

**From:** [BrownScott, Jennifer](#)  
**To:** [Thomas, Sue](#)  
**Subject:** Fw: Todays Call  
**Date:** Thursday, April 22, 2021 8:28:24 AM  
**Attachments:** [White Paper Sci Continuum FINAL.docx](#)

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Attached is a draft I&M document describing different monitoring techniques. There is a useful diagram on page 9. Kevin used this in our discussions with JST to help them understand that different types of monitoring are required based on the question you are trying to answer.

-jennifer

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**From:** Kilbride, kilb <[kevin\\_kilbride@fws.gov](mailto:kevin_kilbride@fws.gov)>  
**Sent:** Monday, April 5, 2021 1:17 PM  
**To:** Loverti, Vanessa <[vanessa\\_loverti@fws.gov](mailto:vanessa_loverti@fws.gov)>; BrownScott, Jennifer <[jennifer\\_brownScott@fws.gov](mailto:jennifer_brownScott@fws.gov)>  
**Subject:** Re: Todays Call

Attached is the document where I presented Figure 2 during today's call. This is product that has not been brought to IR9/IR12 refuge staffs yet because we're still working out guidance for less intensive surveys. As I mentioned, the I&M policy and Survey Protocol Handbook only describe the more intensive, robust surveys. But, those are not necessary for many surveys conducted on refuges.

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**From:** Loverti, Vanessa <vanessa\_loverti@fws.gov>

**Sent:** Monday, April 5, 2021 12:59 PM

**To:** Kilbride, kilb <kevin\_kilbride@fws.gov>; BrownScott, Jennifer <jennifer\_brownScott@fws.gov>

**Subject:** Re: Todays Call

Sounds good. I will see if USGS is available to sit in. I am also available to touch base before the next call if needed.

*Vanessa Loverti  
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**From:** Kilbride, kilb <kevin\_kilbride@fws.gov>

**Sent:** Monday, April 5, 2021 12:15 PM

**To:** Loverti, Vanessa <vanessa\_loverti@fws.gov>; BrownScott, Jennifer <jennifer\_brownScott@fws.gov>

**Subject:** Re: Todays Call

Thanks for sharing, Vanessa. Would you be able to ask Susan if she can join us for our next call? I think it will be important for an USGS research scientist to be involved in order to provide expert and objective input into the design, especially if baseline data becomes imperative. If so, then it would not be feasible to start up aquaculture operations in 2 months.

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**From:** Loverti, Vanessa <vanessa\_loverti@fws.gov>

**Sent:** Monday, April 5, 2021 11:45 AM

**To:** BrownScott, Jennifer <jennifer\_brownScott@fws.gov>; Kilbride, kilb <kevin\_kilbride@fws.gov>

**Subject:** Todays Call

Hi Jennifer and Kevin,

Thank you for allowing me to sit in on the meeting today. I suppose it would have been good to talk prior to this meeting (for me). It seems as if they are very anxious to start the project by June of this year (wow). I have not really had a chance to think about this project or look into the specifics.

I would hope that shorebirds will still use this site as foraging habitat. I am sure this is political, and it would be good to make sure we are all on the same page, so I do not misspeak. I will go back and read the refuges responses to this project.

If birds are not using the 5 acres during full operation because of disturbed than that would be important to know for other phases of the project.

Attached is an example of the type of project that addresses refuge specific questions on habitat use (although not the same question). One question we might ask Willapa NWR is...with these surveys are they seeing shorebirds in oyster farming habitat. Just a few thoughts.

It took me off guard that they wanted to launch right into things. Happy Monday morning:)

Vanessa

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# **White Paper: Continuum of Scientific Activities Supporting Resource Conservation and Management on Units of the Refuge System**

## **Project Team:**

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**February 2020**

## Underlying Principles (Assumptions)

First and foremost, this white paper should be considered supplemental to the 2014 I&M Policy ([701 FW 2](#)) and associated [Survey Protocol Handbook](#) (SPH) regarding survey requirements and their protocols. As such, it minimizes creating new or redefining established terminology associated with the I&M Initiative. Second, this white paper is intended to inform the I&M Coordination Team (IMCT) concisely about complex issues confronting the initiative and it presents the project team's philosophy on these matters. Its primary purpose is to identify issues (see problem statement), where we suggest follow-up work on solutions.

By elucidating these issues, this white paper seeks to further embrace the goal/challenge of the I&M Initiative to support refuge staffs in the consistent conduct of adaptive management, where science informs resource management decision making and builds baseline knowledge about status and trends. It also is intended to help address the following recommendations from the [National I&M Review Report \(2017\)](#):

Rec 1B: A team (e.g. I&M coordinators) should evaluate I&M plans and regional I&M planning processes to distill lessons learned and improve efficiencies.

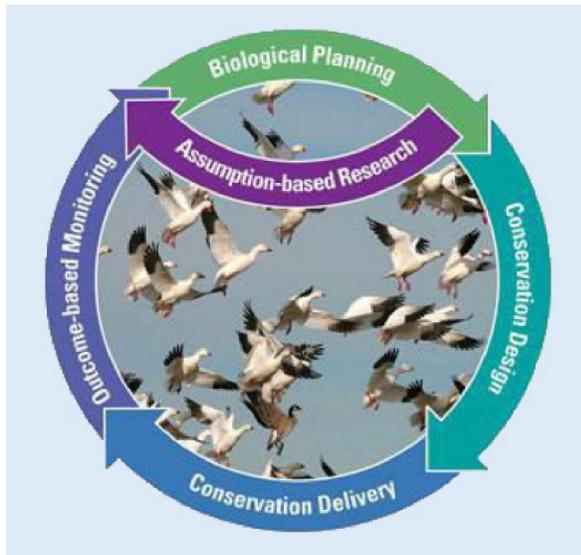
Rec 2A: The I&M program needs to find ways to make protocol development less cumbersome. This may be accomplished, at least in part, by making protocols only as statistically rigorous as needed, not one size fits all.

Rec 5B: In planning for the future, the Service should narrow the focus of the program. Emphasizing "monitoring the right things" and "monitoring things right" to inform management decisions.

