



Using the Delphi Process to Gather Information from a Bald Eagle Expert Panel

Natural Resource Report NPS/SWAN/NRR—2020/2128



ON THE COVER

Bald Eagle in Kenai Fjords National Park
NPS

Using the Delphi Process to Gather Information from a Bald Eagle Expert Panel

Natural Resource Report NPS/SWAN/NRR—2020/2128

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May 2020

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Kolstrom, R., T. L. Wilson, and L. M. Gigliotti. 2020. Using the Delphi process to gather information from a Bald Eagle expert panel. Natural Resource Report NPS/SWAN/NRR—2020/2128. National Park Service, Fort Collins, Colorado.

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Abstract

Bald Eagle (*Haliaeetus leucocephalus*) populations are classified by the Southwest Alaska Network (SWAN) of the National Park Service as a vital sign of biological integrity, largely because of their importance as an indicator species for environmental contaminants and human disturbance. Though Bald Eagles are plentiful in Alaska, it is still imperative to have a monitoring plan that allows for the estimation of population sizes and detection of significant changes in populations. Currently, Bald Eagles are monitored in Kenai Fjords National Park, Katmai National Park and Preserve, Lake Clark National Park and Preserve, and Wrangell — St. Elias National Park, but each park uses different monitoring procedures and evaluation criteria. This makes it difficult for scientists and managers to compare data, detect changes in overall populations, and make effective management decisions. Our research is using a formal structured decision-making process to ensure that the Bald Eagle monitoring conducted by the parks is standardized and meets programmatic goals and objectives. We implemented a Delphi process, which is an iterative survey technique that is used to gather expert opinion. We used online questionnaires to gather information and opinions from National Park Service scientists and managers, eagle experts, and other interested parties. We identified important stressors and feasible monitoring metrics, which were tied to the means objectives for the Bald Eagle monitoring program: minimize cost, minimize effort, maximize ability to detect change in populations, and maximize accurate information about Bald Eagles. We also analyzed monitoring metrics using a consequence table, which determines the performance of each objective in terms of the means objectives chosen by expert panelists. This information will help to create a more accurate conceptual model of the system to guide development of a Bald Eagle monitoring program that can be standardized among Southwest Alaska National Parks.

Acknowledgments

This project was funded by the National Park Service Inventory and Monitoring Division. We would like to thank the following individuals for taking part in the Bald Eagle Expert Panel: A. Miller, M. MacCluskie, J. Putera, B. Mangipane, J. Schmidt, C. McIntyre, D. Payer, E. Dowd-Stukel, M. Hake, S. Kim, S. Lewis, T. Hamon, T. Shepherd, T. Mullet, A. Matz, J. Reynolds, and L. Phillips. Thank you to B. Turner and A. Galinat for reviewing early versions of this manuscript. We thank S.J. Converse, T. Donovan, E. Dowd-Stukel, B. Kendall, and J. T. Peterson for their insights and helping to improve the manuscript. T. H. Shepherd and C. Miller handled formatting and section 508 compliance for the final draft. We also thank C. F. Johnson for editorial assistance and advice for formatting the tables and appendix.

Introduction

Bald Eagles are abundant in Alaska, with populations in the state estimated around 30,000 (Alaska Department of Fish and Game 2017). Southwest Alaska provides suitable coastal habitat for Bald Eagles, many of which reside on National Park Service land in this area (Wilson et al. 2017). The Southwest Alaska Inventory and Monitoring Network (SWAN) is comprised of five units of the National Park Service, including coastal parks Katmai National Park and Preserve (KATM), Kenai Fjords National Park (KEFJ), and Lake Clark National Park and Preserve (LACL) (Bennett et al. 2006, National Park Service 2018b, Figure 1). Along with Wrangell — St. Elias National Park and Preserve (WRST), which is part of the Central Alaska Inventory and Monitoring Network, these parks are home to large populations of breeding Bald Eagles (Wilson et al. 2017, National Park Service 2018c). Bald eagles in the parks are monitored annually by SWAN as part of their Vital Signs Monitoring Plan, which specifies the definition of vital signs monitoring as “the collection and analysis of repeated observations or measurements to evaluate ecological changes in the condition of park resources” (Bennett et al. 2006, Wilson et al. 2017).



Figure 1: Locations of Katmai National Park and Preserve (KATM), Kenai Fjords National Park (KEFJ), Lake Clark National Park and Preserve (LACL), and Wrangell — St. Elias National Park and Preserve (WRST) within the state of Alaska.

In the process of creating a Bald Eagle monitoring program for the SWAN, decision-makers missed key portions of framing the problem and designing objectives (Reynolds et al. 2016). Specifically, the sole objectives identified were to monitor status and trends of Bald Eagle populations. This led to a process by which monitoring methods were chosen based on current practices rather than a formal process to understand how monitoring could be used to learn about eagle ecology or support

management decisions. As a result, the parks currently collect data on Bald Eagles slightly differently from one another and are not able to use their data as effectively as possible. Along with annual estimates of nest occupancy and productivity, each park uses a different combination of the double-observer method (to account for imperfect detection of nests in area-frame counts) and dual-frame sampling (to provide a more rigorous estimate of nest abundance) (Haines and Pollock 1998, Nichols et al. 2000, Alpizar-Jara et al. 2005, U.S. Fish and Wildlife Service 2009). The differences between parks have led to 2 problems: 1) Some of the monitoring metrics (e.g., abundance metrics) are not collected at all parks; 2) regional comparisons are complicated by uncomplimentary estimates.

Kenai Fjords National Park has been conducting aerial surveys along the coast since 2009 using a double observer and dual frame method. Katmai National Park and Preserve has been surveying for Bald Eagles in the entire Naknek watershed since 2010, also using the double observer and modified dual frame method. Lake Clark National Park and Preserve, however, uses only a single observer and the list frame to conduct their surveys, but they have collected an abundance of data from all potential Bald Eagle habitat in the park since 1992 (Wilson et al. 2017). Wrangell — St. Elias National Park and Preserve monitors nesting Bald Eagle territories annually along the Copper River (National Park Service 2018a). This discrepancy between monitoring methods makes it more difficult for park managers to use Bald Eagles as indicators of environmental quality through wider population trends. Through flight surveys, SWAN parks currently monitor the following metrics: “mean number of pre-fledging chicks produced in nests with spring nesting activity,” “proportion of nests that are successful at producing at least one pre-fledging chick,” “total number of Bald Eagle nests,” “total number of nesting pairs,” and “proportion of nests that are used by Bald Eagles for reproduction” (Wilson et al. 2017). It is also important to note that, unlike SWAN parks, Wrangell — St. Elias National Park and Preserve calculates some of these metrics using Bald Eagle nesting territories, rather than individual nests. This inconsistency makes it difficult to examine and compare information between WRST and SWAN parks.

Despite the wealth of Bald Eagle monitoring data already collected in the parks, the scientists and managers cannot use data to make comparisons between parks and recognize larger, region-wide trends in populations. Bald eagle populations in the parks are relatively stable (Wilson et al. 2018), however there are various factors that affect Bald Eagles in these areas. According to expert panelists, the availability of salmon as a food source, suitable nesting sites, seasonal changes in prey species, potential oil spills, contaminants such as mercury, lead, and PCBs, suitability of weather conditions, and disturbance by humans may all have effects on Bald Eagles in Southwest Alaska National Parks. Since it is unlikely that there will be significant biological impacts to Bald Eagles as a result of single stressor, park managers must make decisions that balance both the Bald Eagle populations and park values (Gende et al. 2018, Wilson et al. 2018). It is important for parks to come to a consensus on appropriate monitoring metrics, timing of surveys, and the objectives that will underlie the Bald Eagle monitoring program.

Since Bald Eagle monitoring is ongoing and part of the vital signs monitoring program, it is not reasonable to postpone management or monitoring changes until experimental changes in monitoring

have been explored (Fackler et al. 2014). Instead, an adaptive approach, that aims to reduce scientific uncertainty in dynamic systems, will allow decision-makers to evaluate tradeoffs and use the current knowledge to make the monitoring program useful for making management decisions. An adaptive monitoring program should be based on a conceptual model of the system and should focus on addressing specific and well-defined questions (Lindenmayer and Likens 2009). The Delphi process will help to gather information about Bald Eagles in the Southwest Alaska system and the Bald Eagle monitoring program, so that managers can decide about how to best monitor Bald Eagles in these protected areas (Lyons et al. 2008, Fackler et al. 2014).

Structured decision-making is a transparent way to confront complex problems with multiple objectives, using group decision-making techniques to generate alternatives (Gregory et al. 2012). It provides a formal way for stakeholders to be involved in the decision-making process (Wilson and Arvai 2011). Structured decision-making can be achieved using many different techniques, and value-focused structured approaches have been shown to urge decision-makers to make more informed and better-quality decisions (Arvai et al. 2001). We employed the Delphi method for this project and used intensive surveys of expert opinion to create a more complete conceptual model of the system and gather information to create a consequence table for potential monitoring metrics, that will help parks to come to a reliable consensus on the most appropriate monitoring program for Bald Eagles in Southwest Alaska National Parks (Dalkey and Helmer 1963). In employing the Delphi process here, we are using it as part of a full structured decision-making process to inform monitoring goals, and not management decisions directly.

Originating at the end of the 1940's as part of a classified military defense project and named after the oracle at Delphi, the Delphi process facilitates collecting expert opinion to aid in decision-making when there is insufficient scientific information or contradicting information and opinions (Hasson et al. 2000, Landeta 2006). Based on a flexible methodology, and premise that a collective group belief is more reliable than that of a single expert, the Delphi process consists of a systematic series of questionnaires to guide a group of experts toward a decision or consensus opinion. The process includes controlled feedback, provided to panelists between rounds of questioning, which gives each participant the opportunity to consider the responses of other experts and change their own responses (Rowe and Wright 1999, Skulmoski et al. 2007, Steurer 2011). Along with this controlled feedback, essential features of a Delphi process are anonymity of panelists (at least in their responses) to reduce negative elements of group interaction, iteration of questions to encourage critical thinking, and statistical summaries of group response (Rowe and Wright 1999, Steurer 2011).

