A Summary of the Process Used to Revise the Natomas Basin Habitat Conservation Plan Biological Effectiveness Monitoring Program: Process, Rationale, Options, and Recommendations

Prepared for:

The Natomas Basin Conservancy
2150 River Plaza Drive, Suite 460
Sacramento, CA 95833
Contact: John Roberts, Executive Director
916.649.3331

Prepared by:

ICF
630 K Street, Suite 400
Sacramento, CA 95814
Contact: Douglas Leslie
916.737.3000

June 2017

ICF. 2017. *A Summary of the Process Used to Revise the Natomas Basin Habitat Conservation Plan Biological Effectiveness Monitoring Program: Process, Rationale, Options, and Recommendations*. Draft. June. (ICF 00486.15.) Sacramento, CA. Prepared for Natomas Basin Conservancy, Sacramento, CA.

Contents

Introduction 1
Approach to Monitoring Plan Development and Revision 2
Goals and Objectives of the NBHCP 4
- Primary Goal 4
- Overall Goals 5
- Overall Objectives 6
- Wetland Species/Habitat Goals and Objectives 7
- Upland Species/Habitat Goals and Objectives 8
- Other Requirements of the Monitoring Program Specified in the NBHCP 8

Overview of Monitoring Program Data, Potential Management Actions, Management-Oriented Hypotheses, and Monitoring Options 9
- Swainson's Hawk 9
- Giant Gartersnake 13
- Burrowing Owl 17
- Tricolored Blackbird 20
- Loggerhead Shrike 23
- White-faced ibis 25
- Pacific Pond Turtle 27
- Other Covered Species Not Known to Occur in the Basin 29
- Monitoring Noxious Weeds and Land Cover Types 29

Literature Cited 29

A Summary of the Process Used to Revise the Natomas Basin Habitat Conservation Plan Biological Effectiveness Monitoring Program: Process, Rationale, Options, and Recommendations

Introduction

The Natomas Basin Habitat Conservation Plan (NBHCP) calls for the creation of a Biological Effectiveness Monitoring Program document (BEMP). The BEMP, which describes what biological effectiveness monitoring tasks will be implemented, is designed to go hand in hand with the Site-Specific Management Plans (SSMPs) for each reserve property that are also called for in the NBHCP. The BEMP describes explicitly what will be monitored, how it will be monitored, and how the data will be analyzed and used. The BEMP is essentially a methods document (although it does contain additional information regarding management threshold limits and other relevant material) that provides specific guidance allowing the monitoring program to be replicated independently by entities with no previous experience with the BEMP. It has therefore formed the basis of each request for proposal (RFP) that has been issued by The Natomas Basin Conservancy (TNBC) to conduct biological effectiveness monitoring since the BEMP was created.

When the first RFP to conduct comprehensive biological effectiveness monitoring in support of the NBHCP was issued, the primary directive was to design a monitoring program that complied with all the directives in the NBHCP. Given the legal history of the NBHCP, the strong emphasis on compliance was necessary. Comprehensive biological effectiveness monitoring using the protocols outlined in the BEMP began in 2004, and the final BEMP was approved by the Board and the Wildlife Agencies in 2006. The BEMP was updated in 2009, and the giant gartersnake protocols were revised in 2010.

Implementation of the BEMP has been very successful, resulting in the following accomplishments.

- Prevention of the establishment of several highly invasive noxious weeds that threatened habitat values in created marsh habitats.
- The addition of habitat features (shallow-water emergent marsh habitats, rock outfall structures, steep-sloped grassy bankside habitats) to improve created marsh habitats.
- Documented changes in the distribution and abundance of critical habitats throughout the Plan Area (hereinafter referred to as the Basin).
- Documentation of the natural range of variation in the distribution, abundance, and reproductive parameters of the nesting population of Swainson's hawk.
- Documentation of the natural range of variation in many of the demographic parameters of giant gartersnake populations.
- Documentation of the distribution and abundance of other covered species in the Basin.

Although implementation of the BEMP has been successful, there have been significant changes since the last update of the BEMP. These changes are listed below.

- Our knowledge of the distribution and abundance of the covered species throughout the Basin has increased substantially.
- Our knowledge of the life history requirements and habitat needs of the covered species throughout their range has increased.
- A significant body of knowledge has accumulated resulting from experience implementing monitoring programs associated with HCPs.
- There have been advances in monitoring program design and analytical techniques used to monitor/assess wildlife population health and resilience.

The distribution, abundance, and population trends of covered species in the Basin have now been tracked for 11 or more years. As a result, considerably more is known about the ecology, distribution, abundance, threats, and responses to management of the covered species than was known at the time the NBHCP was written and the BEMP was first designed.

The implementation of citizen science–based programs such as the Breeding Bird Survey, Christmas Bird Count, Monitoring Avian Productivity and Survivorship (MAPS) and others, along with the general advancement of scientific knowledge, has contributed greatly to our knowledge about the level of threat to populations of covered species, their life history requirements, and potential management actions that could be taken to improve population health and resilience.

In addition, the collective experience of the many entities implementing large-scale HCPs, as well as the experience of those regulating them, has shown that it is often more advantageous to allocate limited resources to answering questions of high management importance than to monitoring the status of the system (81 Federal Register [FR] 93702).

Finally, monitoring program design and analysis techniques have advanced significantly, in some cases allowing for more relevant information to be collected in a more cost-effective and robust way.

For these reasons, TNBC has undertaken the process of revising the BEMP with the objectives of improving efficiency, strengthening the ties between monitoring and management (i.e., improving the adaptive management process), and reducing costs. It is the purpose of this document to describe the process by which the BEMP was revised, the options considered, and the rationale behind changes made.

Approach to Monitoring Plan Development and Revision

Several approaches to the design of monitoring programs for large-scale conservation programs have been developed. The *Habitat Conservation Planning Handbook* issued by the U.S. Fish and Wildlife Service and National Marine Fisheries Service in 1996 (61 FR 63854) and its 2000 addendum (65 FR 35242) emphasized that monitoring programs should be driven by clearly defined goals and objectives. Others have advocated that where goals and objectives are vague, new goals and objectives should be derived that are more explicit and quantifiable and measurable to guide monitoring plan development (Atkinson et al. 2004). The newly revised (2016) *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCPH) (81 FR 93702) provides additional guidance regarding monitoring programs for habitat conservation plans. Although the emphasis continues to be placed on goals and objectives as the drivers of monitoring

plan design, greater emphasis is placed on the identification of competing hypotheses regarding the outcomes of management decisions and on using monitoring results to address those competing hypotheses. Thus, monitoring programs are evolving into quasi-research programs designed to address hypotheses of high management concern. Conceptual models are often used to represent our understanding of the ecosystem being monitored and as a means to identify competing hypotheses about how management actions (or the lack thereof) affect the system. Identification of a list of potential management actions is another method used to identify key uncertainties about the system that can then be addressed through monitoring.

