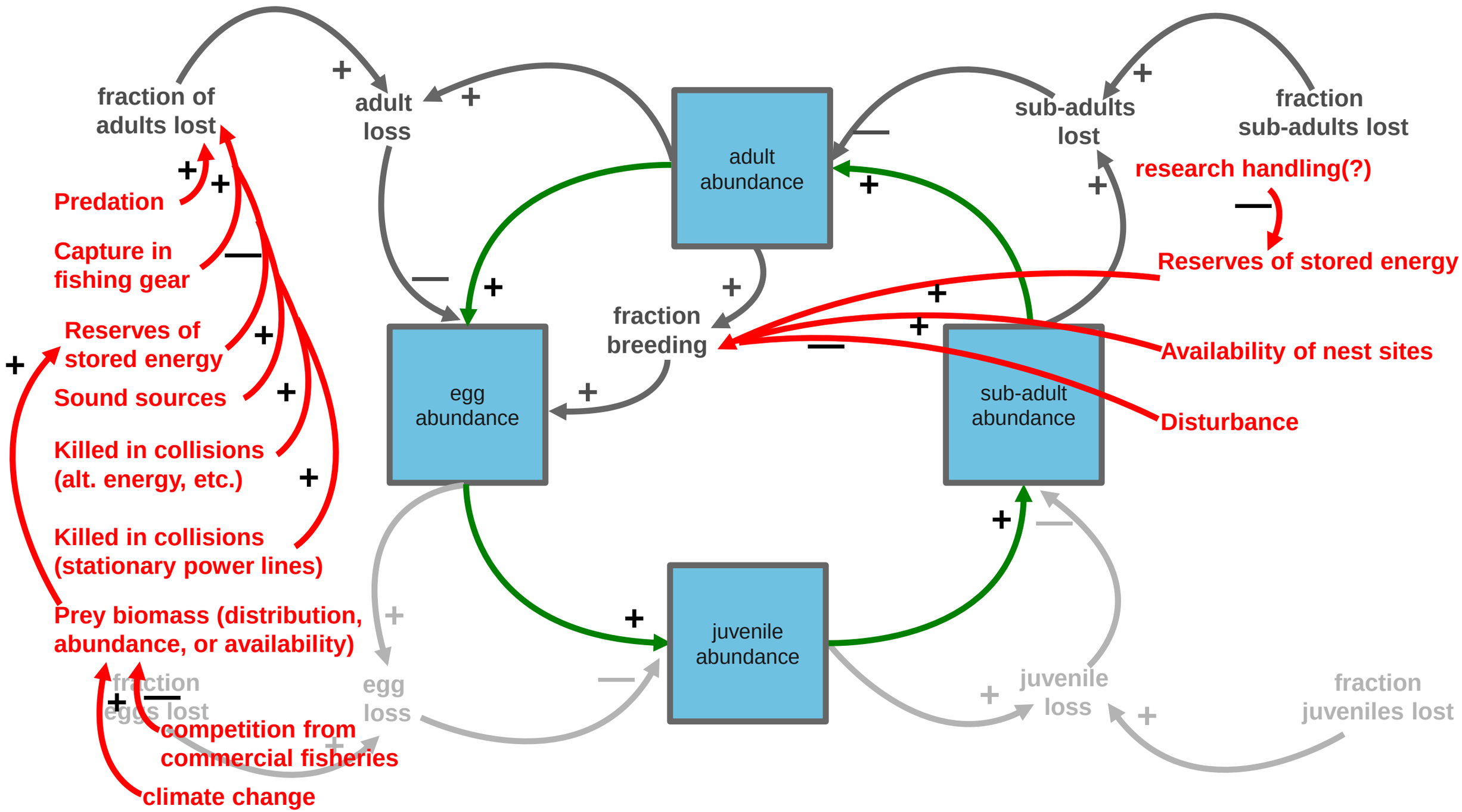
Stressors Acting on Mamu Eggs



Stressors Acting on Mamu Juveniles



Stressors Acting on Mamu Adults/Sub-Adults



Appendix D

Loss of Terrestrial Habitat

- Past and ongoing removal of occupied and unoccupied suitable habitat (Conservation Zones 1,2,3,4*,5*,6*)
  **these zones have experienced past habitat removal, with minute losses currently*

- Past habitat removal has created large gaps (Conservation Zones 2,3,4,5,6)

- Few/no functioning habitat reserve programs outside of the Northwest Forest Plan areas (Conservation Zones 1,2,3)

- No incentives to protect or restore habitat on private, state, and county lands (Conservation Zones 1,2,3)

- Limited protection on non-federal lands (Conservation Zones 1,2,3)

- Climate change effects on fire dynamics (frequency and magnitude) (Conservation Zones 1,2,3)

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Nest Predation

- Fragmentation of occupied habitat, unoccupied habitat, and adjacent forest which leads to increased predation rates and predator numbers.(Conservation Zones 1,2,3)
- Increased recreation use of forested areas and resultant food subsidies for predators, leading to increased predator abundance (e.g., camp grounds, trailheads, roads) (Conservation Zones 1,2,3,4,5,6)
- Increased development or agriculture use of adjacent habitat leading to increase in predator populations (Conservation Zone 3)
- High human footprint index because: Highly urbanized terrestrial habitat; Reserves are perforated by roads, trails, and recreation (Conservation Zone 1)
- Remaining habitat is in small patches with large amounts of edge and surrounded by urban areas, agriculture, dumps etc. Synergistic effects among habitat loss, fragmentation and predation. (Conservation Zones 3,4,5,6)

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Marine Forage

- Existing and proposed removal of forage fish also used by murrelet (Conservation Zone 3)
- Commercial fishing: Loss of rockfish historic has been most severe south of OR border. Even though no current commercial fishery, recreational fishery may continue to have small impact. (Conservation Zones 4,5,6)
- Degradation of spawning grounds of herring and smelt which has reduced populations of forage fish for murrelet.(Conservation Zones 4,5,6)
- Large loss in natural shorelines, estuaries; High contaminant loads; Reduced herring abundance and reduced age structure in herring; Depleted rockfish populations; Large increases in pinnipeds; Other marine risks: derelict fishing gear, gill net fisheries, HABs (Conservation Zones 1,3,4)
- Renewable energy development in murrelet marine habitat (e.g., wave, wind, tidal energy structures) (Conservation Zone 3) – this is a potential future issue in other zones, too
- Climate variability effects on food webs in murrelet marine habitat (e.g., HABs, dead zones, El Nino) (Conservation Zones 2,3,4,5,6)

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Cumulative and Interactive Impacts

- Increased extinction risk due to small population size - demographic heterogeneity/stochasticity (Conservation Zones 1,3,4,5,6)
- Disconnect between high quality terrestrial and marine habitat in terms of location/adjacency (lost productivity zones in some major estuaries) (Conservation Zones 1,2,3,4)
- Energetic, predation risk associated with commute between nesting and ocean habitat (Conservation Zones 1,2,3,4)
- Increased disturbance both inland and/or at sea leads to increased physiological stress and reduced performance (sources of disturbance can include boat traffic, recreationists, vehicle traffic, etc.) (Conservation Zones 1,2,3,4,5,6) – both marine and terrestrial disturbance are particular issues in Zone 1
- Contaminant loading increases vulnerability to disease, decreases fitness (Conservation Zones 1,2,3,4,5,6)
- “Energetic income” probably decreasing due to reduced forage fish availability (Conservation Zone 1)
- Behavioral/social stimuli needed for recruitment (Conservation Zones 4,5,6)
- Potential vulnerability to W. Nile Virus (Conservation Zone 1)

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Post-fledging mortality

- Oil spills and other catastrophic events (e.g., extreme weather events, fire) (Conservation Zones 1,2,3,4,6)
- Avian predation increasing with recovering raptor populations (e.g., bald eagles, peregrine falcons) (Conservation Zones 1,2,6)
- Not much info on incidence of mortality from peregrines and eagles (Conservation Zones 4,5)
- Domoic acid events due to agricultural runoff – phosphorus. Known murrelet mortality from domoic acid. (Conservation Zones 2,6)
- Nets (gillnets, purse seines, derelict gear) (Conservation Zone 1)
- Underwater sound (impulsive) - Impact pile driving, detonations, etc. (Conservation Zone 1)

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Appendix E

Appendix E

Marbled Murrelet Recovery Implementation Team
Ranking of Actions Developed During Stakeholder Workshop

Mechanisms were developed by the Recovery Implementation Team (see Appendix D) Loss of Terrestrial Habitat Nest Predation Changes in Marine Forage Post-Fledging Mortality Cumulative and Interactive Effects
Brainstormed Action Idea, Rationale, Pros, and Cons were developed by stakeholders during the workshop
Geographic Areas: 1N = Puget Sound 1S-2N = Strait of Juan de Fuca and outer Washington coast north of Grays Harbor 2S-4N = outer Washington coast Grays Harbor south to California/Oregon border CA = California/Oregon border south to Point Sur
Ranking: Every Recovery Implementation Team member ranked every action for every geographic area
Ranking Levels and Averages: An average rank was calculated for each action by geographic area 1 = Most important action to take 5 = Least important action 6 = Not applicable
Comments: Provided by Recovery Implementation Team members during ranking process