## Background

A guiding principle for the Mission Statement for the Refuge System is "*We are a science-based organization. We subscribe to the highest standards of scientific integrity and reflect this commitment in the design, delivery and evaluation of all our work.*" Many FWS and DOI policies describe the importance of utilizing "adaptive management". In particular, DOI's Adaptive Management Implementation policy states that adaptive management requires conducting "environmental monitoring" to determine resource status, promote learning, and evaluate progress toward achieving resource objectives.

In 2006, Strategic Habitat Conservation (SHC) was adopted as the Service's framework for landscape-scale conservation. The foundation for the SHC framework is adaptive management that utilizes an iterative cycle of biological planning, conservation design, conservation delivery (implementation of management prescriptions) and effectiveness monitoring (see illustration below). In addition, research can be used to gather scientific information to reduce uncertainties associated with assumptions about the effectiveness of management strategies in producing desired biotic and abiotic responses.



Implementation of the first three elements of SHC (Biological Planning, Conservation Design, and Conservation Delivery) often reveals uncertainties in the biological foundation used for resource conservation and management. Not all assumptions are equally important. Those having the greatest influence on management decisions and outcomes are the highest priorities for research.

Monitoring and research are both integral to the iterative process whereby refuge staffs learn and increase their efficiency and effectiveness of resource management. The Service cannot afford to undertake large-

scale habitat protection, restoration or enhancement endeavors, only to discover after years of management that actions were not well targeted, ineffective, or even counterproductive. Monitoring and research help evaluate the following: assumptions made in population-habitat models and decision support tools, habitat responses to management actions, population responses to management actions, and progress toward resource management objectives.

In 2010, the Service established the I&M Initiative to support the Refuge System in meeting its Mission. The basis for implementing this new program was set forth in the 2014 I&M Policy that articulated how the Refuge System conducts scientifically rigorous natural resource surveys, and promotes efficiency in their conduct and collaboration with survey partners. The following are key aspects of this policy germane to this white paper:

- Every refuge is required to develop and follow an inventory and monitoring plan (IMP) (Section 2.4A).
- An IMP includes prioritized surveys, identifies the surveys selected for implementation, and documents the protocols that describe the survey objectives and methods [Section 2.4A(4)].
- A survey is defined as “A *formal effort designed to inventory or monitor natural resources. A survey requires a sampling design, data analysis, and reporting.*” (Section 2.8N; emphasis is ours).
- The final step in IMP development is to assign protocols (see Figure 1, Exhibit 1, I&M policy), where best available protocol documentation is linked with selected survey records for refuges in PRIMR. Therefore, critically evaluating assigned protocols for surveys is not typically part of the process for developing and approving IMPs.
- Refuges will use approved protocols when conducting surveys (Section 2.4B).
- IMP implementation (Section 2.13) entails a substantial investment of time (refuge and I&M staffs) given multiple elements (as detailed in A-G) focused on supporting the full life cycle of surveys.

- The Project Leader reviews the refuge capacity and status of surveys in an IMP each year and determines which of the selected surveys will be conducted (Section 2.12B).

In conjunction with the I&M Policy, the SPH was published to support the preparation of protocols with consistent quality and content. The following are key aspects of the SPH that are germane to this white paper:

- Every survey in a refuge IMP will be guided by a site-specific protocol. (page 6)
- At a minimum, a survey protocol needs to address eight elements in the narrative section. (Figure 1, page 6)
- A survey protocol helps staff to compare and coalesce data over time because they can repeat surveys in a consistent manner. (page 8)
- Two types of objectives (management and sampling) need to be explicit in every survey protocol. (page 16)
- Sampling objectives include the attribute(s) being measured or estimated, desired accuracy of estimates, magnitude and direction of desired change to detect, timeframe, chance of error that is acceptable, and power to detect a change of specified magnitude. (page 17)
- Although data collection methods may be similar for an inventory or monitoring project, sample design, analysis, and inference may vary greatly depending on survey objectives. (page 20)

## Problem Statement

Since establishment of the Refuge System's I&M Program in 2010, conceptually what constitutes a survey has changed and morphed as our initiative has developed over time. But, this evolution has unfortunately resulted in a disconnect, where there now exists a disparity between theory (what's stated in our I&M Policy) and reality (what actually does and feasibly can occur in the field on refuges). Therefore, we should consider adapting our thinking about what constitutes a survey; this includes embracing the fact many valid and essential surveys conducted on refuges will not and do not need to meet the demanding standards and rigor set forth in our I&M Policy and SPH.

Through the I&M Policy (2014), a survey became defined as "*A formal effort designed to inventory or monitor natural resources. A survey requires a sampling design, data analysis, and reporting.*" The I&M Policy also requires refuge staffs to use approved protocols when conducting their surveys. The SPH stipulates specific requirements for survey protocols, including both SMART management and sampling objectives. But, a significant portion of the surveys currently recorded in PRIMR and, in turn, inventory and monitoring plans (IMPs) do not meet the policy definition nor documentation requirements to be considered surveys.

Field staffs across the Refuge System for decades have referred and continue to refer to a wide range of scientific information collection activities as "surveys". This may, in part, be the result of the previous version of the [I&M Policy \(1995\)](#) that defined a survey

as *"a general term for any type of inventory or monitoring procedure."* Therefore, we believe this challenging situation can be best rectified by demonstrating how various scientific data collection efforts on refuges, including surveys, occur on a continuum defined by effort and corresponding documentation. By doing so, the I&M Initiative can more effectively and efficiently support refuge staffs in developing, appropriately documenting, and implementing scientific collection activities that address the diversity, complexity, and breadth of resource management and conservation issues on refuges.

This does not imply less intensive surveys are less important or invalid for refuges. In fact, many scientific collection activities on refuges do not lend themselves to (or require) a sampling design based upon sampling objectives for various reasons including the following: 1) sufficient information/data may not be available and, thus, it would be premature to develop the sampling objectives and rigorous sampling design essential for qualifying as a survey per the I&M Policy; and 2) sufficient information/data are available, but the costs of and time necessary for conducting power analysis to develop sampling objectives (as stated below) represents a formidable barrier to a refuge staff. As demonstrated by these two scenarios and others that occur on field stations across the System not listed here in the interest of brevity, a more flexible interpretation of what qualifies as a survey, where a sampling design with sampling objectives is not an absolute requirement, is needed.

