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Assessing Management of Raptor Predation for Western Snowy Plover Recovery

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Cover photographs: (1) Adult male western snowy plover in breeding plumage, by Michael L. Baird, flickr.bairdphotos.com; (2) Adult female northern harrier preying on the eggs of a western snowy plover nest, by the Oregon Biodiversity Information Center.

Abstract

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On February 4, 2014, a seven-member expert panel provided objective technical information on the potential effectiveness and feasibility of activities to manage raptors (northern harriers and great horned owls) to aid the recovery of western snowy plovers. The panel discussed and scored the 26 raptor control techniques in nine main categories of habitat modification, exclusions, hazing, live capture and relocation, nest or egg depredation, lethal hunting and removal, conditioned taste aversion, avicides, and combinations of techniques. The panel also identified areas of information that could be useful to help trigger activities for managing raptor predation for western snowy plover recovery, including use of cameras to detect raptor predation events and behavioral patterns, determining thresholds of numbers of predation events, better understanding of raptor nesting timing and locations, and other topics.

Keywords: Western snowy plover, threatened species, raptor control, predation effects, expert panel.

Executive Summary

On February 4, 2014, a seven-member expert panel workshop was held in Portland, Oregon, to provide objective technical information on potential effectiveness and feasibility of raptor predation management activities for aiding recovery of western snowy plovers (*Charadrius nivosus nivosus*) along the Oregon coast, and to provide additional information on potential monitoring and further considerations of raptor control for snowy plover recovery. The Pacific coast population of the western snowy plover was federally listed as threatened on March 5, 1993 (USFWS 1993), under the Endangered Species Act 1973 (16 USC 1531 et seq.), as amended.

The panel discussed and scored the potential feasibility and effectiveness of 26 raptor control techniques in nine main categories of habitat modification, exclusions, hazing, live capture and relocation, nest or egg depredation, lethal hunting and removal, conditioned taste aversion, avicides, and combinations of techniques. Each of these categories is defined in this report and is considered a humane and acceptable form of raptor predation management. For example, the category "lethal hunting and removal" involves the use of live and artificial lures to produce movement and sounds that attract raptors to a selected location where they are subsequently shot.

The panel also identified information that could help inform management activities including use of cameras to detect raptor predation events and behavioral patterns, determining thresholds of numbers of predation events, better understanding raptor nesting timing and locations, and other topics. The panel also suggested raptor predation management needs such as conducting inventories of raptors and their nests, placing monitors in the field dedicated to raptor studies, and other topics on predator behavior and plover demography.

The panel assessed (scored) the potential effectiveness and feasibility of each of the 26 raptor control techniques for controlling the two primary species, northern harriers (*Circus cyaneus*) and great horned owls (*Bubo virginianus*). The techniques with the highest average effectiveness and feasibility scores for controlling northern harriers were lethal hunting/removal, combinations of techniques, dho-gaza net trap, and Goodell's cube trap; and the highest average effectiveness and feasibility scores for controlling great horned owls were lethal hunting/removal, combinations of techniques, Goodell's cube trap, and Swedish goshawk trap. Panelists often differed in their scoring of specific levels of effectiveness and feasibility, which was not unexpected, but the overall panel mean scores provide useful guidance.

The panelists also provided individual insights into the strength of evidence and areas of key uncertainty pertaining to the raptor control techniques, as well as on extenuating factors pertaining to corvid (i.e., American crows [*Corvus brachyrhynchos*] and common ravens [*C. corax*]) and raptor predation management,

such as considerations for cost, workload, information management, planning, and plover recovery goals. They also provided ideas on additional points of discussion, concerns, and suggestions for information gathering and shared their experience in the use of each raptor control technique.

The workshop was structured following the methods of Marcot et al. (2012) for eliciting expert knowledge in a panel setting, as has been successfully implemented in numerous projects. The Western Snowy Plover Expert Panel consisted of seven experts on the biology and ecology of the species, biology and ecology of raptors, and conservation planning and management of threatened and endangered species. Participants were drawn from federal and state wildlife agencies (U.S. Fish and Wildlife Service, Newport, Oregon; Animal and Plant Health Inspection Service Wildlife Services, Roseburg, Oregon; and the Oregon Department of Fish and Wildlife, Salem, Oregon) as well as nongovernmental wildlife institutions (Point Blue Conservation Science, Bolinas, California; Institute of Natural Resources, Portland, Oregon; Institute for Wildlife Studies, Arcata, California; and the High Desert Museum, Bend, Oregon).

Contents

Introduction

The western snowy plover (*Charadrius nivosus nivosus*) (figs. 1 through 3) is a small shorebird found in western North America. The Pacific coast population was listed as threatened under the U.S. Endangered Species Act (ESA) in 1993, and a recovery plan was published by the U.S. Fish and Wildlife Service (USFWS) in 2007 (USFWS 1993, 2007).

The Pacific coast population of the western snowy plover (hereafter, just "western snowy plover") extends from the state of Washington to Baja California, Mexico, with most breeding birds found in California. Predation by increasing populations of generalist predators, including American crow (*Corvus brachyrhynchos*), common raven (*C. corax*), red fox (*Vulpes vulpes*), and coyote (*Canis latrans*) at coastal beaches is one of the primary threats to the western snowy plover (USFWS 1993). A comprehensive predation management program was established in 2002 (USDA and USDI 2002) to protect western snowy plovers where predation threatens their survival and reproductive success.

Other suspected predators found to pose a threat to western snowy plovers, including raptors, have been considered in predation management planning (USDA and USDI 2002). The decision framework for raptor control requires resource managers to evaluate the magnitude of the threat and define a specific plan of action on a case-by-case basis. The raptor control decision framework, therefore, relies on expertise and capacity in the fields of raptor biology, ecology, and management, for which the Western Snowy Plover Working Group sought additional expertise. High levels of egg predation by northern harriers (*Circus cyaneus*) (figs. 4 and 5) during the 2013 breeding period (Psiropulous and Burrell 2013), and suspected predation

Figure 1—Adult male western snowy plover in breeding plumage. Photograph credit: Michael L. Baird, flickr.bairdphotos.com.

Figure 2—A brood of three recently hatched western snowy plover chicks. The legs of western snowy plover chicks are nearly fully grown when they hatch and can be safely banded at this stage in their life cycle. Photograph credit: Kathleen Castelein, Oregon Biodiversity Information Center.

An expert panel provided information on raptor predation management to help in the recovery of western snowy plovers.

by great horned owls (*Bubo virginianus*) (fig. 6), highlighted a need to better clarify and communicate response procedures concerning predation by raptors.

In 2014, we convened a Western Snowy Plover Expert Panel workshop to provide technical information to further develop a decision analysis framework for informing USFWS and its conservation partners specifically about raptor predation management as part of this integrated predator management program. The workshop's objectives were to (1) provide expert knowledge and advice on the efficiency and feasibility of management techniques as part of western snowy plover recovery activities, and (2) identify and prioritize needs for data collection and especially analysis of existing data sets, for aiding real-time monitoring of raptor impacts on western snowy plovers and help trigger potential management activities.

Figure 3—A three-egg western snowy plover nest. Nests consist of a shallow scrape or depression on the surface of the beach, and are sometimes lined with shell fragments, plant debris, small pebbles, and other beach debris. The nest lining tends to increase as incubation progresses. Photograph credit: Daniel Elbert, U.S. Fish and Wildlife Service.

Figure 4—Adult female northern harrier preying on the eggs of a western snowy plover nest. This photo was captured using a motion-sensitive nest camera (Reconyx PC900 Hyperfire). Photograph credit: Oregon Biodiversity Information Center.

Figure 5—Failed nest resulting from predation of three western snowy plover eggs by a northern harrier. Photograph credit: Joseph Metzler, U.S. Fish and Wildlife Service.

Figure 6—Great horned owl on day roost in a Douglas-fir tree. Photograph credit: Bruce Marcot.

The expert panel evaluated feasibility and effectiveness of raptor predation management that could occur at any active breeding or nesting site along the Oregon coast (figs. 7 through 11). These currently include Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, Coos Bay North Spit, Bandon, New River, and Floras Lake. Sites are located on lands managed by the U.S. Department of the Interior Bureau of Land Management, USDA Forest Service, Oregon Department of Fish and Wildlife, Oregon Parks and Recreation Department, and U.S. Army Corps of Engineers, as well as some private lands. Current sites in Oregon are located in Lane, Douglas, Coos, and Curry Counties.

Figure 7—Aerial view of the Western Snowy Plover Habitat Restoration Areas at Coos Bay North Spit, Coos County, Oregon. Photograph credit: Bill Bridgeland, U.S. Fish and Wildlife Service.

Figure 8—Ground-level view of a western snowy plover habitat restoration area. Photograph credit: Daniel Elbert, U.S. Fish and Wildlife Service.

Figure 9—Example of a Carsonite sign placed near the boundary of a western snowy plover nesting area to inform the public of recreation access restrictions during the western snowy plover breeding period. Photograph credit: Bruce Marcot.

Figure 10—Symbolic fencing (ropes and signs) placed around the dry sand portions of beaches during the western snowy plover breeding period on beaches where an abundance of western snowy plovers actively nest. The symbolic fencing informs the public about the presence of nesting western snowy plovers, as well as recreational use and access restrictions intended to reduce disturbance to the birds. Photograph credit: Bruce Marcot.

Figure 11—Western Snowy Plover Expert Panel evaluating effectiveness and feasibility of raptor control techniques. Photograph credit: Laura Todd, U.S. Fish and Wildlife Service.

Although this report is aimed at aiding recovery of western snowy plovers along the Oregon coast, the information provided herein is general to the degree that it could also inform potential management of raptor predation on the species elsewhere within the species' range along the U.S. Pacific coast (fig. 12). Results of the workshop presented here are descriptive and not intended to be prescriptive. Information from the workshop will be used later by USFWS in a structured decision analysis as one facet of western snowy plover recovery.

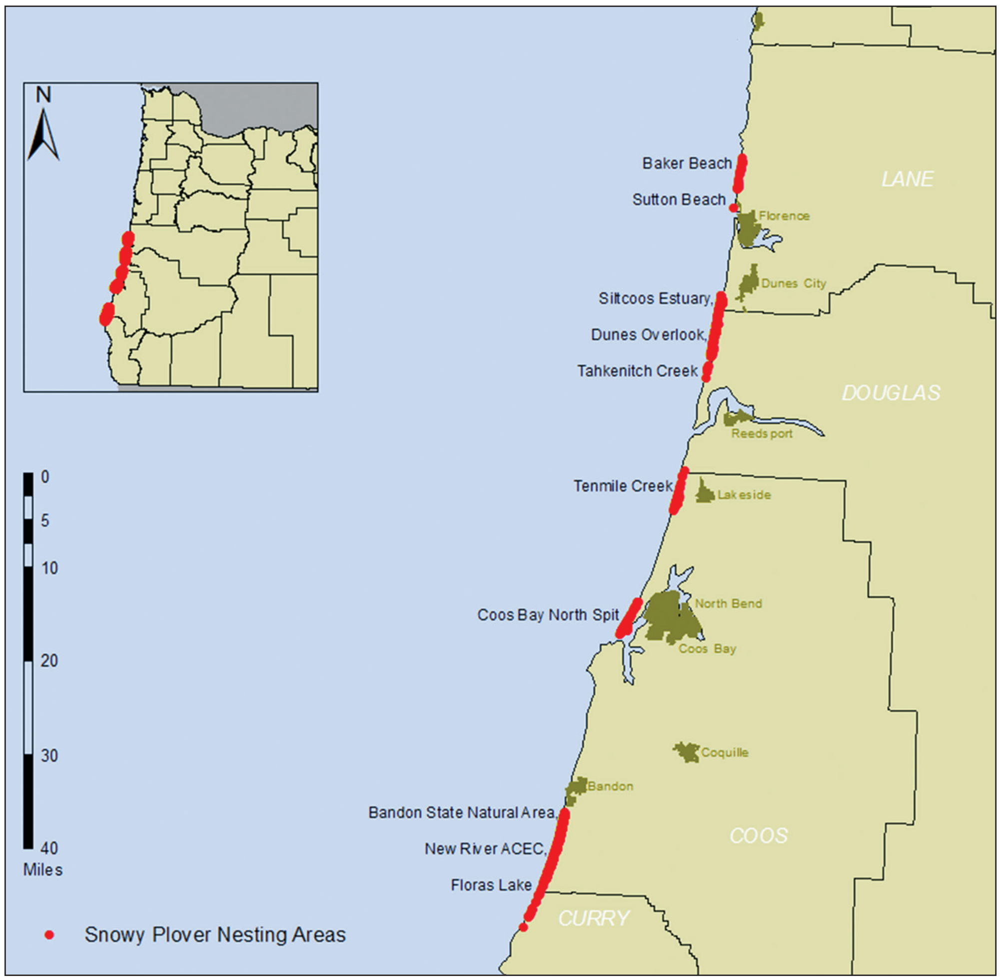

Figure 12—Active breeding and nesting sites of the federally threatened Pacific coast population of the western snowy plover along the Oregon coast.

Workshop Methods, Agenda, and Attendees

Workshop Extent and Participation

The Western Snowy Plover Expert Panel workshop was held over the course of one day and consisted of seven invited panelists with various expertise in western snowy plover biology, ecology, and management; raptor ecology and management; and other topics such as recovery planning for threatened and endangered species (fig. 13). (The letters of invitation sent to prospective panelists as well as to workshop observers are presented in app. 2, and the list of workshop attendees including the expert panel participants and workshop observers is presented in app. 3.)

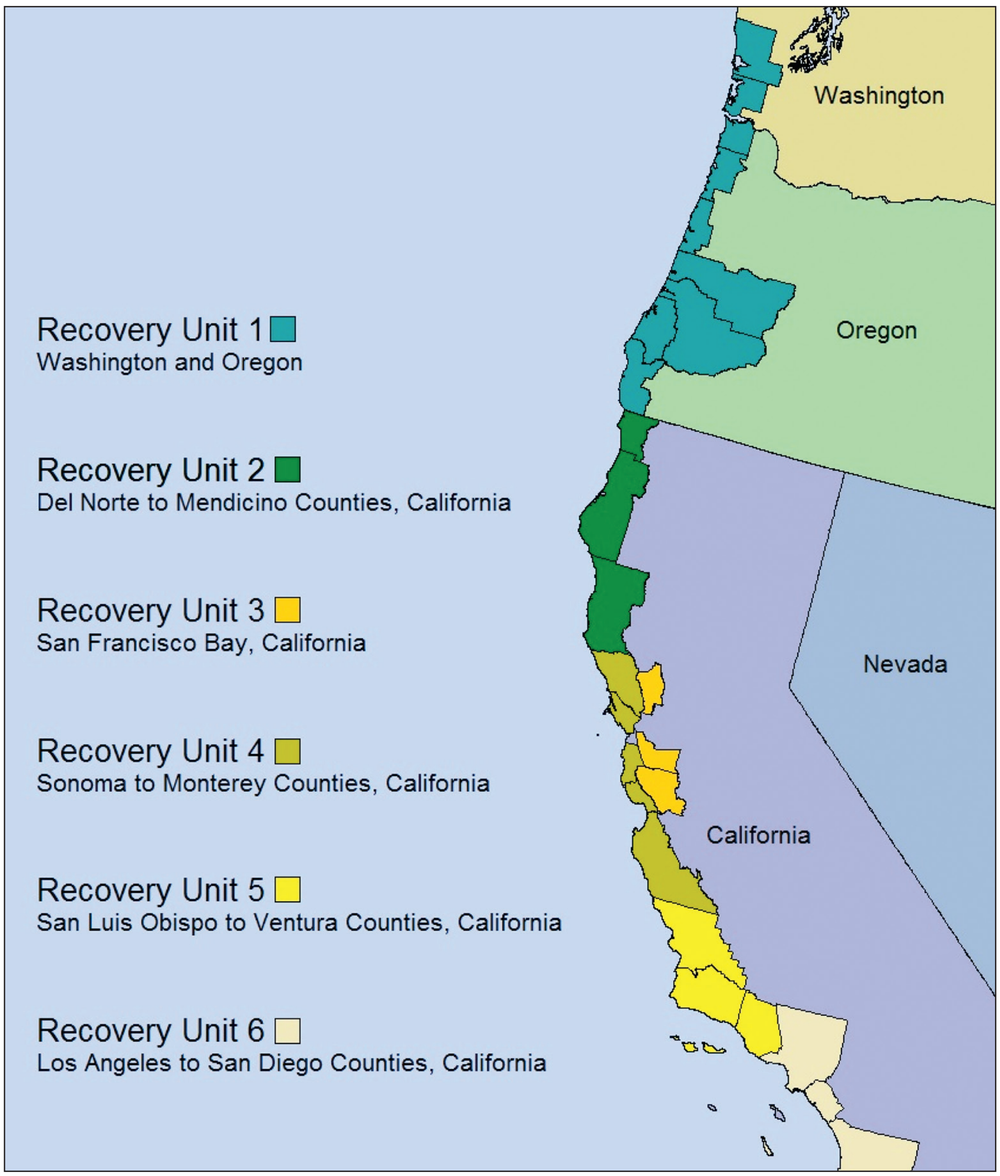

Figure 13—Range of U.S. Fish and Wildlife Service Recovery Units for the federally threatened Pacific coast population of the western snowy plover.