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat 4	Maintain/create incentives for protecting best habitat, in size of blocks that work for murrelets. For nonfederal lands, focus on and prioritize best remaining habitat blocks.	Use modeling data and available science to ID what is best habitat, then incentivize Protect habitat <u>Example of incentives</u>: --revise appraisal process to assign market value to timber --use trust land transfer process in WA --tax breaks -- incentives that allow some harvest, but extend harvest cycle so always some blocks of habitat in suitable, old-forest stage	Could help timberland owners conserve habitat and meet financial needs. --already have model and other information (in-house knowledge with managers) -- focuses on conservation of best stands, regardless of ownership -- --if land transactions occur, can more involve land trusts in mamu conservation If addressed collaboratively, could become a win-win (for landowners, agencies, multiple species benefit) Using wetland conservation program as model, which could provide buffering around the mamu habitat. Easements provide certainty for landowners -- involve land trust expertise in MAMU conservation protects private lands	Errors of modeling, but can use ground-truthing or Lidar, etc --funds not available at this time for (need the funds before you even have the conversation. Not much trust in WA, ex: riparian fund) --if you take land out of production, less land to support jobs and tax base --appraisal change could hurt landowners by increasing tax burden -- may have unwilling sellers --politics	**1.33**	**1.11**	**1.00**	**2.00**		less of a priority in CA just because so few lands available
Loss Terrestrial Habitat 4	Modify forest practice rules to better protect higher value habitat	May be a need to reassess these rules in WA & OR to apply the latest science, particularly re: size of habitat Some rules incentivize landowners to keep their land from becoming habitat for sensitive species (just keep cutting the stands every 35 years so it never grows up) On private lands could provide incentive to manage more diverse forest	Could relieve private landowners of restrictions that may not be helping mamu anyway Could help with cutting of habitat, esp. in Oregon, due to lack of regulations --better protect Occupied habitat	--doesn't involve landowners --discourages collaboration and interaction. --If burden rests on private landowners, engenders resistance. (Landowner quote: When I see more regulations, I go back to the office and say, 'cut more trees down.') --not funded --- it's not the private landowners' jobs to protect habitat	**1.33**	**1.33**	**1.33**	**1.33**		
Loss Terrestrial Habitat 4	Swap resource use on federal land for protection on private land via leases, etc.		Great way to prioritize high quality habitat irrespective of ownership.	Lawsuits, complicated,	**2.33**	**2.33**	**2.33**	**2.33**		
Loss of terrestrial habitat	Treatments to improve adjacent blocks of second growth	Hope that sharpness of edge will decrease; increasing size of trees in adjacent 2nd growth; those stands will provide cover; armors existing habitat, decreasing amount of corvid in the edge.	Speeds up process for old growth characteristics; been successful in getting material out;	Takes a long time; increases fire potential (more for inland stands); causes disturbance to the area (may or may not be negative.	**1.67**	**1.67**	**1.67**	**2.00**	research effects of cutting/thinning adjacent to occupied sites	sensible action but time frame needed will not necessarily stem the immediate decline in MAMU

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat 2,3, Nest Predation (fragmentation)	Develop landscape-scale strategy that blocks up protected habitat Identify gaps (assess the current landscape) to focus the resources / restorations / easements Protect blocks of habitat from harvest If the bird population continues to crash, may be time to revisit current reserve system on federal lands	LSRs are huge habitat areas, including everything from mountain tops to __. They do not identify best habitat by species. Big gaps in distribution of habitat may be a focus / priority for creation of habitat Protect more habitat	Uses landowner knowledge, modeling, other data sources (e.g. NWFP, parks, adjacent private/nonfed lands Parks service treats all below-4,000 feet land as the same, but it isn't the same. Additional detail about species needs would help them be smarter in their actions. Protects multiple species; protects the mamu habitat; protects mamu despite knowledge of limiting factors Allow for better use of limited resources	Hopefully avoid further fragmentation as unintended consequence, esp. on federal lands 1) Difficult to change current state harvest practices; 2) cost of jobs lost; 3) effects to local economy; 4) can lead to increased desire for public access	**1.33**	**1.33**	**1.33**	**1.33**		
Loss Terrestrial Habitat 6	Use FS fire risk model to help prioritize blocks of land Consider climate change future in developing strategy Use the risk model to identify where it is most important to prevent catastrophic fire or other major disturbances. Tie that back to land use restrictions. Prevent or mitigate risk in the areas that are most important to mamu.	Make use of available tools to better plan/strategize at landscape scale	This is an already available tool Allows forward – looking planning (assess the likelihood that a stand will still be there in future, use that to help prioritize)	This will be extremely controversial in some areas, because it might require cutting trees. Trade-off between species' needs. Fire treatments can impact species. The fire models aren't very good Disturbance take prohibits habitat manipulations that would result in long-term benefits	**1.33**	**1.33**	**1.33**	**1.33**		

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat 3	Improve interagency communication and planning (note: not even all the relevant state and federal agencies were here in the room today) Work to improve awareness by state, federal and private entities when generating a management plan or landscape conservation program (make sure the mamu is included in the discussion) Maintain a broader view when a federal government or agency is considering action Include more timber industry in discussion	Improved collaboration between agencies gives opportunity to identify synergies and avoid working at cross purposes … treat the mamu recovery plan similarly to the spotted owl recovery plan Standardize protection priorities between agencies Use science to create a uniform definition of suitable / quality mamu habitat Need to understand who owns the land and how to block it up	Potential to support forest health and resilience Wide dissemination of mamu map would make it possible for other agencies to keep mamu in mind for their planning and actions A model already exists (natural communities conservation program … nccp act) and money goes with that With clear focus on quality habitat, can release some of the regulations on areas that are more marginal in terms of Mamu habitat. Target mitigations / protections on higher quality habitat 1) establish feasibility for purchase or management; 2)coordinate at landscape scale	Unintended Consequences: From a private land standpoint, creates a race to cut land before your neighbor does. Solid, reliable incentives would be important to ameliorate this. (FSC, Forest Certification Program isn't on private landowners' radar.) 1)decision by committee can be difficult	1.33	1.33	1.33	1.33		
Loss Terrestrial Habitat 1	Crown manipulation: cutting trees, selective thinning, trying to get larger branches Develop habitat restoration components (to create new habitat)	Improve existing habitat. At stands, manipulate crowns of trees to initiate reiteration – for large branches, candelabra design. Experimental study. Restoration forestry could focus not just on protecting occupied sites, but could generate new sites	Accelerates canopy/limb characteristics for nesting would mechanically put in defects; Steve HSU; 50-60-100 years; could have habitat; Section 6 money, some support from local FWS office; gets more structure into the stands – thinning reduces canopy --get suitable habitat more quickly --Sempervirens Fund is attempting to address this	Sempevirens fund is attempting to address this. --don't know if it will help--are we creating new edges? Don't want to disturb existing habitat --tradeoffs (esp. short-term) with increasing corvid habitat by thinning (when thinned hab itat is near MAMU nest habitat)	1.33	1.33	1.33	1.33		
Loss Terrestrial Habitat 1	Redefine what habitat is; provide protections – slow down loss on non public land. Better define habitat.	Conserve Habitat	Would better enforce ESA on private land; strengthen regulatory language so suitable habitat is not lost	backlash from public for more regs	3.11	3.11	3.11	3.11		??? Not specific enough for me to properly evaluate. What is meant by "better definition"?
Loss Terrestrial Habitat 4,5	Have dialogue with Oregon ODF and DOF to apply WA approach to forest management, including both incentives, monitoring. Consistency among states in how habitat is treated in timber harvest regulations	Improve conservation of MAMU habitat in OR	Could include database on mamu sites, available to all (Natural Heritage Survey, e.g.) Improve conservation of MAMU, esp. on private lands	Need to be careful about adopting WA model, as it has some problems, which should be fixed before exporting to OR	1.33	1.33	1.33	1.33	Rules and management should be similar in all states. So should USFWS protection of occupied and suitalbe habitat. In Oregon there is no consitency with the other states.	applies only in OREGON, but will need dialog w/WA agencies

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat 1,2, nest predation	Treat entire watersheds instead of parts of watersheds Consider grouping timber treatment in 1 area (e.g. concentrate on 1 drainage)		Integrated plan for the entire watershed. Minimize management goal shift from administrative changes. Concentrates your negative impacts in one point in time, allows recovery Concentrate impacts to 1 area, may be more cost effective mgmt, minimize roads may give study opportunity to compare edge could encourage mamu habitat structure quicker	Makes a big target. A lot of impact at one point in time Many landowners (with many goals), coordination could be very difficult … therefore this idea may work better in places with limited number of different landowners	1.33	1.33	1.33	1.33	in a perfect world this would be the way to go, but this would require changing laws, buying land, etc.	could avoid managing different areas of same watershed at cross-purposes
Loss Terrestrial Habitat 1,2,3	Change culture in how agencies approach landscape planning	Site specific plans may not take the larger habitat needs (watershed level, for example) into account. Each project is managed site by site rather than managing them by the system-wide	Broader view, improve connectivity between conservation interests	On most of the non-federal lands, management is being done by regulation, which isn't effective Creates additional regulatory burden	1.33	1.33	1.33	1.33	this goes with landscape planning and creating blocks of habitat	landscape vs. site-specific mgt; perhaps merge as part of items under lines 1-30???
Loss Terrestrial Habitat 1,2,3	Designate critical habitat within Parks service units This may also be good for Wilderness areas on National Forest Service lands.	There are inholders and other players within parks service lands. There are rules for critical forest service lands, but those rules don't all apply to parks service units.	Give higher level of protection within National Parks Service Unit	Creates another layer of regulation Another layer may keep people from wanting / supporting wilderness designations	1.33	1.33	1.33	1.33	not sure how this would help	prevent extiction; NOTE: lack of expertise by this reviewer means unable to provide zone-specific response (e.g. not sure if this applies more in one zone than
Loss Terrestrial Habitat 4,5	Reach out to private landowners, educate about mamu needs. Give them a clear description of functional / quality habitat and actions they can take to improve marginal habitat.	Non-industrial landowners have a range of goals and management objections. Some landowners want to make good management decisions but don't know what those are	--"Environmentalist landowners" could partner better if they know mamu needs increase knowledge - contributes to conservation --protects, improves habitat on private lands --involves landowners --helps people value old-growth habitat --improve stewardship	--landowners could respond negatively—don't want to create problems for their descendants -- biologists may not make the best educators; resources 1) hard to measure effectiveness 2) Takes a long time to implement 3) can be detrimental-the more public knows, the more anti-species folks could become because the spp represents restriction	1.33	1.33	1.33	1.33		
Loss Terrestrial Habitat 1,4,5	In Oregon require listed species surveys to avoid taking MAMU habitat		Provides a mechanism to conserve MAMU habitat on private land/ legislative mechanisms would have to change	Cost of foregoing logging revenue to common school funds or BOF lands	4.67	3.22	1.78	4.67	Surveys should be occurring on all lands and data should be submitted to state database, like in WA	if species uplisted, this seems certain in Oregon. Only applies in OREGON
Loss Terrestrial Habitat 1,4,5	Protect surveyed, unoccupied suitable MAMU habitat. Forgo harvesting it.	Recognize the value of not currently occupied habitat	Retain habitat for future occupation	Loss forever(200 years+?) of this habitat for nesting	2.22	2.11	2.22	2.11		
Loss Terrestrial Habitat	Take advantage of LIDAR and other habitat data collected by various agencies and not shared, formatted or merged into a region or MAMU range wide data set.		LIDAR and other immagry is expensive but a valuable way to -OR lidar working group to collect LIDAR data in larger blocks	--LIDAR is expensive	1.33	1.33	1.33	1.33	might or might not be helpful. USGS is looking at MAMU habitat using LIDAR.	
Loss Terrestrial Habitat 1,2	Preserve the NWF Plan	Maintain large-scale ecosystem management	Maintain large-scale ecosystem management, rather than individual smaller scale management plans (e.g. for individual National Forests)		1.56	1.56	1.56	2.44	BLM is eroding the NWFP with their thinning plans. Also DeFazios plan to allow logging on all O&C lands, much of whichi is part of the NWFP, will harm the murrelet.	? Not sure, but assuming NWF does not apply in CA? Forgive poor memory on this point.