Ideally, according to the 2016 HCPH, monitoring should accomplish the following objectives.

- Assess the state of the system or species.
- Evaluate competing hypotheses about the effectiveness of management actions,
- Focus on crucial information needed to resolve uncertainty and improve management effectiveness.
- Explicitly show the monitoring data's purpose and use in the adaptive management processes established in the HCP.
- Increase understanding of the system being monitored.

It should be noted, however, that most of the guidance regarding development of monitoring programs is geared toward natural habitats undergoing natural ecosystem processes. In contrast, the NBHCP is primarily an agricultural plan dealing with working landscapes under intensive agriculture and is consequently, in many respects, quite different from such natural ecosystems.

In addition to the objectives for monitoring as set forth in the HCPH, the following questions should be addressed when developing a monitoring program.

- At what threshold does the managing entity change management or initiate further evaluation?
- What criteria are used to determine if/when the conservation program is not working?

These questions are referred to as *management threshold limits* in the NBHCP, which requires that they be identified in the BEMP for the primary covered species (giant gartersnake and Swainson's hawk).

Finally, the NBHCP itself provides a list of questions that should guide development of the monitoring program.

- What kind and quality of information can be gathered with the time and resources available?
- What are the possible outcomes and answers such an investigation might reveal?
- What decisions will be triggered by different outcomes and answers?
- How are these decisions different than those that would be made with existing information?
- What effect will continuing the status quo have on species status and on options for future action?

For purposes of this revision, we first reviewed and evaluated the goals, objectives, and directives in the NBHCP to ensure continued compliance with the terms and conditions of the NBHCP, to provide the background needed to understand the current monitoring program, and to inform the rationale

behind proposed changes to the monitoring program. Then, for each covered species or group of species, we reviewed what has been learned over the first 11 years of monitoring, identified management actions or potential management actions, and identified areas where our knowledge of the system needs to improve with the objective of developing conceptual models to formalize our understanding of the system. On the basis of these reviews, this document identifies monitoring options and makes recommendations on appropriate changes.

Goals and Objectives of the NBHCP

The first step in revising the NBHCP BEMP was to identify the biological goals and objectives outlined in the NBHCP—in particular those pertaining to effectiveness monitoring. The NBHCP provides the following definitions for goals and objectives.

> The NBHCP biological goals are the broad guiding principles for the operating conservation program and provide the rationale behind the minimization and mitigation strategies. The specific biological objectives are the measurable targets for achieving the biological goals. The goals and objectives together provide a framework for developing a monitoring program that measures progress towards meeting those goals and objectives. In addition, the biological goals and objectives must be linked to the adaptive management process in order to ensure that necessary management decisions are based on these guiding principles of the Plan (*Introduction* page I-13).

Unfortunately, the NBHCP does not identify goals and objectives that are consistent with the definitions above. There are many requirements specified in the NBHCP that meet the definition of objectives, such as the minimum block size requirement for reserve lands (NBHCP page IV-14), although they are not identified as such. Most of these are "compliance" type objectives that are not directly related to the monitoring program, and their achievement is documented each year by the Executive Director in the Annual Implementation Report. The lack of formally identified objectives pertaining to monitoring may indicate that objectives for covered species were intended to be developed as part of the site-specific management and/or monitoring plans for each reserve property.

The biological goals and objectives identified as such in the NBHCP are provided below (*Biological Goals and Objectives of the NBHCP* pages I-15 to I-16). A *primary goal* is defined, with the remaining goals divided into four groups: *Overall Goals*, *Overall Objectives*, *Wetland Species/Habitat Goals and Objectives*, and *Upland Species/Habitat Goals and Objectives*. Because many of the goals/objectives are not stated in a way that meets the definitions provided in the NBHCP, we have refined the wording and clarified the interpretation of some of the goals/objectives identified below.

Primary Goal

The "primary goal" of the NBHCP "is to create a system of reserves, with both wetland and upland components, that would support *viable populations* of the giant garter snake, Swainson's hawk and other Covered Species" (italics added).

A *viable population* has been defined as:

> a self-supporting population with sufficient numbers and genetic variety among healthy individuals and breeding pairs that are well enough distributed to ensure a high probability of survival despite the foreseeable effects of demographic, environmental and genetic events, and of natural catastrophes" (Soulé 1987).

The concept of a viable population as it relates to the NBHCP is useful for some covered species and problematic for others, primarily due to the Basin's relatively small size.

We now know from the monitoring efforts implemented to date that the population of giant gartersnakes in the Basin is likely to be and to remain viable in the short to mid-term because of successful implementation of the NBHCP. The population is viable because it is relatively large, and interconnected, and habitat has been set aside and managed for the specific purpose of maintaining the species. However, substantial threats that could negatively affect the giant gartersnake population in the Basin remain.

The Swainson's hawk population in the Basin is more difficult to describe in terms of viability because it is part of a much larger, interconnected population; the size of the population is small relative to the population in the larger region of which it is a part; and many pairs that nest in the Basin likely spend a significant proportion of their time foraging in habitats outside the Basin. It is therefore difficult to assess the degree to which the NBHCP Plan Area contributes to the health and vitality of the nesting population.

As is true for giant gartersnake, data from the monitoring efforts implemented to date indicate that the population of Pacific pond turtles in the Basin is likely to be viable and to remain viable in the short to mid-term because of successful implementation of the NBHCP. The population likely meets the definition of viable for the same reasons as does the giant gartersnake population. Pacific pond turtles have now been detected in every created managed marsh habitat on TNBC reserves.

For the remaining covered species known to occur in the Basin—burrowing owl, tricolored blackbird, loggerhead shrike, and white-faced ibis—monitoring data collected to date indicate that for various reasons, the conservation program outlined in the NBHCP can contribute to the viability of a larger, regional population, but the Basin itself is too small to provide the resources necessary to sustain an independently viable population. For burrowing owl and loggerhead shrike, the number of individuals occurring in the Basin is too small to meet the definition of a viable population. The white-faced ibis population is large in some years, and breeding colonies have become established in two locations (although both have not been active in the same year), but this species wanders widely and is now breeding outside the Basin. Similarly, tricolored blackbirds have established breeding colonies in at least five locations (although never more than two colonies in a single year), but the colonies are too small to represent independently viable populations.

Accordingly, the primary goal of the NBHCP has been divided into two goals as recommended below.

- For giant gartersnake and Pacific pond turtle, the primary goal should remain to support viable populations of these species.
- For the other covered species known to occur in the Basin, the primary goal of the NBHCP should be to contribute substantially and proportionally to the viability of the larger, regional populations of which they are a part.