The objectives for this study are to: 1) Compile a comprehensive panel of experts who can provide reliable information about Bald Eagle monitoring in Southwest Alaska National Parks; 2) Elicit expert opinion about: important stressors that affect Bald Eagles, reliable and achievable monitoring metrics, and measurable objectives we can use as means objectives to refine the Bald Eagle monitoring program in Southwest Alaska National Parks; 3) Quantify metrics based on objective measures; and 4) Select monitoring metrics using a consequence table designed to evaluate the performance of each metric in terms of the specified means objectives outlined by the panel. At the end of this process, we will have compiled information to form a more complete picture of the Bald

Eagles in the Southwest Alaska system and Bald Eagle monitoring program in Southwest Alaska national parks. This will eventually lead to the optimization and standardization of Bald Eagle monitoring among these National Parks. Our approach demonstrates a mechanism that ensures that monitoring is “meaningful” and can inform science-based decision-making, as envisioned by Oakley et al. (2003).

Methods

After defining the problem, we selected an expert panel to respond to questionnaires and provide input, which we refer to as the “Bald Eagle Expert Panel.” As its name implies, the panel included eagle and raptor experts, as well as other scientist types and managers. These panelists were selected through purposive sampling, since their knowledge can be applied to this specific problem (Hasson et al. 2000). Many of these participants are involved with the SWAN. Additional participants were recruited to participate from the National Park Service, U.S. Fish & Wildlife Service, and South Dakota Game, Fish & Parks. The 18 panelists were gathered using a “snowball process.” This means that we generated an initial list of interested participants and gave them the task of suggesting additional experts who may be qualified or interested in participating (Eycott et al. 2011). We then contacted these new individuals, gave them background information about the process, and asked them to participate. This continued until no new names were suggested.

We conducted surveys in a Delphi process framework. In a typical Delphi process, the facilitator sends the expert panel a series of structured questionnaires (Figure 2; Heuer and Pherson 2011). Between each round of questioning, the experts receive a summarized report of panelist responses. They are permitted to change their own responses after reviewing the summary, and before the next questionnaire. This process continues until reasonable consensus is reached, or a sufficient amount of information has been collected (Skulmoski et al. 2007). The goal of the Delphi process is not only consensus among panelists or sufficient information collected, but also to highlight dissenting viewpoints and opinions, since acknowledgment of disagreement leads to overall better quality outcomes (Priem and Harrison 1995, Skulmoski et al. 2007, Steurer 2011).

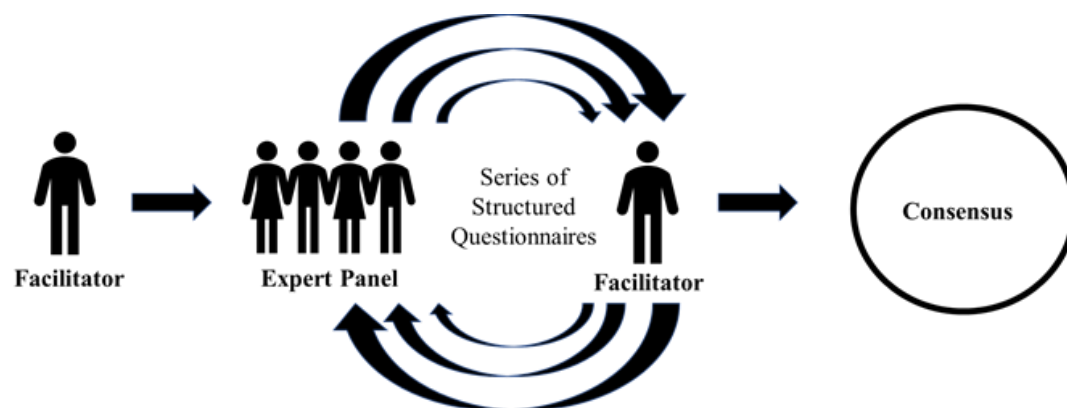


Figure 2. A representation of the Delphi process adapted from (Heuer and Pherson 2011). A facilitator gathers a panel of experts. These experts then receive a series of structured questionnaires, and are provided summarized feedback between each questionnaire. This process ends in reasonable consensus.

Additionally, there are several constraints on this project that make the Delphi process a favorable option. The expert panel consists of scientists and managers located throughout Alaska and in the contiguous United States. Frequent, face-to-face meetings are not feasible, due to time and cost limitations. The Delphi process can be conducted online and facilitates the communication process

among experts who are geographically distant and may have limited time (Linstone and Turoff 1975, Geist 2010). Occasional in-person communication helps to offset the criticism that the Delphi process lacks the ability to create natural and spontaneous conversation (de Loe 1995).

We conducted a series of four questionnaires distributed to panelists electronically (Figure 3). We sent Questionnaire 1 as a Microsoft Word document, which panelists completed and returned via email. For the subsequent questionnaires we used an online survey software package (SurveyMonkey.com). We gave panelists one month from the date the questionnaire was sent to complete the survey (Table 1). Panelists received several reminder emails to complete each questionnaire. After receiving questionnaire summaries, we gave panelists two weeks to contact the facilitator with any changes they would like to make to their responses. These deadlines were flexible and we gave panelists additional time to complete questionnaires if it was requested. Additionally, we conducted an in-person meeting on March 29, 2018 in Anchorage Alaska (in the time frame between Questionnaire 3 and Questionnaire 4), where we formulated means objectives for a future analysis of monitoring scenarios.

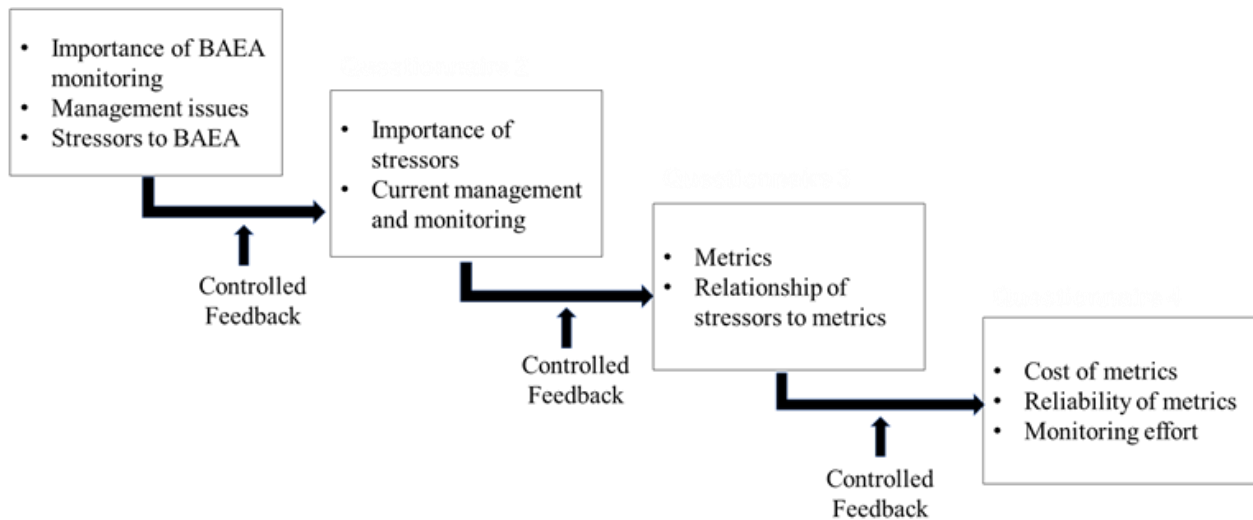


Figure 3. Outline of the general themes that were addressed in each of four questionnaires administered as part of the Delphi process used to evaluate and quantify stressors affecting Bald Eagle populations and metrics used to measure eagle populations. Panelists were given controlled feedback between each round of questioning.

Table 1. Number of panelist responses for each round of questioning are shown in this table. The percent response for each questionnaire is calculated using the number of responses and confirmed non-respondents. Percent Response is calculated using responses and confirmed non-responses.

Questionnaire	Q1	Q2	Q3	Q4
Responses	11	14	13	10
Responses + Confirmed Non-Respondents	12	15	14	12
Percent Response	66.7%	83.3%	77.8%	66.7%

We designed Questionnaire 1 as a tool to gather preliminary information and focus the panelists on the overall themes that would be covered during the Delphi process. Questionnaire 1 addressed several broad topics to gather important information to form a conceptual model of Bald Eagles in Southwest Alaska National Parks, which included: current management and potential management of Bald Eagles, importance of long-term Bald Eagle monitoring, and stressors that impact Bald Eagle populations in their management areas. We asked questions primarily in an open-ended manner, as not to stifle any thoughts or opinions of panelists in the early stages of the process. From Questionnaire 1 we identified a comprehensive list of 18 stressors that was used to develop subsequent questionnaires.

We designed Questionnaire 2 to build on the responses received from panelists in Questionnaire 1. The overall goals for this questionnaire were to elicit feedback on the importance of the 18 stressors on Bald Eagles (identified in Questionnaire 1) and to explore current monitoring and management for Bald Eagles in Alaska National Parks. Panelists ranked broad categories of stressors (created through qualitative data analysis of Questionnaire 1 responses) based on impact to Bald Eagles. Five categories were presented to them, and panelists were asked to rank these categories from most impact to least impact on Bald Eagles. Expert panelists also rated each of the 18 specific stressors on a 5-point scale from “Not important” to “Very Important.”

We designed Questionnaire 3 to further examine important stressors to Bald Eagles in the system, and to begin to address monitoring metrics. An additional goal for this questionnaire was to quantify a link between stressors and monitoring metrics. Panelists were asked to re-evaluate the most important stressors to Bald Eagles by ranking their top five stressors. Recognizing that the metrics provided different information about the overall health of the Bald Eagle population, we asked experts to rate the reliability of 15 monitoring metrics on a 5-point scale (1 = Extremely Unreliable; 2 = Not Reliable; 3 = Somewhat Reliable; 4 = Reliable; 5 = Extremely Reliable). We defined reliability as the ability of the metric (e.g. adult survival) to provide accurate and precise information about the health of the Bald Eagle population. Panelists were also asked to identify any additional monitoring metrics that were not included in the list. Panelists were then asked to select all monitoring metrics (of the original 15 metrics provided) that would respond to changes in each of the 18 stressors.