The Western Snowy Plover Expert Panel workshop followed rigorous procedures to elicit knowledge.

Overall Workshop Structure

The panel workshop was structured following procedures of Marcot et al. (2012) that were previously successful for addressing issues of recovery and reintroduction of threatened and endangered species. These paneling procedures use a modified Delphi expert panel approach, wherein panelists are guided through discussions, brainstorming sessions, and a structured impact-scoring process. The modified Delphi approach provides for equal sharing and learning among panelists, but retains their individual and independent contributions so as to determine similarity or differences in knowledge and judgment among the experts, rather than forcing consensus that would mask individual variations.

Ensuring Knowledge Parity

Each panelist was sent a set of preworkshop reading materials (app. 4) to ensure that all panelists reached "knowledge parity," that is, each panelist had exposure to the same suite of information. These reading materials included information on western snowy plover management, monitoring, recovery, and data availability; potential management techniques; and the intended workshop agenda, discussion topics, and expert paneling procedures. At the start of the panel, to further ensure knowledge parity among all panelists, D. Elbert provided a presentation on the western snowy plover's ESA listing, threats to the species, recovery objectives and activities to date, monitoring data being gathered on the species, sources of nest failure and predation, and types of raptor predation management and control techniques (apps. 5 through 8).

As part of the initial presentation, a flowchart was presented that denoted the role of the expert panel in the overall organization of western snowy plover planning (fig. 14). This was intended to help panelists better understand that they were to provide scientific and technical information, not to specifically advise on or direct management or planning actions per se.

Panel Topics

Panel topic 1 on identification of information for raptor predation management— The workshop agenda (app. 1) then covered three main topic sessions posed to the panelists. Topic 1 pertained to guided panel discussions and brainstorming of raptor predation and was broken into two subtopics: (1) identification of a suite of information that would be useful to generate real-time monitoring indices of raptor predation behavior and impacts on western snowy plovers, to help trigger potential management activities; and (2) suggestions for new data that could be collected to enhance the real-time monitoring indices of raptor impacts, and additional monitoring and research topics. The suggested priority of each item identified in both of the topic 1 sessions were rank-ordered by the panelists; thereafter, we calculated mean priority scores among the panelists and then sorted the themes by decreasing priority.

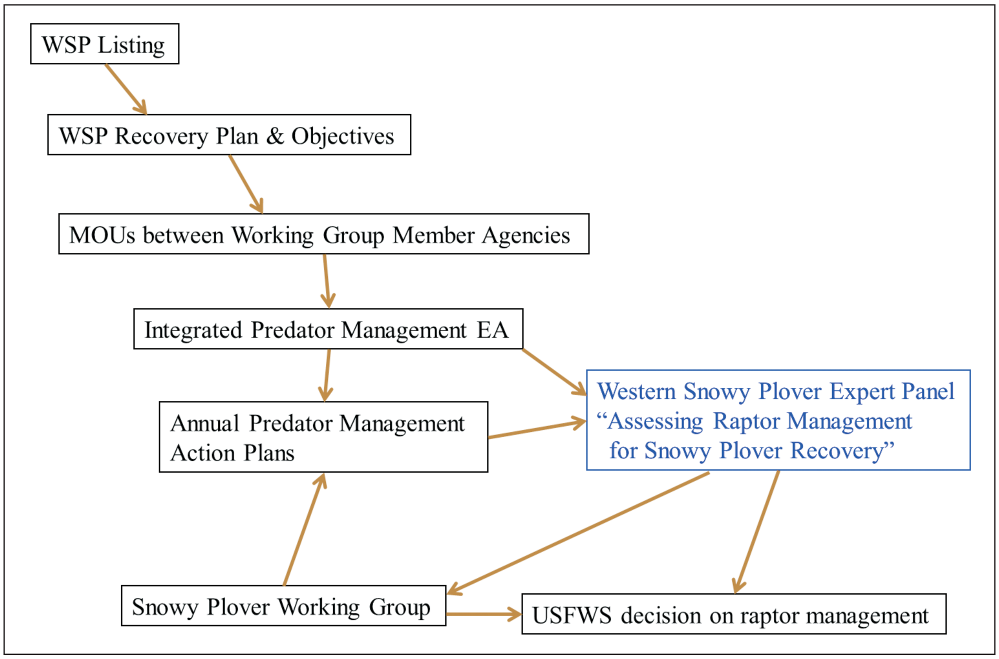

Figure 14—Organization of western snowy plover recovery planning; WSP = western snowy plover; MOU = memorandum of understanding, EA = environmental assessment; USFWS = U.S. Fish and Wildlife Service.

Panel topic 2 on scoring raptor predation management techniques—
Topic 2 pertained first to listing a suite of potential raptor predation management approaches, then having the panelists score the degree to which each approach would be effective and feasible, in particular for two species known to be the main raptor predators of western snowy plovers along the Oregon coast: northern harriers and great horned owls. To do the scoring, each panelist was asked to spread 100 points across one or more of five categories denoting degree of effectiveness (completely ineffective, mostly ineffective, partially effective, mostly effective, and completely effective) and 100 points across one or more of five categories denoting degree of feasibility (completely infeasible, mostly infeasible, partially infeasible, mostly feasible, and completely feasible) (see app. 6 for definitions and app. 7 for the score sheet used). Spreading points across two or more categories allowed the panelists to express their degree of uncertainty in how effective or feasible each management technique could be. In cases when a panelist had no knowledge of a technique, each was instructed to score it as total uncertainty (equal score values across all categories of feasibility or effectiveness).

Two rounds of scoring were conducted, each in silence. After the first round, the panelists each engaged in guided disclosure of their scores and their rationale, allowing other panelists to learn from their thinking and to ask questions. The second and final scoring round also entailed having panelists document in writing their rationale for the scores and what they considered to be key uncertainties, unknowns, and data needed (app. 7). After the second round of scoring, we gathered their score sheets and written documentation and later entered their scores into a database to determine patterns and trends. We also had their written documentation on rationale and uncertainty transcribed and compiled into one document file.

Each panelist had been initially and randomly assigned a code letter (A, B, C, D, E, F, or G) which they noted on all their written forms and score sheets, in lieu of their names. The purpose was to keep individual identities anonymous, thus allowing panelists to feel at ease in offering their expertise without worry of later individual attribution.

Panel topic 3 on further considerations—

In the third and final portion, panelists provided their ideas on any extenuating factors that might be considered if raptor predation management were to be part of western snowy plover recovery activities. Such factors could include considerations for cost, personnel and training needed, stakeholder participation, public reaction, or any other concern, all of which were summarily not to have been considered during their topic 2 scoring of efficiency and feasibility of management techniques.

Panel closeout and next steps—

At various points during the day, we also provided opportunities for invited observers to offer their ideas, perspectives, and questions. We ended the panel with a general discussion of how the panelists' information could be used to inform a decision process in USFWS on raptor predation management for western snowy plover recovery. We also secured the day's notes taken by our two scribes, who recorded much of the panelists' discussions (without attributing specific names to each comment); we then sent the transcribed notes to the panelists for any corrections.

Results

Raptor Predation Management Techniques Addressed

The set of management techniques discussed and scored by the panel fell into nine main categories, some with a number of subcategories, as follows (not listed here in any order of priority): (1) habitat modification; (2) exclusion (figs. 15 through 17); (3) hazing, including use of pyrotechnics, lasers, electric pole shockers, and scarecrows and bird diverters; (4) live capture and relocation, which included variants on noose traps (bal-chatri, phai, verbail, noosed lure, and barak), net traps (bow-net, dho-gaza, net launcher, and Goodell's cube trap), and permanent structures (Swedish goshawk trap and modified Australian crow trap) (e.g., figs. 18 and 19); (5) nest/egg depredation; (6) lethal hunting/removal; (7) conditioned taste aversion; (8) avicides (fig. 20); and (9) combinations of any of the above techniques. After preliminary review and discussion of categories and subcategories initially presented, the panelists chose to add five techniques (net launcher, Goodell's cube trap, conditioned taste aversion, avicides, and combinations of techniques), resulting in the full set of nine main categories listed here. Each of these categories and techniques is defined in appendix 5, and each is considered a humane and acceptable form of raptor predation management (Bloom et al. 2007, Hygnstrom and Craven 1994). For example, the category "lethal hunting and removal" involves the use of live and artificial lures (figs. 18, 19, and 21) to produce movement and sounds that attract raptors to a selected location where they are subsequently shot.[1]

Figure 15—Large exclosure being installed around an active western snowy plover nest for protection against predators. Photograph credit: David Lauten, Oregon Biodiversity Information Center.

Figure 16—Medium exclosure protecting an active western snowy plover nest from predators. Photograph credit: Daniel Elbert, U.S. Fish and Wildlife Service.

Figure 17—Mini predator exclosure surrounding the nest bowl of a recently hatched western snowy plover nest. Photograph credit: Peter Knapp.

Figure 18—Setting up a self-triggering bownet with a white mouse lure for live capture of northern harriers. Photograph credit: Daniel Elbert, U.S. Fish and Wildlife Service.

[1] In this report, "hunting" refers to this particular method of attraction and dispatch as part of a predator control technique, and not to public sport hunting.

Figure 19—Bownet trap set with white mouse lure. Photograph credit: Daniel Elbert, U.S. Fish and Wildlife Service.

Figure 20—Chicken egg treated with compound DRC-1339 (3-chloro-p-toludine hydrocholoride), which is a restricted-use avicide and is registered for control of common ravens (*Corvus corax*) and American crows (*C. brachyrhynchos*). Photograph credit: Jeremiah Psiropolous, Animal and Plant Health Inspection Service, Wildlife Services.

Figure 21—Adult male northern harrier successfully captured by Micah Bell, wildlife specialist with the Animal and Plant Health Inspection Service, Wildlife Services, using a self-triggering bownet trap with white mouse lure. This harrier was targeting western snowy plover nesting areas while hunting and had preyed on numerous western snowy plover eggs prior to being trapped. Photograph credit: Joseph Metzler, Animal and Plant Health Inspection Service, Wildlife Services.

Panel topic 1 on identification of information for raptor predation management— The panelists collectively identified 25 areas of information that would be useful to generate monitoring indices designed to help trigger raptor predation management for western snowy plover recovery (table 1). On average, their top priority areas pertained to communication and information gathering on predator behavior, specifically (1) communication between monitors and Wildlife Services; (2) the use of cameras to detect predation events associated with raptors, determine behavioral patterns associated with predation events, and increase the frequency of such observations; (3) determining thresholds of the number of predation events that would trigger a management action; and (4) better understanding of raptor nesting phenology and location of raptor nests. A number of other information categories also ranked relatively high as suggested priorities.

The panelists also identified 21 categories of new data that could be collected to help enhance monitoring indices for triggering potential management actions (table 2). The top priorities pertained again to predator study—conducting a breeding raptor inventory and survey to map their nests, and establishing in-field monitors dedicated to raptor studies. Other high-priority topics also pertained to predator study as well as to specific data to gather on aspects of plover demography.

The Expert Panel identified key information needs for monitoring raptor predation effects on western snowy plovers, and evaluated techniques for managing predation by northern harriers and great horned owls.

Panel topic 2 on scoring raptor predation management techniques— Means and variations in the panelists' scores of effectiveness and feasibility of management techniques for northern harriers and great horned owls are presented in figures 22 through 25.

For northern harriers (fig. 22), the techniques that the panelists, on average, scored high (at least 40 percent of mean score points) as completely effective or mostly effective included (in decreasing order of scored effectiveness): lethal hunting/removal, combinations of techniques, dho-gaza net trap, nest/egg depredation, and Goodell's cube trap. Some 19 techniques were scored high (at least 40 percent of mean score points) for feasibility; of these 19, the highest scored (at least 60 percent of mean score points) techniques for feasibility were (in decreasing order of scored feasibility): lethal hunting/removal, bal-chatri noose trap, dho-gaza net trap, combinations of techniques, bow-net trap, net launcher, and Goodell's cube trap. Thus, the techniques that seemed to score the highest for both effectiveness and feasibility against northern harriers were lethal hunting/removal, combinations of techniques, dho-gaza net trap, and Goodell's cube trap. However, the panelists often differed widely in their specific scores. For the techniques scoring the highest for effectiveness and feasibility, disagreement of scores among the panelists ranked mostly medium to high (fig. 23) which, however, was generally the case among most categories of techniques.