In addition, the following related issues were identified by the project team while preparing this white paper.

(1) Reconnaissance: Reconnaissance activities (referred to as Recon herein) are simple information-gathering activities, but they generally do not involve consistent, repeatable data collection nor warrant formal data analysis and structured reporting. Although generating useful information, Recon does not conform to the definition of a survey per the I&M Policy. Thus, they are not appropriate for record entry into PRIMR and inclusion in refuge IMPs, unless they may be listed in an appendix for informational purposes only.

(2) Implementation Monitoring: To effectively implement adaptive management, it is imperative for refuge staffs to document management actions that are conducted over time. However, this documentation has been either largely neglected or rarely and inconsistently addressed by refuge staffs. Documenting management actions has been termed "implementation monitoring" by the Council of Environmental Quality (CEQ); it provides essential context for surveys conducted on refuges that assess effectiveness in achieving resource management/conservation objectives. Implementation monitoring has been misclassified as surveys in PRIMR records and IMPs. This is an issue because the I&M Policy defines a survey as *"A formal effort designed to inventory or monitor natural resources..."* That said, implementation monitoring provides essential information to be tracked over time on refuges and it should be conducted; whether it is considered a "survey" and how it's documented is outside the scope of this white paper.

## Solution -- Scientific Continuum

There is a continuum of scientific information gathering activities conducted on refuges to determine resource response and/or status and trends that support adaptive resource management and conservation (Figure 1). This continuum spans from the least to the most intensive type of scientific data collection applicable to refuges; however, the scientific continuum does not address the importance of a survey or activity. The cost and time to collect, process, analyze, and report the needed scientific information also generally increase from reconnaissance (Recon) activities to research. The central portion of the continuum is occupied by surveys, which are either Level 1 or 2, as defined herein. Level 1 surveys do not meet all the requirements specified in the I&M Policy and SPH, in particular rigorously-developed, statistically-based sampling objectives. In contrast, Level 2 surveys have one or more sampling objectives that are met through a rigorous sampling design involving a power analysis and other requirements outlined in the I&M Policy and SPH. The overwhelming majority of surveys currently conducted on field stations throughout the Refuge System are Level 1 and not Level 2. Please see the **Survey Levels** section for detailed description of Level 1 and 2 surveys.

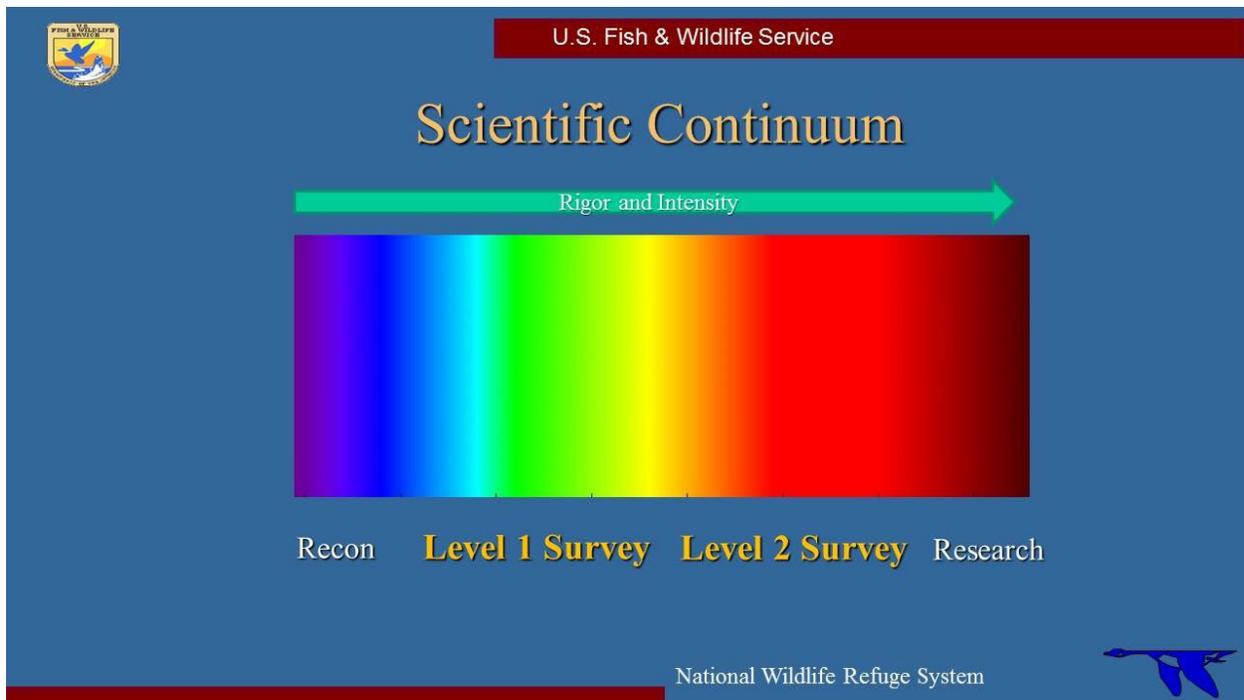


Figure 1. Continuum of Scientific Activities Conducted on Refuges in Support of Adaptive Resource Management.

By utilizing the scientific continuum concept, we embrace the important and foundational role of Level 1 surveys, as well as the selective and strategic use of Level 2 surveys on refuges. On this continuum, there is flexibility to move back and forth between these types of scientific collection activities over time depending upon specific

information needs, staffing, funding, and other factors. In addition, we recognize the need for and role of Recon and management-oriented research activities in conjunction with Level 1 and 2 surveys on refuges to evaluate the resource response to management as well as resource status and trends.