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat	Look at snowy plover working group as model for implementing management, bringing researchers and managers together to plan and implement recovery actions	Improve coordination through regular (annual) gatherings to share information and plans	--better way to get buy-in from parties (landowners) if		**2.44**	**2.44**	**2.44**	**2.44**	not sure if this would be helpful or not. Is it a successful model?	
Loss Terrestrial Habitat	Review PALCO, Champion Timber, Redwood National Park efforts to accelerate old-growth forest characteristics				**2.89**	**2.89**	**2.89**	**2.78**		
Loss Terrestrial Habitat 3,5	Have consistent/centralized databases on known MAMU nest locations and occupied sites		--improve quality of data --have good databases for all 3 states to use in planning, evaluating projects	--cost of doing it	**1.33**	**1.33**	**1.33**	**1.33**		seems necessary for landscape-level planning, prioritizaion in all habitats
Loss of terrestrial habitat	Could we use calls to attract MAMU to unoccupied habitat?		--could be tool for restoration, recovery	--context of calls not known (11 different calls) --complicated	**1.33**	**1.33**	**1.33**	**1.33**		seems relatively inexpensive to try
Loss Terrestrial Habitat Fragmentation	Buy land to place in conservation status	Protect more habitat	1)Protects multiple species 2) protects the mamu habitat 3) protects mamu despite knowledge of limiting factors 4)needs more agency coordination	1)Cost 2)Makes timber lands unprofitable because of domino effect-one land owner sells, others may follow or change practices as a result 3) can lead to increased desire for public access 4)more coordination can be problematic	**1.33**	**1.33**	**1.33**	**1.33**		
Loss Terrestrial Habitat Fragmentation	More HCPs	Should provide for conservation	1)can provide regulatory certainty for the landowner 2)should provide for conservation 3)allows for long-term planning	1)doesn't provide financial certainty 2)might not be sufficient mitigation 3)maybe a lack of enforcement 4)doesn't necessarily provide for biological certainty	**1.33**	**1.33**	**1.33**	**1.33**	HCPs are not necessarily the answer to helping the murrelet, but if there is no other way to protect large blocks on private and state lands then it would be important to do.	
Loss Terrestrial Habitat Fragmentation	Work with land trust groups; secure conservation easements; secure land	Conserve habitat	1)developers pay 2) voluntary 3)tailored to need of landowner 4)long-term protection 5)tax break in CA-variable by state	1)each one is different 2)takes a long time 3) complicated 4)not a well known process	**1.33**	**1.33**	**1.33**	**1.33**		
Loss Terrestrial Habitat Fragmentation	Allow private lands to be sold for mitigation; plus buy equal amounts of adjacent nonhabitat	Regulation not= conservation	1)If conservation, owner can manage to protect and allow buffers to grow over time		**3.33**	**3.22**	**3.11**	**3.11**	It is not clear to me if this would help MAMU. Land swaps are not always beneficial to ESA listed species.	is this at all related to "land swap" idea? Might rate higher if this were possible.

Mechanism-TerrestrialHabitatLoss	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon OVERALL NOTE FROM ZAMON: my lack of knowledge of Forest Landscape Ecology and Forest Management Practices means I could not evaluate the zone-specific appropriateness of some actions; I rated all zones similarly in those cases.
Loss Terrestrial Habitat Fragmentation	Use appraisal process from river and habitat open space	Allow for purchase of occupied habitat	1)IMPROVE PURCHASE PROCESS 2)may reduce larger owners from selling 500 ac or less (WA specific) to small landowner, which under FPR could then be potentially harvested	1)timber companies reduce their ability to partner 2)go another 20 years and not be able to use purchase of private lands into conservation property	**1.33**	**1.33**	**1.33**	**1.33**	this is not totally clear to me	

Mechanisms (Conservation Zone(s) where this was high priority)

1. Past and ongoing removal of occupied and unoccupied suitable habitat
2. Past habitat removal has created large gaps
3. Few/no functioning habitat reserve programs outside of the Northwest Forest Plan areas
4. No incentives to protect or restore habitat on private, state, and county lands
5. Limited protection on non-federal lands
6. Climate change effects on fire dynamics (frequency and magnitude)

Mechanism-Nest Predation	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Nest Predation - Fragmentation	Increasing mgt of private lands to reduce fire –fuel breaks	Save habitat	1)less catastrophic fires	1)lose habitat in process of building fuel breaks 2)fuelbreaks could draw predators-type of break can have diff effects	**4.44**	**4.44**	**4.11**	**4.00**		action outcome seems very uncertain	
Nest Predation - Fragmentation	Un-manage buffers – don't manipulate, let grow		1)easier than managing 2)growing more core habitat	1)more fire prone	**2.78**	**3.44**	**3.11**	**3.11**			
Nest Predation - Fragmentation	Allow OCNMS to purchase/acquire terrestrial habitat			This is currently outside of the OCNMS's purview	**5.11**	**4.00**	**5.11**	**4.78**	buying habitat is very important, but this was tied to OCNMS	does not apply outside 1S-2N (Olympic Coast)	
Nest Predation - Fragmentation	Develop thinning prescriptions to preserve high canopy cover to reduce corvid flight/visibility		1)Reduce corvid entry into stands 2)may be able to do more thinning on the landscape	1)may not some of the other thinning objectives	**2.78**	**2.67**	**2.67**	**2.78**			Sounds like someone did some experiments on this???, If not, then just conjecture?
Nest Predation - Fragmentation	Timing forest activities to avoid nesting season			1)fish window restrictions 2)may be more expensive because have to build to higher standard	**2.89**	**2.78**	**2.78**	**3.00**	This should already be happening.	certainly a no-brainer whenver possible	
Nest Predation - Recreation	Better/more effective outreach in to visitors to encourage appropriate behavior and educate about consequences of people's actions-pet food, bird feeders	lessen the amount of human food available to predators	1)could be inexpensive 2)people take ownership 3)helps in wildlife disease control 4) can be fined 5) involve public in meaningful way, get conservation message 6) could be more effective than what we're doing now	1)diff to measure effect 2)hard to effect visitor/people's behavior 3) people like to feed wildlife 4) biologists are not the best educators sometimes	**2.78**	**2.78**	**2.78**	**2.78**		related to objective on worksheet line 63; maybe merge???	See comment below about "Bear Rules"
Nest Predation - Recreation	Relocate campgrounds/dayuse areas		1)removes food source for predators	1)people may not come to parks anymore-lack of support 2)cost 3)may increase dispersed camping (FS and BLM lands)	**2.78**	**2.78**	**2.78**	**2.78**			
Nest Predation - Recreation	Evaluate recreational activity in mamu habitat				**2.67**	**2.67**	**2.67**	**2.56**		necessary to help prioritize, guide actions aimed at recreation	public education
Nest Predation - Recreation/corvids	More trash mgt; Improve dump technology; Put into county zoning laws – trash regulation/dump location, recycling to ultimately reduce dump; Promote composting; Make county dumps free		1)easy to implement from parks perspective 2)co-generation plants are big industry– creates jobs 3) reduce dumping within habitat	1)cost 2)diff to modify behavior	**2.78**	**2.78**	**2.78**	**2.78**			
Nest Predation - Recreation	Planning for new campgrounds/dayuse areas should take into account spp effects		1)provide for conservation	1)could cost more if cannot tie into existing sewage,water etc	**1.33**	**1.33**	**1.33**	**1.33**			public and park-employee education
Nest Predation - Recreation	Control # humans in the recreational areas, e.g. limit backcountry permits			1)limits people's use of NF areas 2)more concentration of people's use	**3.89**	**3.67**	**3.67**	**3.89**		to some extent, may be happening already	
Nest Predation - Recreation	Use military to develop methods to deter corvids from an area, but not murrelets		1)conservation cost could be minimal		**3.78**	**3.78**	**3.78**	**3.78**		refers to apparent already-funded gov't initiative which seeks to introduce military tech into civilian applications; potentially high payoff, but not clear what, if any, technology is applicable to MAMU issue; cost to implement, even if technology is identified, might be prohibitive	
Nest Predation - Recreation	Close recreation/campground for a season and see how murrelets respond				**3.56**	**3.56**	**3.56**	**3.11**		seems very worthwhile to try to measure direct effects, but may be difficult to evaluate statistically b/c so few MAMU nests available for study; may be difficult to implement in Puget Sound area due to higher density of human use	not long enough period
Nest Predation - Recreation	Work with commercial shellfish/fish processing facilities to reduce their contribution to corvid food source				**2.78**	**3.11**	**3.33**	**3.22**			
Nest Predation - Development/Ag – adjacent	Promote utilization of land in crops that do not draw corvids – e.g. potatoes		1)fewer predator	1)social impact 2)feasible? 3)cost- 4)may require incentives	**2.78**	**2.78**	**2.78**	**2.78**			Of course, adjacent to mm breeding habitat
Nest Predation - High human Footprint	Re-location of old roads out of occupied sites; look for opportunities to decommission roads to help unfragment nest habitat		bigger blosk of habitat, reduce fragmentation, and adjacent to existing habitat (to soften edges and provide future nest areas adjacent to existing)	1)costly; 2)may still want roads in place for future stand management, roads are where second growth is (could stage to do treatment first)	**3.22**	**3.11**	**3.00**	**3.11**	Road are not as important in the scheme of things as cleacuts, or thinning in buffers or occupied sites.	hard to measure population impact	