Table 1—Results of panel brainstorm discussion on information that would be useful to generate monitoring indices to help trigger raptor predation management for western snowy plover recovery[a]

		Priority rank by panelist									
Information	Theme	A	B	C	D	E	F	G	Sum	Mean	Range[b]
Communication between monitors and Wildlife Services	Communication	1	1	1	1	1	1	1	7	1.0	0
Use cameras to explore predation problems and to trigger a management response, e.g., to determine predator reactions to exclosures and predator behavior	Predator behavior	1	1	1	1	2	1	1	8	1.1	1
Determine thresholds of number of predation events that would trigger an action	Predator behavior	1	1	1	2	1	1	1	8	1.1	1
Increased frequency of observations, with cameras	Predator behavior	1	1	1	1	2	1	1	8	1.1	1
Understand better raptor nesting phenology; locate raptor nests	Predator phenology	2	1	1	1	1	1	1	8	1.1	1
Densities of plovers—number of nests/unit area	Plover abundance	2	1	2	1	1	1	1	9	1.3	1
Develop demographic models of plovers to determine when raptor predation management may be necessary; helps determine compensatory vs. additive predation	Plover demography	1	1	2	2	1	1	1	9	1.3	1
Monitor raptor nests closely re: phenology of young production, for deciding on egg removal	Plover phenology	2	1	1	1	2	1	1	9	1.3	1
Camera use: trail cameras and video cameras	Predator behavior	1	2	1	1	2	1	1	9	1.3	1
Continue and expand camera observations to determine unknown predation sources	Predator presence	1	1	1	2	2	1	1	9	1.3	1
Measurement of plover response to predator removal	Plover production	3	1	2	1	1	1	1	10	1.4	2
Determine, for a given site, plover numbers, productivity, or density that could be a threshold for predator incursion	Plover abundance	2	1	2	1	1	3	1	11	1.6	2
Predator use of a site; determine predator behavior	Predator behavior	2	2	2	1	2	1	1	11	1.6	1

Table 1—Results of panel brainstorm discussion on information that would be useful to generate monitoring indices to help trigger raptor predation management for western snowy plover recovery[a] (continued)

Information	Theme	Priority rank by panelist							Sum	Mean	Range[b]
		A	B	C	D	E	F	G			
Correlate plover phenology and raptor phenology to determine when to take action	Predator phenology	1	2	3	1	2	1	1	11	1.6	2
Develop a list of raptor species in advance and their susceptibility to being trapped, removed, relocated, finding their nests, etc.	Raptor ecology	2	2	1	1	1	2	2	11	1.6	1
Raptor nesting status phenology	Raptor phenology	2	2	1	1	2	2	1	11	1.6	1
Plover brood survival, weekly	Plover phenology	1	1	2	1	2	3	2	12	1.7	2
Employ info weekly on predator presence	Predator phenology	1	2	3	1	2	2	1	12	1.7	2
Determine predator diets and diet ecology	Predator behavior	2	2	2	2	1	2	2	13	1.9	1
Track numbers of predators by species intensively throughout to determine predator replacement and turnover within the season	Predator behavior	3	1	2	2	2	2	1	13	1.9	2
Identify individual problem predators—possibly mark individuals	Predator presence	3	2	3	1	2	1	1	13	1.9	2
Identify alternative prey being taken by predators	Predator behavior	3	2	2	2	1	3	2	15	2.1	2
Timed scan / survey to record predators observed or track occurrence—predator species and numbers	Predator presence	1	1	3	2	3	3	2	15	2.1	2
Small mammal surveys as prey for raptors	Prey ecology	3	2	3	2	1	3	3	17	2.4	2
Avoiding decisions based on raptor behavior	Predator behavior	3	3	3	3	1	3	2	18	2.6	2

[a] Items are sorted by decreasing mean priority (= increasing mean scores).
Priority ranks:
1 = essential.
2 = important but not necessarily essential.
3 = worthwhile but of lower importance.
[b] Range = the difference between the maximum and minimum score values across the panelists; this is a simple indicator of the degree to which all panelists agreed (low range values) or disagreed (high range values).

Table 2—Results of panel brainstorm discussion on new data that could be collected to enhance monitoring indices to help trigger raptor predation management for western snowy plover recovery, and suggestions for additional monitoring and research topics

		Priority rank by panelist									
Data, monitoring, and research	**Theme**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Sum**	**Mean**	**Range[a]**
Breeding raptor inventory and survey to map nests; best time is during raptor hatchling/fledgling period; 2-mi buffer of snowy plover site and within each site	Predator study	1	2	1	1	1	1	1	8	1.1	1
Need raptor monitors dedicated to raptor studies; seasonality depends on techniques to employ, probably early in the season as augmenting Wildlife Services	Predator study	1	2	1	1	1	1	1	8	1.1	1
Search for raptor nests; consider using volunteers, bird observers	Predator study	1	2	1	1	1	2	1	9	1.3	1
Determine how harriers respond to exclosures; determine their behavioral response; via use of cameras at nests with and without exclosures	Predator study	1	2	1	1	2	2	1	10	1.4	1
For monitors, gather the evidence as images of tracks, information that pinpoints a particular predator species, in part to educate others making management decisions	Data	2	2	1	1	1	2	1	10	1.4	1
Do a camera study to determine predator behavior around plover nests	Predator behavior	2	1	1	2	2	1	2	11	1.6	1
Compare information on harriers and exclosures with other states	Data	2	2	1	1	2	2	1	11	1.6	1
Use video recordings of nest area to identify unknown predator	Predator study	1	2	1	1	2	2	2	11	1.6	1
Do a population viability analysis of plovers to determine which life stage is most sensitive to perturbations	Plover demography	3	2	2	1	2	1	1	12	1.7	2
Tracking movements of raptors that are translocated	Predator study	1	1	2	1	2	3	2	12	1.7	2
Analyzing current data on site-specific hatch and fledgling rates, determine mean rates (past 5 to 10 years), to compare productivity of sites	Plover demography	3	2	2	1	1	3	1	13	1.9	2
Marking raptors in the area to determine problem individuals	Predator study	3	1	3	2	1	1	2	13	1.9	2

Table 2—Results of panel brainstorm discussion on new data that could be collected to enhance monitoring indices to help trigger raptor predation management for western snowy plover recovery, and suggestions for additional monitoring and research topics (continued)

		Priority rank by panelist									
Data, monitoring, and research	**Theme**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Sum**	**Mean**	**Range[a]**
Determine, map raptor use of the area; GIS; determine spatial and temporal use and overlap of use among multiple predators; can help to find nests as well	Predator study	2	1	3	2	2	3	1	14	2.0	2
Framework for monitoring raptors and their prey at plover sites, in a formalized and integrated protocol that would be repeated at different sites, e.g., once every 3 years	Framework	2	1	3	2	1	3	2	14	2.0	2
Literature review and field survey to determine harrier habitat suitability, to determine habitat modification to lessen habitat suitability	Predator study	3	2	2	1	2	2	2	14	2.0	2
Determine how habitat modification actually influences raptor habitat use or non-use; via telemetry	Predator study	3	1	2	2	3	1	2	14	2.0	2
Look at small mammal densities over time, cf. harrier densities over time; determine episodic nature of harrier occurrence	Predator study	2	2	3	2	1	2	2	14	2.0	2
Put up raptor perches with cameras before the season starts to identify frequency of raptor occurrence and species presence	Predator study	2	2	3	2	2	3	2	16	2.3	1
Do trapline survey of rodents; Sherman traps, March–August, regular interval; mark-recapture	Predator study	3	2	3	2	1	3	3	17	2.4	2
Telemetry of individual predators to determine predator nests and to track how they use a site for feeding	Predator study	3	2	3	3	3	1	2	17	2.4	2
Correlate weather/rainfall and vegetation, to track raptor activity and impact on plovers, to determine correlations with weather patterns, and to ascertain predictability of raptor behavior and occurrence as a function of weather and vegetation	Predator study	2	2	3	2	3	3	2	17	2.4	1

[a] Range = the difference between the maximum and minimum score values across the panelists; this is a simple indicator of the degree to which all panelists agreed (low range values) or disagreed (high range values).

Note: Items are sorted by decreasing mean priority (= increasing mean scores).

1 = Essential.

2 = Important but not necessarily essential.

3 = Worthwhile but of lower importance.

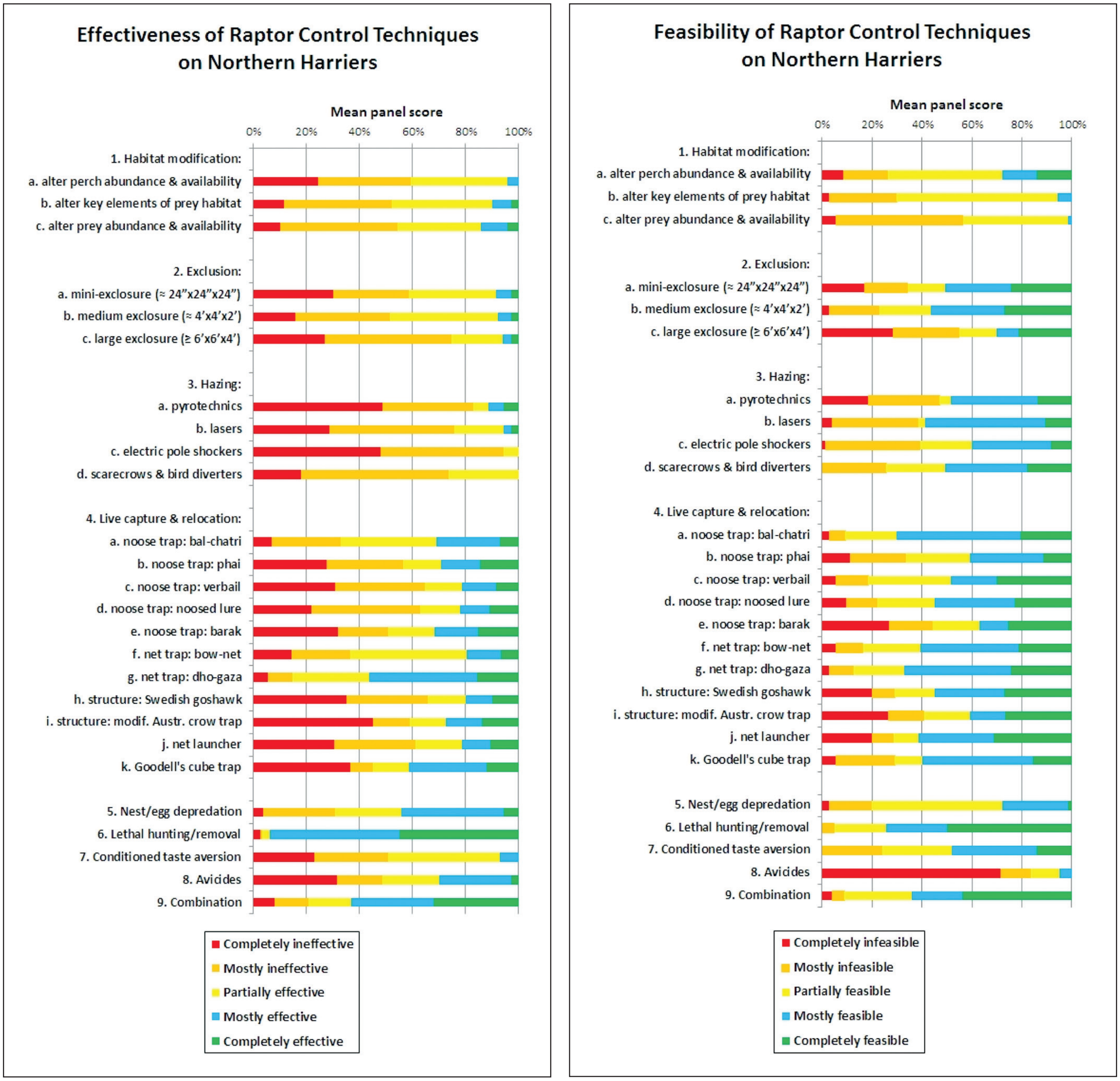

Figure 22—Mean scores of the seven expert panelists of effectiveness and feasibility of raptor control techniques on northern harriers.

Raptor Management Technique	Effectiveness					Feasibility				
	a. Completely ineffective	b. Mostly ineffective	c. Partially effective	d. Mostly effective	e. Completely effective	a. Completely infeasible	b. Mostly infeasible	c. Partially feasible	d. Mostly feasible	e. Completely feasible
1. Habitat modification										
a. alter perch abundance & availability	1.44	0.73	0.87	1.84	undefined	2.18	1.29	0.86	1.60	2.65
b. alter key elements of prey habitat	1.28	0.51	0.66	1.56	2.65	2.65	0.84	0.47	1.38	undefined
c. alter prey abundance & availability	1.41	0.55	0.56	1.53	2.65	2.65	0.66	0.87	2.65	undefined
2. Exclusion										
a. mini-exclosure (≈ 24"x24"x24")	1.19	0.65	0.89	1.71	2.65	2.18	1.38	1.23	1.36	1.57
b. medium exclosure (≈ 4'x4'x2')	1.21	0.32	0.60	1.73	2.65	2.65	1.44	1.03	1.00	1.36
c. large exclosure (≥ 6'x6'x4')	0.94	0.58	0.77	2.65	2.65	1.45	1.27	1.29	1.84	1.71
3. Hazing										
a. pyrotechnics	1.00	1.34	1.71	1.71	1.71	1.98	1.50	1.84	1.16	1.42
b. lasers	1.50	0.84	1.41	2.65	2.65	1.84	1.28	1.71	0.94	1.84
c. electric pole shockers	0.85	0.86	1.98	undefined	undefined	2.65	1.06	1.08	1.20	2.18
d. scarecrows & bird diverters	2.56	0.84	1.69	undefined	undefined	undefined	1.49	1.00	1.13	2.09
4. Live capture & relocation										
a. noose trap: bal-chatri	1.10	0.92	0.75	1.23	2.65	2.65	1.72	1.08	0.79	1.77
b. noose trap: phai	1.19	1.13	0.68	0.68	0.68	0.94	0.66	0.70	1.10	0.94
c. noose trap: verbail	1.12	1.06	0.98	1.16	1.25	1.71	0.95	1.02	0.77	1.17
d. noose trap: noosed lure	0.73	0.75	0.72	0.94	0.94	1.29	0.95	0.90	1.00	1.53
e. noose trap: barak	1.02	0.45	0.46	0.50	0.68	1.22	0.81	0.90	0.94	1.33
f. net trap: bow-net	0.55	0.58	0.66	1.16	1.47	1.71	1.02	1.03	0.74	0.99
g. net trap: dho-gaza	1.38	1.33	0.63	0.57	0.96	2.65	1.26	1.12	0.94	1.57
h. structure: Swedish goshawk	1.19	1.02	0.92	1.28	1.28	1.83	1.26	1.15	1.22	1.36
i. structure: modif. Austr. crow trap	0.94	0.77	0.77	0.77	0.77	1.40	0.79	1.00	0.79	1.40
j. net launcher	1.04	1.01	0.90	0.94	0.94	1.83	1.25	1.29	0.90	1.11
k. Goodell's cube trap	1.21	1.25	0.76	1.05	0.95	1.71	1.50	1.02	0.77	1.15
5. Nest/egg depredation	2.09	1.27	0.79	0.78	1.71	2.65	1.53	0.68	0.89	2.65
6. Lethal hunting/removal	0.66	2.65	1.71	0.75	0.75	undefined	1.91	1.77	1.14	0.94
7. Conditioned taste aversion	1.73	0.70	0.80	2.65	undefined	undefined	0.98	1.03	1.38	2.65
8. Avicides	1.51	2.18	1.71	1.51	2.65	0.68	1.90	1.78	1.91	undefined
9. Combination	1.37	1.32	0.95	1.28	1.14	2.24	1.73	1.12	1.06	1.18

Key to degree of variation among panelist scores:	
undefined	mean = 0 (all panelists scored 0); no variation
low	0.0 ≤ CV ≤ 0.5
medium	0.5 < CV ≤ 1.0
high	CV > 1.0

Figure 23—Degree of variation among the seven expert panelists in how they scored effectiveness and feasibility of management techniques on northern harriers. Values are coefficient of variation (CV) of scores among the panelists (CV = standard deviation/mean).

For great horned owls (fig. 24), the techniques that the panelists, on average, scored the highest (at least 40 percent of mean score points) as completely effective or mostly effective included (in decreasing order of effectiveness): lethal hunting/removal, combinations of techniques, Goodell's cube trap, bal-chatri noose trap, Swedish goshawk trap, and the verbail noose trap. Some 18 techniques were scored high (at least 40 percent of mean score points) for feasibility; of these 18, the highest scored (at least 60 percent of mean score points) techniques for feasibility were (in decreasing order of feasibility): lethal hunting/removal, Goodell's cube trap, Swedish goshawk trap, combinations of techniques, and net launcher. Thus, the techniques that seemed to score the highest for effectiveness and feasibility against great horned owls were lethal hunting/removal, combinations of techniques, Goodell's cube trap, and Swedish goshawk trap. As with the scores on northern harriers, the panelists tended to diverge on their scores on great horned owls (fig. 25).

Thus, the techniques that ranked highest for effectiveness and feasibility in common for harriers and owls were lethal hunting/removal, combinations of techniques, and Goodell's cube trap.