By correctly classifying a smaller number of scientific activities as Level 2 surveys, the workload of refuge and I&M staffs will be greatly lessened because the full requirements for site-specific protocols (SSPs) would be substantially reduced, applying just to Level 2 surveys. In turn, achieving the full life cycle (survey designing to reporting) will be better realized if less rigorous analysis and reporting are necessary for Level 1 survey activities compared with Level 2 surveys. Another advantage of the continuum is embracing the previously mentioned dynamic movement from one type to another over time, as needed. For example, a Level 1 survey can be a precursor to the development of a Level 2 survey. In these cases, it may be premature to develop a Level 2 survey, where a Level 1 survey can provide a foundation for its future development. Conversely, logistics or a shift in management priority at a refuge may result in re-classifying a Level 2 survey to a Level 1 survey or possibly even Recon.

Because research has already been well described elsewhere in the literature, we only briefly mention it herein. Similarly, we will only briefly address Recon activities given it lacks many of the elements (e.g., established field methods repeated over time) necessary to be considered a survey. After brief descriptions of Recon and research, the remainder of this white paper is dedicated to describing Level 1 and 2 surveys, including and how Level 1 surveys are applicable to refuges.

## **What is Recon?**

As depicted in Figure 1, Recon is the least intensive type of scientific activity that occurs on refuges. In contrast with a survey, Recon activities do not have an established field methodology and sampling design (probability-based or not). Instead, information is typically gathered “ad hoc” where there may be no intent for it to be repeated by others over time (Figure 2; Case Study #3 in Appendix). As a result, there are typically biases associated with where data are collected and at what time and under what conditions; detectability among varying vegetative, hydrologic, or topographic conditions; and/or detectability among different age, phenology, or sex cohorts of species.

Information could be recorded as field notes and/or digital images that may be scanned after returning to an office setting. Given the ad hoc nature of data collection, information associated with Recon should be maintained, but is rarely transferred to a database. Thus, there is maximum flexibility in terms of what is documented for Recon. Reporting may not be done or it could be as simple as a “trip report” describing what was seen or found on a refuge.

If the desire is to gather information quickly and opportunistically, repeatable data collection methods within a monitoring framework would not be critical nor necessary. The information obtained from Recon, however, can be very useful in justifying quick-response management actions on a refuge or developing a Level 1 or Level 2 survey.

For example, detecting a highly invasive plant species new to a refuge management unit can result in an herbicide treatment to eradicate/control it. Detecting a sick or diseased animal can result in carcass collection, testing it for potential diseases, and further actions to eliminate or reduce the incidence of the disease in the larger population. Noting the presence of a species can provide important information about what and how species or species groups are utilizing refuge resources, where this information can and should be stored in FWSpecies.

### **What is research?**

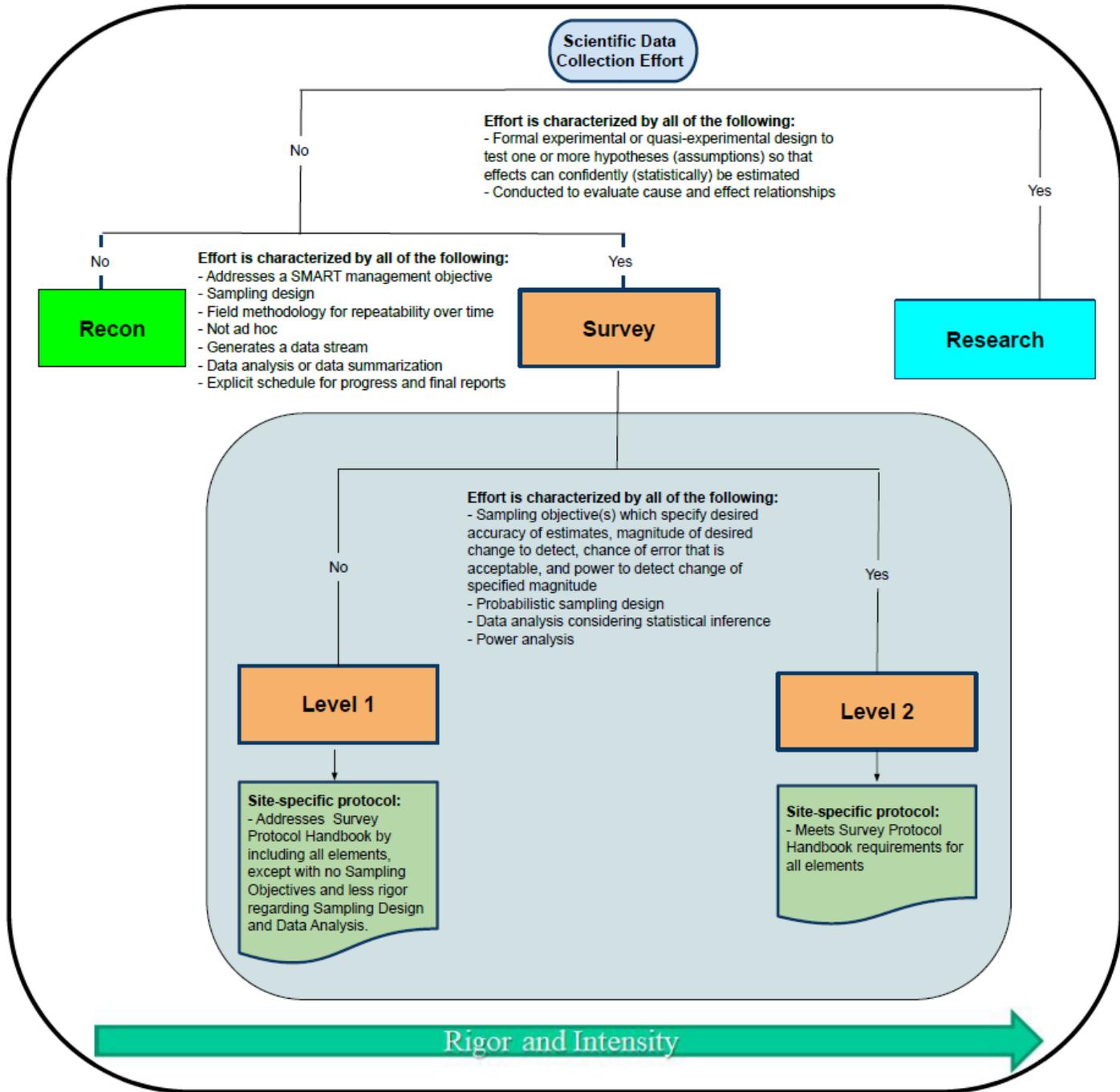
As depicted on the continuum, research is characterized by the highest level of scientific rigor (Figures 1 and 2). In PRIMR, research is defined as “*An investigation designed to refute one or more hypotheses using a formal experimental or quasi-experimental design.*” There are two main types of research that occur on refuges: management-oriented and ecologically-based. These are analogous to monitoring to inform management and baseline (surveillance) monitoring. Management-oriented research is characterized by an experimental design with replicates of one or more treatments and a control to test hypotheses (assumptions) so that effects can confidently (statistically) be attributed as a response to a treatment(s) (Figure 2). In contrast, ecological research is typically used in situations where it is not feasible to conduct a controlled experiment; that is, it is not possible to randomly assign members of a sample to treatment or control groups. Ecologically-based research may be conducted in order to learn about relationships between the distribution and abundance of a particular species and its habitat or how communities and ecosystems function more generally.