Overall Goals

The overall goals of the NBHCP were defined as follows.

1. Establish and manage in perpetuity a biologically sound and interconnected habitat reserve system that mitigates impacts on Covered Species resulting from Covered Activities and provides habitat for existing, and new viable populations of Covered Species.

2. Implement an adaptive management program that responds to changing circumstances affecting Covered Species and their habitats.
3. Preserve open space and habitat that may also benefit local, non-listed and transitory wildlife species not identified within the NBHCP.
4. Ensure that direct impacts of Authorized Development upon Covered Species are avoided or minimized to the maximum extent practicable.

From goal 1 we derived the following objectives for the monitoring program.

- Determine if the reserves are biologically sound. We interpreted *biologically sound* to mean a habitat or ecosystem that is in good condition and serving the purpose for which it was created. *Good condition* is a subjective phrase that we defined to mean supporting the covered species it was designed to support in greater numbers than would otherwise be obtained without intervention by TNBC.
- Determine if reserves are *interconnected*, meaning that covered species can migrate from one reserve to another throughout the reserve system.
- Determine if reserves are occupied by the covered species they were designed to support.

With respect to goal 2, the adaptive management program has been implemented rapidly because of the challenges that have been posed by the various outcomes of managed marsh creation. Thus, the biggest issues have involved habitat creation and management. The responses have been based primarily on the potential threats perceived by the monitoring team species experts and not necessarily on the data collected from the monitoring program itself. Because the habitat management actions have not been tied specifically to the monitoring program, the adaptive management program is not well documented.

From goal 3 we derived the following objective.

- Determine if species richness and abundance are higher on reserve lands than they are on adjacent or equivalent habitats elsewhere in the Basin.

Goal 4 is a compliance issue and not directly tied to the biological effectiveness monitoring program.

Overall Objectives

The NBHCP identifies four overall objectives. However, it should be noted that these objectives do not meet the definition of an objective as defined in the NBHCP or any of the other ecological literature.

1. Minimize conflicts between wildlife and human activities, including conflicts resulting from airplane traffic, roads and automobile traffic, predation by domestic animals, and harassment by people.
2. Maintain and operate flood control, irrigation and drainage facilities in a manner that minimizes take of Covered Species and promotes vegetative cover that enhances habitat values for Covered Species, consistent with the Water Agencies' legal obligations.
3. Ensure connectivity between TNBC reserves to minimize habitat fragmentation and species isolation. Connections between reserves will generally take the form of common property boundaries between reserves, waterways (primarily irrigation and drainage channels) passing between reserves and/or an interlinking network of water supply channels or canals.

4. Within individual TNBC reserves, provide a mosaic of habitats that support both wetland and upland species, and that are configured to support species that utilize both types of habitat.
5. Implement monitoring programs with qualitative and/or quantitative monitoring methods to evaluate management objectives and strategies for the reserve system. TNBC shall develop each monitoring plan and shall submit the plan for review by NBHCP TAC and approval by the Wildlife Agencies prior to implementation.
6. Increase the diversity and abundance of Covered Species on reserve lands.
7. Revise the reserve design and management based on the most current biological data.

Except for objective 6, these overall objectives are more directly related to the compliance aspects of the NBHCP and are not directly related to the BEMP

We have revised and refined objective 6 to make it more measurable and quantifiable as shown below.

- Determine if the design and management of reserve lands has resulted in a greater diversity of covered species than before acquisition.
- Determine if the abundance of covered species has increased on reserve lands since the time of acquisition.

Wetland Species/Habitat Goals and Objectives

The NBHCP has defined the following goals and objectives (the NBHCP does not make a distinction between goals and objectives in this part of the Plan) specifically for wetland species and the habitats on which they depend.

1. Acquire, enhance and create a mosaic of wetland habitats with adjacent uplands and connecting corridors to provide breeding, wintering, foraging, and cover areas for wetland species in the Plan Area.
2. Provide habitat to maintain, attract and sustain *viable populations* of the Covered Species. The habitat areas should be configured to encompass natural species migration areas, minimize species isolation, and prevent future habitat fragmentation.
3. Document population trends of Covered Species through monitoring.

Goal/Objective 1 is compliance related and not directly related to the monitoring program. Goal/Objective 2 was addressed in previously established objectives.

Goal/Objective 3, while not meeting the definition of a goal or an objective, does direct that the monitoring program track population trends of covered species that depend on wetland habitats. The BEMP was designed to meet this goal/objective for covered species. However, because tracking population trends for some covered species is difficult, time consuming, costly, and relatively imprecise (i.e., not providing results with a high level of confidence), we evaluated options that did not include tracking population trends for some covered species (see *Overview of Monitoring Program Data* and the discussions of *Potential Management Actions* and *Management-Oriented Hypotheses* presented for individual covered species).

Upland Species/Habitat Goals and Objectives

The NBHCP has defined the following goals and objectives (the NBHCP does not make a distinction between goals and objectives in this part of the Plan) specifically for upland species and the habitats on which they depend.

1. Acquire, enhance and create a mosaic of upland habitat types for breeding, foraging, and cover for species dependent on upland habitats.
2. Ensure reserve land connectivity with travel corridors for upland-dependent species. The habitat areas should encompass grasslands, agricultural croplands, riparian habitats, and shelter and nesting habitat areas (fence rows, clusters of shrubs and small trees), as well as wetland areas to provide a year-round source of water for upland species. The upland areas should be configured to enhance natural species migration, minimize species isolation, and prevent future habitat fragmentation.

These Goals/Objectives are more directly related to the compliance aspects of the NBHCP and are not directly related to the BEMP.

Other Requirements of the Monitoring Program Specified in the NBHCP

In addition to goals and objectives, the NBHCP contains several "directives" with respect to monitoring. These are outlined primarily in Chapter VI of the NBHCP under Plan Implementation. The relevant directives are listed below.

- In order to measure the effectiveness of meeting the biological goals and objectives, the Biological Effectiveness Monitoring Plan shall be designed to track population trends of the Covered Species (NBHCP VI-15)
- In order to measure the effectiveness of meeting the biological goals and objectives, the Biological Effectiveness Monitoring Plan shall be designed to evaluate the effectiveness of the Mitigation Land design, restoration and management in providing habitat and supporting the Covered Species (NBHCP VI-15).
- The monitoring plan shall track population trends on TNBC Mitigation Lands as well as at some selected non-reserve sites within the Natomas Basin. Non-reserve sites will serve as controls to compare success of Mitigation Land design and management in supporting and increasing the abundance of Covered Species.

In summary, our review of the goals, objectives, and directives in the NBHCP has led to the following list of suggestions regarding revised goals, objectives, and directives for the monitoring program.