Interpreting mean and variations in panel scores—
The divergence of panelists' scores on raptor control techniques (figs. 22 and 24) does not necessarily indicate reduced confidence of the effectiveness or feasibility of specific management techniques. Rather, the divergence of scores more likely reflects differences in individual experience and expected methods of application of the techniques. The criteria we used to select the panelists resulted in a panel with a range of experience geographically and topically.

The mean panel scores (figs. 23 and 25) are an indication of this particular expert community as a whole. For instance, with northern harriers (fig. 22), mostly or completely effective techniques pertain to live capture and relocation (technique numbers 4a through 4k) and to nest/egg depredation, lethal hunting/removal, avicides, and combinations (technique numbers 5, 6, 8, and 9), and far less to habitat modification, exclusion, and hazing (technique numbers 1, 2, and 3), whereas nearly all techniques were scored on average as being mostly or completely feasible except for habitat modification and use of avicides.

U.S. Fish and Wildlife Service managers also may wish to understand how the knowledge and thinking of individual experts differ in the degree to which various management techniques may be effective and feasible. For example, consider lethal hunting and removal of northern harriers (technique number 6 in figs. 22 and 23). This technique averaged among all panelists the highest score of all techniques for being mostly or completely effective and mostly or completely feasible (fig. 22). The variation among panelist scores (fig. 23) for this technique indicates much

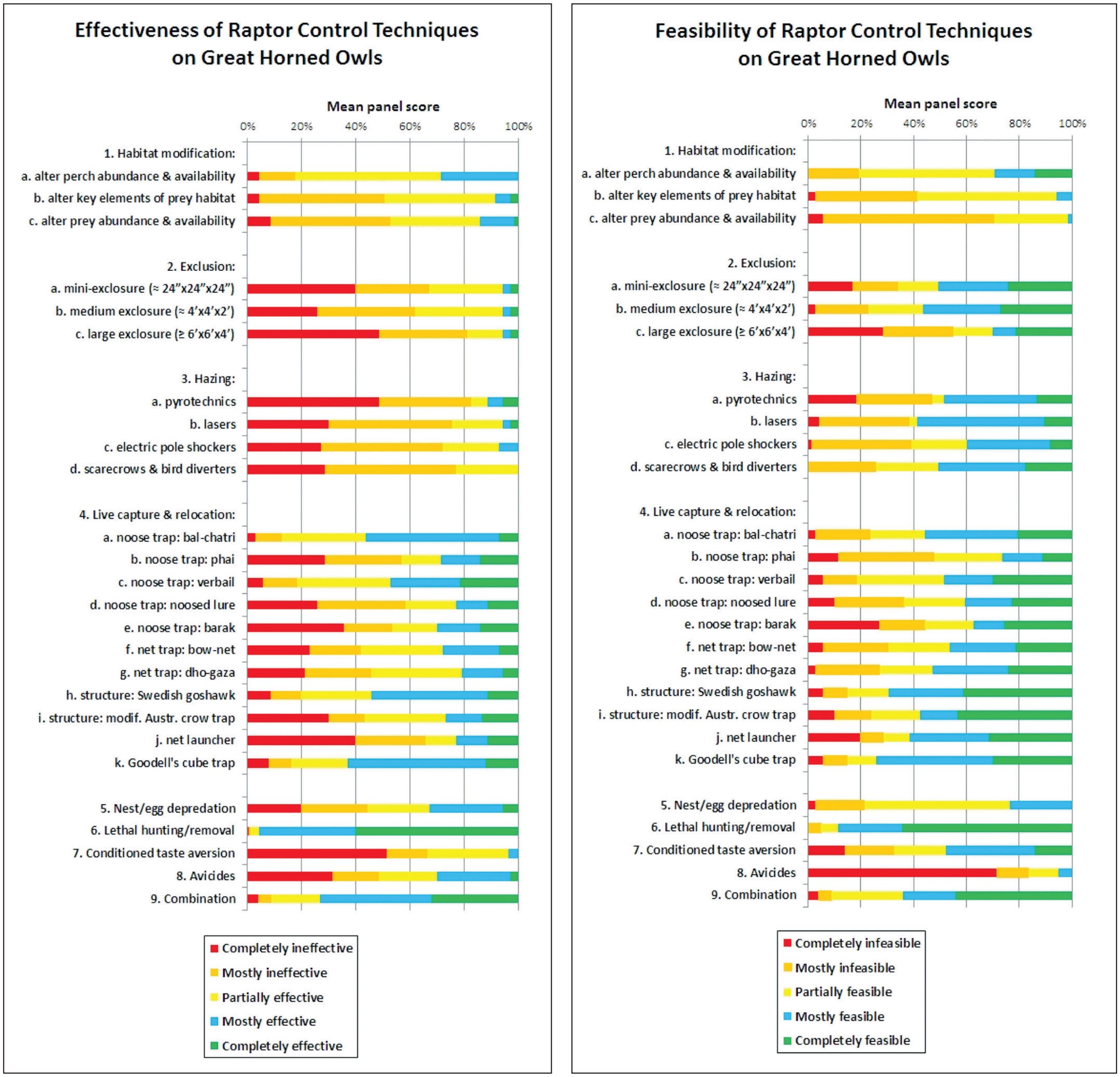

Figure 24—Mean scores of the seven expert panelists of effectiveness and feasibility of raptor control techniques on great horned owls.

Raptor Management Technique	Effectiveness					Feasibility				
	a. Completely ineffective	b. Mostly ineffective	c. Partially effective	d. Mostly effective	e. Completely effective	a. Completely infeasible	b. Mostly infeasible	c. Partially feasible	d. Mostly feasible	e. Completely feasible
1. Habitat modification										
a. alter perch abundance & availability	1.25	0.97	0.45	0.89	undefined	undefined	1.22	0.67	1.29	2.65
b. alter key elements of prey habitat	1.25	0.48	0.55	1.98	2.65	2.65	0.87	0.64	1.38	undefined
c. alter prey abundance & availability	1.25	0.55	0.52	1.72	2.65	2.65	0.45	1.05	2.65	undefined
2. Exclusion										
a. mini-exclosure (≈ 24"x24"x24")	1.11	0.84	1.14	2.65	2.65	2.18	1.38	1.23	1.36	1.57
b. medium exclosure (≈ 4'x4'x2')	1.45	0.68	0.84	2.65	2.65	2.65	1.44	1.03	1.00	1.36
c. large exclosure (≥ 6'x6'x4')	0.88	1.06	1.33	2.65	2.65	1.45	1.27	1.29	1.84	1.71
3. Hazing										
a. pyrotechnics	1.00	1.34	1.71	1.71	1.71	1.98	1.50	1.84	1.16	1.42
b. lasers	1.50	0.89	1.41	2.65	2.65	1.84	1.28	1.71	0.94	1.84
c. electric pole shockers	1.51	0.95	1.10	2.65	undefined	2.65	1.06	1.08	1.20	2.18
d. scarecrows & bird diverters	1.41	0.84	1.69	undefined	undefined	undefined	1.49	1.00	1.13	2.09
4. Live capture & relocation										
a. noose trap: bal-chatri	1.71	1.00	0.67	0.54	2.65	2.65	1.77	1.08	1.01	1.77
b. noose trap: phai	1.13	1.13	0.68	0.68	0.68	0.94	0.83	0.70	0.69	0.94
c. noose trap: verbail	1.71	0.97	0.98	1.05	1.67	1.71	0.95	1.02	0.77	1.17
d. noose trap: noosed lure	1.33	1.01	0.90	0.94	0.94	1.29	1.29	0.90	0.79	1.53
e. noose trap: barak	0.85	0.45	0.46	0.50	0.68	1.22	0.81	0.90	0.94	1.33
f. net trap: bow-net	1.15	0.57	0.61	0.84	1.33	1.71	1.38	1.03	0.64	0.99
g. net trap: dho-gaza	1.67	1.42	0.98	0.79	1.71	2.65	1.46	1.12	1.18	1.57
h. structure: Swedish goshawk	1.25	0.94	0.70	0.67	0.94	1.71	1.26	1.15	1.22	1.05
i. structure: modif. Austr. crow trap	1.17	0.77	1.17	0.77	0.77	1.10	0.79	1.00	0.79	1.03
j. net launcher	1.04	1.33	0.94	0.94	0.94	1.83	1.25	1.29	0.90	1.11
k. Goodell's cube trap	1.27	1.25	0.74	0.63	0.95	1.71	1.26	1.02	0.77	1.17
5. Nest/egg depredation	1.83	1.50	1.28	1.25	1.71	2.65	1.41	0.62	0.91	undefined
6. Lethal hunting/removal	2.65	2.65	1.71	0.95	0.54	undefined	1.91	1.72	1.14	0.69
7. Conditioned taste aversion	0.96	1.23	1.28	2.65	undefined	2.65	1.30	1.36	1.38	2.65
8. Avicides	1.51	2.18	1.71	1.51	2.65	0.68	1.90	1.78	1.91	undefined
9. Combination	2.24	1.73	1.07	0.88	1.14	2.24	1.73	1.12	1.06	1.18

Key to degree of variation among panelist scores:	
undefined	mean = 0 (all panelists scored 0); no variation
low	0.0 ≤ CV ≤ 0.5
medium	0.5 < CV ≤ 1.0
high	CV > 1.0

Figure 25—Degree of disagreement among the seven expert panelists in how they scored effectiveness and feasibility of management techniques on great horned owls; values are coefficient of variation (CV) of scores among the panelists (CV = standard deviation/mean)).

agreement among panelists, because variation among panelists was relatively low for extreme values of feasibility and effectiveness (e.g., completely feasible and completely infeasible). In this way, the score results provide a means of identifying raptor control techniques with high (or low) expected effectiveness and feasibility, and with a degree of agreement among panelists.

Panelists also expressed a broad array of reasons for their scores of the array of management techniques, and they noted areas of key uncertainties and data needs that led to their scoring of effectiveness and feasibility (app. 10). Regarding lethal hunting and removal, panelists cautioned that although it could be effective at reducing predation caused by harriers and owls, it may still be difficult to reduce snowy plover nest failure if removal of territorial adult raptors results in an influx of additional raptors with an ability to predate snowy plover eggs, chicks, or adults. Panelists also cautioned that sociopolitical concerns could prevent otherwise effective and feasible techniques from being used.

Goodell's cube trap was a structure newly introduced to the panel by panelist Goodell, and few panel members had familiarity with it. In general, though, they felt it would be useful based on the description given, although one panelist noted that it may not be effective on harriers. A combination of techniques ranked high for harriers and owls, although which specific techniques would be combined for each species were not identified.

Experts varied in their experience with raptor control techniques, but jointly identified those of higher effectiveness and feasibility among a total of 26 potential techniques.

Panel topic 3 on further considerations—

Panelists also provided a number of ideas on extenuating factors pertaining to corvid and raptor predation management, cost and workload, information management, planning, and plover recovery goals (table 3). Many of these points may be useful for the Recovery Unit 1 Western Snowy Plover Working Group and managers to consider if management techniques are deemed necessary and are implemented. As examples, the panel suggested using field personnel with raptor expertise for data collection, and that successfully implementing raptor predation management might entail considerations for finite time, cost, and staff so as to best focus raptor control only where and when specifically identified, thus requiring clarity on raptor monitoring goals and objectives.

Overall panel discussion comments—

A number of additional points of discussion, concerns, and suggestions were raised by the panelists, specifically on topics pertaining to identifying information useful for generating indices to help trigger a raptor control decision; means of gathering that information; other raptor control methods to consider; rationale for scoring effectiveness and feasibility of raptor control methods; and further extenuating factors in instituting a raptor control program (app. 11).

Table 3—Results of panel brainstorm discussion on extenuating factors that could influence real-world implementation of raptor predation management for western snowy plover recovery[a]

Extenuating factor	Theme
Maintain emphasis on corvid control, and not switch resources to raptor predation management. Corvid management is paramount. There may be limited funds to cover both corvid and raptor predation management.	Corvid management
Cost is a constraint, especially with state budgets shrinking. Large-scale raptor removal would not be acceptable from permitting level, public standpoint, and funding.	Cost
Will take some time to collect and analyze the information proposed.	Information managementt
Would need raptor expertise, whether volunteers or agency personnel, for data collection.	Personnel
The existing environmental assessment (EA) constrains the existing program; would need to revisit the EA if there are significant changes to the program.	Planning
Difficult to determine the decision point for harrier control specifically. Does the within-season decision point always pertain to harrier control? We have the threshold numbers but need to define the process for the decision point.	Planning
Some agencies might not wish to take part in raptor management even though they have a snowy plover habitat restoration area on their lands.	Planning
The case of barred owl control to recovery spotted owls may help inform the raptor-plover situation.	Planning
Larger landscape issues of how individual agencies are constrained by their jurisdictions. Need collaborative efforts and need to involve many groups. Need partnerships.	Planning
Could involve groups such as flying clubs and others to mobilize and and help with tasks. Need to look more broadly than just trained biologists for some tasks. Could help to reduce costs.	Planning
We focus on nest success, but do not know what the fate of chicks are, or of adults. The ultimate goal is population growth, not nest success per se.	Planning
Keep perspective over the last decade on where plover recovery has come; are we becoming less sensitive to issues such as harrier control? Yes.	Planning
Revisit population goals for each colony, vs. managing take for individuals. For plovers, makes sense to have a long-term goal every 3 years or so; problem is with specific raptor management, not a system issue.	Plover goals
Will be a need for public review of a new raptor management plan; will be an ongoing issue. Will be a permitting issue.	Public
For proactive outreach, who do we need to inform? There may be outside sensitivity especially for harrier control. This could be a "stopping point" for a raptor control program.	Public
Raptor predation management cost and personnel needed: could be tail wagging the dog. Massive resources might still not provide successful results.	Raptor management

Table 3—Results of panel brainstorm discussion on extenuating factors that could influence real-world implementation of raptor predation management for western snowy plover recovery[a] (continued)

Extenuating factor	Theme
May be difficult identifying which individual raptor may be responsible for predation; in so doing, this may take time and result in undue predation rates. Need to clarify goal, whether it is to track individual raptors' predation behavior, vs. generally asserting a raptor control approach.	Raptor management
Public reaction to killing raptors may not be acceptable.	Raptor management
Time management is the key factor limiting being able to actually engage in harrier trapping, control, finding nests, etc. This is a matter of cost. If raptor predation management is instituted, may need to drop some corvid control activities. But do need to first explore nonlethal raptor control techniques before lethal techniques are engaged; there is a cost factor for this. Would need to find volunteer staff, for example, to locate raptor nests.	Raptor management
Time, cost, and staff constraints have led to focusing raptor control only where and when specifically identified.	Raptor management
Raptors caught could be brought into an educational institute, but this could be seen as a conflict of interest.	Raptor management
There may be legal constraints on use of avicides.	Raptor management
If exploring live capture techniques, how are various agencies involved in relocating raptors? Need to work as a team, need to discuss, and come up with a best protocol before the issue arises.	Raptor management
Could engage a working group to engage education especially for raptor live capture. Could find a good outcome for captured raptors, especially with the guidance of the working group.	Raptor management
Related is the work load for both predator control and monitoring.	Workload

[a]Items are sorted alphabetically by theme. Panel method used: structured panel discussion.

Summary and Conclusions

Raptor predation on western snowy plovers might be most effectively and feasibly controlled by direct removal, use of net or cube traps, or combinations of approaches.

The expert panel provided individual and collective information on potential, new monitoring activities and data to gather for tracking the effect of raptor (northern harrier and great horned owl) predation on western snowy plovers along the Oregon coast. The panelists scored the effectiveness and feasibility of 26 techniques for controlling raptors.