We recognize that it can be difficult to discern if a particular scientific endeavor is a research project or an intensive survey activity; an important distinction would be the objective(s).

### **What is a survey?**

A “survey” is a scientific information gathering activity that entails either inventorying or monitoring of natural resources. The definitions of inventory and monitoring as stated in the revised I&M Policy are provided below.

Detailed instructions for conducting a survey, as described in the SPH, require eight elements, including sampling design, data analysis, and reporting. Although there are two types of survey protocols containing these elements (*protocol framework* and *site-specific protocol*), refuge staffs are primarily focused on preparing SSPs (or their draft documents called initial survey instructions).



*What is an inventory?*

An inventory is a survey to estimate presence, abundance, or distribution of species, habitats, ecological communities, or abiotic features at a particular time.

*What is monitoring?*

Monitoring is a survey repeated through time to document changes in select attributes of wildlife, plants, habitats, ecological communities, or abiotic resources. There are two categories of monitoring applicable to refuges:

**(1) *Baseline Monitoring*** is monitoring that is not tied to specific predictions of how a natural resource will respond to management or specific environmental stressors, but instead is designed to document change over time of a natural resource. It is also referred to as *surveillance monitoring*. Examples include monitoring wildlife population trends, disease incidence, climate change, and wilderness character.

**(2) *Monitoring to Inform Management*** is monitoring to assess whether a natural resource is approaching or exceeding a known threshold, or if a resource is responding to a management action or system stressor in a specified manner. This type of monitoring involves defining the threshold values or expected response and then surveying to measure the response or a closely related indicator. Comparing results with expected values may show a need for initiating, intensifying, or altering management actions. It generally means monitoring in an adaptive management context to improve management or evaluate progress toward achieving management objectives. It is also referred to as targeted monitoring.

## **Survey Levels 1 and 2**

Along with survey categories (e.g., baseline, monitoring to inform management), inventory and monitoring activities can be classified by level of intensity. Survey approaches can be described as “planes” or “levels” ranging from flexible and rapid to tightly prescribed to implement. Specifically, survey approaches and methodologies can be categorized as either more flexible, and less intensive (Level 1) or more intensive and highly prescriptive (Level 2).

### *Level 1 Surveys*

Many different types of surveys currently being conducted on refuges can be classified as Level 1. Although there is more than one type of a Level 1 survey, they all lack rigorously-developed, statistically-based sampling objectives. Such sampling objectives may never be needed or they could be developed in the future (power analysis conducted, etc.) and thus a Level 1 survey could transition to a Level 2 survey. Such a transition would be on a case-by-case basis, depending on management needs, information that is available, etc., as described below.

It is important to note Level 1 surveys can involve data collection that is qualitative (ordinal or categorical) or quantitative. In the case of quantitative data, it may consist of

an index rather than an absolute measurement (e.g., index of population size). Because such surveys collect qualitative and/or quantitative information, their data can and should be analyzed statistically.

The primary advantage of Level 1 surveys is that they can be implemented with rapid procedures (less complex) for designing and implementing data collection, data analysis, and reporting. Thus, they may provide the basis for exploratory analyses that may develop into more detailed, rigorous surveys or research projects. They may also provide early warning signals because they can be implemented quickly.

As previously noted, there are many varieties of Level 1 surveys. Without being prescriptive in presenting a comprehensive listing of Level 1 surveys, we provide an example within Case Study #2 (see Appendix).

Level 1 surveys should be implemented in a manner that promotes high repeatability with acceptable accuracy and precision and reduced observer bias. Statistical considerations for Level 1 surveys are addressed below (see **General guidance on appropriate collection and analysis of data for surveys**).

The following are some of the characteristics of Level 1 surveys that would be conducted on refuges:

- Represents the vast majority of surveys being currently conducted on refuges throughout the System and reported in PRIMR.
- Practical, scientific activity in support of a resource management issue on a refuge, especially those that are not controversial and with lower uncertainty about resource response to one or more management actions, or where interim information is needed.
- Supports a full project life cycle for adaptive resource management.
- Data analysis can be summary (descriptive) statistics, but statistical inference is not excluded.
- Flexible sampling within and among years is acceptable considering available resources and time to implement it (but see **General guidance on appropriate collection and analysis of data for surveys**, below).
- Protocols are needed but their development is less detailed than that described in the SPH; protocols will have all eight elements, but some will likely be less detailed/rigorous (especially sampling design, data analysis, and reporting).
- Can be an initial phase (precursor or preliminary phase) for a Level 2 survey in order to develop components like sampling objectives.