- For giant gartersnake and Pacific pond turtle the primary goal should remain to support viable populations of these species.
- For the other covered species known to occur in the Basin, the primary goal of the NBHCP should be to contribute substantially to the viability of the larger, regional populations of which they are a part.
- Determine if the reserves are biologically sound. We interpreted *biologically sound* to mean a habitat or ecosystem that is in good condition and serving the purpose for which it was created. *Good condition* is a subjective phrase that we defined to mean supporting the covered species it was designed to support in greater numbers than would otherwise be obtained without intervention by TNBC.

- Determine if reserves are *interconnected*, meaning that covered species can migrate from one reserve to another throughout the reserve system.
- Determine if reserves are occupied by the covered species they were designed to support.
- Determine if species richness and abundance are higher on reserve lands than they are on adjacent or equivalent habitats elsewhere in the Basin.
- Determine if the design and management of reserve lands has resulted in a greater diversity of covered species than before acquisition.
- Determine if the abundance of covered species has increased on reserve lands since the time of acquisition.
- Document population trends of covered species (inhabiting wetlands) through monitoring.

The following three directives were retained in their original form from the NBHCP.

- The Biological Effectiveness Monitoring Plan shall be designed to track population trends of the Covered Species (NBHCP VI-15).
- The Biological Effectiveness Monitoring Plan shall be designed to evaluate the effectiveness of the Mitigation Land design, restoration and management in providing habitat and supporting the Covered Species (NBHCP VI-15).
- The monitoring plan shall track population trends on TNBC Mitigation Lands as well as at some selected non-reserve sites within the Natomas Basin. Non-reserve sites will serve as controls to compare success of Mitigation Land design and management in supporting and increasing the abundance of Covered Species.

Overview of Monitoring Program Data, Potential Management Actions, Management-Oriented Hypotheses, and Monitoring Options

In this section, we provide a brief overview of our state of knowledge regarding each of the covered species known to occur in the Basin based on the last 11 or more years of monitoring data. We then derive a list of potential management actions that could be taken to positively influence each species, derive several management-oriented hypotheses and questions, and evaluate several monitoring options. In the evaluation of monitoring options, we assumed that increases to the monitoring budget would be unrealistic.

Swainson's Hawk

Swainson's hawk inhabits grassland plains and agricultural regions of western North America during the breeding season and grassland and agricultural regions from Central Mexico to southern South America during the nonbreeding season (England et al. 1997). Swainson's hawks usually nest in large native trees, such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontii*), walnut (*Juglans* spp.), and willow (*Salix* spp.), and occasionally in nonnative trees such as eucalyptus (*Eucalyptus* spp.).

Nesting pairs are highly traditional in their use of nesting territories and nesting trees. Many nest sites in the Central Valley have been occupied annually since 1979 (Estep unpublished data), and

banding studies conducted since 1986 confirm a high degree of nest site and mate fidelity (Estep in preparation).

In the Central Valley, Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetative cover (providing access to the ground) and high densities of prey (Bechard 1982; Estep 1989, 2009; Anderson et al. in preparation). These habitats are usually hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Fields lacking adequate prey populations (e.g., flooded rice fields) or those that are inaccessible to foraging birds (e.g., vineyards and orchards) are rarely used (Estep 1989; Babcock 1995). Urban expansion and conversion of agricultural lands to unsuitable crop types are responsible for a continuing reduction of available Swainson's hawk foraging habitat in the Central Valley.

Monitoring Results

The Swainson's hawk population in the Basin has been monitored continuously since 1999. However, in 2001, the study area was expanded to include both sides of the peripheral water bodies that form the boundaries of the Basin. The comprehensive monitoring program began in 2005; these efforts included tracking annual changes in the amounts of various categories of Swainson's hawk foraging habitats in the Basin.

Because Swainson's hawks are large, relatively conspicuous predators that are tied to a specific location (the nest) for an extended period, it is relatively easy and inexpensive to conduct a complete census of the breeding population. Accordingly, the monitoring program currently consists of a complete census of the breeding population and monitoring various measures of reproductive success.

The average number of occupied territories over the 17-year monitoring period is 53.6 (SD = 7.2, range = 44–65). The coefficient of variation (CV) is 13.1%, indicating moderate variability from year to year. However, there has been a statistically significant increase in the breeding population of Swainson's hawks over the 16-year monitoring period, while the amount of available foraging habitat has remained relatively constant. Changes in the size of the breeding population are significantly correlated with the total acres of alfalfa and the total acres of upland agricultural habitats within the Basin.

Variation in reproductive success has exhibited much greater variation over the monitoring period. The CV for the number of young produced per occupied territory is 35.6%, due primarily to significant drops in the number of young fledged in 2011 and 2013. In addition, there has been a statistically significant decline over time in the mean number of young fledged per successful nest, which is surprising given that this metric is mathematically stable (i.e., it is a mean of a collection of numbers that can only take on the values 1,2, or 3). This has led us to hypothesize that the population may be experiencing a long-term decline in prey availability that may be due to a reduction in row and field crop habitats outside the Basin. However, there are several other possibilities, including drought, increased use of pesticides, application of a new pesticide, and some form of pesticide poisoning that is taking place on the wintering grounds outside the Basin that affects reproduction (analogous to the effects produced by DDT in the 1960s and 70s).

However, evidence collected to date indicates that impacts on Swainson's hawk in the form of habitat conversion allowed under the NBHCP have not been significant enough over the course of the monitoring period to negatively affect the breeding population.

Potential Management Actions

The following list of potential management actions was developed for Swainson's hawk population in the Basin.

- Convert upland agriculture entirely to alfalfa.
- Install native grassland borders adjacent to agricultural fields to provide refugia for prey species.
- Plant a mix of upland agricultural crops with complementary harvest times since Swainson's hawks forage extensively behind harvest and mowing equipment.
- Plant trees preferred by Swainson's hawks for nesting to replace trees lost to natural causes or to development or other anthropogenic activities.
- Coordinate the timing of mowing and harvesting activities to coincide with critical times in the nesting period and to ensure abundant available prey throughout the nesting season.
- Reduce or eliminate where possible the use of pesticides on upland agricultural lands.

Management-Oriented Hypotheses and Questions

- To what extent are breeding pairs utilizing and dependent upon foraging habitats inside the Basin?
- At what stage in the nesting cycle is prey most likely to be a limiting factor?
- Why do so few Swainson's hawk pairs in the Basin nest in trees or tree clumps away from the peripheral water bodies surrounding the Basin?
- Are populations limited by factors that occur during the nonbreeding season outside the Basin?
- Are Swainson's hawks in the Basin being exposed to toxins and do those toxins negatively affect survival or reproductive success?