Techniques scoring the highest effectiveness and feasibility for control of northern harriers were lethal hunting and removal, combinations of techniques, dho-gaza net trap, and Goodell's cube trap, and for control of great horned owls were lethal hunting and removal, combinations of techniques, Goodell's cube trap, and Swedish goshawk trap. Although the panelists varied in their scoring of specific levels, they generally agreed on the techniques that were mostly or completely effective and feasible.

Based on their own individual experiences, the panelists also suggested a number of extenuating factors to consider when instituting a raptor control program, particularly regarding the need for trained personnel; for collecting data consistently; for considering best allocation of finite time, funds, and staff; and for clarifying goals and objectives for raptor monitoring. They also noted the need for determining thresholds for the number of predation events that would signal when raptor control may be warranted.

In general, results of the panel will be considered by USFWS managers in a broader risk analysis and risk management framework for monitoring and managing predation to aid in the recovery of western snowy plovers.

Acknowledgments

We thank Michael Burrell, Carleton Eyster, Eleanor Gaines, Dave Garcelon, John Goodell, Martin Nugent, and Laura Todd for their participation and contributions as expert panelists. We also thank Jody Caicco and Vanessa Loverti for serving as scribes during the panel discussions, and Cindy Burns, Jody Caicco, Jeffrey Dillon, and Jennifer Kirkland for their kind patience and contributions as workshop observers. We appreciate the administrative and technical support afforded to the success of the workshop by personnel of the Oregon Fish and Wildlife Office; our thanks go particularly to Rollie White for supporting this work. Bruce Marcot participated under an interagency work agreement between the U.S. Forest Service Pacific Northwest Research Station and the U.S. Fish and Wildlife Service Oregon Fish and Wildlife Office. We appreciate the support of all the participating federal, state, and private agencies and institutions (please see app. 3). The structure and operating procedures of the expert panel session adhered to the Federal Advisory Committee Act, ensuring that panelists provided scientifically focused information, but not management direction, to the federal agencies.

Metric Equivalents

When you know:	Multiply by:	To find:
Inches (in)	2.54	Centimeters (cm)
Feet (ft)	0.3048	Meters (m)
Yard (yd)	0.9144	Meters (m)
Mile (mi)	1.609	Kilometers (km)

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Appendix 1: Workshop Agenda

Agenda–Snowy Plover Expert Panel Meeting
"Assessing Raptor Predation Management for Snowy Plover Recovery"

February 4, 2014, 8:30 am – 5 pm, U.S. Fish and Wildlife Service, Portland, Oregon

Prework for Snowy Plover Expert Panel:

Review items sent out in advance: 2013 Snowy Plover Monitoring Annual Report; 2013 Snowy Plover Predator Management Action Plan Summary; 2013 Snowy Plover Predator Management Annual Report; Summary of data that is currently collected and available for analysis; Snowy Plover Decision Analysis Project Summary

Snowy Plover Expert Panel:

Times are approximate and can be flexible

Time	Topic	Main messages	Lead	Objective
8:30-8:50 am	Welcome			
	Roster Check In, introductions (SP Expert Panel; Workshop Facilitators & Advisors; Observers; Note-taker)	Introductions to the workshop. No decisions to be made. No major changes to the agenda.	Dan Elbert	*Goal & expectations for the workshop:* To provide objective technical information on potential effectiveness and feasibility of management activities for Snowy Plover recovery.
	Overall workshop goal			
	What you should have received/brought			
	Agenda review			
	Welcome by USFWS Managers	Welcome (Paul Henson).	Local FWS manager(s)	
8:50-9:10 am	Overview of methods			
	Roles of SP expert panel, facilitators, and observers – clarify how workshop fits overall SP recovery actions	Information sharing.	Dan Elbert, Bruce Marcot	*Present flow chart diagram* of overall project, and how this workshop fits in.

Time	Topic	Main messages	Lead	Objective
	Summarize specific workshop objectives Summarize overall panel methods: guided discussions and individual scoring Grounding: define key terms and concepts to be addressed; summarize operating assumptions Lunch choices	Scoring and written info (by the *scribe*) will be anonymous. Adherence to panel etiquette and assumptions.		*Workshop objectives* - The panel will address: 1. How does raptor predation affect SP productivity? 2. What is the efficacy (effectiveness & feasibility) of various management techniques on SP recovery?
9:10- 9:40 am	Background Presentation Brief review of SP recovery, including recent monitoring, and SP predator management action plan and annual report Brief introduction of the topic – species involved, what is known from monitoring. Include addressing the question of whether raptor predation is compensatory or additive to other mortality sources.	Presentation	Dan Elbert	The purpose is to ensure that all panelists are equally up to speed on the key topics, and have a chance to ask questions (i.e., leveling and elevating playing field). Briefly summarize recent findings and knowledge of raptor predation on SPs.
9:40- 10:00 am	**Topic 1: panel discussions of raptor predation on snowy plovers & raptor predation management** *Guided panel discussion topics:* What suite of information could be used to generate indices that help trigger a decision on whether to implement raptor predation management, in real time? Biological impacts (demography/productivity) Evidence that is needed Seasonal/temporal components What new data could be collected that would enhance these indices, in real time? What is the best way to gather the information? That is, *suggestions for additional monitoring & research* to inform a raptor predation management program.	Expert panel discussion (*Scribe* will capture panel's key discussion points)	Panel, guided by Bruce Marcot & Dan Elbert	Engage the expert panel in a guided discussion of raptor predation on SPs. Bruce will capture the panelists' key ideas on each topic.

Time	Topic	Main messages	Lead	Objective
10:00- 10:20 am	Break			
10:20 am- 12:00 pm	**Topic 1: panel discussion of raptor predation effects on snowy plover productivity** (continue, as needed)			The panelists will provide their priority scores on the two themes discussed prior to the break.
12:00- 12:40 pm	Lunch Lunch items may be brought into the panel meeting room, instead of everyone dispersing.			
12:40- 1:00 pm	Review of the morning's guided topic discussion on raptor predation effects on Snowy Plovers. Also briefly solicit comments from non-panelist observers in the room.	Brief review	*Scribe*, Bruce, & Dan	Quick review of the main topics suggested by the panelists. Note that scribed notes will be sent to all panelists later for their review.
1:00- 3:30 pm	**Topic 2: panel evaluation of efficacy of raptor predation management methods**			
	Overview of panel procedures for this session	Review of panel methods.	Bruce Marcot	Briefly describe the topics, questions, scoring methods, operating assumptions, & terms.
	Brief review of management techniques. Panelists may also suggest additional techniques for their evaluation.	What techniques have been, or could be used?	Dan Elbert	Brief review of a short list of management techniques. Questions from panelists to ensure everyone understands them equally.
	Round one scoring: Panelists individually and silently score effectiveness and feasibility of each management technique.	Begin panel scoring. Can add combinations.	Bruce Marcot	Panelists provide initial judgments via their score values, and denote rationale for their scores.
	Round one disclosure: 1. Panelists each disclose their scoring and rationale, uninterrupted except for clarification questions. 2. Panelists then engage in more open discussion on their scoring and thinking.	Panelists each present their results.		Panelists disclose their scores and reasoning. Marcot will enter scores into a spreadsheet and can display overall results.
	Round two scoring	Second round of panel scoring.		
	Round one disclosure	Panelists each present their results.		As above.

Time	Topic	Main messages	Lead	Objective
3:30- 3:50 pm	Break			
3:50- 4:45 pm	**Topic 3: discussion about extenuating factors** Panel to engage in a guided discussion about the following extenuating factors that FWS could consider when deciding on a raptor predation management plan for SP recovery: cost, personnel needed, & training needed stakeholder participation public reaction Open the floor to observers for their comment, questions, and observations.	To provide to FWS a collective set of experiences and professional opinions on additional considerations for raptor predation management.	Dan Elbert	Panelists to provide their personal experience in each topic, *not* to engage in speculation. The method to use here may be a "structured brainstorming" approach whereby each panelist will be asked for their top 2 ideas, suggestions, or caveats; and subsequent panelists are asked not to repeat others' ideas; and we go around the panel sequentially until everyone has provided their main ideas. This can be done for each of the above bulleted list of topics or combinations thereof.
4:45 pm- end	**Wrap-up & close-out** What's next: The *scribe*, Dan, and Bruce will compile the day's notes, discussions, and results, and send to each panelist for their review. Use of the panel's input: develop a template for a decision process for raptor predation management for FWS. Panelists will be asked to provide any statements on the topics covered today. Panelists will be asked to briefly critique the day's procedures, if they wish. Open the floor to all observers and non-panelists, for final comments and suggestions. **End**	Review next steps.	Dan Elbert, Bruce Marcot	Panelists will have an opportunity to review their input, but NOT to change their scores. Information sharing.

Appendix 2: Letters of Invitation Sent to Each Invited Expert Panelist and to Each Invited Guest Observer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Newport Field Office
2127 SE Marine Science Drive
Newport, Oregon 97365
Phone: (541) 867-4558 FAX: (541) 867-4551

Reply To: Raptor Management Panelist Invitation_Example
File Name: 8181.0854G
TS Number: 14-260

January 24, 2014

Panelist Name
Title
Organization
Street Address
City, State, Zip

Dear Panelist,

Thank you for agreeing to participate in the February 4, 2014, expert panel workshop to provide technical, biological, or scientific information on raptor predation management as part of the Pacific coast population of western snowy plover (*Charadrius nivosus nivosus*) recovery activities. Although much of the initial discussion will be based from experiences in Oregon, the results of this panel session will support the Service with key information for our decision making processes associated with managing the risk of raptor predation of snowy plovers and their eggs and chicks, and could also inform western snowy plover recovery activities across the Pacific coast range.

As part of the expert panel, you will be asked to help assess the potential effects of raptor predation on snowy plovers, the effectiveness and feasibility of various management techniques, and to identify and prioritize existing and new information that could trigger a decision on whether to implement raptor predation management. Please be aware that all materials and communications associated with this expert panel meeting will be subject to the Freedom of Information Act.

Dr. Bruce Marcot, research wildlife biologist with Pacific Northwest Research Station, U.S. Forest Service, and Daniel Elbert, endangered species biologist with the Service, will serve as facilitators of the workshop and for all exercises involving your assessments. Dan Elbert will also serve as the key contact for panel members.

Enclosed with this letter is a packet of background materials that includes a draft workshop agenda, pre-reading materials and a scoring-sheet. Although we intend to cover some of these items in presentations at the front end of the workshop we ask that you familiarize yourself with these materials ahead of time. Additionally, we ask that you score biological effectiveness and technical feasibility of each management technique and to *not* consider cost, political sensitivity, management budgets, etc., as described on page 6 of the agenda.

Pre-reading materials include: 2013 Snowy Plover Predator Management Action Plan; 2013 Snowy Plover Monitoring Draft Annual Report; 2013 Snowy Plover Predator Management Annual Report; Summary of data that is currently collected and available for analysis; and a peer-reviewed article describing procedures applicable to expert paneling in general.

The panel session will be held in Portland at our Oregon Fish and Wildlife Office (2600 S.E. 98th Avenue, Suite 100, Portland, OR, 97266) on February 4, 2014, from 8:30 am to 5:00 pm. If you are not from the Portland/Vancouver area and will need accommodations, a convenient hotel is the Residence Inn 1710 NE Multnomah Street, Portland 1-503-288-1400. A Shuttle will be available if you will need a ride from the airport or to the Oregon Fish and Wildlife Office. We will provide coffee and refreshments during the panel session, and will have menus from a nearby restaurant to order in (please bring cash). After the conclusion of the panel session you are also invited to join us for a social gathering.

Thank you for your support in the conservation of the western snowy plover, and we look forward seeing you on February 4. Please contact Dan Elbert (541-867-4558 x239, daniel_elbert@fws.gov) if you have any further questions.

Sincerely

Paul Henson

State Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Newport Field Office
2127 SE Marine Science Drive
Newport, Oregon 97365
Phone: (541) 867-4558 FAX: (541) 867-4551

Reply To: 8181.0854G

File Name: Raptor Management Guest Invitation_Example

TS Number: 14-260

January 24, 2014
Invited Guest
Title
Organization
Street Address
City, State, Zip

Dear Invited Guest,

We would like to invite you or your agency representative to attend an expert panel session that will provide technical, biological, and scientific information on raptor predation management as part of the Pacific coast population of western snowy plover (*Charadrius nivosus nivosus*) recovery activities. Although much of the initial discussion will be based from experiences in Oregon, the results of this panel session will support the Service with key information for our decision making processes associated with managing the risk of raptor predation of snowy plovers and their eggs and chicks, and could, therefore, inform western snowy plover recovery activities across the Pacific coast range.

Implementation of a multi-agency integrated predator management program is a prime example of the type of commitment and cooperation that is moving the plover towards recovery in Oregon, and much of the credit for this improvement lies with of our State and Federal land management partners. As key agencies actively involved in western snowy plover recovery activities, I encourage you to attend this important event. As an invited guest you will have the opportunity to observe the development of the expert knowledge-based decision model and be given ample opportunity to speak, ask questions and provide ideas at certain points during the panel session.

The panel session will be held in Portland at our Oregon Fish and Wildlife Office (2600 S.E. 98th Avenue, Suite 100, Portland, OR, 97266) on February 4, 2014, from 8:30 am to 5:00 pm. In order to ensure that all attendees receive further directions, please provide us a list of attendees and their email addresses to Daniel Elbert, daniel_elbert@fws.gov, or Laura Todd, laura_todd@fws.gov.

Thank you for your support in the conservation of the western snowy plover, and we look forward seeing you in February.

Sincerely

Laura L. Todd, Field Supervisor

Appendix 3: List of Workshop Attendees

Expert Panel Participants

Michael Burrell, District Supervisor, APHIS-Wildlife Services, Roseburg, Oregon

Carleton Eyster, Snowy Plover Biologist, Point Blue Conservation Science (formerly Point Reyes Bird Observatory), Bolinas, California

Eleanor Gaines, Zoology Projects Manager, Institute of Natural Resources, Portland, Oregon

Dave Garcelon, President, Institute of Wildlife Studies, Arcata, California

John Goodell, Curator of Natural History, High Desert Museum, Bend, Oregon

Martin Nugent, Threatened and Endangered/Sensitive Species Coordinator, Oregon Department of Fish and Wildlife, Salem, Oregon

Laura L. Todd, Field Supervisor, Newport Field Office, U.S. Fish and Wildlife Service, Newport, Oregon

Workshop Planning Team and Meeting Facilitators

Daniel C. Elbert, Endangered Species Biologist, Newport Field Office, U.S. Fish and Wildlife Service, Newport, Oregon

Bruce G. Marcot, Research Wildlife Biologist, Pacific Northwest Research Station, USDA Forest Service, Portland, Oregon

Workshop Observers

Cindy Burns, Wildlife Biologist, Siuslaw National Forest, Central Coast Ranger District / Oregon Dunes Natural Recreation Area, USDA Forest Service, Reedsport, Oregon

Jody Caicco, Forest Resources Division Manager, Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service, Portland, Oregon

Jeffrey A. Dillon, Endangered Species Division Manager, Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service, Portland, Oregon

Jennifer Kirkland, Wildlife Biologist, Coos Bay District, USDI Bureau of Land Management, North Bend, Oregon

Workshop Scribes

Jody Caicco, Forest Resources Division Manager, Oregon Fish and Wildlife Office, U.S. Fish and Wildlife Service, Portland, Oregon

Vanessa Loverti, Wildlife Biologist Shorebird Coordinator, Migratory Birds and Habitat Programs, Pacific Regional Office, U.S. Fish and Wildlife Service, Portland, Oregon

Appendix 4: List of Pre-Workshop Reading Materials Sent to Each Expert Panelist

1. "A Decision Analysis Approach to Raptor Management for Snowy Plover Recovery: Project Summary" by Dan Elbert and Bruce G. Marcot (internal white paper).
2. 2013 Snowy Plover Predator Management Action Plan (Western Snowy Plover Working Group, Recovery Unit 1, 2013)
3. 2013 Snowy Plover Monitoring Draft Annual Report (Lauten et al. 2013)
4. 2013 Snowy Plover Predator Management Annual Report (Psiropoulos and Burrell 2013)
5. Summary of data that is currently collected and available for analysis (see app. 11).
6. Peer-reviewed article describing procedures applicable to expert paneling in general (Marcot et al. 2012)
7. Contact list of all invited panelists (see app. 4)
8. Snowy Plover Expert Panel Workshop agenda (see app. 1)
9. Snowy Plover Expert Panel Workshop scoring sheet (see app. 7)
10. List of management techniques (see app. 5)
11. Snowy Plover Expert Panel Workshop Operating Assumptions and Key Terms (see app. 6)

Appendix 5: List of Potential Management Techniques Provided to the Panelists

Raptor Predation Management Techniques for Snowy Plover Recovery

4 February 2014

Strategies and techniques were identified and defined primarily using the following sources:

Ash, L. 2014. Traps and trapping. The modern apprentice: falconry, ecology education. http://www.themodernapprentice.com/

Bloom, P.H.; W.S. Clark, and J.W. Kidd. 2007. Capture techniques. In: Bird, D.M.; Bildstein K.L. eds. Raptor research and management techniques, Blaine, WA: Hancock House.