### *Level 2 Surveys*

As previously mentioned, the defining characteristic of Level 2 surveys are detailed, statistically-based sampling objectives of their protocols that are determined through a power analysis (see next section). Specifics of protocol development follow those detailed in the SPH. Specifically, Level 2 surveys will have sampling objectives in the Introductory element of the protocol that are quantitative (e.g., detect a 40% decrease in a population during a 15-year period) with statistical considerations stipulated. To fully

specify a sampling design, as detailed in the SPH, a statistical power analysis is required (Nur et al. 1999). See additional information about power analysis in the next section. An additional distinguishing characteristic of a Level 2 survey is the survey has been designed to test a specific quantitative question(s) with sampling design specifications providing high confidence of successfully evaluating it. For example, rather than simply asking if a population has demonstrated a declining trend, the survey may be evaluating whether the target population has declined by 40% or more over a 15-year period. If this is the case, would we have sufficient statistical power to detect such a change? It is important to note that in order to answer such a question, and thus provide the appropriate sampling design, information must be in hand regarding variability in the response variable with respect to the proposed protocol, etc. (examples in Wood et al. 2017 and Bridgeland et al. 2018).

As part of the Level 2 protocol development, statistical challenges in obtaining high accuracy and precision need to be addressed, including consideration of sources of error and how to minimize them, as described in the SPH (see Bridgeland et al. 2018). The more detailed and intensive methods used for a Level 2 survey will allow a rigorous design to be implemented, which, for example, may include stratification (Wood et al. 2017, Bridgeland et al. 2018) not likely be incorporated into a Level 1 survey.

The following are characteristics of Level 2 surveys conducted on refuges:

- Only a small percentage of surveys occurring on refuges would be classified as Level 2 surveys that would need to fully meet the requirements articulated in the I&M Policy and SPH.
- Typically, Level 2 surveys are cooperative in nature, extending beyond a refuge. SSPs for a refuge-specific Level 2 survey would be needed only in exceptional cases such as a high-priority, or emerging issue, where it would be highly visible and often potentially controversial to our partners and the Public; where high-priority resource management issues, especially those that are labor intensive, expensive to implement, and where uncertainty exists about resource response (e.g., new large-scale restoration project).
- Strict adherence to the sampling design and data collection over time are imperative in order to successfully address sampling objectives.
- Protocol development typically begins with initial survey instructions (ISI) or step down for an approved protocol framework.
- Due to a more rigorous sampling design, the time required to analyze the data and report out results is likely to be greater than for a Level 1 survey.
- Level 1 survey may transition into Level 2 due a number of factors including logistics, funding, cooperator status, high uncertainty about a resource response to management actions, or an issue is controversial or highly visible to the Public. As noted, Level 2 surveys require additional information (identification of specific effect targets, specified time period, and the power analysis to support the sampling design of a Level 2 survey).

### *Power Analysis*

Power analysis involves stipulating the desired probability to detect a specific change over time or difference (i.e., “effect size”) at a specified p-value. The probability of

detecting the specified target effect will depend on the sampling design (number of replicates, number of surveys, desired time period), but it will also depend on the variability in the dependent variable, more specifically the appropriate “error” term in the statistical analysis. Statistical power will also depend on the specific statistical comparison being made and the statistical test used for the data analysis.

Conducting a statistical power analysis, which provides high rigor in the design and implementation of a specific monitoring program, requires two key components: (1) specification of a biologically-meaningful target value for detection (i.e., effect size); and (2) sufficient information on variability in the response variable, under the appropriate survey conditions (i.e., accurate estimation of the error term). An example of an approved SSP complete with the appropriate power analysis is the San Francisco Bay NWR Complex’s Secretive Marshbird Protocol (Wood et al. 2017; see Case Study #4 in the Appendix); this is one of only a small percentage of SSPs currently in ServCat that meet protocol requirements in our I&M Policy and associated SPH.

In many cases, specification of either or both components listed above is not possible. For example, we may not be able to specify the precise percent change over a specific time period that we wish to detect. What percent is biologically meaningful? What percent change or difference would or should elicit a management response? Answering these questions may require further study or follow up. In addition, we may not have sufficient information on exactly where or when surveys should be conducted, which, in turn will affect the response that we would like to be tracking. Finally, we may not have information regarding variability in the response variable, under the conditions that the survey will be conducted.

Thus, while there is much to be gained from conducting a power analysis, refuge staffs and others desiring to carry out a power analysis may not have the information at hand or the capacity and expertise to carry out such analysis. Level 2 surveys, which involve completion of all elements listed in the SPH, cannot be implemented without the suitable power analysis. However, a Level 1 survey may provide the means to obtain essential information needed for the completion of the sampling design (with power analysis) or provide interim information until a Level 2 survey can be carried out (See Case Study #1 in the Appendix).

## **General Guidance about Collecting and Analyzing Data for Surveys**

Regardless of the level, every survey in accordance with I&M policy, needs a written protocol that meets the minimum requirements described in the SPH. Although every survey protocol has eight elements, it is the level of documentation for key elements (sampling design, data analysis, and reporting) that is more rigorous for a Level 2 survey; in contrast, some elements such as data management should be similar in terms of the amount of documentation for Level 1 and 2 surveys.

One of the key differences between a Level 1 and Level 2 survey is the articulation of one or more sampling objectives that then drive a more robust/rigorous sampling design and subsequent data analysis for Level 2 surveys. For Level 2 Surveys these sampling objectives are based upon power analysis (see above). The I&M policy and associated

SPH state all surveys must be what we term Level 2 surveys, but we recognize it's not necessary or realistically achievable on refuges. Hence, Level 1 surveys play an essential role; they are sufficient and appropriate for the vast majority of surveys on refuges.

Because Level 1 surveys are diverse in their form and application, there is no single type of Level 1 survey as previously noted. Level 2 surveys also are diverse, but they do share an important, distinguishing characteristic from Level 1 surveys. Mainly, sufficient information is at hand to specify a protocol that can be implemented consistently and with sufficient intensity of effort (rigor) to reliably detect statistical significance of an effect that is specified a priori. Thus, Level 1 surveys do not have (i) sufficient information regarding the response variable to carry out a power analysis, or (ii) consistent implementation of a protocol for collecting data, or (iii) sufficient intensity of sampling effort to reliably detect statistical significance with high probability.