The purpose of Questionnaire 4 was to gather information about monitoring metrics suggested by panelists in Questionnaire 3. In this questionnaire, we combined four metrics meant to query the panelists’ willingness to trade-off information by measuring reproductive output several different ways into a single metric called “productivity.” We asked panelists questions about reliability and responsiveness of these new metrics, so that they could be combined with the metrics from Questionnaire 3. We also asked questions about the cost of conducting one year of monitoring for each metric. Panelists were given multiple choice options with cost ranges from \$0–5,000 to \$25,000+ (1 = \$0–5,000; 2 = \$5,000–10,000; 3 = \$10,000–15,000; 4 = \$15,000–20,000; 5 = \$20,000–25,000; 6 = \$25,000+). As an additional metric of cost, we asked experts to estimate the number of annual person days each monitoring metric would require.

We summarized survey results and presented the results to panelists after each survey using both qualitative and quantitative methods. For open-ended questions, we manually completed a qualitative

summary of questionnaire results by identifying broad themes and categorizing panelist responses. We displayed data graphically for several questions, using proportions of panelists whose responses corresponded to specific themes. To analyze the ranking of the five broad categories (Food Availability, Environmental Factors, Climate Change, Contaminants, and Disturbance), we used weighted averages based on panel responses. A ranking of 1 (e.g. most impactful) received the highest value of 5. A ranking of 2 received a value of 4. A ranking of 3 received a value of 3. A ranking of 4 received a value of 2, and a ranking of 5 received the lowest value of 1. Categories with higher weighted averages were evaluated as having more of an impact. For questions asking panelists which metrics are responsive to changes in stressors, panelists were permitted to choose more than one response. Therefore, we used frequency distributions to display results to panelists.

An additional component to this process was an in-person meeting with all available panelists. Attendees included those who were able to travel to Anchorage, AK on March 29, 2018, or video conference into the meeting. This meeting involved a presentation of the results collected to that point, as well as several hours for panelist discussion. We covered several topics of discussion, including current needs and desires for the Bald Eagle monitoring program, generating means objectives for choosing Bald Eagle monitoring metrics, and quantifying how the metrics relate to objectives. These steps were necessary for the next step of our research, which was to use a formal structured decision-making process to optimize the Bald Eagle monitoring program.

We synthesized information collected from questionnaires in several ways. First, we analyzed monitoring metrics based on their composition of reliability score (weighted average), cost score (weighted average), and estimate of effort (mean annual person days) to determine feasibility. We created a weighted scatterplot with cost on the x-axis, reliability on the y-axis, and effort designating the size of each point, and divided it into four sections based on cost and reliability.

We divided sections based on weighted average thresholds that correspond to multiple choice responses. We placed the threshold for Reliable vs. Unreliable at a weighted average value of 3.0, which corresponds to the multiple-choice response “Somewhat Reliable.” We drew a horizontal line on the weighted scatterplot to denote the reliability threshold. We placed the threshold for determining Low Cost vs. High Cost at the center of the range of weighted averages assigned to metrics by panelists (weighted averages of cost ranged from 3.0–6.0), which was 4.5. We drew a horizontal line on the weighted scatterplot to denote the cost threshold. We included mean effort in this compilation by altering the weights of each point in the weighted scatterplot. Unlike cost and reliability, we will not use effort specifically to exclude metrics, but it will be considered in any decisions that are made.

Finally, we combined important stressors and feasible monitoring metrics into an influence diagram, which incorporates the means objectives generated by panelists in the in-person meeting. We included all four of the means objectives in the influence diagram, based on information collected in the questionnaires. This influence diagram connects important stressors to Bald Eagles to feasible monitoring metrics. In this diagram, we used only the seven most important stressors to Bald Eagles, as identified by panelists. We included only monitoring metrics that were placed in the “Low Cost, Low Reliability” and “Low Cost, High Reliability” sections. The four means objectives: “Minimize

Cost,” “Maximize Accurate Information about Bald Eagles,” Minimize Effort,” and “Maximize Ability to Detect Change” were included in the diagram.

We created links between stressors and metrics based on data from panelists in Questionnaire 3 and Questionnaire 4, which identified monitoring metrics that will respond to changes in each of the stressors. A review of the definition of consensus in 100 Delphi studies showed that for processes using a percentage of panelists to define consensus, 75% was the median threshold (Diamond et al. 2014). Using this threshold, we drew links between each stressor and metrics that were identified by $\geq 75\%$ of panelists as being responsive to that stressor. We then connected monitoring objectives to relevant means objectives. For the objective “Minimize Cost,” we drew links from monitoring metrics that fell in the “Low Cost, Low Reliability” and “Low Cost, High Reliability” categories. We linked the objective “Minimize Effort” to monitoring metrics, based on metrics that have mean effort values of less than 20 annual person days, as estimated by panelists. We linked the objective “Maximize accurate information about Bald Eagles” to metrics that fell into the “Low Cost, High Reliability” category.

We linked feasible monitoring metrics with the fourth objective, “Maximize Ability to Detect Change,” by creating a contingency table that relates the sensitivity of feasible monitoring metrics to important stressors. Stressors are denoted in each of the rows, and feasible monitoring metrics are denoted in each of the columns. Each cell received a value of either 0 or 1. A cell at the intersection of a metric and a stressor receives a value of 1 if panelists rated that metric as responsive to the stressor. Alternatively, a cell receives a value of 0 if panelists rated that metric as non-responsive to a stressor. We consider metrics to be responsive to a stressor if $\geq 75\%$ of panelists rated it as such. The sum of each row denotes how many metrics may measure a change in each stressor. The sum of each column represents the sensitivity of each metric, or how responsive that metric is to changes in important stressors (Table 2). Metrics are assigned a link to the objective “Maximize Ability to Detect Change” if that metric is responsive to $>50\%$ (a sensitivity value of four or more) of the most important stressors to Bald Eagles.

Table 2. A contingency table relating stressors and metrics. Sensitivity is the number of stressors that measured each metric. The sum of each column shows sensitivity and the sum of each row shows the number of metrics that may measure each stressor.

Stressors	Total number of Bald Eagle nests	Changes in distribution (immigration/emigration) in the study area	Total number of nesting pairs	Proportion of nests used by Bald Eagles for Reproduction	Total number of chicks produced	Mean number of pre-fledging chicks produced in nests with spring nesting activity	Mean number of young produced per nesting pair	Proportion of nests that are successful at producing at least one pre-fledging chick	Number of Metrics that Measure Each Stressor
Availability of salmon	0	0	0	1	1	0	1	1	4
Nest site availability/suitable nesting location	1	1	1	1	0	0	0	0	4
Seasonal change in prey	0	1	1	0	1	1	1	1	6
Oil spills	0	1	0	0	0	0	0	0	1
Mercury, lead, and PCBs	0	0	0	0	1	1	1	1	4
Weather conditions	0	0	0	0	1	0	1	1	3
Human Disturbance	0	0	0	0	0	0	0	0	0
Sensitivity	1	3	2	2	4	2	4	4	-

Finally, we analyzed monitoring metrics using a consequence table. For this analysis, we combined four metrics: “Mean number of chicks fledged per nesting pair,” “Total number of chicks produced,” “Mean number of young produced per nesting pair,” and “Mean number of pre-fledging chicks produced in nests with spring nesting activity,” both of which we combined and reclassified as “Productivity.” This was done to reduce confusion among panelists and simplify the monitoring metrics. We listed each means objective vertically, along with corresponding performance measures. The full suite of monitoring metrics (including the new metric, “Productivity”) are displayed horizontally. In the intersecting cells, we listed the estimated consequences for each monitoring metric, as they relate to each means objective.

Inputs for the objective “Minimize Cost” are taken from panelist responses to questions asking about the annual cost for performing each metric. The values in the consequence table are the weighted averages calculated from multiple choice responses. Inputs for the objective “Minimize Effort” are taken from the mean of panelist responses to a question asking to estimate the annual number of person days each metric would require. Inputs for the objective “Maximize Ability to Detect Change” are a measure of sensitivity. This value is a count of the stressors on Bald Eagles, to which each metric is responsive. These values come from panelist responses to questionnaires and the original list of 18 stressors. Inputs for the objective “Maximize Accurate Information about Bald Eagles” are the weighted averages of panelist responses about the reliability of each metric.

Because we did not directly query the panel about a combined productivity metric, to gather inputs for the “Productivity” metric, we approximated values using another metric as a reference point. Specifically, we used the metric “Proportion of nests successful at producing at least one pre-fledging chick” as a reference point. This metric requires two May surveys, whereas productivity surveys can be achieved using only one May survey. Therefore, the cost and effort are slightly lower for “Productivity” than for “Proportion of nests successful at producing at least one pre-fledging chick,” and the ability to detect change and accurate information about Bald Eagles will be slightly higher. We asked panelists to readjust numbers in the consequence table that they felt did not accurately describe the performance of each monitoring metric.

We eliminated metrics by using the consequence table. If a metric performs better than another metric in all four means objective categories, the lesser performing metric is outcompeted. The lesser performing metric is subsequently eliminated from consideration for the monitoring program. This simplified the list of metrics that would be considered for the monitoring program

Results

Response rates for each questionnaire are shown in Table 1. Submitted responses to questionnaires, as well as confirmed non-responses were factored into the “Percent Response.” Because Delphi participants are permitted to be only observers if they choose, these confirmed non-responses were included in the response rate.

Qualitative data analysis of responses to the four questionnaires yielded several noteworthy points about Bald Eagle monitoring and management in Southwest Alaska National Parks. First, all panelists agreed on the importance of frequent Bald Eagle monitoring. Because the Bald Eagle is protected legally (by the Migratory Bird Treaty Act of 1918, Lacey Act of 1900, and Bald and Golden Eagle Protection Act of 1940), is an important indicator species in SWAN parks, and is valued by many park visitors, panelists agreed that it is important to monitor and protect this species. Although panelists agree that changes in Bald Eagle populations are likely to be slow and gradual (barring a catastrophic event or large point source contamination), several experts noted that less frequent monitoring (currently, monitoring occurs annually in SWAN parks) will make identifying trends in populations more difficult.

Panelists identified a list of 18 stressors that influence Bald Eagles in their management areas: availability of salmon, nest site availability/suitable nesting locations, seasonal changes in prey, oil spills, environmental contaminants (e.g., mercury, lead, and PCBs), weather conditions, human disturbance, eating lead-contaminated carcasses, increases in visitation, development, ocean acidification, loss of nests to wildfire and landslides, wind-generated power, retreat of glaciers, increase in flooding events, exotic diseases, marine debris, and illegal take of feathers. Panelists rated this extensive list of stressors by importance to come up with a simplified list of the seven most important stressors to Bald Eagles living on federally protected lands in Alaska. These are: availability of salmon, nest site availability/suitable nesting locations, seasonal changes in prey, weather conditions, environmental contaminants, oil spills, and human disturbance. Most panelists felt that this list will adequately explain the most likely cause of changes in the Bald Eagle population in SWAN parks, however several panelists mentioned that the possibility still exists for an unknown exotic disease or an undefined catastrophic event to impact the Bald Eagle population.