Monitoring Options

We identified three options for the Swainson's hawk monitoring program. The first option is to continue to annually census the breeding population and measure reproductive success. The second option is to implement a research program to systematically answer some of the management questions outlined above. Although implementing both options would meet all the requirements of the NBHCP, the increase in monitoring effort does not seem warranted given the current apparent health of the breeding population of Swainson's hawks in the Basin.

Option 1

Option 1 would entail continuing the complete census of the breeding population of Swainson's hawks in the Basin and continuing to measure reproductive parameters.

The advantages of implementing Option 1 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, with the possible exception of the requirement to provide data that will help refine the design and management of the reserve system.

- It provides data that can be used to define management threshold limits and indicate when those limits are reached.
- It is relatively inexpensive.

The disadvantages of implementing Option 1 are as follows.

- It may not provide the information necessary to determine the cause of declines in population size or reproductive success when they occur.
- It may not meet the requirement to provide data that will help refine the design and management of the reserve system.

Option 2

Option 2 would entail discontinuing the complete census of the breeding population of Swainson's hawks in the Basin and the measurement of reproductive parameters in favor of implementing a research program directed at answering the management-related hypotheses and questions outlined above. This option would likely consist initially of radio-tagging hawks to estimate the amount of time they spend foraging in the Basin and perhaps to measure survival. It would also include taking blood samples for analysis of pesticide loads.

The advantages of implementing Option 2 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirement to provide data that will help refine the design and management of the reserve system.
- It may provide the information necessary to determine the cause of declines in population size or reproductive success when they occur, although trends in population size would necessarily be subjectively inferred because trends in population size would no longer be monitored.

The disadvantages of implementing Option 2 are as follows.

- It would not provide data that can be used to determine if management threshold limits have been reached unless those limits are based on changes in the availability of foraging habitats.
- It would not meet the requirement to track changes in population size.
- Necessary funding could be more variable from year to year than Option 1, and could possibly be more expensive.

Recommendations

We recommend continuing the current monitoring program because it is relatively inexpensive, provides the data to derive meaningful management threshold limits and to determine if/when those limits are met, and can indicate when/if Option 2 might become necessary. In addition, we recommend that TNBC begin quantitatively monitoring the use of pesticides and herbicides on mitigation lands to determine if these practices are negatively affecting Swainson's hawk populations.

Giant Gartersnake

Giant gartersnake is a large aquatic gartersnake endemic to wetlands in California's Central Valley. Giant gartersnake historically occurred in marshes, sloughs, and other habitats with slow-moving, relatively warm water and emergent vegetation, especially tules (*Schoenoplectus [Scirpus] acutus*). Although conversion of wetlands to agriculture has nearly extirpated giant gartersnake, the species persists in rice fields (Halstead et al. 2010). Canals associated with rice agriculture can provide marsh-like habitat conditions throughout the giant gartersnake active season—late March through early October (Wylie et al. 2009)—and rice fields themselves are emergent wetlands for a portion of the giant gartersnake active season. The quality of rice agricultural habitats relative to natural or restored marshes is an area of active research.

The draining of wetlands and subsequent urban and agricultural development have contributed to the loss of more than 95% of giant gartersnake's original habitat (Frayer et al. 1989). The few remaining natural wetlands are fragmented, the natural cycle of seasonal valley flooding by high Sierra snowmelt has been limited, and the waters have been diverted by a network of dams and levees. As a result, giant gartersnake populations have become fragmented with only relatively small isolated populations remaining.

Monitoring Results

The giant gartersnake population in the Basin has been monitored continuously since 2005. However, in 2010 the monitoring protocols were changed, and monitoring on non-reserve lands was discontinued in favor of increasing effort on reserve lands and assessing the efficacy of a new occupancy monitoring approach to population monitoring.

Giant gartersnakes are extremely elusive and difficult to observe and capture. Estimating trends in populations is therefore extremely difficult, labor intensive, and complex. Sophisticated sampling and analysis techniques are required to make valid inferences about the population. Because of these difficulties, assessing trends in the Basin-wide population of giant gartersnakes with a reasonable degree of certainty is currently not possible.

Accordingly, the current monitoring program has focused on tracking population trends and demographic parameters at five distinct locations on reserve lands, and assessing occupancy at a random sample of wetland units (defined as the area between two water control structures, whether they are in created wetlands or canals associated with rice agriculture).

Monitoring data collected to date have provided us with estimates of population size at the five demographic monitoring sites and changes in abundance over time. This dataset has also provided estimates of apparent survival and recruitment, as well as assessments of the probability of the population being stable, increasing, or decreasing.

In general, the available evidence indicates that three of the five demographic monitoring sites (Natomas Farms, Lucich North and Lucich South) had stable population trends while the other two sites (BKS and Sills) had increasing population trends. Variation in the demographic parameters measured is high, and the estimates are imprecise.

However, the proportion of wetland units occupied, which has only been measured since 2010, has decreased over time. The reasons for this decline are unknown.

Potential Management Actions

Management of giant gartersnake populations is complex, because the management of their habitats is complex. Marsh habitats are dynamic ecosystems that change over time. Ecological succession—the gradual process by which ecosystems change and develop over time—in marsh habitats can take place rapidly relative to other ecosystems. As a result, both the design and management of marsh habitats have many potential tradeoffs, and the outcomes of design decisions and management actions can be fraught with uncertainty. For example, marsh designs that work in one location may not be successful in another location due to differences in the seed bank and soil characteristics.

Here, we start by listing habitat characteristics that evidence indicates are most favorable to giant gartersnakes. These should be incorporated into any plan to design marsh habitats and are the characteristics that management action should be designed to achieve. We then list potential management actions that can be used to achieve these characteristics. Finally, we list other potential management actions that can be undertaken to favor giant gartersnake populations. However, it should be noted that the majority of management actions ae those designed to achieve and maintain the design characteristics of the created marsh habitats.

Habitat Characteristics

- Habitat comprised primarily of emergent vegetation in the form of tule that is arranged in such a way as to maximize the interface between emergent vegetation and open water. Emergent vegetation at wetland edges, clumps of vegetation in open water, and pockets of open water in stands of emergent vegetation should be maximized.
- Herbaceous bankside vegetation to provide cover for giant gartersnakes when they are moving between aquatic and upland habitats.
- Burrows and muskrat lodges that provide potential hibernation, basking, and shelter sites. Burrows are created by muskrat, crayfish, California ground squirrel, and other small mammals.
- Minimize aquatic floating vegetation.

Management Actions to Maintain Habitat Characteristics

- Manipulate water levels.
- Implement mechanical or chemical control/removal of noxious weeds or undesirable vegetation such as cattails.

Other Management Actions to Benefit Giant Gartersnake Populations

- Minimize disturbance.
- Minimize mowing of vegetation.
- Periodically drain wetlands to eliminate large, predatory fish.
- Minimize sudden fluctuations in water levels
- Mimic natural hydrology.