Mechanism-Nest Predation	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Nest Predation - High human Footprint	County landuse planners need to be better educated about spp needs		1)better land use	1)one more thing for planner to address	**2.78**	**3.00**	**2.89**	**2.89**	other agencies as well		
Nest Predation - High human Footprint	Reduce human activity pressures, e.g. birth control				**5.00**	**5.00**	**5.00**	**5.00**		not practical	
Nest Predation - Small patches	Review and understand whether state forest practice rules will provide for buffer habitat around patches-WA		1)greater understanding of efficacy of buffers		**2.44**	**2.78**	**3.56**	**3.89**	this should apply to all states	assume not applicable in non-Washington zones	
Nest Predation - Small patches	Grow buffer habitat around occupied sites		1)easy to get feds to implement	1)hard to get private to implement-cost 2)difficult to show success(can be answered by research)	**1.89**	**2.00**	**2.00**	**1.67**		include research component if at all possible; managing private land will always be more difficult by definition - acknowledge that but should not let that limit potentially beneficial action	
Nest Predation - Small patches	Provide incentive for private landowner to grow buffer/habitat		1)provides buffer 2)potential to increase cooperation	1)costly 2)program like this leads to a haphazard pattern – can't plan as well – leads to patchy implementation 3)those who participate can lead to damage on neighbor's land	**2.78**	**2.78**	**2.78**	**2.78**		should be possible to mitigate for cons; at this point, even haphazard conservation is better than no improvement at all	
Nest Predation - Corvids	Lethal control of corvids – shooting, baited traps, bounty	Reduce populations of predators	1)Reduce pops 2)Straightforward implementation 3)Low cost 4)Measureable results 5) lessen abundance of predators; [Portia Halbert: 30 per year have been removed – once territorial paris are removed, bands of juvis will appear a day or two and move on. (during breeding season). New adults set up in Feb-March – has seen a decrease in abundance	1)Humane concerns 2)PR concerns 3)Ongoing effort 4)Continued cost 5)Noise from guns in forest may disturb mamu 6)remove one, create vacuum for another to fill 7)may lead to another species listing 8) Not popular with people Hard to get all of them; removal of territory holders, could have increase of floaters. Ravens occupy large territories; timing and followup is important. Removing them can increase numbers by inviting floaters. Some ravens are food source specialists – killing them may invite ravens that are nest predators. Many negative effects that may need to be considered. (Keith Bensen).	**2.78**	**2.78**	**2.78**	**2.78**		need to be research-oriented approach which documents effectivenss as well as possible undesirable results	
Nest Predation - Corvids	Get predators to eat them		1)gets rid of them	1)may not work 2)may eat mamu	**5.00**	**4.89**	**4.78**	**4.56**		no specific, proven agent available that might not have other undesirable effect on	
Nest Predation - Corvids	Need more coordination among predator removal projects		1)better communication		**3.11**	**3.00**	**2.89**	**2.67**		not sure if it applies in all zones? (that is, not sure where corvid control is present already)	

Mechanism-Nest Predation	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Nest Predation - Corvids	More training of corvids to avoid mamu eggs; Taste aversion study to train jays	Should reduce nest predation	1)help with predation issue 2) Cost effective; studies have been done at the same time stellars jay and raven work is happening in the same areas; perhaps we can meld (Keith Bensen)	1)costly 2)requiring repeat work 3)Uncertainties to knowing how this will relate to how many chicks are produced; a lot of effort? Not good to put people in trees, work is done in the understory. Not a substitute for control of food for jays (human)	**2.78**	**2.78**	**2.78**	**2.78**			
Nest Predation - Corvids	Piggyback on corvid control for plovers		1)better bang for buck	1)competition for $	**3.89**	**3.78**	**3.44**	**3.67**	same as line 53 above	not clear to me that areas of concern for plovers (beaches) would have impact on nest predation at inland forest sites per se	
Nest Predation - Corvids	Expand on surveys/Track/monitor corvid increases	Need to know the # corvids; need to have ratio of fledglings to adults; numbers of fledglings, correlating to forest management	Increase knowledge about corvids	cost	**1.89**	**2.00**	**2.00**	**1.89**	Corvid surveys should be happening at all sites where thinning is conducted to look at impacts.	if these are prime mortality mechanism, need to understand their behavior	
Nest Predation - Corvids	Get an understanding of how corvids use habitat; possibly piggyback on other species research/inventory/monitoring that documents corvid behaviors				**2.11**	**2.11**	**2.00**	**1.89**			
Nest Predation - Corvids	Develop recommendations for how to soften edges		1)if got soft edge, keep it 2)describes where is can/can't work 3)could encourage better landscape planning	1)may be difficult for private owners to implement 2)may end up with rule of thumb that is of limited value	**2.78**	**2.78**	**2.78**	**2.78**			
Nest Predation - Corvids	Make videos about corvids for public outreach/education				**2.56**	**2.67**	**2.67**	**2.56**			Public education in general, which applies to several of the ideas
Nest Predation - Recreation/Corvids	Restrict trail use during breeding season	Controls nest predation		Corvid response is greater in highly used areas vs. backcountry areas. Nest predation continues as a problem. Needs to be used along with other methods.	**3.78**	**3.89**	**3.89**	**3.44**			"Bear rules" should be invoked in all coastal state and federal parks, i.e. no open food allowed.

Mechanism-Marine Forage Changes	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Mantua	Comments - Zamon	Comments - Ainley	Comments - Fiorello
Marine Forage 1, 2, 3, 4, 5	Tighten and enforce current laws to protect and and recover forage fish habitat.	Current laws need to be revisited. Enforcement is lacking. Staff shortages result in patchy survey effort. Example laws include: Hydraulic Project Approval, Growth Management Act, Shoreline Management and analogs in other states.	Increase forage fish production, improve resiliency from climate change impacts.	Political pressure for status quo. Might require additional staff resources.	1.33	1.67	1.56	1.44				
Marine Forage 1, 2, 3, 4, 6	Assess populations and identify limiting factors on forage fish populations.	Determine most important factors limiting forage fish populations.	Provides a good foundation for management decisions. Could feed into ecosystem based fisheries management strategies	Large scale effort, would probably require original research.	1.33	1.44	1.44	1.33		it is not clear what controls population dynamics; this needs to be understood. Opportunities for partnership abound b/c other needs requires this same information (e.g. salmon management, fisheries management, etc.)		
Marine Forage 1, 2	Quantify recreational and commercial fishing loss/harvest	Harvest of prey species may have a "legacy" effect. Some recreational harvests go largely unreported. It is important to understand how fisheries affect forage fish populations. Might be significant impact to forage fish production	Could identify a substantial limiting factor and lead to better management decisions. Need to understand impacts of baitfish harvest ot inform management decision. May go under radar.	Might trigger additional regulation or fishing restrictions. Large scale effort.	2.44	2.44	2.44	2.44	fishing impacts on forage fish, right?	There should be some information out there already to obtain a ball-park figure. If fishing is NOT a limited factor, and ocean conditions have more effect on forage fish pops, then we need to know that.		
Marine Forage 1, 3, 4, 5, 6	Develop a spatial model and a better understanding of the relationship between murrelet occurrence in the marine environment and forage fish occurrence. Integrate data collection efforts to contribute information.	Integration of data collection efforst has not been done to date, but could combine existing bird surveys with fish, zooplankton, and oceanographic data collection efforts to improve understanding of spatial relationship between food web and murrelet interactions. Spatial modelling of these data could identify important foraging areas ("hotspots"). Large scale planning could lead to conservation efforts that improve the resiliency of the prey base to climate change impacts. Products could be used to make informed decisions about where to locate renewable energy facilities.	More efficiently identify marine areas that would reap benefits for murrelets if protectected, share limited resources, improve coordination amongst resource agencies. Can prioritize efforts where the greates gaps are. Could improve resiliency of forage fish populations to climate change impacts. Could leverage spill response and renewable energy dollars	Large scale, may impact use of identified areas. Expensive; foraging areas may change over time; time may be limiting to regrow habitat	1.56	1.56	1.56	1.56	would allow for identification of something like 'critical feeding habitat'	required to focus on projects that provide most "bang for buck" with limited resources		
Marine Forage 1, 2	Conduct a Section 7 Consultation on commercial fisheries programs as they relate to reductions in the prey base for murrelets.	Evaluate, and potentially reduce, the impact of commerical fisheries on the murrelet food base. Precedent can be found in the USFWS evaluation of the effects of anchovy harvest on brown pelicans.	Ensure that commerical fisheries do not outcompete murrelets for forage fish.	Push-back from industries (potentially)	1.56	1.56	1.56	1.56		this seems to be a must-do, especially if MAMU are uplisted in ESA standing		
Marine Forage 1, 3, 4, 6	Restore estuaries.	Remove invasive plants. Preserving spawning grounds for important species such as herring. Conserve eelgrass and tideflats. Consider role of sediment transport and loading impacts on forage base.	A lot of opportunity, build off momentum being generated by NOAA and FWS emphasis on eelgrass and spawning area protection	Lack of data on fish use, there is not a lot we can do, location may not correspond with the best areas for MAMU. Technical challenges to removing invasive species. Hydropower issues related to sediment transport. Typically small and fragmented; hard to do something comprehensive.	2.33	2.56	2.44	2.44		not clear there would be a direct, rapid, and positive effect on MAMU	Good luck! Which estuaries do you have in mind?	
Marine Forage 1, 2,	Recover eulochon. Identify, protect, and recover spawning habitat.	Super high energy food source.	Don't know the extent of their occurrence or historic abundance. Used to be abundant, would recover two species at once.	Expensive. Might impact hydropower productions.	2.78	2.78	2.78	3.22		While it is true eulachon recovery must be addressed, to my knowledge, except during spawning, eulachon are distributed offshore and in deep-water habitat which is not, to our knowledge, used by MAMU.		
Marine Forage 1	Remove competitors (marine mammals).	Reduce competition with murrelets.	Reduce competition for forage fish.	Public relations. Would require an Act of Congress.	4.67	4.78	4.78	4.78		Scientifically, it is not apparent whether removing mammals would result in increases in MAMU reproductive success. Effects on forage fish in food web unknown.		
Marine Forage 1, 2, 3, 4, 5	Establish Marine Protected Areas, that include offshore forage fish production, nearshore foraging, and nesting habitat.	Protect key forage fish spawning, rearing, and holding habitat. Allow for more strategic planning. Siting of current Marine Protected Areas was probably not done with murrelets in mind. Forage fish productivity would increase. Consider alternative sources of funding such as in-lieu fee programs.	Protect and enhance forage fish production, allow for better siting of facilities for renewable energy and aquaculture, reduce adverse effects to forage fish and murrelets from anthropogenic stressors. Reduces direct mort due to fishing gear and practices; reduce competition w/ humans for forage fish	Could interfere with tribal U&As. Politically difficult. Law suits. Fishing, and recreational use opposition.	1.67	1.89	1.56	1.33				
Marine Forage 3, 6	Address climate change effects: Site bulkheads landward to account for potential climate change effects.	Preserve spawning area by pushing new construction back off beach.	Prepare for predicted changes. Prevents loss of spawning habitat with sea level rise.	Property rights. Private landowner concerns. Costly.	3.00	3.00	3.22	3.22		good idea but not necessarily of immediate benefit to MAMU	Sure thing, but MM don't have to the force behind this	
Marine Forage 3, 4	Evaluate impacts of dredging on forage fish production.	Negative effects on spawning habitat and migratory corridors, Columbia Rivers, Grays Harbor and Willapa Bay, throughout Oregon (Quilleute), SF Bay.	Increase forage fish productions.	Interfere with shipping/commerce.	3.11	3.11	3.22	3.11		could be very site- and species specific.		