We began quantitative data analysis by examining five broad categories of stressors. Panelists (n = 13) were asked to rate the impact of broad categories of stressors that affect Bald Eagles in their respective management areas (Figure 4). Based on weighted averages calculated from panelist rankings, panelists considered food availability the most impactful category of stressors to Bald Eagles, followed by environmental factors, climate change, contaminants, and disturbance. Panelists rated human disturbance as having the lowest impact on Bald Eagles in the management areas represented by expert panelists.

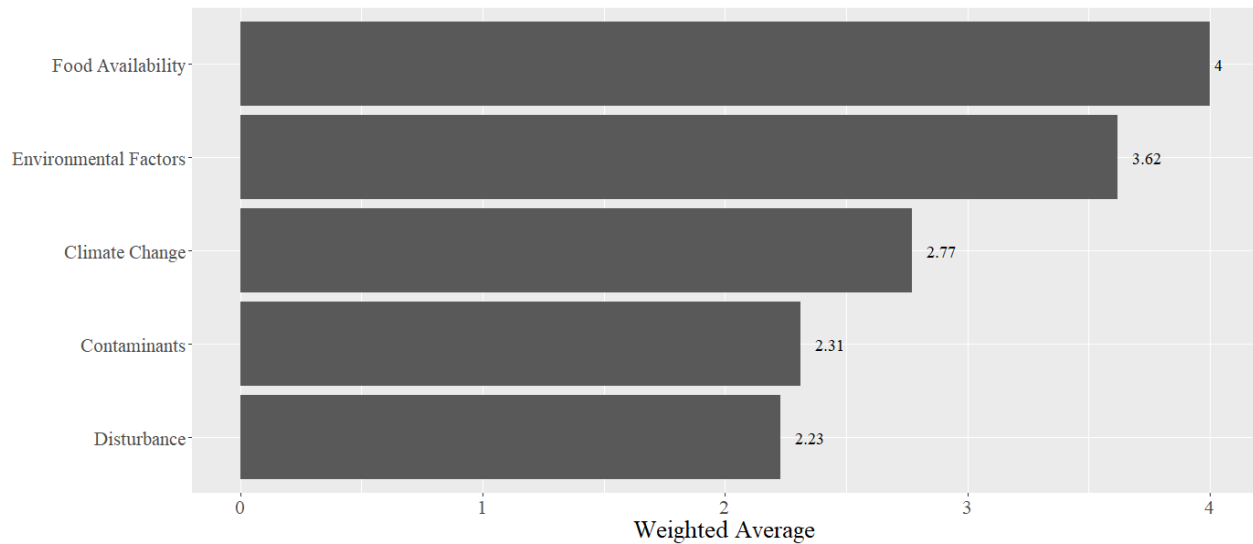


Figure 4. Weighted average of the impact of broad categories of stressors to Bald Eagles. Higher weighted averages represent categories of stressors that were rated by panelists as having more impact to Bald Eagles.

We analyzed reliability of monitoring metrics in terms of a weighted average of panelist response; higher weighted averages indicate higher reliability. Based on this measure, “Adult Survival” was rated as the monitoring metric with the highest reliability and “Total number of Bald Eagle nests” was assigned the lowest reliability score (Table 3). We also represented cost as a weighted average of panelist response, with higher weighted averages representing higher costs. “Abundance of Bald Eagles as determined by statewide aerial surveys” was rated as having the highest cost, and “Total number of Bald Eagle nests” was rated as the lowest-cost monitoring metric (Table 3). Effort is displayed as the mean number of annual person days that each monitoring metric would require. “Abundance of Bald Eagles as determined by statewide aerial surveys” is rated as requiring the most amount of effort and “Total number of Bald Eagle nests” was rated as having the lowest effort.

Table 3. Monitoring metric names, reliability scores, cost scores, and mean effort (estimated using annual person days). Reliability and Cost are given scores based on weighted averages from panelist responses. Effort is shown using mean annual person days, as estimated by panelists. Number of respondents (n) is denoted in each cell.

Label	Metric	Reliability	Cost	Effort
1	Total number of Bald Eagle nests	2.3 (n=11)	3.0 (n=5)	11.5 (n=4)
2	Changes in distribution (immigration/emigration) in the study area	2.8 (n=10)	4.4 (n=5)	26.7 (n=3)
3	Abundance at winter concentration sites	2.9 (n=10)	4.7 (n=3)	33.3 (n=3)
4	Total number of chicks produced	3.0 (n=12)	3.8 (n=5)	23.0 (n=4)

Table 3 (continued). Monitoring metric names, reliability scores, cost scores, and mean effort (estimated using annual person days). Reliability and Cost are given scores based on weighted averages from panelist responses. Effort is shown using mean annual person days, as estimated by panelists. Number of respondents (n) is denoted in each cell.

Label	Metric	Reliability	Cost	Effort
5	Proportion of breeding to non-breeding eagles	3.1 (n=10)	5.2 (n=5)	28.0 (n=3)
6	Nestling survival from hatching to fledging	3.3 (n=12)	4.6 (n=5)	31.3 (n=3)
7	Mean number of young produced per nesting pair	3.3 (n=12)	4.0 (n=5)	30.0 (n=4)
8	Mean number of pre-fledging chicks produced in nests with spring nesting activity	3.3 (n=12)	3.8 (n=4)	20.0 (n=3)
9	Proportion of nests used by Bald Eagles for reproduction	3.4 (n=12)	3.4 (n=5)	13.0 (n=4)
10	Proportion of nests that are successful at producing at least one pre-fledging chick	3.6 (n=12)	3.6 (n=5)	16.0 (n=4)
11	Mean number of chicks fledged per nesting pair	3.6 (n=12)	4.6 (n=5)	19.5 (n=4)
12	Abundance of Bald Eagles as determined by statewide aerial surveys	3.7 (n=10)	6.0 (n=4)	63.3 (n=3)
13	Total number of nesting pairs	3.8 (n=12)	3.8 (n=5)	12.0 (n=4)
14	Subadult survival	3.8 (n=12)	5.8 (n=5)	35.0 (n=4)
15	Adult survival	4.0 (n=12)	4.8 (n=5)	27.5 (n=4)

We plotted metrics based on Cost and Reliability and divided them into four categories: “Low Cost, High Reliability,” “High Cost, High Reliability,” “Low Cost, Low Reliability,” and “Low Cost, Low Reliability” (Figure 5). Monitoring metrics that fall into the “Low Cost, Low Reliability,” and “Low Cost, High Reliability” categories are considered feasible monitoring metrics. Feasible metrics include: “Total number of Bald Eagle nests,” “Changes in distribution (immigration/emigration) in the study area,” “Total number of chicks produced,” “Mean number of young produced per nesting pair,” “Mean number of pre-fledging chicks produced in nests with spring nesting activity,” “Proportion of nests used by Bald Eagles for reproduction,” “Proportion of nests that are successful at producing at least one pre-fledging chick,” and “Total number of nesting pairs.” We then evaluated whether metrics were sensitive to each of the seven important stressors. Arranging these data in a contingency table revealed that each metric was responsive to up to four stressors (Table 2).

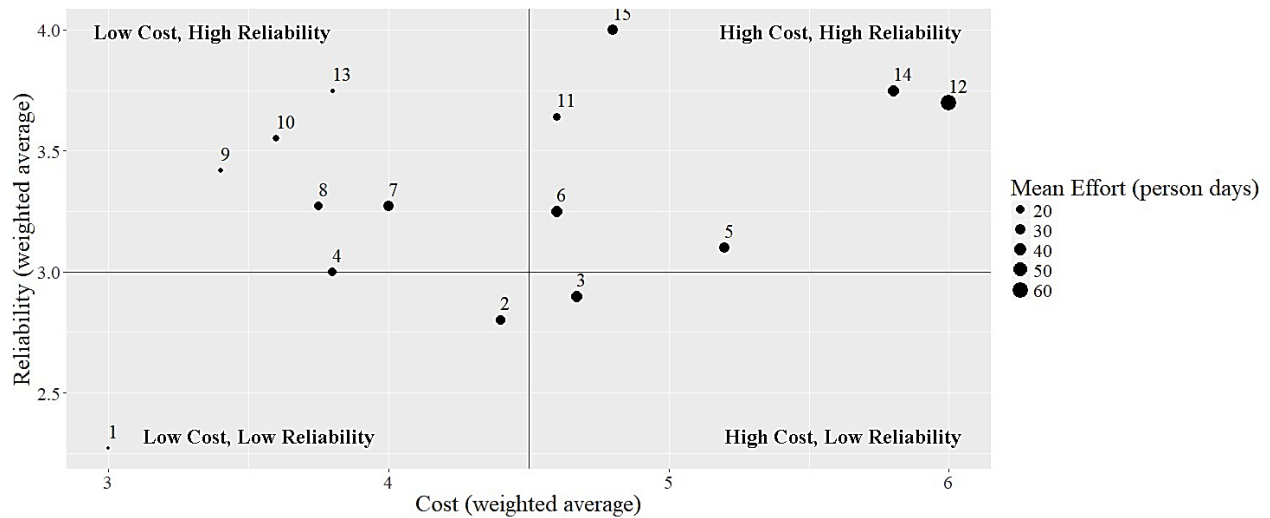


Figure 5. Scatter plot of cost and reliability of Bald Eagle monitoring metric scores. Values are a weighted average of panelist Responses. Reference labels are defined in Table 3. The plot is divided into four categories to illustrate tradeoffs between cost and reliability. 1 = Total number of Bald Eagle nests, 2 = Changes in distribution (immigration/emigration) in the study area, 3 = Abundance at winter concentration sites, 4 = Total number of chicks produced, 5 = Proportion of breeding to non-breeding eagles, 6 = Nestling survival from hatching to fledging, 7 = Mean number of young produced per nesting pair, 8 = Mean number of pre-fledging chicks produced in nests with spring nesting activity, 9 = Proportion of nests used by Bald Eagles for reproduction, 10 = Proportion of nests that are successful at producing at least one pre-fledging chick, 11 = Mean number of chicks fledged per nesting pair, 12 = Abundance of Bald Eagles as determined by statewide aerial surveys, 13 = Total number of nesting pairs, 14 = Subadult survival, and 15 = Adult survival.