Management-Oriented Hypotheses and Questions

- Why does the Fishman's Lake Preserve area support such small populations of giant gartersnake, and what can be done to increase them?
- How do water source and temperature affect giant gartersnake occupancy and demographics?
- How far can giant gartersnakes disperse through canal habitats?
- Do large, predatory fish negatively affect giant gartersnake populations?
- Do large bullfrog populations negatively affect giant gartersnake populations?
- Are shallow-water habitats with emergent vegetation important for prey production or to provide cover for foraging neonates?
- Do herbicides negatively affect giant gartersnake?

Monitoring Options

We identified three options for the giant gartersnake monitoring program. The first is to continue the current monitoring program to assess changes in abundance and demographic rates at five preserve sites and to continue to measure occupancy at a random sample of preserve sites. The second is to switch to a full occupancy monitoring approach with minor changes to the design of the occupancy monitoring program. The third is to implement a research program to systematically answer some of the management questions outlined above.

Option 1

As noted above, the current monitoring program focuses on intensively monitoring abundance and demographic rates at five distinct locations on preserve lands. Demographic monitoring is conducted during the first half of the giant gartersnake active season when capture probabilities are highest. Occupancy monitoring is then conducted during the second half of the giant gartersnake active season. Capture probabilities are lower during this time. Trapping is conducted at a random sample of wetland units for 21 days or until two snakes are captured, whichever comes first. When one of these criteria are met, the traps are moved to another wetland unit.

The advantages of implementing Option 1 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, with the possible exception of the requirement to provide data that will help refine the design and management of the reserve system.
- It provides data that can be used to define management threshold limits and indicate when those limits are reached.
- It provides estimates of demographic rates, which could potentially indicate where populations are having trouble were they ever to decline.

The disadvantages of implementing Option 1 are as follows.

- It may not provide the information needed to help refine the design and management of the reserve system.
- Estimates of demographic rates are imprecise.

- Demographic rates are only determined at five locations chosen because they provide the highest capture probabilities. Thus, they may not be representative of the rest of the preserve system.

Option 2

The monitoring team has been developing Option 2 over the last 6–8 months. Recent advances in analytical techniques and computational software have made this new design possible. Under Option 2, the monitoring program would be changed to reflect a full occupancy monitoring approach. The five demographic monitoring sites would be discontinued under this option. Instead, occupancy monitoring at a randomly selected sample of wetland units within the preserve system would be monitored throughout the giant gartersnake active season. However, the occupancy monitoring approach would be modified slightly so that each site is sampled for 21 days, irrespective of the number of giant gartersnake captures and recaptures. This approach would allow us to estimate abundance and/or demographic rates at any site at which there are a sufficient number of captures/recaptures.

The advantages of implementing Option 2 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirement to provide data that will help refine the design and management of the reserve system.
- It may provide the information necessary to determine the cause of declines in population size or reproductive success if/when they occur.
- It provides information at a larger sample of randomly selected sites, allowing conclusions drawn to be validly extrapolated to the rest of the preserve system.
- The stratification of the sampling system into wetland units and its application across the entire giant gartersnake active season increases capture probabilities and thus increases the statistical power to detect differences among wetland units that can be correlated with habitat variables.

The disadvantages of implementing Option 2 are as follows:

- It would not track changes in abundance and changes in demographic rates with as much power as Option 1.
- It may not meet the requirement to track population trends required in the NBHCP, although this outcome is less likely than the positive outcome.

Option 3

Option 3 would entail discontinuing the current monitoring program in favor of implementing a research program directed at answering the management-related hypotheses and questions outlined above. This approach would likely focus initially on determining the dispersal capabilities of giant gartersnakes and the factors that impede or enhance dispersal capabilities. It may also consist of studying the Fisherman's Lake area population to determine why the population there appears to be so small.

The advantages of implementing Option 3 are as follows.

- It would address one of the more important issues regarding the long-term viability of giant gartersnakes in the Basin: specifically the connectivity of the individual snake populations within the Basin.
- In the long term, it may provide data to help refine the design and management of the reserve system.

The disadvantages of implementing Option 3 are as follows.

- It does not meet the requirement in the NBHCP to track population trends of covered species.
- It does not provide the information necessary to determine when/if quantitatively derived management threshold limits are met.
- It may not provide the information required to help refine the design and management of the reserve system.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for about the same cost as the current monitoring program. It would increase our ability to make inferences about habitat characteristics that are associated with the most resilient and healthy populations of giant gartersnake—inferences that will be applicable to the entire reserve system.

Burrowing Owl

Burrowing owl (*Athene cunicularia*) is a small, long-legged owl found in open landscapes. Burrowing owls can be found in grasslands, rangelands, agricultural areas, deserts, or any other open area with low vegetation. They nest and roost in burrows, such as those excavated by California ground squirrels. They require very low vegetation and available burrows, because they must be able to see into the distance to detect incoming predators. Suitable environments include edges of cattle pastures and row crops or alfalfa fields where the squirrels are active but the vegetation is low. Burrowing owls can even inhabit quasi-urban settings such as near airports, golf courses, and even parking lots if they can find a safe place with burrows, and vegetation remains low. They are known to take advantage of artificial nest sites (plastic burrows with tubing for the entrance) and perches. Pairs of owls will sometime nest in loose colonies.

Monitoring Results

The burrowing owl population in the Basin has been monitored continuously since 2005. Burrowing owls are relatively stationary, tied to the location of their burrows, but they can be inconspicuous and difficult to detect at a distance. Because they nest underground, measuring reproductive success can be time-consuming. The monitoring program currently consists of monthly surveys of reserve lands throughout the year and monthly surveys throughout the Basin along preestablished survey routes. The Basinwide surveys do not cover the entire Basin but rather represent a sampling of available habitat. However, whenever the presence of owls is reported, those sites become part of future surveys.

The distribution of burrowing owls in the Natomas Basin is highly clustered. Most owls occur in one of four colonies, most of which are on non-reserve lands. One colony is in the parking lot of the

former Arco Arena, another in a weedy field of grass hay surrounded by development that is mowed each spring. A third is at the site of an abandoned homestead that burned down and has never been cleaned up. The fourth colony is along the top edges of the Highline Canal that separates the Elsie and Tufts tracts of the Central Basin Reserve. Additional individuals or pairs occasionally show up in various locations but do not persist for more than 1 year.

The breeding population of burrowing owls in the Basin is small. The largest number of breeding pairs detected (15) was in 2012, all but one of which occurred on non-reserve lands. The maximum number of pairs on reserve lands occurred in 2010, when four pairs were observed on the Elsie, Tufts, Sills, and BKS tracts of the Central Basin Reserve.