Mechanism-Marine Forage Changes	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Mantua	Comments - Zamon	Comments - Ainley	Comments - Fiorello
Marine Forage 1, 6	Research exactly what murrelets eat. Consider continuing data collection from every murrelet collected for research. Keep in centralized database.	Distinguish from what they are eating now, and what they would be eating where forage is more abundant (or not sub-optimal). Fecal ring studies?	Connect murrelet populations with what is going on in the marine environment.	Feasibility; laboratory challenges regarding use of genetic markers; expensive	1.56	1.44	1.44	1.56				
Marine Forage 1	Implement alternative techniques for harvesting herring roe	Can spawn multiple times, could be alternative harvest techniques.	Protect energetically important prey source.		3.78	4.00	4.00	3.78		due to uncertainty in MAMU feeding habits, not clear this would result in positive effect for MAMU		
Marine Forage 1, 2	Identify and eliminate derby style fisheries.	Leads to overfishing.	Would prevent overfishing and monitor impacts.	Blow-back from fishers. Perception of regulatory impacts. Difficult to manage. Conflicts with Indian fisheries.	3.67	3.67	3.67	3.67			Huh? What does this have to do with forage fish?	
Marine Forage 1, 2, 3, 4, 5	Revise Marbled Murrelet Critical Habitat to include marine habitat.	Identify and designate marine habitat as part of murrelet critical habitat. Where murrelets spend the majority of the life.	Would contribute to identification of marine protected areas.	Marine resources users will object.	1.22	1.22	1.11	1.11		MAMU depend on ocean to survive. Scientifically, this seems a no-brainer.		
Marine Forage 1, 3, 4, 6	Conduct public outreach and education on the importance of a healthy marine forage base. Educate the public regarding effects of shoreline armoring.	A lot of people don't understand the value. Audobon Society and Pew Research are beginning efforts. Could partner with other agencies, NGOs. Would increase public support of habitat acquisition, restoration, and protection. Need to understand the implications for forage fish.	Help prepare for climate change impacts	Public perception.	2.33	2.33	2.33	2.33				
Marine Forage 4	Develop ways to reduce non-point source pollution impacts on forage fish.	Minimize impacts and increase forage fish survival, specifically prevent domoic acid poisoning.	Build on partnerships (Puget Sound Partnership); landscape level effort.		2.56	3.00	3.00	2.89				
Marine Forage 4	Minimize underwater sound impacts on forage fish in critical areas and at critical times.	Underwater sound impacts reduce forage fish numbers over relatively large spatial scales.	Protect forage fish spawning and holding.	Competing species conservation needs.	2.78	3.00	3.00	3.00				
Marine Forage 1, 2	Conduct fisheries sustainably. Prevent fisheries with 3-5 miles of murrelet foraging areas.	Foraging in the nearshore (out to about 3-5 miles), could make fisheries more sustainable by locating further offshore and by incorporating ecosystem-based strategies.	Provide for continued forage fish recruitment.	Fishers will be unhappy.	2.22	2.22	2.22	2.22		we do not know if prey depletion in MAMU habitat is a problem or not. Therefore, not clear whether this type of action would benefit MAMU.		
Marine Forage 1, 2	Manage competitive avian species by managing human fishery differently in areas where they compete with each other.	Murrelets are at a competitive disadvantage with other avian species (ex., murres and/or western grebes, pelicans)	Conserve murrelets and other birds by allowing more abundant prey species.	Many avian competitors are also decreasing.	4.11	4.11	4.11	4.11		not clear that bird-on-bird competition has anything to do with MAMU decline. Unlikely, in my opinion.		
Marine Forage 3,	Research the effects on non-native eelgrass of forage fish spawning.	Possibility of low reproductive success if eggs desiccate because non-native eelgrass grows at inappropriate depths.	Identify additional limiting factor for forage fish.		3.56	3.56	3.33	3.56			Research on eel grass/fish is extensive, though maybe not currently…go to library	
Marine Forage 2, 4	Understand the overlap of aquaculture/mariculture effects in murrelet foraging areas on forage fish and foraging murrelets	Spatial overlap with important foraging areas for murrelets and spawning areas for forage fish.	Protect both foraging areas for murrelets as well as spawning areas for forage fish.	Economic issues with aquaculature, especially at established facilities.	3.22	3.67	4.00	4.00		applies primarily in Puget Sound, WA estuaries, given my knowledge of where aquaculture efforst are		
Marine Forage 4,	Research effects of boat disturbance on foraging in foraging hotspots.	Frequent disturbance can cause foraging area abandonment and subsequent reproductive failure. Studies in AK on boat disturbance on Kittlitz's murrelets. Could feed into evaluations of marina placement.	Reduce energetic impacts. Lead to improved regulations.	Spatially difficult to isolate.	3.22	3.44	3.44	3.33				
Marine Forage 4	Protect kelp habitats. Reintroduce kelp and otters to improve ecosystem function.	Important nurseries and there is a historic decline.	Some examples already (N. Coast of Olympic Pennisula)		2.56	2.89	2.78	2.67		some FF species not dependent on kelp habitat (e.g. anchovy, sardine)	Hello? How about asking for the moon? Otherwise, what does kelp habitat have to do with mm?	
Marine Forage 1, 3, 6	State and Federal resource agencies can write letters to NOAA Science Center directors for NW and SW Fisheries Science Centers and the Pacific Fisheries Management Council supporting forage fish surveys and/or research	Issue is coming up in a number of fronts such as offshore energy development but there is no consistent coast-wide effort. Would inform efforts to designate important marine habitat. Coastal pelagic forage fish advisory council already in place – could partner.	Wouldn't take long; get size/class information; would inform reserve decisions. Would allow industry to proceed through management of shared marine resources. Forage fish population data would enhance commercially fished species management too.	Wading into politics.	1.11	1.11	1.11	1.11		no cost, potential high benefit, movements to support forage fish work already afoot.		
Marine Forage 4	Make spill response resources available in the event of a Harmful Algal Bloom (HAB).	Have been problems in getting resources because coordination and response systems were not in place. HABs are perceived as a "natural event" so oil spill response approaches don't typically apply.	Having plans and tools on hand in the event of a big event before it is too late. Early response could result in rehabilitation of murrelets and better monitoring.		3.11	3.11	3.22	3.11		important to look at any direct impacts to MAMU or food chain in area w/MAMU; events unpredictable, but potential knowledged gained from any effects on MAMU could be very useful		This is definitely an issue in CA, where we have excellent capactiy for dealing with marine wildlife disasters but can only activate system in the case of a petroleum spill.
Marine Forage 1, 6	Research life histories and species specific traits of forage fish.	As some species may be more valuable than others in terms of energetic value or availability at key times of year, there is value in looking at traits of particular species to know how they will respond to climate change.	Could inform conservation of energetically important species.		3.11	3.11	3.11	3.11		basic life history information needed to understand suite of potential prey in MAMU marine habitat.	done	
Marine Forage 4	Conduct efficacy monitoring of estuarine restoration projects and invasive species management.	Information could feedback into design of additional restoration projects.	Improve likelihood of successful restoration efforts		3.22	3.33	3.33	3.33		not sure this would result in short or medium term MAMU gains		