The in-person meeting with available expert panelists generated more in-depth discussion and covered complex topics. The most significant information gathered from this meeting was the list of four means objectives that panelists felt should be used to choose metrics for the monitoring program. The means objectives are specific, measurable, relevant, mutually exclusive, and collectively exhaustive. Our objectives hierarchy (sensu Conroy and Peterson 2013) was simple, so we did not break objectives into fundamental and means objectives. Our objectives include: minimize the cost of the monitoring program, minimize the effort of the monitoring program, maximize the amount of accurate information collected about Bald Eagles, and maximize ability to detect change in Bald Eagle populations. Panelists also created a separate set of metrics that will be used to assess whether those means objectives are being met. Cost will be measured in dollars, annually. Effort will be measured in number of annual person days, that include office time that is not usually incorporated into dollar estimates. Estimates of effort will include field preparation, field surveys, and data handling. Panelists suggested that the ability to detect change should be measured in terms of minimum detectable change. As a proxy for this metric, we used the sensitivity score to determine ability to detect change. Panelists suggested that accurate information about eagles can be measured using abundance, productivity, and dynamics. As a surrogate for these more complicated metrics, we used a reliability score collected from panelists. Although not included as a means

objective, panelists felt that an underlying objective is the ability to integrate information about Bald Eagles across parks. These results are visually represented by an influence diagram (Figure 6).

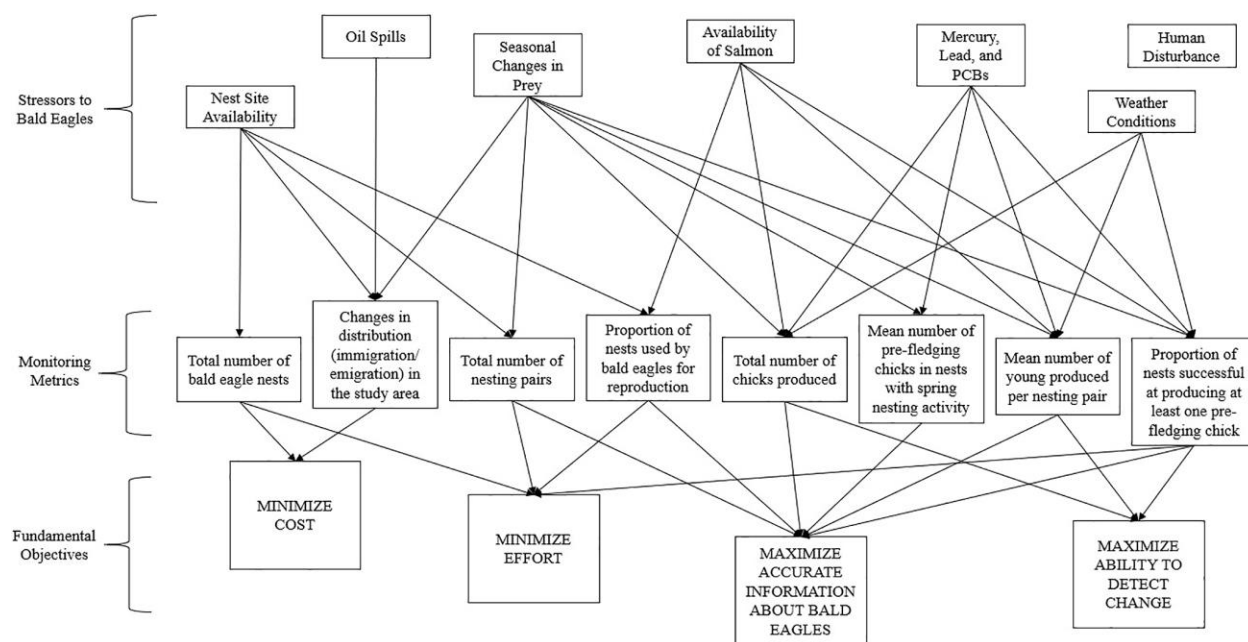


Figure 6. An influence diagram linking the most important stressors to Bald Eagles in Southwest Alaska National Parks to feasible monitoring metrics and means objectives, defined by the expert panel. Stressors are connected to feasible monitoring metrics, based on panelist opinion of responsiveness. Metrics are connected to means objectives based on cost, effort, reliability, and sensitivity.

The consequence table summarizes the compiled information from the Delphi survey. The best performing metric for the objective “Minimize cost” (Total # Bald Eagle nests) has a weighted average cost value of 3.0. The worst performing metric in this category (Abundance of Bald Eagles as determined by statewide aerial surveys) has a weighted average cost value of 6.0. The best performing metric for the objective “Minimize Effort” (Total # Bald Eagle nests) has a mean annual effort value of 11.5 days. The worst performing metric in this category (Abundance of Bald Eagles as determined by statewide aerial surveys) has a mean annual effort value of 63.3 days. The best performing metric for the objective “Maximize ability to detect change” (Changes in distribution) has a sensitivity value of 9.0. The worst performing metrics in this category (Abundance at winter concentration sites; Proportion of breeding to non-breeding eagles) have sensitivity values of 0. The best performing metric for the objective “Maximize accurate information about Bald Eagles” (Adult survival) has a weighted average reliability value of 4.0. The worst performing metric in this category (Total # Bald Eagle nests) has a weighted average reliability value of 2.3 (Table 4).

Table 4. The consequence table used to determine which metrics should remain in consideration for the Bald Eagle monitoring program. Each metric was assigned a score for the four means objectives, based on panelist responses. Cells that have the “best” value for a means objective are shaded with gray fill, and cells with the “worst” values for a means objective are shaded with black fill. Metrics that are outcompeted by other metrics in all four categories are considered “Dominated” and are thus eliminated from further consideration

Objective	Performance measure	A. Total # of Bald Eagle nests	B. Changes in distribution	C. Abundance at winter concentration sites	D. Productivity	E. Proportion of breeding to nonbreeding eagles	F. Nesting survival from hatching to fledging	G. Proportion of nests used by Bald Eagles for reproduction	H. Proportion of nests successful at least one pre-fledging chick	I. Abundance of bald eagle as determined by statewide surveys	J. Total # nesting pairs	K. Subadult survival	L. Adult survival
Minimize cost	Weighted average of annual cost	3.0 ^a	4.4	4.7	3.5	5.2	4.6	3.4	3.6	6.0 ^b	3.8	5.8	4.8
Minimize effort	Mean # annual person days	11.5 ^a	26.7	33.3	15.0	28.0	31.3	13.0	16.0	63.3 ^b	12.0	35.0	27.5
Maximize ability to detect change	Sensitivity	5.0	9.0 ^a	0.0 ^b	5.5	0.0 ^b	1.0	3.0	5.0	8.0	2.0	5.0	6.0
Maximize accurate information about Bald Eagles	Mean average reliability	2.3 ^b	2.8	2.9	3.7	3.1	3.3	3.4	3.6	3.8	3.7	3.8	4.0 ^a
Dominated by ^c	n/a	–	–	D,F,G,H,J	–	D,G,H,J,I	D,G,H,J	–	D	D,K,L	–	L	–
Eliminate	n/a	No	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	No

^a Cells that have the “best” value for a means objective (also shaded with gray fill).

^b Cells with the “worst” values for a means objective (also shaded with black fill).

^c The letters used here correspond to the prefix letter values assigned to the metrics described in the third through fourteenth columns in the in the first row (letters A-L), and indicate that column metric is outcompeted by, or dominated by, the other metrics listed in that cell.

We used the consequence table to generate a list of monitoring metrics that remain, after elimination of dominated metrics. The metrics that withstood the elimination process and remain in consideration for the monitoring program include “Total number of Bald Eagle nests,” “Changes in distribution,” “Productivity,” “Proportion of nests used by Bald Eagles for reproduction,” “Total number of nesting pairs,” and “Adult survival.”

Our graphical analysis of monitoring metrics and the analysis of metrics using the consequence table yielded similar lists of feasible monitoring metrics. Both analyses identified “Total number of Bald Eagle nests,” “Changes in distribution,” “Proportion of Bald Eagle nests used for reproduction,” and “Total number of nesting pairs” as feasible metrics. Additionally, three of the four metrics that were combined to form “Productivity” were considered feasible in the graphical analysis, and “Productivity” was considered feasible through the consequence table analysis. There were only two inconsistencies between these analyses. The graphical analysis of metrics identified “Proportion of nests that are successful at producing at least one pre-fledging chick” as a feasible metric, while the consequence table showed this metric outcompeted by the “Productivity” metric. However, these metrics are similar and the information for “Proportion of nests that are successful at producing at least one pre-fledging chick” is completely contained in the information for “Productivity.” The consequence table identified “Adult survival” as a feasible metric, while the graphical analysis eliminated this metric based on cost.

Discussion

When Bald Eagle monitoring began in the SWAN, key parts of problem-framing were skipped, leading to a situation where parks conducted monitoring differently, complicating efforts to compare Bald Eagle status and trends regionally. Here, we used the Delphi process to gather information from a panel of experts about the stressors that affect Bald Eagles, the metrics that may be used to monitor Bald Eagle populations, and the means objectives that can be used to choose a common long-term monitoring program in the SWAN. By linking this information, we can better conceptualize the system, and evaluate alternatives that will ultimately lead to an optimal monitoring program that can be standardized among Southwest Alaska National Parks. In a subsequent step, decision-makers will choose the optimal monitoring scenario, which balances the means objectives of minimizing cost and effort, maximizing the information collected, and maximizing the ability to detect change (Kolstrom et al. in review).

Using the Delphi process, we collected information about stressors that affect Bald Eagles, as well as the monitoring metrics that may be used to gain a more complete picture of the system. The topics outlined through qualitative data analysis highlight the commitment of panelists to forming an optimal Bald Eagle monitoring program that will allow the SWAN parks to detect changes in Bald Eagle populations in a timely fashion. Bald Eagles are subject to many stressors and the responses to these questionnaires emphasized the need to clarify how a long-term monitoring program would be responsive to changes likely to affect their populations.