*A Level 1 survey may serve as a necessary precursor* to the development and implementation of a Level 2 survey. Data collected for Level 1 surveys may provide important information to quantify the magnitude of variation in the response variable and factors (covariates) that may influence it such as timing (within the day, throughout the season(s)), spatial heterogeneity, and detectability. Said in another way, Level 1 surveys can be designed and conducted to provide information on the magnitude of "error" in the response variable and sources of the error. In a subsequent Level 2 survey, the latter can be addressed through stratification as well as statistically controlling for the sources of error. A Level 1 survey can provide the information that is needed for specifying a rigorous sampling design, as well as the constituents needed for a power analysis (Nur et al. 1999).

*Level 1 surveys often satisfy a need for an initial assessment.* The initial assessment may indicate whether additional resources should be allocated to develop a Level 2 survey; however, it may also indicate how the survey should be designed in order to reliably obtain data needed to fulfill management objectives. For example, a Level 1 survey can be used to develop tradeoff scenarios to estimate the costs of a monitoring program (i.e., Level 2 survey) versus the effect size that could be detected. The following are two important characteristics of a reliable, robust survey: representative sampling for the population of interest and accounting for potential confounding factors. Although these are critical for a Level 2 survey, they may also be important for a Level 1 survey.

Thus, an important consideration is whether the subjects of survey are representative of the population of interest. For example, are some individuals or nests more conspicuous or available to be surveyed? If so, how is this being dealt with in the data collection and sampling design? A Level 1 survey provides the opportunity to collect such information.

*We recommend a Level 1 survey to collect data on possible confounding factors* (covariates) in addition to the sources of error mentioned above. A Level 1 survey is more flexible, and thus an appropriate means by which to cast the net widely to collect information on these factors. For example, one might collect covariate data (e.g., time of day, weather conditions) for a Level 1 survey, where it provides the opportunity to

collect information on a wider range of values rather than specifying a narrow range of time or of weather conditions.

If the monitoring is intended to assess the response of a natural resource (e.g., wildlife) to one or more management actions or other environmental driver (e.g., weather or climate; habitat succession), we recommend simultaneously collecting data on more immediate manifestations of the management action or environmental driver, which are then postulated to influence the target (e.g., wildlife). This would be in addition to collecting information on the management implementation. For example, a three-track monitoring stream in response to weed control might include information on: a) monitoring application of an herbicide, b) monitoring the plant response to the herbicide (not just the target plant, but other plants), and c) monitoring the wildlife response. While this approach is germane to Level 1 and 2 surveys, a Level 1 survey may represent an initial assessment, yet one that may provide the basis for implementing management action(s) in a timely fashion.

*The level of effort for a Level 1 survey may be variable.* This is not a hallmark of Level 1 surveys, but rather reflects the recognition that Level 2 surveys involve a consistent and comparatively higher level of effort. Because effort in Level 1 surveys may be variable, it is important to record it so subsequent statistical analysis can then include the effort metric as a covariate in the analysis. If survey effort is allocated in a variable fashion, it is important to consider how effort is distributed in space and time. Preferably, the distribution of effort is independent of the target that is being monitored; for example, surveys should not be conducted only or mainly where abundance of a target species is suspected to be high. Data on absence or low density of a resource is also informative. As much as possible, the data to be analyzed should be maximized relative to all the data that have been collected and not selectively retained. There may be missing data (perhaps due to the variable effort), but these issues can be addressed statistically; consultation with a statistician may be recommended.

In summary, Level 1 surveys may involve less rigorous and sometimes more variable effort compared with Level 2 surveys. That said, Level 1 surveys should be carefully developed with an explicit rationale and not rely on an *ad hoc* approach given that a Level 1 survey often forms the basis for a subsequent Level 2 survey. Level 1 surveys also may provide the basis for management actions that need to be taken in a timely manner.

## Next Steps

The IMCT should decide whether or not to recognize the discrepancy between the stated I&M Policy and what actually happens on Refuges, as described in this white paper. If recognized, then it is important move forward with working on solutions such as the Level 1 and Level 2 surveys concept. We do not envision the distinction between Level 1 and 2 surveys will substantially affect how surveys would be treated for most of the IMP process. An exception could be survey selection (Step 3 in the I&M policy), where surveys may not be selected for an IMP considering the greater workload associated with preparing more rigorous protocols for Level 2 surveys (sampling

objectives and description of statistical procedures, including power analysis). The major divergence for Level 1 and 2 surveys will occur during IMP implementation for stations; specifically, protocol development that would be less cumbersome/stringent for Level 1 surveys. Although suggested as the next step, it is beyond the scope of this white paper to articulate detailed guidance regarding the content distinctions of SSPs for Level 1 and 2 surveys.

Therefore, with the concurrence of the IMCT on the principles described in this white paper, it is recommended that one or more teams should be formed to prepare guidance for the appropriate protocol documentation associated with Level 1 and 2 surveys. The DMT would also be engaged on PRIMR enhancements, as needed.

## References

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## Appendix

### **Case Study #1: DRAFT Site-specific Protocol for Monitoring Plants at Southeast Farallon Island, Farallon Islands National Wildlife Refuge, California.**

This protocol is one of 18 SSP records publicly accessible in ServCat as of early August 2019. Specifically, this draft SSP, which was completed in 2018, can be found in ServCat at this reference ([105793](#)). This protocol includes the eight elements as well as a host of standard operating procedures (SOPs) and supplemental materials (SMs) as per the SPH. The draft SSP is currently the subject of a major revision, but as such, the draft SSP illustrates the distinction between Level 1 and Level 2 surveys.

As described in the summary, this protocol is intended to provide standardized methods for monitoring plant composition, abundance, and distribution on SE Farallon Island (SEFI). It relies upon the following 3-tier survey approach: 1) an assessment of native and non-native plant composition and cover using 33 marked vegetation plots sampled on a 5-year interval; 2) a rapid assessment across SEFI using 58 circular plots sampled biennially; and 3) a rapid assessment of targeted invasive plant infestation levels along with native species cover and composition in specific locations where management actions are being taken on SEFI. This SSP bundles and describes three survey activities (tiers), including when, where, and how they should be implemented over time. In 2018, all three tiers had been piloted on SEFI. Information from this pilot effort was used to refine the draft protocol (Holzman 2018).