Mechanism-Marine Forage Changes	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Mantua	Comments - Zamon	Comments - Ainley	Comments - Fiorello
Marine Forage 1, 3, 4	Preserve and protect high quality terrestrial habitat adjacent to forage fish habitat.	Offset impacts to terrestrial habitat, improve liklihood of success of habitat conservation efforts, offset impacts to forage fish habitat, reduce energetic costs of commuting murrelets.	Protect terrestrial areas from development that would impair forage fish production; prioritize protection of habitat that is expected to be more beneficial due to proximity to foraging.	Habitat areas threatened with development and close to shorelines may have high predator activity. Known foraging areas likely moves.	**1.78**	**2.00**	**1.78**	**1.89**		related to Critical Habitat designation in Line 16 above		
Marine Forage 3, 4, 6	Map and preserve tidelands and eelgrass that provide forage fish spawning habitat.	Protect habitat for forage fish spawning by identifying eelgrass beds and tidelands. Allow for continued forage fish production. Increase resiliency of forage fish populations to climate change impacts.			**2.22**	**2.33**	**2.56**	**2.56**		forage fish most likely to be eaten by MAMU are not necessarily dependent on tidelands/eelgrass outside of Puget Sound/N. WA		
Marine Forage 1, 2	Increase forage opportunities with artificial reefs near high quality habitat.	Attract fish that could be potential prey.	Could bolster important forage fish populations.		**3.00**	**3.11**	**3.00**	**3.00**		until it is known which species MAMU feed on (reef-associated vs. pelagic), and how forage fish respond to reefs, not clear this would have positive impact	You mean, site ocean energy projects near to MM foraging areas?	
Marine Forage 1, 2, 3, 6	Use trawl surveys to research abundance of prey of certain size classes during the nesting season.	What are temporal changes in prey species size class as it relates to feeding nestlings.	Know whether fishing is reducing abundance of important size-classes of prey and whether it would be necessary to limit fisheries or alter mesh size of nets.		**1.78**	**1.78**	**1.78**	**1.78**		need to know what is out there as potential MAMU food	FWS needs to hire a fish biologists or a bird biologist with fish interest, i.e. in the John Piatt mode.	
Marine Forage 1, 6	Examine possibility of supplemental feeding of murrelets.	Provide food where it is now lacking and develop strategies to address future prey base issues.	Reduce energetic costs.	Logistically difficult.	**5.22**	**5.22**	**5.22**	**5.22**		impossible to measure in the wild - highly unlikely that you can "chum" MAMU in to feed; other predators just as likely to benefit from supplementation		
Marine Forage 1, 3, 4, 5, 6	Partner with existing efforts (Puget Sound Partnership; SF Bay Delta; Lower Columbia Estuary) and consortiums to raise awareness and find opportunities to share resources. May be able to access local governments. Use MOAs to formalize resource sharing committments.	Some efforts use murrelets as an indicator species. Raise murrelet issues in their forums to put murrelets on their radar screen. Can coordinate with salmon recovery objectives. Allows for identification of efficiencies	Issues are similar to many of the salmon recovery objectives and strategies (terrestrial and aquatic, watershed scale, etc.). Elevate mamu concerns. Procedural item but may produce substantial benefits. Can yield better access to funds	Murrelets are a relatively unknown to many of these groups.	**2.44**	**2.33**	**2.44**	**2.44**		many potential opportunities for partnership unexploited, especially on open coast of WA/OR		

Mechanisms (Conservation Zone(s) where this was high priority)

1. Existing and proposed removal of foraging fish also used by murrelet (3)
2. Commercial fishing: Loss of rock fish historic has been most severe south of OR border. Even though no current commercial fishery, recreational fishery may continue to have small impact. (4,5,6)
3. Degradation of spawning grounds of herring and smelt which has reduced populations of forage fish for murrelet.(4,5,6)
4. Large loss in natural shorelines, estuaries; High contaminant loads; Reduced herring abundance and reduced age structure in herring; Depleted rockfish populations; Large increases in pinnipeds; Other marine risks: derelict fishing gear, gill net fisheries, HABs (1,3,4)
5. Renewable energy development in murrelet marine habitat (e.g., wave, wind, tidal energy structures) (3) – this is a potential future issue in other zones, too
6. Climate variability effects on food webs in murrelet marine habitat (e.g., HABs, dead zones, El Nino) (2,3,4,5,6)

Mechanism-PostFledgling Mortality	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Post-Fledging Mortality - All mechanisms	Pursue creating a centralized database for these sources of mortality	Understanding the sources of mortality will help us to subsequently understand how to manage the sources	Easy access to data when it's needed	Expensive, difficult to do (logistically), involves a lot of people/agencies	2.11	2.11	2.11	2.11		so little is known that this would really be useful; with good outreach prior to a data call, it may not be as difficult as one thinks to get buy-in	
Post-Fledging Mortality - All mechanisms	Synthesize sources of mortality and the proportion of pop'n affected, ages affected		Ability to prioritize management strategies.	Availability of resources, may not be able to do anything about the mortality.	1.78	1.78	1.78	1.78	can be done with above		Several ideas are about understanding mm population dynamics better; requires research and modeling
Post-Fledging Mortality - All mechanisms	Test the assumption of whether or not post-fledging mortality is a driver for population dynamics	If it's not a problem, we need to know!	Helps figure out "how big a problem is this" and thus allocate resources better	Data intensive, need to do better monitoring, costs $$	2.11	2.11	2.11	2.22			
Post-Fledging Mortality - All mechanisms	How long do MMs live and what's the age-specific mortality? Figure out. Mark-recapture of known-age animals, follow their fates.	Helps test the hypothesis of "post-fledging mortality is an important to MMs", and knowing age structure of the population, which helps you to manage the population better	Better allocation of resources, better results from management	Hard to do, costly to do, in a long-lived population, it will take a long time. Different areas of the range will yield different results, so you'll need to test a lot of areas.	2.00	2.00	2.00	1.89			
Post-Fledging Mortality - All mechanisms	Integrate resources between fisheries people and wildlife people in terms of data		Reduces costs overall; increases coordination;	Competing objectives and methods would need to be fixed; complicated coordination/logistics	2.11	2.11	2.11	2.11		related to items in line 2-3 above	
Post-Fledging Mortality - All mechanisms	Explore what sources of mortality are operating on other seabirds. Hannah Nevins is doing a seabird mortality study, says Christine Fiorello.	May be able to gain some information about at-sea sources of mortality on seabirds	Gives some insights into that part of MM ecology (at sea mortality)	May be that other sources are unique to those seabirds and not to MMs; mostly you'll get better insight into marine ecosystems vs terrestrial ecosystems	2.89	2.89	2.89	2.89			
Post-Fledging Mortality - All mechanisms	What's the effective population size of murrelets (below what point does the adult population get too low) – couple with nest success and nest predation; can you use genetics to get at this? Demography and genetics don't get at the whole of this.	Help determine limiting factor to pop dyn	Used in determining the primary limiting factor to pop growth. Sets a critical lower limit for species (numbers) management.	Time intensive – requires modelling	2.89	2.89	2.89	2.78			
Post-Fledging Mortality - All mechanisms	Minimize activities that are known to have an adverse effect on MMs in the marine environment, e.g., altering shipping lanes	Avoid oiling birds during that vulnerable season			3.33	3.33	3.44	3.33	shipping lanes are only a problem when the ships come into the estuaries and rivers	high uncertainty here b/c little understood about post-fledging ecology	"Shipping lanes" are already 'offshore' unless you're talking about Puget Sound, in which case there's not much room.
Post-Fledging Mortality - Auto collisions/Predation-high human footprint	Reducing new road construction in murrelet habitat/Plan new roads outside of occupied habitat	Reducing mortality of birds due to collision	Reduces forest fragmentation and perforation; reduces poaching; reduces predation	Reduces forest management and forest fire response ability; resistance from public in areas that they want more access	2.56	2.33	2.44	2.89		some items related to habitat, better addressed under that	
Post-Fledging Mortality - Avian Predation	Concerted effort to study whether and how often peregrines and eagles are taking MMs and the subsequent impact on the population; work with raptor researchers to get this information – they may already have the information in their databases; not focus habitat acquisition in predator rich areas	Understand how such predation affects murrelet population dynamic	Not too expensive to mine current data bases; better understand interaction between raptors and MM	Conflicts among resource agencies, public perception when have two important species in competition; could be expensive to do added research; may cause impacts to raptors themselves, but this can be handled through study design	2.56	2.56	2.56	2.33		really appears to be major concern only in CA?	
Post-Fledging Mortality - Avian Predation	Document other species that may be predating murrelets	Would identify all of the agents of mortality	Expanding the support group to other entities that might be able to help reduce that stressor; if you know the agents, you can manage their habitat, too; if you investigated all predator influences, you'd understand how or if those predators are keying in on MMs in some manner	Expensive,	2.44	2.44	2.44	2.89		could be related to items in lines 2-3 above	
Post-Fledging Mortality - Boat collisions	reduce boat activity in fledgling period	fledglings respond more than adults, are sensitive to boats. Reduction in boat traffic/speed would reduce effects	would be beneficial to sensitive fledglings	reduce boat activity in fledgling period	3.56	3.78	3.78	3.67	marine reserves will help this in important areas		
Post-Fledging Mortality - Net entanglement (Derelict gear)	Outreach and incentives to fishermen regarding compliance with immediate recovery of lost gear	Reduce mortality of MMs and other seabirds	Direct way to reduce risk to MMs and side benefits to other seabirds	Expensive	2.44	3.11	3.11	2.89			
Post-Fledging Mortality - Net entanglement (Derelict gear)	Secure more funding and remove derelict nets and gear on a prioritized basis related to proximity to important foraging habitat.	Reduce mortality of MMs and other seabirds. Derelict gear may impact individual murrelets and forage fish populations. Removal is ongoing but could be prioritized based on murrelet foraging ecology.	Direct way to reduce risk to MMs and side benefits to other seabirds. Benefits are pretty immediate and long lasting. Coordinate with NW Straits Commission and others.	Expensive	2.11	2.89	2.89	2.56			