Burrowing owl populations and reproductive success have been declining in the Basin. The reasons for the decline are unknown, but may be related to drought conditions over the last 5 years. In addition, habitat in the form of burrows created by ground squirrels is a potentially limiting factor. Burrows at existing sites have been used for extensive periods and have likely become infested with feather lice and other parasites. It appears that these burrows are being abandoned, but they may become reoccupied once parasite infestations are ameliorated.

Potential Management Actions

The following list of potential management actions were developed for the burrowing owl population in the Basin.

- Create artificial berms in the center of grassland habitats that are away from trees and other potential perch sites for predators.
- Allow California ground squirrels to inhabit these grassland sites or consider introducing them once berms have become established.
- Graze rather than mow these sites to maintain low-stature vegetation and provide manure piles to increase insect populations.

Management-Oriented Hypotheses and Questions

- Will burrowing owls inhabit artificial berms?
- What compaction rate is optimal to provide structural integrity and minimal vegetation growth but still allow for burrowing by California ground squirrels?
- Can California ground squirrels be successfully translocated?
- What methods work best to translocate California ground squirrels?
- Can burrows be treated to facilitate reoccupancy by owls?
- Can owls displaced by development be successfully translocated to habitats on reserve lands created for them?

Monitoring Options

We identified three options for the Burrowing owl monitoring program. Option 1 is to continue monthly surveys on reserve and non-reserve lands. Option 2 is to continue the monthly reserve and non-reserve land surveys, but to limit them primarily to the breeding season and a few winter months. In addition, the South Basin portion of the non-reserve lands survey would be

discontinued, as there have been no detections of covered species in this area aside from detections of burrowing owls in the Arco Arena, Elkhorn Blvd, and Aimwell Street colonies. These colonies would continue to be monitored, but the rest of the survey route would be abandoned. Option 3 is to implement a research program to systematically answer some of the management questions outlined above.

Option 1

The advantages of implementing Option 1 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data required to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It will continue to add to an extensive data set that provides information on long-term trends in species relative abundance.

The disadvantages of implementing Option 1 are as follows.

- It is more costly than Option 2.
- Survey effort in some months provides little information of value.

Option 2

The advantages of implementing Option 2 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It reduces costs relative to Option 1.

The disadvantages of implementing Option 2 are as follows.

- It will interrupt a data set that has been collected continuously since 2005 and may therefore decrease its value.

Option 3

The advantages of implementing Option 3 are as follows.

- It would address some of the questions about how to successfully encourage burrowing owls to colonize reserve lands.
- It would improve our knowledge of how to successfully create burrowing owl habitat in the Basin.

The disadvantages of implementing Option 3 are as follows.

- It does not meet the requirement in the NBHCP to track population trends of covered species.
- It does not provide the information necessary to determine when/if management threshold limits are met.
- It will terminate a dataset that has been collected continuously since 2005 and may therefore decrease its value.
- Some of the research questions can only be addressed if TNBC implements some of the management options outlined above. Answers to these questions could potentially be addressed under Options 1 and 2 when/if these management actions are taken.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for less cost than the current monitoring program, with only a minor decrease in the value of the data. We also recommend that site-specific management plans incorporate the creation of habitat for burrowing owls and specific goals for burrowing owl habitat.

Tricolored Blackbird

Tricolored blackbird (*Agelaius tricolor*) is a highly social and gregarious bird that forms the largest colonies of any North American landbird and occurs almost entirely in California. The colonial nature of tricolored blackbird makes it particularly vulnerable to extinction. Birds adapted to nesting in agricultural fields have been disturbed and killed *en masse* by harvesting when birds are nesting in the harvested fields. Native grasslands once used for nesting and feeding have been lost to urban and agricultural development, and nesting habitat in the form of wetlands have been greatly reduced. Tricolored blackbirds are also vulnerable to predation when nesting by black-crowned night herons and other nest predators—likely the reason they often prefer to nest in nonnative Himalayan blackberry (*Rubus armeniacus*) and other thorny nesting substrates that provide some protection from predation. Diet during the breeding season is comprised primarily of insects associated with dairy feedlots, grasshopper outbreaks, beetles, moths, butterflies, and dragonfly and other aquatic insect larvae. Pre- and post-breeding foods may include ripening seed heads of rice and other grain crops.

Monitoring Results

The tricolored blackbird population in the Basin has been monitored continuously since 2005. Because tricolored blackbirds are colonial with a distinctive call, they can be easy to detect during the breeding season but very difficult to enumerate during the nonbreeding season because they form large, mixed-species flocks with other blackbird species and European starlings. The monitoring program currently consists of monthly surveys of reserve lands throughout the year and monthly surveys throughout the Basin along preestablished survey routes. The Basinwide surveys do not cover the entire Basin—and should thus be considered a sampling of the population—but any nesting colonies within the Basin are likely to be detected because the locations of virtually all of potential nesting habitats are known.

Tricolored blackbird numbers have always been small in the Basin, although five distinct breeding locations have been documented since comprehensive monitoring began in 2005. However, breeding has not occurred in the Basin since 2010. The reasons for the lack of breeding are

unknown. The primary hypotheses concerning the decline are lack of potential nesting habitat and lack of foraging habitat (or perhaps more specifically of prey availability).

Potential Management Actions

The following list of potential management actions was developed for the tricolored blackbird population in the Basin.

- Promote the growth of large, dense stands of Tule surrounded by water to improve potential nesting habitat.
- Create irrigated pasture, preferably near nesting habitat
- Use cattle grazing to increase insect populations.
- Reduce or eliminate the use of pesticides, particularly insecticides.
- Experiment with growing crops that have been used as nesting habitat.
- Establish large patches of Himalayan blackberry, nettles, and other plants that provide the structure preferred by nesting tricolored blackbirds.

Management-Oriented Hypotheses and Questions

- What limits blackbird populations (nesting or foraging habitat)?
- Will blackbirds nest in grain fields in the Natomas Basin, and if so, which grains are most likely to be used?
- What caused the abandonment of the nesting colonies that have been used historically (predation, disturbance)?
- How much foraging habitat is enough to induce breeding?

Monitoring Options

We identified three options for the tricolored blackbird monitoring program. Option 1 is to continue monthly surveys on reserve and non-reserve lands. Option 2 is to continue the monthly reserve and non-reserve land surveys, but to limit them primarily to the breeding season and a few winter months. In addition, the South Basin portion of the non-reserve lands survey would be discontinued, as there have been no detections of tricolored blackbirds in this area for several years. Option 3 is to implement a research program to systematically answer some of the management questions outlined above.

Option 1

The advantages of implementing Option 1 are as follows

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data required to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.

- It will continue to add to an extensive data set that provides information on long-term trends in species relative abundance.

The disadvantages of implementing Option 1 are as follows.

- It is more costly than Option 2.
- Survey effort in some months provides little information of value.