Hygnstrom, S.E.; Craven S.R. 1994. Hawks and owls. Handbook: Prevention and Control of Wildlife Damage. Paper 63.

1. Habitat Modification

This strategy involves altering the abundance and availability of key components of raptor habitat, raptor prey habitat, or raptor food sources, in order to make snowy plover nesting areas and adjacent areas less attractive to raptors, resulting in less use by raptors.

2. Exclusion

This strategy involves the use cages constructed of 2″× 4″ welded wire that are centered around plover nests in order to restrict access of predators to plover nests and eggs. Exclosures can be categorized into three general sizes: mini-exclosure (≤ 2′× 2′× 2′), medium exclosure (≈ 4′× 4′× 2′), and large exclosure (≥ 6′× 6′× 4′).

3. Hazing

This strategy involves the use of scare tactics to frighten, disturb or harass a raptor sufficiently that a change in behavior occurs, resulting in the avoidance of the target area.

3a. Pyrotechnics: Pyrotechnics include a variety of exploding or noise-making devices. The most commonly used are shell crackers, which are 12-gauge shotgun shells containing a firecracker that is projected 50 to 100 yards (45 to 90 m) before it explodes. Noise, whistle, and bird bombs are also commercially available. They are fired from pistols and are less expensive to use than shell crackers, but their range is limited to 25 to 75 yards (23 to 68 m).

3b. Lasers: Using lasers with very bright beams and very low divergence that appears as a physical danger to the raptor, causing the raptor to fly away in order to avoid the laser beam. Lasers can be used to scare birds from a long distance (100 m to 1 km).

3c. Electric pole shockers: Each unit consists of a ground wire running 1 inch (2.5 cm) from and parallel to a wire that is connected to an electric fence charger. When a raptor lands on a pole, it receives an electric shock and is repelled from the immediate area. Other perching sites in the area should be removed or made unattractive. Shocking units are energized from dusk until dawn for owls and during daylight hours for hawks. The electric pole shocker keeps raptors from perching within a threatened area but does not exclude them from nesting in or using a nearby area. Most hawks and owls are highly territorial. A pair that is allowed to remain will aggressively defend the area and usually exclude other hawks and owls. Thus, farmers may actually find it beneficial to coexist with a pair of hawks or owls that have learned to avoid an area protected by pole shockers.

3d. Scarecrows and bird diverters: Scarecrows are effective at repelling raptors when they are moved regularly and used in conjunction with shotgun fire or pyrotechnics. Bird diverters discourage birds from roosting on utility poles, towers, street lights, and other structures.

4. Live Capture and Relocation

This strategy can involve the use of a variety of trapping techniques in order to non-lethally capture raptors, which are subsequently relocated and released.

Noose traps

4a. Bal-chatri: The bal-chatri is a small cage, often in a half cylinder, conical, or rectangular shape, with many monofilament nooses attached to the exposed surfaces. A lure animal, such as a mouse or non-native bird is placed in the cage. The trap is then deployed within sight of a perched raptor. The movement of the lure animal will attract the raptor, and when the raptor lands on the trap, the nooses will ensnare the raptor's toes and feet.

4b. Phai: The phai is a hoop made out of a rigid material (e.g., metal or wood), and has many upright nooses placed along its length. A lure animal, such as a non-native bird, is placed (tethered) in the center of the hoop. The trap is deployed within sight of a raptor. The movement of the lure animal will attract the raptor and it will make a stoop down to capture the lure. As the raptor extends its legs to grab the lure, its legs are ensnared by the hoop's nooses. This trap can capture a raptor from any angle of approach.

4c. Verbail: The verbail trap is mounted to a pole that is deployed in an open area away from any other perches of similar or greater size, which attracts raptors that use perches for hunting to land on the trap. The perch is collapsible and acts as the triggering mechanism. When tripped, the body of the trap flips a padded noose around the leg(s) of the raptor. Two spring-wired arms tied to the noose simultaneously spring out in opposite directions, tightening the noose and holding the bird firmly. A separate line attached to the noose allows the trapped raptor to flutter to the ground, while remaining tethered to the pole.

4d. Noosed lure: A lure animal, such as a non-native bird, is equipped with a jacket that is covered in nooses. The jacket is then tied to a weight using a shock cord that tethers the pigeon in place so that it can fly up to 5 or 10 feet (1.5 to 3 m), but no further. The weight is heavy enough that the raptor is not be able to drag it. The movement of the lure animal attracts the raptor, which will make a stoop down to capture the lure. As the raptor strikes the lure animal, it's toes and feet become entangled in the nooses.

4e. Barak: The barak is a trained decoy raptor equipped with a noosed feathery ball disguised as prey. The barak is flown within sight of a target raptor. The barak stimulates a kleptoparasitic response in the target raptor, which tries to rob the barak of its "prey" and subsequently becomes ensnared in the nooses of the feathery ball, and the two raptors fall to the ground where they can be retrieved.

Net traps

4f. Bow-net: The bownet is a circular, spring loaded, and netted trap, that lies folded on the ground. The trap is baited with a lure animal that is tethered to the center of the trap, in order to attract the attention of a passing raptor. The movement of the lure animal (natural or stimulated by pulling a line attached to the tethered animal) will attract the raptor and it will make a stoop down to capture the lure. The trap is sprung just as the raptor arrives at the lure, causing one half of the circle to release over the raptor, creating a net over the now trapped bird. These traps can be sprung manually by pulling a rope or line connected to a pin that holds the trap folded together, using a remote controlled release mechanism, or can have an automatic release that is tripped by the raptor.

4g. Dho-gaza: The dho-gaza is a small net attached at its four corners to a pole frame. The net is attached in such a way as to be easily pulled off the pole frame (e.g., clothepins, paperclips, etc.). A cinch-line string attached at one end of the pole frame is run through the outer mesh squares of the net along all four sides, and then attached again to the frame. A lure animal is tethered to the ground near the base of the trap. Prey species such as sparrows and starlings, or predator species such as great horned owls can be used to attract the raptor. The trap is positioned within sight of a raptor, and perpendicular to the path the raptor is expected to take to get the lure animal. The lure animal is placed on the opposite side of the net from the raptor. The movement of the lure animal (natural or stimulated by pulling a line attached to the tethered animal) will attract the raptor and it will make a stoop down to capture the lure. Before the raptors gets to the lure, the raptor will hit the net, which detaches from the pole frame, and the cinch-line string will close the net behind the raptor, effectively forming a net bag around the raptor.

4j*. Net launcher: A trapper sits in a blind and projects a net over the target raptor from a hand-held device using a 308 cartridge.

4k*. Goodell's cube trap: This trap consists of caged box with a separate compartment housing a lure animal and a funneled top with a perch. The target raptor enters the trap and cannot escape. Because of its size, the trap can be left unattended like a Swedish goshawk trap. (Source: J. Goodell, pers. comm., 4 February 2014.)

Permanent structures

4h. Swedish goshawk: A large box made of wood and wire mesh, which has a top that opens up. This construction typically measures approximately 1 x 1 x 1 m and can be a permanent structure. Bait is set inside the box, or in a separate wire mesh compartment under the main area of the box, and the hawk or owl drops in from the top. The raptor entering the trap triggers the two pieces of the roof to close behind it, trapping the raptor in the box.

4i. Modified Australian crow trap: A large box constructed of wood and poultry netting with sloped roofs leading to a thin opening that runs the length of the trap, and baited with lure animals such as non-native birds. This construction typically measures approximately 2 x 2 x 2 m, and results in a permanent structure. The raptor is attracted to the trap from the movement and sound of the lure animals inside the trap. The raptor is funneled to the thin opening between the sloped roofs, enters the trap through the opening, and becomes trapped inside.

5. Nest/egg depredation

This strategy aims to inflict nest failure and cause breeding raptor(s) to abandon an area. This strategy requires that the nest site is located and can involve interrupting nest construction, addling or removal of eggs, or removal of nestlings.

6. Lethal hunting and removal

Involves the use of live and artificial lures to produce movement and sounds that attract raptors to a selected location where they are subsequently shot.

7. Conditioned taste aversion[1]

This strategy involves the use of a non-lethal chemical compound (repellent) applied to a bait that would non-lethally affect the target raptor that preys on the bait and thereby teach them to avoid a specific food source.

8. Avicide[1]

This strategy involves the use of a lethal chemical compound (toxicant) applied to a bait that would lethally affect the target raptor, similar to what is used to control corvids.

9. Combination[1]

A combination of any of the previously identified strategies and techniques to manage raptor predation.

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[1] Categories of techniques added by the expert panelists during the panel session.

Appendix 6: Materials Provided to Expert Panelists During the Workshop: Snowy Plover Expert Panel Operating Assumptions, and Snowy Plover Expert Panel Key Terms

Snowy Plover Expert Panel Operating Assumptions

4 February 2014

Panel etiquette

Respect everyone's views and ideas; we are not here to critique each other. Let everyone finish their statements without interruption.

Invited guest etiquette

Invited observers will be expected to be courteously silent during the formal panel procedures, but toward the end of the day everyone present will be given ample opportunity to speak, ask questions and provide ideas.

Equal say

Each panelist will have equal opportunity and adequate time to express their ideas, and will be encouraged to think individually (no "group think" allowed).

Expert panel method

Panelists will be asked to follow the agenda and structure for guided discussions and scoring.

Panelists will be given opportunity and time to explain and discuss their ideas and scores, to best learn from each other.

However, scoring will be done silently and individually, not as a group consensus.

Contributions will not be attributed by individual panelists' names.

Expert judgments

Panelists will provide their best technical and scientific judgments.

Panelists will expressly *not* consider cost or political circumstances when scoring effectiveness and feasibility of potential management techniques.

Panelists will *not* second-guess management availability (budgets, personnel, etc.).

Panelists will *not* consider agency-specific issues (USFS, BLM, ACOE, OPRD), and will assume that the same treatment will be applied to all of the Oregon sites; that is, the set of Oregon sites will not differ significantly in effectiveness or feasibility of potential management techniques.

Snowy Plover Expert Panel Key Terms

Raptor—Any diurnal or nocturnal bird of prey (hawk, eagle, falcon, owl) that could prey on Snowy Plover eggs, young, or adults, or otherwise cause harassment to Snowy Plover nesting.

Effectively, however, only two species have been observed to be anything like consistent predators on Snowy Plovers along the Oregon coast: Northern Harriers (*Circus cyaneus*) and Great Horned Owls (*Bubo virginianus*).

Terms and levels used in scoring management techniques (see Appendix 6):

Effectiveness—The degree to which executing a particular management technique will result in significantly lessened mortality of Snowy Plover eggs, young, and/or adults, and/or lessened harassment of nesting Snowy Plovers.

a. *Completely ineffective*: neither mortality nor harassment of Snowy Plovers by raptors are reduced in any way.

b. *Mostly ineffective*: only a minority of mortality and harassment events on Snowy Plovers by raptors are eliminated.

c. *Partially effective*: about half of mortality and harassment events on Snowy Plovers by raptors are eliminated.

d. *Mostly effective*: the majority of mortality and harassment events on Snowy Plovers by raptors are eliminated.

e. *Completely effective*: mortality and harassment of Snowy Plovers by raptors are fully eliminated.

Feasibility—The degree to which a particular management technique can be technically implemented, regardless of cost, politics, and agency operations and personnel. "Technical" can refer to equipment, operational methods (e.g., efficacy of netting a bird), or other biological circumstances.

a. *Completely infeasible*: the management technique cannot be implemented due to technical impediments.

b. *Mostly infeasible*: the management technique can be only partially implemented due to technical impediments.

c. *Partially feasible*: the management technique can be mostly implemented, but with technical impediments that may or may not be solvable.

d. *Mostly feasible*: the management technique can be fully implemented once one or more minor technical impediments are resolved.

e. *Completely feasible*: the management technique can be fully implemented with no technical impediments.

Appendix 7: Worksheet Used by the Expert Panelists to Score Efficiency and Feasibility of Management Methods

Snowy Plover Expert Panel Score Sheet

Panelist code: _______________ Date: _______________

	Place your score(s) to sum to 100					*Place your score(s) to sum to 100*				
	Effectiveness					**Feasibility**				
Management Technique	**a. Completely ineffective**	**b. Mostly ineffective**	**c. Partially effective**	**d. Mostly effective**	**e. Completely effective**	**a. Completely infeasible**	**b. Mostly infeasible**	**c. Partially feasible**	**d. Mostly feasible**	**e. Completely feasible**
1. Habitat modification										
a. alter perch abundance & availability										
b. alter key elements of prey habitat										
c. alter prey abundance & availability										
2. Exclusion										
a. mini-exclosure (≈ 24”x24”x24”)										
b. medium exclosure (≈ 4’x4’x2’)										
c. large exclosure (≥ 6’x6’x4’)										
3. Hazing										
a. pyrotechnics										
b. lazers										
c. electric pole shockers										
d. scarecrows & bird diverters										
4. Live capture & relocation										
a. noose trap: bal-chatri										
b. noose trap: phai										
c. noose trap: verbail										

Management Technique	Effectiveness: a. Completely ineffective	b. Mostly ineffective	c. Partially effective	d. Mostly effective	e. Completely effective	Feasibility: a. Completely infeasible	b. Mostly infeasible	c. Partially feasible	d. Mostly feasible	e. Completely feasible
d. noose trap: noosed lure										
e. noose trap: barak										
f. net trap: bow-net										
g. net trap: dho-gaza										
h. structure: Swedish goshawk										
i. structure: Mod. Austr. crow trap										
5. Nest/egg depredation										
6. Lethal hunting/removal										
7. Net launcher										
8. Conditioned taste aversion										
9. Goodell's Secret Cube Trap										
10. Avicides										
11. Combination										

Snowy Plover Expert Panel Score Sheet

Panelist code: _______________ Date: ________________

Management Technique	Rationale for your scores	Key uncertainties, unknowns, & data needed

Appendix 8: Summary of Data Sets on Western Snowy Plover That Are Currently Collected and Available for Analysis

Breeding Season Monitoring

The Oregon Biodiversity and Information Center (ORBIC) has conducted over 20 years of intense nest, demographic, and population monitoring at every plover site in Oregon. Nearly every bird produced in Oregon has been banded. Individual-based data on demography, parentage, and reproductive success are available in electronic databases managed by ORBIC. Plover monitors survey each nest site multiple times per week and report observations of breeding activity in electronic databases on a weekly basis during the breeding season.