Consistent with the findings that prey availability (especially early in the breeding season) influences reproductive success of Bald Eagles in Alaska, panelists rated food availability as the most impactful, broad influence on Bald Eagle populations (Hansen and Hodges 1985, Steidl et al. 1997). Despite the fact that visitation is an extremely common disturbance in some protected areas (Gende et al. 2018), panelists rated human disturbance as the least important broad category of stressors to Bald Eagles. Several panelists mentioned that visitor impact in SWAN parks is mostly localized and not likely to have real, lasting effects on Bald Eagle populations in the parks. However, protecting Bald Eagle nests from human disturbance using buffer zones has been shown to influence population-level responses such as increased nest occupancy and greater reproductive success (Cruz et al. 2018).

Panelists were asked to consider a large list of monitoring metrics. This list included the metrics that are currently monitored: “mean number of pre-fledging chicks produced in nests with spring nesting activity,” “proportion of nests that are successful at producing at least one pre-fledging chick,” “total number of Bald Eagle nests,” “total number of nesting pairs,” and “proportion of nests that are used by Bald Eagles for reproduction.” It is important to note that these currently monitored metrics do not completely correlate with the most reliable metrics, as rated by panelists. In fact, one of these currently monitored metrics, “total number of Bald Eagle nests” was rated by panelists as the least reliable monitoring metric. This comparison of currently monitored metrics with most reliable metrics accentuates the need to re-evaluate the current monitoring plan, to ensure that scientists and managers are gaining an accurate and complete picture of the status of Bald Eagle populations in the parks. It is also important to note that several of the most reliable metrics were also rated as the most

expensive. For example, monitoring adult survival and subadult survival would be highly reliable, but since parks are limited by cost and both of these metrics fall into the “high cost” category, it may not be feasible for parks to begin monitoring survival of adult and subadult Bald Eagles. It may also be important to emphasize that all metrics in the “High Reliability, Low Cost” category are already monitored by parks, indicating that compromises may already be occurring in the monitoring program.

Experts considered metrics in both “Low Cost, High Reliability” and “Low Cost, Low Reliability” categories as feasible monitoring metrics. Although “Low Cost, Low Reliability” metrics are not ideal, it can be argued that for very little or minimal additional cost, it is better to collect more information on Bald Eagles. For example, “total number of Bald Eagle nests” is low in reliability but is most likely a metric that can be easily calculated during flight surveys for additional metrics. Through comparisons of cost and reliability, with consideration to effort, the list of feasible metrics includes: “Total number of Bald Eagle nests,” “Changes in distribution (immigration/emigration) in the study area,” “Total number of chicks produced,” “Mean number of young produced per nesting pair,” “Mean number of pre-fledging chicks produced in nests with spring nesting activity,” “Proportion of nests used by Bald Eagles for reproduction,” “Proportion of nests that are successful at producing at least one pre-fledging chick,” and “Total number of nesting pairs.” Although mean number of annual person days required for each monitoring metric was included as a measure of effort, this measure was not used to exclude metrics from consideration. This is due to small sample sizes of respondents for questions regarding effort. More accurate estimates of the effort needed to conduct each monitoring metric may be needed to determine the feasibility of metrics and exclude high-effort metrics from consideration.

An important step in structured decision-making is sketching the decision to visualize the problem at hand (Gregory et al. 2012). By creating an influence diagram that connects important stressors to Bald Eagles in Southwest Alaska, monitoring metrics that may be used to detect changes in populations, and means objectives generated by expert panelists, we can more clearly picture the complex and interconnected nature of this problem. If Bald Eagles were to experience a decline in SWAN parks that is detected by monitoring metrics, scientists and managers may be able to use this influence diagram to link the decline to possible causes and ensure that they are upholding the underlying objectives of the monitoring program. However, the graphical representation would require the linkages to be parameterized in order to establish testable hypotheses of system dynamics.

The means objectives of “minimize cost” and “minimize effort” were connected to monitoring metrics through information collected from panelists about the cost and effort required for each metric. Although cost and effort seem to be linked, the panel viewed them as separate, because much of the work associated with monitoring (e.g., survey planning, data management, and data analysis) are not factored into standard costs estimates that are dominated by aircraft costs. The objective “maximize accurate information about Bald Eagles” was linked to monitoring metrics through information collected about reliability of the monitoring metrics. More reliable metrics will provide more accurate information about Bald Eagle populations in SWAN parks. The objective “maximize ability to detect change” was connected to monitoring metrics through the sensitivity of those metrics

to changes in important stressors. It is important to note that no single monitoring metric achieves all four of the means objectives that are important to panelists. Instead, a suite of metrics was evaluated for gathering accurate information about Bald Eagles and maximizing the ability to detect change, while conserving money and time. Panelists then rate means objectives in order of importance, so that optimization techniques may be used to build a monitoring program.

Panelists rated “Human Disturbance” as one of the most important stressors to Bald Eagles in Southwest Alaska, however this stressor had no links to the feasible monitoring metrics. By human disturbance, we mean disturbance at nesting sites through anthropogenic activity. The National Park Service is responsible for both protecting resources and providing opportunities to human visitors, and though human activity may not affect the sustainability of a population, parks may still manage to uphold their values by reducing human impact (Gende et al. 2018). Human disturbance has the potential to be a significant issue to Bald Eagles nesting in the parks. Comments from several panelists and literature review illustrate that managing for human activity does have the potential to affect breeding success of Bald Eagles (Cruz et al. 2018). Many studies have documented both direct and indirect effects of human activity on raptors (Richardson and Miller 1997). Grubb and King (1991) documented Bald Eagles flushing in response to human activity and Stalmaster and Newman (1978) note the negative effects that humans can have on Bald Eagles, in both their distribution and behavior.

The consequence table allowed us to remove metrics that are not able to compete with other metrics and streamline the list of possible monitoring metrics into a smaller, more feasible list to be considered. This list of metrics matches closely the list of currently monitored metrics, except for the metric “Proportion of nests successful at producing at least one pre-fledging chick.” This metric is currently monitored, however was outcompeted in the consequence table (Table 4). This indicates that better information can be collected for fewer resources by a different metric, thus eliminating the need for this metric. This may be considered by SWAN when reevaluating their monitoring program.

Sample size of respondents is one of the limiting factors in the statistical analysis of the results of our Delphi process. There is no set number of panelists that should be recruited for a typical Delphi process, but the expert panel should provide a representative sample for the specific question being asked (Steurer 2011). Boje and Murnighan (1982) found that in their study of two modified Delphi processes, increased group size did not affect the accuracy of group response in a structured setting. We felt that our Bald Eagle expert panel, consisting of 18 scientists and managers, was adequate for this Delphi process. However, response rates varied throughout the process. We expect that survey fatigue contributed to a drop in the response rate, especially for more complex and detailed questions. Survey fatigue has been studied for many years, and usually, longer surveys correlate with lower response rates (Porter et al. 2004). This limited our ability to statistically analyze panelist response, and caution should be used when attempting to generalize some of the results of this study to other sites. It has been demonstrated that rates of drop-out may be high in later stages of Delphi processes (Day and Bobeva 2005), which we experienced during our Delphi process.

Although Questionnaire 4 had a similar overall response rate to the other questionnaires, there was a significant drop in response rates for the last several questions in this questionnaire. The lack of

responses may be attributed to several factors. First, these questions elicited information that was perhaps more difficult and time-consuming for panelists. Second, these questions asked for specific information about Southwest Alaska National Parks. Several panelists who were not affiliated with a specific National Park in Southwest Alaska may have skipped these questions due to lack of knowledge about the specific system. Third, since panelists that are directly affected by the outcome of the Delphi process are more apt to participate and be engaged in the process, those panelists that were not affected may have chosen not to participate in these questions (Hasson et al. 2000).

Additionally, linguistic uncertainty contributed to some confusion among panelists. Productivity is an imperfect surrogate of true population demographics, because it is impossible to verify nest initiation or successful fledging using aerial surveys. It is an inherently flawed demographic index that combines elements of fecundity and recruitment. There are several methods used to obtain this metric, all of which use the term productivity. Ambiguity, and under-specificity in terminology used to describe productivity metrics contributed to confusion among panelists (Regan et al. 2002, McIntyre and Schmidt 2012). We were unclear in our descriptions of metrics and did not communicate our reasons for describing “productivity” several ways, which caused misunderstandings about the information being collected from the monitoring metric. Although our aim was to explore productivity metrics in various ways that would require different amounts of survey effort, it was not communicated clearly enough to our panel. Ultimately, we were compelled to combine these slightly different metrics into a single measure of productivity. Future research using these productivity measures may be improved by clarifying the assumptions and bias associated with various productivity metrics and population estimators.

By using the Delphi process, we gathered information about the seven most important stressors to Bald Eagles on federally protected land in Alaska. We queried a panel of experts about various monitoring metrics and compiled a list of metrics that are feasible based on cost, reliability, and effort. Finally, we linked important stressors to responsive metrics, based on panelist opinion, and identified how each monitoring metric would help to achieve the means objectives of this long-term Bald Eagle monitoring plan. In the second phase of our project, metrics from the consequence table were weighted using swing weights so that metric performance could be compared directly. We then developed alternative monitoring scenarios that incorporate different metrics used and vary the timing and scope of the monitoring efforts. To complete the process of selecting the best monitoring program for SWAN parks, we used a Bayesian Decision Net to compare each monitoring scenario, based on how well it achieves the means objectives identified by the panel and the overall utility of each monitoring scenario (Kolstrom et al., in review). This analysis facilitated a better-informed decision that uses components of structured decision-making to combine scientific knowledge and human judgement (Gregory et al. 2012).

Note: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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Appendix A

This appendix shows the questions asked in the four questionnaires that were used for this study. The questionnaires below are provided for transparency and information purposes only and should not be filled-out here.

Questionnaire 1

Thank you for agreeing to participate in this Delphi process to optimize and standardize the Bald Eagle monitoring programs in Southwest Alaska National Parks. Your opinions and insights will be extremely helpful in identifying an optimal sampling regime. Please note that your participation in any/all parts of this process is voluntary and you may discontinue participation at any point during the process.

Specifically, we need your help to identify the most useful information in better understanding Bald Eagle populations and trends, such as the metrics that will be most useful in identifying long-term trends in Bald Eagle populations, how to identify significant population changes, and key uncertainties of current monitoring objectives.