It is explicitly stated that this SSP is draft and subject to update and revision. As noted in the protocol's summary, a power analysis is identified as needing to be conducted in the future. The protocol includes SMART objectives associated with each of the tiers that are presented in Element 1 (Section 1.4). In Table 2 within Element 2 (Sampling Design), the protocol presents three "sampling objectives", but they are essentially goal statements for sampling that convey desired future condition without specificity. The SSP states the tiers vary in where, when, and how data are to be collected and analyzed; the amount of survey effort required; and statistical rigor. The vision for the tiers is that they would provide the refuge staff with long-term statistically rigorous assessments of vegetation status and trends, and short-term rapid assessments of invasive status and trends Refuge-wide and in targeted treatment areas to measure response to management.

In summary, this draft SSP is a bundle of three Level 1 surveys that are transitioning into Level 2 surveys. The bundling of surveys (monitoring tiers) will provide a comprehensive assessment (picture) of the effectiveness of invasive plant treatments and the short- and long-term response of the native plant community on SEFI. The initial piloted phase of the project generated data that are necessary to conduct power analysis when funds are available. Following the power analysis, sampling objectives would be crafted and the sampling design for the tiers revised and updated, as necessary.

## **Case Study #2: Site-specific Protocol for Integrated Waterbird Management and Monitoring (IWMM): Pocosin Lakes National Wildlife Refuge**

This approved SSP can be found in ServCat at this reference ([89310](#)). This SSP for Pocosin Lakes is based entirely on the national protocol framework (PF) for the IWMM standardized approach for non-breeding waterbirds (Loges et al. 2014). This PF provides an integrated set of Level 1 surveys for rapidly assessing both habitat conditions and estimating use by waterbirds within individual, managed wetlands throughout the non-breeding period. The majority of its survey techniques entail whole-wetland visual assessments of habitat conditions or counts of waterbirds that can be rapidly conducted from the perimeter of wetland units. For example, the “unit condition survey”, which is done multiple times throughout the non-breeding period, entails ocular estimation of the % cover of different habitat classes from 1-3 vantage points on the wetland perimeter where 70% of the unit can be observed. Because these are ocular estimates, they sacrifice accuracy and precision in exchange for quick data collection. That said, this PF offers standardization of waterbird and habitat surveys during the non-breeding period to assess the effectiveness of management within individual wetland units. The content and structure of the PF follows standards set forth in the U.S. Fish and Wildlife Service’s How to Develop Survey Protocols: a Handbook (Version 1.0). Each of eight elements is addressed in this PF, including a protocol introduction, sampling design, field methods, data management, analysis, reporting, personnel requirements and training, operational requirements, and references.

IWMM supports an adaptive management process to inform local, regional/state, and flyway managers about how they can best meet the needs and support populations of migrating and wintering waterbirds. Its monitoring assesses how well field stations are meeting their SMART management objectives in individual wetlands in order to adjust their management actions to address emerging threats. The IWMM protocol includes an SOP for recording management actions (implementation monitoring) in order to fully embrace the adaptive management concept. The bundle of rapid assessment surveys that comprise IWMM would be considered Type 1s because there are no stated sampling objectives.

## **Case Study #3: Initial Survey Instructions for Non-avian Terrestrial and Marine Wildlife Observations: Howland Island, Baker Island, and Jarvis Island National Wildlife Refuges**

These initial survey instructions (ServCat reference [114599](#)) support three scientific data collection efforts described in PRIMR (FF01RHOW00-014, FF01RBKI00-013, FF01RJRS00-014) and in the Howland Island, Baker Island, and Jarvis Island National Wildlife Refuges’ IMP (ServCat reference [53562](#)). These data collection efforts document the presence and relative abundance of introduced land mammals, marine mammals, reptiles, terrestrial crabs, and other conspicuous wildlife. Observations are recorded on an opportunistic and ad hoc basis, dependent upon the ability of observers to access these remote refuges, and are often incidental to established systematic surveys. The field methods are neither repeatable nor structured by a sampling design (probability-based or not). Data are captured in field notes and/or digital images that are

ultimately summarized (i.e., qualitative descriptions or total counts) in an end-of-field-season trip report, which is scanned and stored on ServCat.

While these data collection efforts support several management objectives identified in the Refuges' Comprehensive Conservation Plan and are included in both PRIMR records and the IMP, the lack of an established field methodology, sampling design, data stream, and data analysis lead us to classify these efforts as Recon, rather than surveys, per the definitions herein. However, given the infrequency of visits to these refuges, even presence-only information is valuable for management, particularly with regards to introduced species.

#### **Case Study #4: Site-specific Protocol for Monitoring Marsh Birds at Don Edwards SF Bay and San Pablo Bay NWRs**

This approved SSP can be found in ServCat at this reference ([68062](#)). This SSP was designed to be fully compatible with the national protocol framework (PF) for secretive marsh birds (Conway and Seamans 2016). It articulates a standardized, statistically-based protocol that provides increased confidence in data integrity and improves the ability to detect true population trends over time in order promote recovery of an endangered species. It conveys well detailed sampling objectives, description of conducted power analysis, and discussion for sources of error. The statistical power analysis considered detection of increasing and decreasing trends, as well as the detection of short-term changes. One of its strengths is that the management objectives, which were the basis for the sampling objectives, were strongly rooted in the details of the USFWS Tidal Marsh Recovery Plan. The protocol facilitates the estimation of detection probability, which is a critical component for monitoring secretive marsh birds, which have low detectability. The protocol includes a probabilistic sampling design, a data management procedure and data analysis techniques. The sampling design incorporates stratification with respect to marsh characteristics, to improve the accuracy and precision of trend estimation.

According to a protocol co-author, this 85-page SSP took over four years to collect and analyze the appropriate data, meet with Refuge Staff, conduct the power analyses, and prepare the document. Substantial portions of the protocol were led by a statistician, with the assistance of a quantitative ecologist. This SSP is one the few Level 2 surveys for the Refuge System in that it meets all the requirements as per the I&M Policy and SPH.