Breeding Window Survey

All currently occupied and historical breeding sites are surveyed to count the number of snowy plovers present. Each site is surveyed in one pass during a one-week window in mid to late May following the rangewide protocol. In addition to counting the number of snowy plovers present, additional information about the presence and abundance of potential predators is recorded. This survey has been conducted in Oregon every year for at least the past 20 years. These data are available in electronic databases managed by USFWS.

Winter Window Survey

All currently occupied and historical wintering sites are surveyed to count the number of snowy plovers present. Each site is surveyed in one pass during a one-week window in mid to late January following the rangewide protocol. In addition to counting the number of snowy plovers present, additional information about the presence and abundance of potential predators is recorded. This survey has been conducted in Oregon every year for at least the past 20 years. These data are available in electronic databases managed by USFWS.

Nest Failures

When plover nests fail, ORBIC plover monitors identify the source of the nest failure when feasible. Nest failures have been attributed to factors including predation (e.g., corvid, coyote, red fox, raccoon, avian predator, rodent predator, unknown predator, etc.), nest abandonment, one egg nests, infertile, overwashing, burial by sand, and others. These data are compiled in electronic databases managed by ORBIC. These data are reported on a weekly basis, and are compiled in an annual report after the conclusion of the breeding season.

Predator Surveys and Removal

APHIS-WS wildlife specialists conduct predator surveys and management activities on a daily basis from late February through August. Data recorded include the total number of hours spent on predator management activities at specific nesting sites each day (e.g., predator survey, raven or crow calling, setting traps, etc.). APHIS-WS wildlife specialists also collect and record data on the number of individuals by predator species that are removed from a nesting site every two weeks. These data are compiled in electronic databases managed be APHIS-WS. These data are reported on a bi-weekly basis, and are compiled in an annual report after the conclusion of the breeding season.

Appendix 9: Results of the Expert Panel Scoring of Efficiency and Feasibility of Management Methods, Listed by Individual Panelists (A-G, Specific Names Withheld Here for Anonymity)

Data tables displaying the 7 panelists' individual scoring of efficiency and feasibility of management methods are available in a supplementary document from the authors of this report upon request.

Appendix 10: Written Explanatory Notes From the Seven Expert Panel Participants (Denoted Here by Panelist Codes A-G), Recorded From Their Scoring of Efficiency and Feasibility of Management Methods

Snowy Plover Expert Panel Score Sheet   Panelist code: A Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Habitat Modification	I think perch alteration/removal could be accomplished, but would be only effective for GHOW[1]. Don't really see altering prey/habitat as effective, and changes the ecosystem for a multitude of species.	Establishing a food plot some distance away might serve as an attractant for GHOW/NOHA[2], but could also attract corvids to the area. Doing a study plot might be in order.
Exclusion	Certainly some threats for adult plovers. Don't know enough about size of exclosures vs. potential dangers to provide a strong support for this idea.	
Hazing	Probably not that effective for raptors—hard to do for owls and harriers are moving quickly through areas so would be hard to target.	
Live Capture & Relocation	Trap types are species specific, hence the score differences. The right traps are highly effective… given enough time and with trained personnel.	Translocation still has a lot of unknowns, especially with regard to birds returning to original site, and raptor survival. More data needed based on satellite telemetry. Transmitters placed on translocated birds.
Nest/Egg Depredation	If effort put into finding nests, this could help reduce plover losses as adults would not be foraging to feed young. However, adults still present and could still kill plovers.	
Lethal Hunting	Is mostly effective, but still difficult for both of these species. Not necessarily easier than trapping.	Removal of territorial adults can cause an influx of floater birds or territory expansion by adjacent territory holders. These are good reasons to know that you are removing individual that are taking plovers/nests.
Others	Avicides—Not legal for raptors. Taste Aversion— might work well for harriers if they eat eggs.	

[1] GHOW = great horned owl
[2] NOHA = Norther harrier

Snowy Plover Expert Panel Score Sheet   Panelist code: B Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Habitat Modification	In simple habitat feaure like "perches" & "cover" (removal) the technique/method is effective and feasible. If it is making raptor habitat less "desirable", we do not usually know enough about species/ habitat interaction to make changes. Removing "cover" from beaches to avoid predator cover maybe ineffective as young plovers benefit from vegetation/logs for protection too.	Often unable to determine which elements of habitat to manipulate (remove or enhance).
Exclusion	Not sure about this. Small exclosures can be effective at protecting nests/eggs but no good for fledglings. Large exclosures may provide perches for harriers or owls.	
Hazing	Cannot see how these techniques could ever be effective or precise to affect predators & not plovers too.	
Live Capture	Not familiar enough to review individual techniques. May have a role to play in combination. Also a challenge if used in combination with relocation. Relocation has all sorts of issues relating to birds returning/homing to some nesting area within the same nesting season. May do more to "look good" politically. Trapping is difficult to achieve practically.	
Nest/Egg Depredation	Nest/egg removal of harriers or eggs may be worthwhile although difficult to find. May reduce predation if adults are not provisioning their young with prey (plover chick). Harriers would remain present and prevent other harriers (or owls) filling the vacant vacuum. May prevent re-nesting if repeated.	
Lethal Hunting/Removal	Likely to be very effective in outcome and in cost/return. Will remove birds that are doing the damage. The down-side is political & P.R. which would be a necessary element to plan/prepare for.	
Live capture etc.	Could be a useful tool.	
Conditioned-taste aversion	May play a role to reinforce or combine with other techniques. Placing additional eggs in the environment may add to risk and attraction of predators.	
Avicides	Very effective & practically feasible, but is unlawful. Therefore is not an option.	

Snowy Plover Expert Panel Score Sheet Panelist code: C Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Habitat	Tremendous undertaking to alter prey habitat and abundance. Uncertain how such change could impact local ecosystem beyond plovers.	
Exclusion	Exclusions have been known to minimize corvid predation but could cause adult plover mortality by raptors. Raptors cue in exclosures.	Uncertain how harriers would respond to exclosures. Certain owls would benefits with exclosure use.
Hazing	All in all, poor, short-term and labor-intensive with little effectiveness.	
Live Capture Relocate	Each trap is species specific. All time-intensive when dealing with individual raptor. Harrier nest location essential if technique implemented.	Uncertain on relocation sites, who is responsible for relocating, etc.
Egg Depredation	Better option is capture adults.	Uncertain of effectiveness, vs. time to find nest.
Lethal Removal	Most effective technique. Selectively target individual.	

Snowy Plover Expert Panel Score Sheet   Panelist code: D Date: 2/4/2014

Management technique	**Rationale for your scores** *(General note: Tended to not consider most options completely feasible or infeasible)*	**Key uncertainties, unknowns, & data needed**
Habitat Modification	Considered this to be methods to reduce habitat suitability—Partially effective. All would have mostly partial effectiveness and depending on site & conditions, partially feasible.	Unclear if prey habitat manipulations would also affect plovers. Unclear if altering raptor prey abundance meant increasing or decreasing prey.
Exclusion	Mostly ineffective, could reduce predation but could actually increase predation of adults. Large exclosures include predation & too hard to effect.	Not sure if mini-exclosures would work in OR conditions. Comparison of the threshold at which benefits of exclusions outweigh the loss of nests/adults.
Hazing	Most would also affect plovers. Most have not worked consistently when tried in the past. Time-intensive & person needs to be present.	Not sure if we could use electric shockers given the sand/salt environment.
Live Capture & Relocation	Many techniques I had little knowledge of. Ranked the ones I thought had been tried with mixed success in California, relocated birds mostly return so decreased effectiveness scores.	Don't know how many techniques would work. Least experience with trapping. How likely would it just come right back?
Nest Depredation	Thought NOHA may abandon area if nest was removed, but changed core when others thought it wouldn't.	Not sure how owl would be affected or if nests would be found. Not entirely sure how GHOW/ NOHA would respond, whether they would leave the area or continue to prey on plover.
Lethal	Seems to be most effective and feasible. Concerned about feasibility if a large response is needed (lots of owls or harriers).	Unclear how it would affect predator populations. Not sure if other owls or harriers would replace those killed. Unclear about how timing alters effectiveness.
Others—Goodell's	Goodell's trap seems like it would be effective.	Not familiar with how the technique compares to other trapping techniques.
Combination	Considered using nest location with trapping adult.	Seems like it would be effective, but not sure how feasible based on time and resources required.

Snowy Plover Expert Panel Score Sheet   Panelist code: E Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Habitat Prey abundance/ availability	Increasing attractive prey at adjacent area will draw raptors away from SNPL. Irrigated alfalfa or irrigated grass.	
Habitat management	Addresses underlying phenomenon constant	
B-C trap	Opportunistically effective for NOHA. Regularly effective for GHOW. Regularly effective for other hawks.	
Dho-gaza	Regularly effective for NOHA at nest and all raptors at nest & falcons with prey lures.	
Funnel type box-type trap	Regularly effective for GHOS and most buteo & accipiter.	
Individual raptor management	Circumstantial, skill dependent, always changing	
Management Framework		
1. Manage for population goals vs. management response based on raptor take of SNPL circumstance.		
2. Establish demographic "sweet-spot" for each colony.		
3. If colony drops below goals (avg. over x years) then WS is engaged to manage individual raptor depredation scenarios.		

Snowy Plover Expert Panel Score Sheet   Panelist code: F Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Exclosures	Small exclosures wouldn't work in OR because of wind—nests get buried. Large exclosures are very time intensive to erect – lots of disturbance of adults. Predators have been able to get into large exclosures. Medium exclosures work well against corvids. Do not work with owls. Exclosures do not benefit survival to fledgling. If chicks fledge into habitat with high predation, adult effort wasted—may reduce fitness.	Unsure how well they work against harriers. Uncertain effectiveness against harriers, but suspect harriers hunting style would lead to increased adult depredation. Need to identify how much potential adult loss offsets improved nest success. Also how successful are we at getting chicks to fledge after exclosure use. Do exclosures attract some predators?
Habitat Modification	Give plovers more open space, improve camouflage. Probably not reasonable to remove non-plover prey. But could make habitat less attractive to predators.	
Trapping & Relocation	This method is effective from a plover's perspective. But it is not effective to relocate raptor—they die or come back…	Not sure on specific methods, but overall this seems an option. Lots of work. Do relocated birds come back? Is this just a temporary fix?
Lethal Control	Likely to improve plover success at all life stages.	Do other predators just fill in?
Nest/Egg Depredation	Could be effective if it kept non-problem birds on a territory, & kept predator population down.	
For all these techniques, need to make sure they do not divert funding/time/attention from ongoing management (e.g., corvid control).		

Snowy Plover Expert Panel Score Sheet Panelist code: G Date: 2/4/2014

Management technique	Rationale for your scores	Key uncertainties, unknowns, & data needed
Habitat	Perches (including nest sites for owls). Balance removing vegetation cover for prey with maintaining plover chick cover.	Regional owl population? Impact of nesters vs. nonbreeders?
Exclusion	Loss of Adults Most adult loss likely due to raptors. Need for frequent monitoring. Reduced effectiveness (not effective for owls). Likely high risk with NOHA. Small exclosure not effective with high wind, coyotes. Frequency of use will likely lead to increased problems observed (adult loss)/	Review literature (PIPL).
Hazing	Limited effectiveness of lasers by day. Fog can reduce effectiveness of electric poles.	Feasibility on owls?
Live Capture	Feasibility reduced over large landscape scale.	Question of whether relocating leads to death of raptor.
Nest Removal	Difficulty of locating all owl nests in some areas. Owls nest early. Provides time (buys time) and increases options.	Assess usefulness for keeping "favorable" raptor pair (territorial).
Lethal	Must ID & get target individual.	
Goodell's Trap	Not effective for NOHA	
A combination of all techniques would be most effective.		

Appendix 11: Comments From the Seven Expert Panel Participants as Recorded During the Workshop by Two Independent Scribes (see app. 3)

Snowy Plover Expert Panel Meeting—Notes "Assessing Raptor Predation Management for Snowy Plover Recovery"

February 4, 2014, 8:30 am–5:00 pm

U.S. Fish and Wildlife Service, Portland, Oregon

Introduction

Two scribes were asked to capture the content of the discussion as it was divulged during the expert panel discussion topics. These notes were not necessarily intended to present a linear progression of thought, but were intended as an additional tool to gather information and expertise for later use. At times, this methodology resulted in successive comments that contradicted preceding comments. Additionally, the identities of the panelists and invited guests were intentionally kept anonymous, in order to promote an open and candid exchange of information and expertise that might otherwise have been inhibited if the scribes had been asked to attribute the comments and questions to individuals.

Attendees

Cindy Burns	Invited Guest	US Forest Service	cburns@fs.fed.us
Michael Burrell	Panelist	APHIS-Wildlife Services	michael.b.burrell@aphis.usda.gov
Jody Caicco	Scribe	US Fish and Wildlife Service	jody_caicco@fws.gov
Jeff Dillon	Invited Guest	US Fish and Wildlife Service	jeffrey_dillon@fws.gov
Daniel Elbert	Facilitator	US Fish and Wildlife Service	daniel_elbert@fws.gov
Carleton Eyster	Panelist	Point Blue Conservation Science	ceyster@pointblue.org
Eleanor Gaines	Panelist	Oregon Biodiversity and Information Center	egaines@pdx.edu
David Garcelon	Panelist	Institute of Wildlife Studies	garcelong@iws.org
John Goodell	Panelist	High Desert Museum	jgoodell@highdesertmuseum.org
Jennifer Kirkland	Invited Guest	Bureau of Land Management	jkirkland@blm.gov
Vanessa Loverti	Scribe	US Fish and Wildlife Service	vanessa_loverti@fws.gov
Bruce Marcot	Facilitator	US Forest Service	bmarcot@fs.fed.us
Martin Nugent	Panelist	Oregon Department of Fish and Wildlife	martin.nugent@state.or.us
Laura Todd	Panelist	US Fish and Wildlife Service	laura_todd@fws.gov

Morning Session

8:30-8:50 am—Welcome and introductions

8:50-9:10 am—Overview of methods

Background presentation

Questions generated from presentation:

What is the average hatch rate for western snowy plover (SNPL)? Recent hatch rate is 45%. How does that compare with CA? Not known for the entire state.

Would like to add a clarification, in previous years we have had rodent predation on SNPL. Rodents are a predator on plover eggs at these sites. Some of the predation of SNPL nests may be attributed to rodent, harriers or other species not identified.

What are the long-term goals for SNPL/predator management? Are there sites that are putting a lot of resources into addressing predation issues with little return? If we (managers) intervene at critical stages (managing predation) that we will grow plovers. The recovery plan does have recovery goals for each site.

What are some non-lethal techniques that have been used for raptor management? Bal-chatri traps, bow net, multiple traps have been used and baited with anything from mice to quail. We have also used audible devices to draw in predators during the study (two week period); audible devices ran for 6 to 8 hours a day. The issues are that Northern Harrier densities are so low that observations and opportunities to trap are few.

Density dependent mortality could be a concern at some of these sites.

Is there a reference site for harriers (a colony or typical harrier site that has been identified)? We do not know? It becomes difficult because density changes with latitude and longitude. As you go south and north there are fewer birds (harriers) and the population is not as dense/concentrated.

9:40-10:00 am—topic 1: panel discussions of raptor predation on snowy plovers & raptor predation management

What suite of information could be used to generate indices that help trigger a decision on whether to implement raptor predation management, in real time?

Note: Called upon each panelist to provide top 2 ideas to generate indices.

Utilize cameras to observe and document unknown predations. Track individual predators that were seen at the site (trouble birds).

Determine best time to take action (during harrier hatching/fledgling season?). At what point in the predator's biology correlates with plover nesting/timing. Is there a timing issue?