Attached is the first of a series of questionnaires designed to seek your input on these questions. Please be as detailed as possible in your responses. **We are requesting that your responses be sent back to us by May 17, 2017.** Your contributions will remain anonymous to other participants. After this first round of questioning is complete, your responses will be summarized and made available for review by all participants. We will then send a list of several follow-up questions. You will then receive a second questionnaire, and this iterative process will continue until reasonable consensus has been reached.

Please do not hesitate to contact me with any questions, comments, or concerns. Thank you once again for your participation in this process.

Sincerely,
Rebecca Kolstrom
South Dakota State University

1a) What are some of the most prominent management issues in your management area? Do any of these management issues relate to Bald Eagles/Bald Eagle populations? In what seasons are these management decisions most important?

Click or tap here to enter text.

1b) How important is a long-term Bald Eagle monitoring program to your overall program mission? Please rate your response and provide any explanation you feel necessary (check one option).

- ☐ Not at all important
- ☐ Slightly important

- ☐ Important
- ☐ Fairly Important
- ☐ Very important

2) Please describe various factors (environmental, anthropogenic, etc.) that affect Bald Eagle populations in your management area. What types of influences affect Bald Eagle populations?

Click or tap here to enter text.

3) The IUCN Red List defines a species as vulnerable if there is “an observed, estimated, inferred, or suspected reduction of at least 20% over the last 10 years,” and this is the current standard for monitoring detection of Bald Eagle population changes in SWAN parks.

Is this an appropriate standard to apply to Bald Eagles in SWAN parks? What should be the threshold to trigger conservation action for Bald Eagles in SWAN parks?

Click or tap here to enter text.

4) Are Bald Eagle populations more likely to change slowly or catastrophically in response to stressors (including those that you listed in Question 2)? How quickly do you want to know that populations are changing? Is 10 years, as outlined in the IUCN standards, an adequate amount of time to detect management issues that may arise on NPS lands?

Click or tap here to enter text.

5) The following is a list of current participants in this Delphi Process.

- Dr. Dave Payer (NPS)
- Dr. Joel Reynolds (NPS)
- Laura Phillips (NPS)
- Dr. Carol McIntyre (NPS)
- Dr. Amy Miller (NPS)
- Dr. Tammy Wilson (NPS)
- Dr. Margaret MacCluskie (NPS)
- Dr. Joshua Schmidt (NPS)
- Dr. Troy Hamon (NPS)
- H. Sharon Kim (NPS)
- Timothy Mullet (NPS)
- Buck Mangipane (NPS)
- Judy Putera (NPS)

- Mary Hake (NPS)
- Tim Shepherd (NPS)
- Eileen Dowd Stukel (South Dakota GFP)
- Dr. Steve Lewis (USFWS)

Are there any individuals you feel should be included or would like to be included on this expert panel? Please include their contact information.

[Click or tap here to enter text.](#)

Questionnaire 2

Thank you for your participation in the second round of questioning for the Bald Eagle Expert Panel Delphi Process. We very much value your input and insights, and appreciate your thoughtful responses. Please note that your participation in in any/all parts of this process is voluntary and you may discontinue participation at any point during the process.

Questionnaire 2 is designed to gather more specific information about the stressors that affect Bald Eagles and Bald Eagle populations. These questions are based on the responses that were received from Questionnaire 1, and your answers will provide useful information that will aid in the process of identifying an optimal sampling regime. Please complete these questions to the best of your ability and feel free to add any additional comments that you feel would be helpful or pertinent.

Just as in the first round of questioning, your contributions will remain anonymous to other participants, but a summary of these results will be sent to the Bald Eagle Expert Panel for review after responses to Questionnaire 2 are received and analyzed. We are requesting that your responses to Questionnaire 2 be submitted by September 18, 2017.

As always, do not hesitate to contact me with questions, comments, or concerns. Thank you once again for your participation.

Best,
Rebecca Kolstrom
South Dakota State University

1) Please enter your name.

[Click or tap here to enter text.](#)

Ranking Stressors

2) The following are categories of stressors that affect bald eagles, as outlined by panelists in Questionnaire 1. Please rank the following types of stressors in order of impact to bald eagles in your management area (1 = most impactful, 5 = least impactful). If you have additional comments, please submit them in the comment box in Question 3.

[Choose an item.](#) Environmental factors

Choose an item.	Climate change
Choose an item.	Food availability
Choose an item.	Contaminants
Choose an item.	Disturbance

3) Use this space to enter any comments.

Click or tap here to enter text.

Evaluating Stressors

The following are 18 individual stressors that affect bald eagles, as outlined by panelists in Questionnaire 1. Please rate these stressors, as they relate to your management area, based on: 1) Importance for bald eagles and 2) Importance for monitoring.

Please rate each item as follows by selecting a response for each evaluation per each individual stressor:

Importance for Bald Eagles: 1 = Not at all important to 5 = Very important; No Opinion

Importance for Monitoring: 1 = Not at all important to 5 = Very important; No Opinion

Add any comments you feel necessary in the comment box.

4) Nest site availability/suitable nesting locations

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

5) Weather conditions

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

6) Loss of nests to wildfire and landslides

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

7) Increase in flooding events

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

8) Retreat of glaciers

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

9) Seasonal changes in prey fish

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

10) Availability of salmon

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

11) Eating lead-contaminated carcasses

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

12) Ocean acidification

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

13) Mercury, lead, and PCBs

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

14) Disturbance at winter concentration sites and during nesting

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

15) Marine debris

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

16) Wind-generated power

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

17) Development

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

18) Increases in visitation (vessel traffic and visitor use)

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

19) Illegal take of feathers (leading to disturbance and/or illegal killing)

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

20) Oil spills

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

21) Exotic diseases

Importance for Bald Eagles: Choose an item.

Importance for Monitoring: Choose an item.

Additional Comments here:

Click or tap here to enter text.

Evaluating Time Frames for Detection

For each of the stressors listed below, please select one or more time frames that would be suitable time frames for detection of a change in the stressor. These time frames were listed by panelists in Questionnaire 1. You may select more than one option. Please add any comments you feel necessary.

Select suitable time frames for detection.

Nest site availability/suitable nesting location: Choose an item.

Weather conditions: Choose an item.

Loss of nests to wildfire and landslides: Choose an item.

Increase in flooding events: Choose an item.

Retreat of glaciers: Choose an item.

Seasonal changes in prey fish: Choose an item.

Availability of salmon: Choose an item.

Eating lead-contaminated carcasses: Choose an item.

Ocean acidification: Choose an item.

Mercury, lead, and PCBs: Choose an item.

Disturbance at winter concentration sites and during nesting: Choose an item.

Marine debris: Choose an item.

Wind-generated power: Choose an item.

Development: Choose an item.

Increases in visitation (vessel traffic and visitor use): Choose an item.

Illegal take of feathers (leading to disturbance and/or illegal killing): Choose an item.

Oil spills: Choose an item.

Exotic diseases: Choose an item.

Add any comments you feel necessary

Click or tap here to enter text.

Management and Monitoring Decisions

For any of the stressors listed in the previous questions, describe any management actions/decisions that might be influenced by significant changes (increase/decrease) in the stressor. Additionally, list any monitoring data that is currently being collected or that could potentially be collected to measure any of these stressors.

Click or tap here to enter text.

Questionnaire 3

Thank you for participating in Questionnaire 3 of the Bald Eagle Expert Panel. This questionnaire will focus on linking potential metrics with eagle populations. Please call or email me with any questions or concerns.

Thank you,
Rebecca Kolstrom
rebecca.kolstrom@sdstate.edu

Please enter your name.

Click or tap here to enter text.

Ranking Important Metrics

The following graph shows the results of a question from Questionnaire 2. Panelists were asked to rate various stressors based on their importance for bald eagles. The numbers at the end of each row represent the weighted average of panelist scores. Higher weighted averages indicate stressors that are more important for Bald Eagles.

After reviewing these data, please choose (based on your own opinion) the six most important stressors for bald eagles. For each ranking position (1-6), choose a stressor from the dropdown list. 1 = most important stressor for bald eagles; 6 = sixth most important stressor for bald eagles.

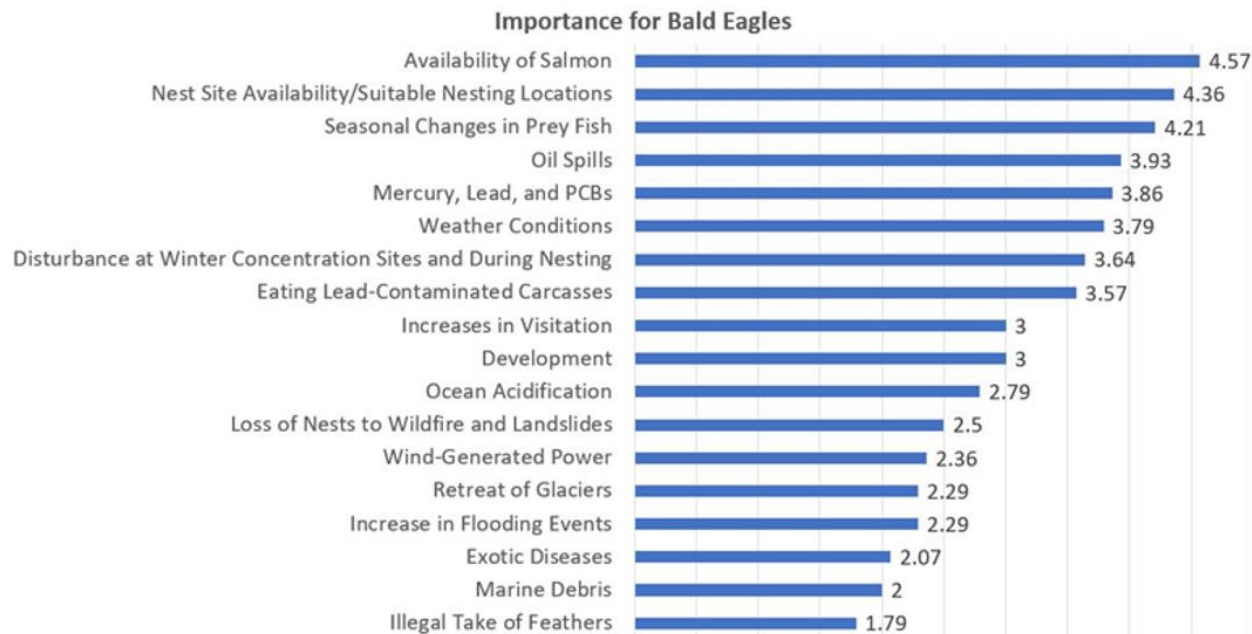


Figure Questionnaire 3-1. Stressors potentially effecting bald eagle populations in Alaska, USA. The expert panelists scored stressors in questionnaire 2 according to their perceived importance for effecting bald eagle populations. The results are shown here ranked by mean importance score. Higher numbers indicate a potentially larger importance of that stressor for determining bald eagle population dynamics.