Mechanism-PostFledgling Mortality	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Post-Fledging Mortality - Domoic acid (May be due to agricultural runoff)	Stronger recognition of importance of buffers, including enforcement; incentives to place them on agricultural lands. Better regulation and enforcement of chemical runoff pollution.	Stems runoff; this is done in lots of places but enforcement not so much. There are regulations on these things, but better enforcement would reduce impacts	Reduce pollution affecting water quality, which may reduce domoic acid events; improves habitat for a lot of other species that may be interrelated to MMs; = rearing habitat for MM prey species; tax breaks through USFWS and state programs	Incentives can be expensive (or not: Riparian Heroes! Banquet). Private property rights issues; would involve multiple levels of gov't;	3.78	3.78	3.78	3.67	seems like a hard thing for USFWS to do	based on knowledge of DA problems in ocean, sincerely doubt this is major source of present mortality schedule	
Post-Fledging Mortality - Energy projects	Range-wide analysis of existing and planned inland and marine energy projects to determine cumulative and long-term mortality and demographic repercussions	Reduce mortality due to energy projects; maintain and increase MM pop's	This is unknown information – need to have cumulative, range-wide understanding of how all these work together to affect the MM population	Energy companies may be upset if it turns out their project is problematic ; green energy rage takes away from that momentum; confuses the public (but they need to be informed)	3.11	3.11	3.11	3.11		Recent result - Radar Ridge development halted b/c MAMU concerns!!!	
Post-Fledging Mortality - Energy projects	Use similar methods for modeling mortality estimates from interactions with energy projects	Everyone uses different models, can't compare results from the different models, can't compare project impacts	Consolidation of information on impacts	Regional differences in flight patterns, size of turbines, spacing, hours of operation, may confound the ability for us to do this	3.44	3.44	3.44	3.44			
Post-Fledging Mortality - Extreme weather events	Extreme events are expected to become more prevalent; ensuring those areas are protected, no deterioration of those areas; beached bird monitoring	Protecting birds during extreme weather events	Ensure protection of needed refuge areas will be protected; may be consistent with other efforts such as water quality protection	May not be needed; need more wintering season surveys to see where birds are holding; radio tracking could help find this out	4.67	4.67	4.67	4.67	if you were talking about forests and windthrow, that would be a higher priority	big unknown due to lack of info on winter ecology	
Post-Fledging Mortality - Misc.	Improve radio-telemetry technology for MMs; investigate causes of problems; use other bird species, not MM	Decreased mortality or impacts from MMs	We could really use the information that can be gained from doing more telemetry work, if only the birds didn't react so negatively.	Getting manufacturers to do the work; we don't know why the radios don't work; cost of failure is high for the bird; if we don't know what the problem is, could	2.67	2.67	2.56	2.56			
Post-Fledging Mortality - Impact pile driving	Implement impact hammer pile driving restrictions	to reduce problem with underwater sound; can kill birds underwater	reduce impacts to MM, especially during fledgling season	public outcry due to many existing restrictions for pile driving	3.11	3.67	3.67	3.67			
Post-Fledging Mortality - Misc	Explore other ways to monitor movements of MMs (other than telemetry)	Telemetry causes impacts to MMs that are unacceptable; other methods may be "friendlier"	Lower impacts to MMs as a result; information on movement; maybe less bias	Unknown; testing methods is expensive, time consuming,	3.11	3.11	3.11	3.11			
Post-Fledging Mortality - Net entanglement	Explore if gillnet fishery overlaps high forage concentration areas; consider restrictions and/or improved enforcement of fisheries in those areas. Institute seasonal restrictions	Decreased net entanglement of MMs and other seabirds		May not small impact if gillnet fishing is not prevalent; post-fledging mortality rate may be very low	1.78	3.11	3.22	3.44		I don't think this type of fishery is active in CA anymore??? Most gill-netting taking place in Puget Sound, Straits, some in WA/OR coastal estuaries for salmon	
Post-Fledging Mortality - Net entanglement	Put research/monitoring individuals on the boats – fisheries observers on each vessel; could use a proxy species to determine if MMs may be entangled	Can get a count of where and how often these events happen. Possibly reduce lethal impacts of gill nets on Mamu	Reduce impacts; fill data gaps. Could look at related species and see if there's a relationship between that species and MMs in terms of how often they're entangled	Expensive, trying to observe a very rare event; end up with wide confidence intervals. Logistics, politics. May not be effective. Not clear who is responsible.	2.56	3.44	3.56	3.56			
Post-Fledging Mortality - Net entanglement	Work w/ fishermen so that they don't toss away dead birds that they catch in their nets; education and outreach; incentives? Some of these go to the Burke Museum instead of to FWS, when they're part of the observer program. Also do stomach content analysis.	Get fresh specimens; understand what they're eating	Builds goodwill; disease and mortality data that are currently lacking, esp. when these will be fresh specimens. Understand more about what fish prey murrelets are eating	Time intensive, building trust which can take a lot of time, cultural resistance	1.89	2.00	2.00	2.00		Sea Grant in WA, OR, CA may be excellent mechanism for this type of work	
Post-Fledging Mortality - Oil Spills	Ensure there are spill response plans, personnel, and equipment in place in areas known to be heavily used by MMs	Especially an issue in remote areas, where equipment isn't often available	Currently not very well-coordinated; quicker response to events; may be able to prevent mortality by being able to respond quickly	Multiple agencies have responsibility over these; no one is definitively responsible for wildlife impacts, though in some states that authority/responsibility is sent down to the state agencies; expensive	2.22	2.11	2.11	2.22			
Post-Fledging Mortality - Oil spills	Document all other sources of MM mortality due to these events	Would identify all of the agents of mortality around these events; how many die due to this cause	Low cost, because can use existing data for oil spills; could use habitat as a proxy for #birds for other events	Other catastrophic events don't have data around them in terms of #s of birds; could be difficult to pull data together, because no centralized database	2.33	2.56	2.56	2.33			
Post-Fledging Mortality - Oil spills	Improve prevention of low-level pollutant discharge (laws are in place, but not enforced fully) – e.g., bilge water release, spills at fueling stations	Chronic issue; low level things like this rarely get reported, but the cumulative impact could be large	Could large, chronic impact at a large scale.	Difficult to monitor, takes a lot of personnel	3.11	3.22	3.22	3.00	seems like this would be a hard thing for USFWS to do		

Mechanism-PostFledgling Mortality	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Nelson	Comments - Zamon	Comments - Ainley
Post-Fledging Mortality - Oil spills	Decreased reliance on oil	Good for all species due to fewer oil spills	Fewer oil spills	Hard to do, expensive – constraints and costs, mindset change,	4.00	4.00	4.00	4.00		excellent way to prevent spills, but socially extremely difficult or impossible w/o alternative energey for vehicle, heating, other fuel needs	
Post-Fledging Mortality - Oil spills	Support research leases to understand effects from energy devices	Effects are unknown, and we need to know!	Fewer oil spills; maybe more alternative sources of energy - potentially lots of benefits	Analysis paralysis – some level of dislike for trying new things when don't know how they may affect species	4.22	4.00	4.00	4.00			
Post-Fledging Mortality - Oil spills	reinforce oil tankers (double hulling)	reduce chance of oil spills	reduce impacts of oil spills	costs a lot of money	3.89	3.89	3.89	3.89	seems like this would be a hard thing for USFWS to do, but the impact would be huge and positive	I think this is already in place….at least for most large US ports….	Double hulls already required along this coast, I believe
Post-Fledging Mortality - Oil spills, extreme weather events, impact pile driving, etc.	Employ a strategy for recovering dead MMs (utilize existing beached bird surveys), and then identifying sex and age of bird (sub-adult vs adult); make sure all are available for necropsy before specimens are frozen (in the case of holding them for oil spill cases); can use endoscope to sex; can pull feathers for other reasons; can tell age; NOAA has samples of pinniped stomachs, but those samples aren't analyzed for contents, more for energy – could get that info out of that data Beached bird surveys – getting information directly to them so that they can age them, at least; we (FWS) need access to those specimens to determine cause of death (like COASST and Oregon Coast Watch)	To determine causes of death. So we know what age of birds are lost to varieties of events	Better understanding of causes of mortality and/or ages of birds that are affected. Useful data could be the result, more information than we have now.	NRDA process issues, they're icky!, too icky and they're not useful for your needs, opportunistic and unreliable data at times, due to deterioration of the specimen. Surveys are sporadic, volunteer based, can get low quality data, poor handling techniques, chain of custody issues, need a permit to collect (which if under COASST, for example, they would have)	1.89	1.89	1.89	1.89		merge this with items in Lines 2 and 3	
Post-Fledging Mortality - Wind turbine strikes	Locate wind turbines away from occupied sites and flyways	Reduce bird strikes	Reduce mort rates, strikes; decreased energetic costs if birds are flying around these areas to reach nesting sites	Costs to wind company, lost opportunity; costs of re-siting;	1.89	1.78	1.67	2.00			
Post-Fledging Mortality - Collision	Design renewable energy strucutures to minimize impacts	Structural and siting modifications can be made (ex: type of structures, guy wires, and lighting) to reduce impacts.	Reduce collision risk.	Political pressure to support renewable energy efforts.	1.33	1.33	1.33	1.33			