We need information on raptor nesting phenology (to ID nesting status, we need monitoring). Could be helpful to look at weekly brood survival to see what suites of chicks are disappearing due to predation (kind of hard to document ultimate cause). It may be possible to identify an individual predator by a specific unique character.

Use of cameras needs to incorporate a high level of follow through to accurately documenting depredations of plover nests. Need to be hiring volunteers to survey raptors, specifically. Need a greater capacity for monitoring (need to increase frequency of observations).

Are densities of plovers nesting in a particular area influencing predation by harrier (increased incidents)? It seems like we may be seeing an increase in predation because of density. Can we collect a density of nest per unit area to see if there is a correlation? These observations are very important for Wildlife Services (WS).

When raptors target prey, what number of events needs to be documented on a nest before a response is initiated? We need to agree on a tolerance level for WS to respond. Number of events documented to trigger a response or action (lethal or non-lethal). For example, Ravens are not given an opportunity to trigger an action, they are just taken (shot) if they are in the area, but with harriers what do we do with the trigger.

At the Pendleton site we tried to get a handle on recording corvids and harriers. Mark Colwell had incorporated predator surveys at specific time intervals to record any predator species observed and also to look for predator tracks (predator surveys include species and numbers). This provides us with a random sample of what goes on at individual nest sites or what species are present (baseline).

Locate raptor nests soon as possible, ID nest site, and then use a dho-gaza to trap the bird (harrier). New info may enhance predator management. If you knew where the nests were then you would have new info to take action – knowing where the nest is increases our options (addle eggs, etc.). Use cameras as an info gathering tool.

Is there any effort to demographically model when to take action on harriers? We need to provide the drivers and to determine what the harrier population is doing?

Use cameras to document predator behavior at under varying circumstances. Suggestion to develop a study looking at use of enclosures and non-enclosures. Also, should consider other management that is occurring at the site, where enclosures are utilized (should we be cautious and more sensitive at these sites).

Should be noting what predator monitors are observing and document (relayed back to decision makers). Also, need to include small mammal surveys (prey for raptors).

Need to stress our management goal as the key trigger. Identify if there is a sweet spot at any given site (for predators). Identify the predator trigger (i.e., over 90 plover nests?). Monitor over a 3 to 5 year window then reassess. Raptors - document point source circumstances.

Assess and identify alternate prey for harriers (e.g., if you have a lot of vole species or ducks at a site). Make alternatives more available for harriers (one strategy)?

Predator behavior is not the trigger. Avoid decisions, pending further information on raptor behavior. Developing lists of species in advance ranked by trap, relocate, or kill. Take into consideration what predator you are targeting, their suitability of being trapped and removed. Some species will be more difficult to trap than others.

Phenotypic means of identifying predators (harriers) (capture and marking) mark with dye spray type markers. Need to know what are the predators actually feeding on at each site (through the season would be an idea (site specific). How can we make the site less attractive for predators? Again, how are harriers actually using the site? Need emphasis on the behavior of the raptors.

What could you do if plover depredations increase? Are there options to remove nests and/or young? We would need to monitor raptor nests closely and make a management decision to remove eggs or young. Strategy may be to track harrier numbers intensively throughout site (e.g. by removing 10 ravens - are you having an effect on plover success). We could track regional response (likelihood) to determine predator replacement during the season.

10:20 am–12:00 pm—topic 1: Panel discussion of raptor predation effects on snowy plover productivity

What is the best way to gather the information?

Investigate how harriers respond to exclosure (do they respond as other raptors do). Test to see how they respond to exclosure – direct observations, cameras, e.g., Owls perch on enclosure, so do harriers do this too? Are they attracted to the exclosures? Use cameras to document predation with and without nest exclosures.

Need a raptor observer/staff/monitor dedicated to raptor research. Monitoring would need to be employed early in the season to track raptors (during most essential/appropriate time).

Analyze current plover data from the past 5 to 10 years (to compare productivity data and site specific hatch rates/fledge rates). Area suggestion - example ~10 mi at Coos Bay, OR. Erect raptor perches before the season starts to observe frequency of raptor species/occurrence (critically important).

Is there a correlation (harrier's taking plovers) with vegetation and or rainfall or weather patterns (look at historical data)? Could track raptor impacts on plovers with weather patterns to better predict predation events based of weather and/or vegetation changes.

Track movements of raptors (harriers) that are translocated (after removal) to evaluate removal technique and determine if translocation is a viable option for management.

Compare SNPL nest exclosure information with other states. Search for raptor nests to document locations. Utilize volunteers to survey (look at ways to collect data without funding). Gather new data (e.g., images of tracks) gather evidence to document what is occurring so that management decisions can be developed. .

Run a population viability analysis (PVA) of plovers to see at what stage they may be susceptible to management actions (at what life stage). Do a camera study to look at predator behaviors around nests (marking problem individuals in plover areas).

Small mammal live-trap line for small rodents and then a survey for raptors (suggestion to use Sherman traps from March to Aug at regular intervals). Small mammal trapping should be done the year prior (prior to what?), when harriers are hatching/feeding and fledging young. Area for trapping should include a 2-mile area + 2 miles out from plover boundary.

Package the prey and predator survey/monitoring into a single protocol to make repeatable and integrate into perpetuity. Develop a framework for a long-term monitoring for raptors and prey (includes small mammals etc.). Reevaluate the formalized protocol once every three years.

Good to have telemetry to see how they use the area (primary predator species). Find where the nests are. How do they use the entire area? Map where focused individuals are located and problem areas for plover predation. GIS Data layer (use of the area). Detail of mapping effort- down to the individual plover nest.

Conduct a literature review and survey. One option is to make habitat less attractive for raptors (tree removal) —habitat management suitability. Use telemetry on harriers and owls and follow-up on results.

Observer Note: Use video cameras over a broad area (in addition to a trail camera). Would work at some sites and not so well as other. Maybe useful if you have an unknown predator taking plovers….

Look at small mammal densities and raptor numbers over time (is there a correlation).

Other methods of trapping noted:

Using a net launcher to capture harriers. Sit in a blind. Use a .308 cartridge. While we only tried this once, we attempted using a net gun (Coda; powered by a .308 blank cartridge) to try to capture harriers. Not suggesting it is the best trapping method by any means, but it is another trick in the bag.

Use condition taste aversion (this is a compound that will affect any bird that preys on eggs).

Use Avicide to kill birds similar to what is used to control corvids.

Create a list of trapping techniques that are species specific (advise best approach for each species). Develop a list of trap types and species that are good candidates for us.

Afternoon Session

12:40 pm–1:00 pm—Review of the morning's guided topic discussion of raptor predation effects on snowy plovers

Went over the mornings scoring—including data, monitoring and research. There was a spread among the panelists- which is fine.

The group needed additional time to finish scoring.

1:00 pm–3:30 pm—topic 2: panel evaluation of efficacy of raptor predation management

1St round of scoring. The panelists then disclosed how they scored:

Habitat modification—not a lot of experience in dealing with raptors in terms of altering habitat.

Removing perches may be feasible and possible. Removing perches may help with some raptor species; perhaps not so much with harriers as they are not perch hunters.

Harriers maybe not so much.

Changing prey may be too difficult and only partially effective.

Exclusionary devises are unknown at this point. Perhaps smaller cages could reduce adult mortality—ranked the smaller ones more effective.

Hazing—no experience—just don't know.

Pole shockers may be a good idea and effective.

Scare crows may be effective—things that move are better than things that don't move.

Live capture-relocation very effective and feasible.

Nest egg depredation didn't score real high. Removing offspring would potentially reduce the amount of hunting the adults would have to do, but still have the adults themselves who are hunting.

Habitat modifications more broadly—perhaps partially effective. How much area do you treat? Difficult to deal with in a landscape setting

Exclusions—effectiveness on habitat exclosure with eggs—problem with fledgings. Larger structure versus smaller make a difference.

Hazing—can cause disturbance to plovers as well. Not effective technique to be precise.

Live capture and relocation—not enough experience to say.

Lethal hunting and removal—very effective from a practicable point of view. Could be an overwhelming public relations problem.

Taste aversion—can be an effective tool. Positive elements but labor intensive.

Avicides—right substances can be highly effective, but restrictions may deter use.

Combination may be the preferred approach.

Habitat modification—overall would rate ineffective—altering perches feasible and something that is done.

Feasibility of habitat manipulation and prey abundance would be difficult.

Exclusion—great horned owls—having exclosures could benefit the owl. Very ineffective.

Hazing—pyrotechnics, lasers, not feasible.

Electric pole shocker—don't know enough about.

Scare crows could work in certain circumstances but have to combine with lethal.

Live capture—feasible, but very labor intensive.

Nest egg depredation—could be effective, but how would change behavior?

Lethal hunting—very effective

Taste aversion—don't know, but not likely very effective.

Trapping—very effective

Net launcher—ineffective with the large landscapes—better luck with a traps.

Habitat modification—partially effective.

Exclusions—minimally effective and potentially loss of adults.

Hazing is not effective.

Scare crows—ineffective.

Traps—depends on conditions and time of year—and question feasibility.

Nest depredation—could be effective for harriers.

Lethal hunting—effective.

Taste aversion—don't expect it will work.

Avicides—no idea if will work.

Combination—most feasible.

Habitat modification—removing perches may work. Consider planting alfalfa spring summer window—very feasible and effective. Artificial food plot or native habitat approach.

Hazing—minimal effective for raptors.

Live capture—there are differences between harriers and owls. May be effective depending on methods.

Nest depredation—would not recommend.

Lethal hunting—practicable measure.

Taste aversion may work for scavengers.

Habitat modification could be effective long term strategy—improve plover habitat reasonable.

Altering prey abundance does not seem practicable.

Exclosures—small would not work—too much sand—medium may work, but not with owls and may not harriers—larger exclosures—a lot of work and disturbance to the birds.

Hazing—not certain that scarecrows or pyrotechnics will work.

Capture and relocation—viable option—but are the birds going to come back?

Nest and egg depredation—may work.

Lethal hunting and removal—good solution for our situation.

Avicides—not feasible.

Taste aversion—sounds interesting.

Habitat modification only partially effective and may not be feasible—challenge of veg cover for the plover chicks—depends on the landscape.

Exclosures—risk to the adults is well documented. Need frequent monitoring—not feasible—medium exclosure may be best compromise.

Hazing—not effective and difficult to employ at an appropriate scale.

Live capture—question if feasible?

Nest egg depredation a viable option of disrupting the nest.

Lethal—effective and highly feasible- targeting appropriate individuals is often difficult.

Taste aversion—low feasibility.

Time factor in when the bird is caught.

Questions from panelists or observers?

Could increase the density of birds with irrigated alfalfa? Longer term it would support those birds that are drawn into the area. Cost benefit could be feasible—concern bring more raptors to the area, and perhaps increasing corvids in the area as well.

Where would we be relocating these raptors to? Have the ability to travel great distances—and would they return? Interstate transfers as an issue? Do they survive? Removed 33 birds last year. Have not seen any birds return yet. May depend on the species and how far you move them.

Removed a harrier or owl—how long does it take for them to return? Don't know—would take a lot of work to determine rates of return.

Have any harriers been removed and return over the cascades? Not sure…

Taste aversion? Raven experiment discussed.

2nd Round of Scoring. Disclosure and sharing opportunity; Explained what you changed and why.

Modified feasibility for live capture and relocation because of the difficulty in catching harriers in a large landscape.

Ranked a combination of techniques to be the most effective.

Switched scores by lumping a bit more. Made exclosures less effective because of owls.

Lethal removal as the most effective and feasible option.

Made changes to egg depredation to partially effective and feasible for both species.

Lethal control—great horned owls are a native invader—removal may open other window of conservation for other species.

Dropped avicides down to overall feasibility issues. Taste aversion bumped up a bit.

Mini exclosures reduced down—less effective- uncertainty of threshold of benefits v. risks.

Live capture—relocation- adjusted.

Nest egg depredation—reduced effectiveness for the owl.

Lethal removal—ranked higher.

Combination—variety of methods more effective.

Without constraints, all options feasible

Changed the capture techniques a bit.

Not too many changes in the ranking—downgrading the overall ranking a bit due to uncertainties.

Made a few adjustments—exclusions—smaller size impacts to the birds.

3:50 pm–4:45 pm—topic 3: Discussion about extenuating factors:
Overarching subject of population goals of other factors- what are the goals for each colony? Is there a window of what are targets? Figure out if we can withstand the take. Manage the premise of take of individuals of plovers– have more of a long term goal that you may revisit every 3 years. Overall don't believe raptors behavior is a systemic problem. Is it a frequent occurrence? Tail wagging the dog of raptor issues—ton of resources being spent for tricky situation. Uphill battle as a management decision. Look at population of plovers first and avoid too many situations of tackling the raptor situation.

Do we have population goals for plovers? Yes, the numbers are in the recovery plan – agencies manage for population goals–time period targets–do have a range the agencies have to target at each site. Numbers are not in place for every site. Clarification provided.

Maintain emphasis on corvid control—would be concerned if resources switched to raptor management. Why is that a concern? Money is an issue—talking about diverting funds from corvids to raptors is a concern. How does raptor management fit into—concern of competition for funds to cover both corvids and raptors. Also workload of control and monitoring is of concern.

Will take time to collect and analyze the information.

Only a few raptors that are causing problems in CA—sometimes difficult to know if which raptor is responsible. Caution of what is it going to take action—decide what really is the goal—possible to know – what is it going to take to take action?

Public reaction—killing raptors in CA will be difficult.

Trying to give direction to staff of how to deal with this—funding issues—don't see an intensive project of proactively removing raptors. Look forward to finding something in the middle—going to have people responding to corvids and dealing with raptors is not possible. Time management—checking traps daily. Not much time to do both. Will go where the biggest priority is—if a harrier, will likely have to drop corvid stuff. Our existing Environmental Assessment gives direction of exploring non-lethal techniques in addition to lethal. Need to take care of the problem before it gets bigger. All comes down to costs. If we are really going to look for nests this year we need to get started. Only target raptors where they are impacting a colony. Don't have the staff to react proactively.

Educational institutions to take harriers into captivity—option to consider.

Funding constraints – trying to figure out how to manage the population within budget. Not acceptable to consider removing all raptors. Important to develop a protocol –

Will be review for public review of a new raptor management plan.

We already have an EA which limits us to how and what we can do—expand beyond the existing program—workload concerns (if there are significant changes to the program). We need raptor expertise—need data collection and raptor observation expertise and action items. Need that resource somehow.

Decision points along the way—really looking at additive losses as the season unfolds. At what point do we trigger decision points of harrier control? Get to some decision point at a certain loss during the season—given the losses from other sources, the harrier one will be at some point later in the season—what are the decision points that allows the management action to take place? How do we get to the threshold for a decision to take place?

Outreach—who do we inform? A lot of people watching what we do—early phase of harrier issues—who do we communicate with? Proactive outreach—potential limitation.

If certain agencies don't want to partake in the management plan, could be a major issue.

Legal issues associated with avicides—labeling, etc.

Exploring live capture technique? Who is involved? Time constraints associated with capture—part of protocol—work with all the agencies—

Larger landscape issues—agencies constraints within jurisdictions—collaborative approach, partnerships to address larger scale issues.

Are there ways to get around some of the costs associated with capture and relocation, volunteer groups to help to defray some of the increased costs of the program by having them transport the birds?

Most of what was discussed was related to nest success, but important to remember overall population growth. Keep in mind all that is unknown—overall goal is population goal, not nest success.

Working group—education—airport group—objective way to find a good outcome for the birds. Committee formed that could be from a variety of stakeholders. Harriers are under-represented in the raptor education world.

Big picture —are we getting higher production of young—keep sensitive to such issues such as harrier control.

Wrap Up & Close-Out

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