For each ranking position (1-6), choose the appropriate stressor from the dropdown menu.

1 (Most Important Stressor for Bald Eagles) Choose an item.

2 Choose an item.

3 Choose an item.

4 Choose an item.

5 Choose an item.

6 (Sixth Most Important Stressor for Bald Eagles) Choose an item.

Reliability of Population Metrics

There are many ways to measure changes in bald eagle populations. Some of the most common are listed below, using descriptive language for metrics to avoid misinterpretation of terminology. Please rate the following metrics based on reliability.

3. Which metrics will provide reliable evidence of changes in bald eagle populations? For each metric, rank its reliability on a scale from Extremely Unreliable to Extremely Reliable.

Total number of Bald Eagle nests: Choose an item.

Proportion of nests used by bald eagles for reproduction: Choose an item.

Proportion of nests that are successful at producing at least one pre-fledging chick: Choose an item.

Mean number of pre-fledging chicks produced in nests with spring activity: Choose an item.

Mean number of young produced per nesting pair: Choose an item.

Total number of nesting pairs: Choose an item.

Total number of chicks produced: Choose an item.

Nesting survival from hatching to fledging: Choose an item.

Sub-adult survival: Choose an item.

Adult survival: Choose an item.

Additional Metrics

4. Please provide a list of additional metrics, not mentioned in the previous question, that would provide indications of changes in bald eagle populations.

[Click or tap here to enter text.](#)

Demonstrating Empirical Relationships

Successful biological monitoring depends heavily on demonstrating that an attribute has a reliable, empirical relationship with a population metric.

We want to identify which of the bald eagle population metrics will respond to changes in the following stressors, which were identified by the panel. Use your knowledge of bald eagle biology and life history to identify any metrics that will measure a population response to each stressor. You may pick more than one metric for each stressor.

5. Availability of Salmon.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

6. Nest Site Availability/Suitable Nesting Locations.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

7. Seasonal changes in prey fish.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

8. Oil spills.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

9. Mercury, Lead, and PCBs.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

10. Weather Conditions.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

11. Disturbance at Winter Concentration Sites and During Nesting.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

12. Eating Lead-Contaminated Carcasses.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

13. Development.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

14. Increase in Visitation.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

15. Ocean Acidification.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

16. Wind-Generated Power.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

17. Loss of Nests to Wildfire and Landslides.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

18. Retreat of Glaciers.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

19. Increase in Flooding Events.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

20. Exotic Diseases.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

21. Marine Debris.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.

- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

22. Illegal Take of Feathers.

- ☐ Total number of Bald Eagle nests.
- ☐ Proportion of nests used by bald eagles for reproduction.
- ☐ Proportion of nests that are successful at producing at least one pre-fledging chick.
- ☐ Mean number of pre-fledging chicks produced in nests with spring nesting activity.
- ☐ Mean number of young produced per nesting pair.
- ☐ Mean number of chicks fledged per nesting pair.
- ☐ Total number of nesting pairs.
- ☐ Total number of chicks produced.
- ☐ Nesting survival from hatching to fledging.
- ☐ Sub-adult survival.
- ☐ Adult survival.

Questionnaire 4

Thank you for participating in Questionnaire 4 of the Bald Eagle Expert Panel. This questionnaire will include questions about new metrics identified by panelists, as well as timescales, cost, and effort. Please call or email me with any questions or concerns.

Thank you,
 Rebecca Kolstrom
 rebecca.kolstrom@sdstate.edu

Please enter your name.

[Click or tap here to enter text.](#)

Stressors and Metrics

You may recognize these first questions from Questionnaire 3. They are being asked again to evaluate the importance of new metrics suggested by panelists in the previous survey.

2. Which metrics will provide reliable evidence of changes in bald eagle populations? For each metric, rank its reliability on a scale from Extremely Unreliable to Extremely Reliable.

Changes in distribution (immigration/emigration) in the study area: Choose an item.

Proportion of breeding to non-breeding eagles: Choose an item.

Abundance at winter concentration areas: Choose an item.

Abundance of bald eagles as determined by statewide aerial surveys: Choose an item.

Successful biological monitoring depends heavily on demonstrating that an attribute has a reliable, empirical relationship with a population metric.

We want to identify of the bald eagle population metrics will respond to changes in the following stressors, which were identified by the panel. Use your knowledge of bald eagle biology and life history to identify any metrics that will measure a population response to each stressor. You may pick more than one metric of each stressor.

3. Availability of Salmon.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

4. Nest Site Availability/Suitable Nesting Locations.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

5. Seasonal changes in prey fush.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.

- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

6. Oil Spills.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

7. Mercury, Lead, and PCBs.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

8. Weather Conditions.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

9. Disturbance at Winter Concentration Sites and During Nesting.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

10. Eating Lead-Contaminated Carcasses.

- ☐ Changes in distribution (immigration/emigration) in the study area.

- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

11. Development.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

12. Increase in Visitation.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

13. Ocean Acidification.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

14. Eating Lead-Contaminated Carcasses.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

15. Loss of Nests to Wildfires and Landslides.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

16. Retreat of Glaciers.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

17. Increase in Flooding Events.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

18. Exotic Diseases.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

19. Marine Debris.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

20. Illegal Take of Feathers.

- ☐ Changes in distribution (immigration/emigration) in the study area.
- ☐ Proportion of breeding to non-breeding eagles.
- ☐ Abundance at winter concentration areas.
- ☐ Abundance of bald eagles as determined by statewide aerial surveys.

21. According to panelists, the following stressors are the most important for bald eagles:

- Availability of Salmon
- Nest Site Availability/Suitable Nesting Locations
- Seasonal Changes in Prey Fish
- Weather Conditions
- Mercury, Lead, PCBs
- Oil Spills
- Disturbance at Winter Concentration Sites and During Nesting

If the conceptual model were to eliminate all other stressors, would the seven stressors listed above accurately explain changes in the bald eagle population observed in Alaska National Parks?

Choose an item.

Comments

Click or tap here to enter text.

22. “Disturbance at Winter Concentration Sites and During Nesting” was suggested as an important stressor for bald eagles. Are you aware of any winter concentration sites in the parks that should be monitored?

Click or tap here to enter text.

23. Are there any summer activities (bear viewing, etc.) that would affect bald eagles in the parks?

Click or tap here to enter text.

Timescales

24. In response to changes in **Availability of Salmon**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

25. In response to changes in **Nest Site Availability/Suitable Nesting Locations**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

26. In response to changes in **Seasonal Changes in Prey Fish**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

27. In response to changes in **Oil Spills**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

28. In response to changes in **Mercury, Lead, and PCBs**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

29. In response to changes in **Weather Conditions**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

30. In response to changes in **Disturbance at Winter Concentration Sites/During Nesting**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

31. In response to changes in **Eating Lead-Contaminated Carcasses**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

32. In response to changes in **Development**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

33. In response to changes in **Increase in Visitation**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

34. In response to changes in **Ocean Acidification**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

35. In response to changes in **Wind-Generated Power**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

36. In response to changes in **Loss of Nests to Wildfire and Landslides**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

37. In response to changes in **Retreat of Glaciers**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

38. In response to changes in **Increase in Flooding Events**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

39. In response to changes in **Exotic Diseases**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.⁹

40. In response to changes in **Marine Debris**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

41. In response to changes in **Illegal Take of Feathers**, how quickly will we be able to detect changes in bald eagle populations?

Choose an item.

42. Surveys of bald eagles are currently conducted annually. How would conducting bald eagle surveys less frequently affect quality/applicability of the data?

Click or tap here to enter text.

43. Estimate the price for one year of surveying for each of the following metrics in your park area. If you are not linked to a specific park, you may skip this question or estimate for an average Southwest Alaska National Park.

Adult survival: Choose an item.

Subadult survival: Choose an item.

Total number of nesting pairs: Choose an item.

Mean number of chicks fledged per nesting pairs: Choose an item.

Proportion of nests that are successful at producing at least one pre-fledging chick:
Choose an item.

Proportion of nests used by Bald Eagles for reproduction: Choose an item.

Mean number of pre-fledging chicks produced in nests with spring nesting activity:
Choose an item.

Mean number of young produced pre nesting pair: Choose an item.

Nesting survival from hatching to fledging: Choose an item.

Total number of chicks produced: Choose an item.

Total number of Bald Eagle nests: Choose an item.

Changes in distribution (immigration/emigration) in the study area: Choose an item.

Proportion of breeding to non-breeding eagles: Choose an item.

Abundance at winter concentration sites: Choose an item.

Abundance of bald eagles as determined by statewide aerial surveys: Choose an item.

44. For each of the following metric, estimate the annual number of workdays needed to complete these surveys in your park area. If you are not linked to a specific park, you may skip this question or estimate for an average Southwest Alaska National Park.

Adult survival: Click or tap here to enter text.

Subadult survival: Click or tap here to enter text.

Total number of nesting pairs: Click or tap here to enter text.

Mean number of chicks fledged per nesting pairs: Click or tap here to enter text.

Proportion of nests that are successful at producing at least one pre-fledging chick:
Click or tap here to enter text.

Proportion of nests used by Bald Eagles for reproduction: Click or tap here to enter text.

Mean number of pre-fledging chicks produced in nests with spring nesting activity:
Click or tap here to enter text.

Mean number of young produced pre nesting pair: Click or tap here to enter text.

Nesting survival from hatching to fledging: Click or tap here to enter text.

Total number of chicks produced: Click or tap here to enter text.

Total number of Bald Eagle nests: Click or tap here to enter text.

Changes in distribution (immigration/emigration) in the study area:
Click or tap here to enter text.

Proportion of breeding to non-breeding eagles: Click or tap here to enter text.

Abundance at winter concentration sites: Click or tap here to enter text.

Abundance of bald eagles as determined by statewide aerial surveys:
Click or tap here to enter text.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 953/168938, May 2020

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

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