Mechanism-Cumulative & Interactive Impacts	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Raphael	Comments - Nelson	Comments - Zamon	Comments - Ainley	Comments - Fiorello
Cumulative 2, 4	Conduct landscape-level assessments to identify highest quality marine and terrestrial habitats.	Increase species resiliency by guiding implementation and integration of terrestrial, marine, and estuarine conservation efforts. Needs to incorporate multiple governmental levels. Addresses habitat quality and development (e.g., stormwater)/forest harvest	Money can be leveraged; can tackle larger actions; complex problems benefit from collaboration; prioritize limited funds; improve competitiveness for grants, accomodate potentially important social attractant behavior, maintains public support	Scale – hard to get cooperation amongst so many players, hard to funs, could provide a disincentive by encouraging landowners to harvest, "kissing areas off" is a difficult trade-off, could be abandoning other areas, in zone 5 where there are few birds, may have better success at recovering populations where desities are small than where they are already high, requires careful application	1.56	1.56	1.56	1.56			understanding how MAMU are intergrating habitat use across marine/terrestiral boundaries is important.		
Cumulative 1,3,6	Integrate studies from AK to CA (including outside the listed range) to determine specific factors at work in each zone.	Improves our ability to prioritize actions that play a role in recovery.	Can better understand the relationships between stressors across the range and across populations?		2.33	2.33	2.33	1.78			synthesis may really aid in understanding, especially w/r/t figuring out whether different actions/approaches would be required for different zones	I thought that is what this exercise is about?	Important to keep in mind that the species appears to be declining even where it is not listed.
Cumulative 5,6,8,3	Study and apply results, when applicable, from surrogate species.	Expands our knowledge base and zone of influence.	Only way to address these mechanisms given the difficulty of studying murrelets.	Comparing nesting issues would be difficult since they are rather unique.	3.22	3.22	3.22	3.22	too many unkowns about efficacy of surrogate approach		potential to be good source of information on marine side of questions, less so in terrestrial\		
Cumulative 1, 2, 3, 4,6,7,8	Limit stressors in terrestrial habitat.	Manage stressors in terrestrial nesting such as expansion of campground, trails, roads, to reduce disturbance and predation, and to increase productivity. Reduce perforation into suitable habitat.	Could increase reproductive success in those habitats; more acceptance by managers due to less restrictions (carrot); help prioritize our efforts.	Difficult to achieve. Policing the public is difficult and would be unpopular. There are costs to moving roads (powerlines, etc).	2.44	2.56	2.56	2.44	too vague		low rank due to more specific actions being well-covered in other sections (e.g. terrestrial habitat, nest predation, etc.)		
Cumulative 2,3,6,	Recruit new habitat.	Manage all forests, not just known sites, for recruitment habitat, including keeping high quality habitat on the landscape. Improves connectivity between feeding and nesting sites.		Complex issues are difficult to address.	2.22	2.22	2.33	2.22			not specific enough to evaluate - what is meant by "recruit"?		
Cumulative 2,3,6	Reduce predation in Zone 6, or anywhere there are small populations.	Prevent perforation and predator attraction stressors. Will maintain existing populations by preventing predation caused by perforation/disturbance.			1.89	1.89	1.89	1.33	Reduce predation does not necessarilymean kill corvids	this is applicable to all zones	only applies to Zone 6	Needs to be more specific. Nest predation? Adult predation? You're going to kill peregrine falcons?	
Cumulative 2,3,6	Fund the Regional Fisheries Enhancement Working Group efforts in Washington and form groups in other states.	Increasing availability of foraging habitat. Example is work that the North Olympic Salmon Coalition group is doing to map forage fish spawning areas on the Olympic Peninsula.			2.56	3.00	3.33	3.56		see if it helps in WA then implement elsewhere	unclear how proposed mechanism would work outside of WA		
Cumulative 1	Reassess/Consider captive breeding programs.		Buffers against extinction in wild.	Doesn't address other stressors.	4.44	4.44	4.44	3.89			given catastrophic pop decline, seems that this is a must-try. No one had tried raising MAMU from egg yet; perhaps try w/surrogate species. Look to CA Condor work for models		
Cumulative 1	Determine IF murrelets are experiencing small population risks – and where.				3.00	3.00	2.67	2.22			isn't it well-established pops are at risk?		
Cumulative 1	Determine IF artificial platforms would be occupied			Could make it more attractive to predators if it were obvious;	3.56	3.56	3.56	3.22			might be way to enhance nesting, improve protection from predators		
Cumulative 1,2,4	"Market the murrelet" = outreach	More funding, more public support,			2.44	2.44	2.44	2.44			this will be necessary for both the public, but perhaps more importantly to other partnering agencies/organizations as well		
Cumulative 3,4,6,7	Manage nearshore areas to limit disturbance.	Restrict human activites in important nearshore areas. Change vessel traffic patterns in marine environment; e.g., close nearshore areas to vessels or slow them down and alter shipping lanes farther offshore.			2.44	2.67	2.78	2.78		related to marine reserve issue	hard to tie to positive effects on MAMU recruitment		
Cumulative 3,4,6	Close forest roads during nesting.	Change vehicle traffic patterns to minimize impacts on mamu; close forest roads during breeding season			3.22	3.11	3.00	2.67	this one repeats the one in nest predaion/fragmentation	might be most important in crowded parks; otherwise logging road traffic disturbance is minimal			
Cumulative 1,5	Research contaminant loads that may impact murrelets.	Collect contaminant loading data from murrelets and other related species.			2.00	2.22	2.33	2.22			would be good to know, given issues w/other top predators		
Cumulative 2,3,6	Research murrelet energetics and develop an energy budget.	Measure the energetic requirements of murrelets	Allows us to assess cumulative impacts; can look at other alcids for this (reduces costs)	Time, resource, and data intensive = expensive	3.11	3.11	3.11	3.11				pie in the sky	
Cumulative 1,2,4,7	Use LIDAR or assess habitat quality on the ground to validate habitat model.	Ground-truthing the habitat model would help identify areas that may be important for protection	Mamu are tied to platforms vs. stands; model doesn't tell you about trees/platforms	Very complicated	2.44	2.44	2.44	2.56		project underway by USGS in Oregon; same problem with satellite though…can't see platforms	Related to objective under terrestrial habitat		
Cumulative 2,3,6,7	Manage habitat and surrounding areas for resilience to fire and wind	Reduces the risk of habitat loss due to fire and wind			2.78	2.67	2.56	2.44		create buffers to existing occupied sites; but not thinning in or near occupied sites	Related to objective under terrestrial habitat	Something missing.	
Cumulative 3,7,8	Determine disease prevalence in murrelets.				3.22	3.22	3.22	3.11			difficult b/c requires handling birds		

Mechanism-Cumulative & Interactive Impacts	Brainstormed Action Idea	Rationale (how the idea addresses the mechanism)	Pros	Cons	1N Avg	1S-2N Avg	2S-4N Avg	CA Avg	Comments - Raphael	Comments - Nelson	Comments - Zamon	Comments - Ainley	Comments - Fiorello
Cumulative 1,2,4	Improve analysis of disturbance.	Would allow for identification of the disturbances that are biologically most important; update existing models; integrate visual disturbance.	Would allow for more strategic restrictions; some tools already in place; allow for focus on most important issues; improve buy-in from regulated community.	Difficult to assess.	**3.67**	**3.56**	**3.44**	**3.22**			a bit unspecific on what needs improvement		
Cumulative 8	Explore the idea of vaccination of mamu to WNV		Has already been done with a threatened species; can help maintain birds in zone 6 while habitat regrows.	Handling of thousands of murrelets.	**4.44**	**4.44**	**4.44**	**4.22**	don't know prevalence in first place		unclear whether WNV even a problem for seabirds; might need to explore that a bit more		
Cumulative 1,2,3,6	Assess vulnerability to foraging competition.	Identify how foraging competition might be minimized to target protection efforts where they'll have the most gain.		Difficult to assess due to changes in environment from year to year.	**3.56**	**3.56**	**3.56**	**3.56**			very difficult or impossible to measure b/c we known so little of MAMU foraging requirements AND MAMU are rare species (tiny sample size, little power to resolve competition)		
Cumulative 1,2,3,6	Model the cost-benefit ratio of nesting inland vs close to foraging habitat; coast vs. nesting inland to determine if increased risk of predation along the coast.		Can key on areas that give you the most return on your investment; allows for ID of potential recovery areas farther from the coast but within the modeled energetically viable range	Requires a grad student;	**2.44**	**2.44**	**2.44**	**2.44**			related to item on Line 2 above; potentially merge in that		
Cumulative 1	Uplist species from threatened to endangered.	Uplist portions (5,6, &1) or the entire range based on the urgency of threats.	Increases awareness of urgency for public	Cost at the expense of something else; slows review time within FWS.	**3.00**	**3.11**	**3.11**	**2.22**		at state and federal levels	seems like this is coming…		
Cumulative 3,4	Outreach to private landowners to reduce threats from use of roads (to limit disturbance from road use)		Less disturbance; increased cooperation and awareness	Decreased cooperation; link between that kind of disturbance and nest abandonment is weak.	**3.67**	**3.67**	**3.67**	**3.44**					
Cumulative 2,3,6	Establish high energy fish farms where we know murrelets forage.		Helps recovery eulachon.	Now we have hatchery eulachon.	**3.78**	**3.78**	**3.78**	**3.78**			other predators as likely to benefit as murrelets; not clear yet whether forage fish are limiting factor in marine environment		
Cumulative 1,7	Determine genetic differences	Zone 6: Santa Cruz birds may be genetically different.			**3.22**	**3.22**	**3.22**	**3.11**	Don't we already know this?	already done!	needed for making conservation/management decisions		

Mechanisms (Conservation Zone(s) where this was high priority)

1. Increased extinction risk due to small population size-demographic heterogenetiy/stochasticity (1,3,4,5,6).
2. Disconnect between high quality terrestrial and marine habitat in terms of lcoation/adjacency (lost productivity zones in some major estuaries (1,2,3,4)
3. Energetic, predation risk associated with commute between nesting and ocean habitat (1,2,3,4)
4. Increased disturbance both inland and/or at sea leads to increased physiological stress and reduced performance (sources of disturbance can include boat traffic, recreationists, vehicle traffic, etc. (1,2,3,4,5,6) – both marine and terrestrial disturbance are particular issues in Zone 1.
5. Contaminant loading increases vulnerability to disease, decreases fitness (1,2,3,4,5,6)
6. Energetic income probably decreasing due to reduced forage fish availability (1)
7. Behavioral/social stimuli needed for recruitment (4,5,6)
8. Potentail vulnerability to W. Nile Virus (1)

Appendix F

Marbled Murrelet Recovery Implementation Team

Data sets available:

- Santa Cruz Predatory Bird Group for data re: Distribution of Peregrines
- The table reviewed today is one of several. Gary Falxa knows where the others are. Also 3 people from the effectiveness monitoring team volunteered to add to the references at the end of what was distributed today.
- Seabird Survey (west coast since 1981, including aerial work, all oil spill surveys, etc.) Contact Glen Ford. He does the mortality assessments for oil spills.
- U.S. Navy Marine Resource Evaluation. Installing an underwater training range will be a great source of data when it's up and running. Underwater training range (Keyport, NWTR). Specifically: Key Port (2005-8) and NW Training Ranges (data collection started ± 2000).Craig has these.
- Mathias Leu Human Footprint Index GIS dataset. Includes components on corvids, available by web (ask Marty or Emily).
    - Similarly, the Eco Trust (Portland) has done work related to salmon that included a human footprint index
- Work by Halpurn, et al., Cumulative Impact Analysis re: human footprint and natural stressors in the marine environment.
- Bill Sydeman put together an atlas of at-sea birds, metadata available online (Jen).
- NMFS Puget Sound lower trophic level surveys. EPA-funded Casey Rice, Seattle. He also has long term data from the Skagit River Estuary.
- North Olympic Salmon Coalition beach spawning surveys
- Corvid distribution report (CA) Luke George, Humboldt U.
- Josh Adams @ USGS-CA. Aerial surveys, Coastwide of seabirds, mammals and turtles. He is also collecting other dataJen.
- NMFS SW Fisheries Science Center has long-term surveys of juvenile rockfish and other species, might be directly relevant to MAMU (Zach)
- SWSFC: Ocean salmon surveys from Newport, OR to San Fran. (Sean Hayes)
- Newport Line (Bill Peterson @ NWFSC). Oceanography plankton. This is already in Craig Strong's list in the NWFP.