Option 2

The advantages of implementing Option 2 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It reduces costs relative to Option 1.

The disadvantages of implementing Option 2 are as follows.

- It will interrupt a dataset that has been collected continuously since 2005 and may therefore decrease its value.

Option 3

The advantages of implementing Option 3 are as follows.

- It would address some of the questions about how to successfully encourage burrowing owls to colonize reserve lands.
- It would improve our knowledge of how to successfully create burrowing owl habitat in the Basin.

The disadvantages of implementing Option 3 are as follows.

- It does not meet the requirement in the NBHCP to track population trends of covered species.
- It does not provide the information necessary to determine when/if management threshold limits are met.
- It will terminate a dataset that has been collected continuously since 2005 and may therefore decrease its value.
- Some of the research questions can only be addressed if TNBC implements some of the management options outlined above. Answers to these questions could potentially be addressed under Options 1 and 2 when/if these management actions are taken.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for less cost than the current monitoring program, with only a minor decrease in the value of the data. We also recommend that site-specific management plans

incorporate the creation of habitat for tricolored blackbird and specific goals for tricolored blackbird habitat.

Loggerhead Shrike

Loggerhead shrike (*Lanius ludovicianus*) is a passerine bird nicknamed the butcherbird after its carnivorous tendencies. It consumes prey such as amphibians, insects, lizards, small mammals, and small birds. Due to its small size and weak talons, this predatory bird relies on impaling its prey on thorns or barbed wire to facilitate consumption. The numbers of loggerhead shrike have significantly decreased since the 1960s. The species requires an open habitat with an area to forage, elevated perches, and nesting sites. They are often found in open pastures or grasslands, and often nest in fence-rows or hedge-rows near open pastures. Open pastures and grasslands with shorter vegetation are preferred as it increases their hunting efficiency. Longer vegetation often requires more time and energy to be spent searching for prey, so these birds gravitate toward areas of shorter vegetation.

Monitoring Results

The loggerhead shrike population in the Basin has been monitored continuously since 2005. Shrikes are relatively inconspicuous and secretive with a tendency to call infrequently. They can therefore be difficult to detect and their nests are difficult to find. The monitoring program currently consists of monthly surveys of reserve lands throughout the year and monthly surveys throughout the Basin along preestablished survey routes. The Basinwide surveys do not cover the entire Basin, and should thus be considered a sampling of the population.

Loggerhead shrike numbers have always been small in the Basin, with a maximum number of approximately 10 breeding pairs. The population in the Basin has been declining significantly since 2010. The reasons for the decline are unknown, but may be related to the drought or to a reduction in insect prey.

Potential Management Actions

The following list of potential management actions was developed for the loggerhead shrike population in the Basin.

- Create irrigated pasture, preferably near nesting habitat.
- Use cattle grazing to increase insect populations.
- Reduce or eliminate the use of pesticides, particularly insecticides.

Management-Oriented Hypotheses and Questions

- What limits loggerhead shrike populations (nesting or foraging habitat)?
- What are the characteristics of nesting habitat that can be reproduced on reserve lands?
- Are insect populations a limiting factor?
- Is disturbance a limiting factor?

Monitoring Options

We identified three options for the Loggerhead shrike monitoring program. Option 1 is to continue monthly surveys on reserve and non-reserve lands. Option 2 is to continue the monthly reserve and non-reserve land surveys, but to limit them primarily to the breeding season and a few winter months. In addition, the South Basin portion of the non-reserve lands survey would be discontinued, as there have been no detections of loggerhead shrike in this area for several years. Option 3 is to implement a research program to systematically answer some of the management questions outlined above.

Option 1

The advantages of implementing Option 1 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It will continue to add to an extensive dataset that provides information on long-term trends in species-relative abundance.

The disadvantages of implementing Option 1 are as follows.

- It is more costly than Option 2.
- Survey effort in some months provides little information of value.

Option 2

The advantages of implementing Option 2 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It reduces costs relative to Option 1.

The disadvantages of implementing Option 2 are as follows.

- It will interrupt a data set that has been collected continuously since 2005 and may therefore decrease its value.

Option 3

The advantages of implementing Option 3 are as follows.

- It would address some of the questions about how to successfully encourage loggerhead shrikes to nest on reserve lands.

- It would improve our knowledge of how to successfully create loggerhead shrike habitat in the Basin.

The disadvantages of implementing Option 3 are as follows.

- It does not meet the requirement in the NBHCP to track population trends of covered species.
- It does not provide the information necessary to determine when/if management threshold limits are met.
- It will terminate a dataset that has been collected continuously since 2005 and may therefore decrease its value.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for less cost than the current monitoring program, with only a minor decrease in the value of the data. We also recommend that site-specific management plans incorporate the creation of habitat for loggerhead shrike and specific goals for loggerhead shrike habitat.

White-faced ibis

White-faced ibis (*Plegadis chihi*) is a wading bird that breeds colonially in marshes, usually nesting in bushes, low trees, or tules. They eat a variety of organisms, including fish, crayfish, newts, frogs, and invertebrates such as insects, leeches, snails, and earthworms. In the Natomas Basin, the species forages extensively in created emergent wetlands and flooded rice fields. Across the species range, white-faced ibis numbers declined extensively due to loss of wetland habitats and pesticide poisoning, primarily DDT.

Monitoring Results

The white-faced ibis population in the Basin has been monitored continuously since 2005. Ibis are relatively large, conspicuous, and colonial, and are therefore relatively easy to detect and count. The monitoring program currently consists of monthly surveys of reserve lands throughout the year and monthly surveys throughout the Basin along preestablished survey routes. The Basinwide surveys do not cover the entire Basin—and should thus be considered a sampling of the population—but any nesting colonies within the Basin are likely to be detected because the locations of virtually all the potential nesting habitats are known.

White-faced ibis populations began expanding into the Basin prior to the onset of the comprehensive monitoring program in 2005 and continued expanding until 2007 when the first nesting colony was established on the BKS tract of the Central Basin Reserve. Nesting there continued for the next 4 years and then shifted to the Willey preserve, a wetland created by the Sacramento Airport Systems as mitigation for illegal fill of wetland habitats. That nesting colony has since been abandoned, but large numbers of ibis continue to use habitat in the Basin extensively during the summer when rice fields are flooded.

Potential Management Actions

The following list of potential management actions was developed for the white-faced ibis population in the Basin.

- Promote the growth of large, dense stands of tule surrounded by water to improve potential nesting habitat.
- Reduce or eliminate the use of pesticides, particularly insecticides.
- Minimize disturbance in created emergent marsh habitats during the breeding season.

Management-Oriented Hypotheses and Questions

- Why have ibis discontinued breeding in the Basin?
- What are the characteristics of nesting habitat that can be reproduced on reserve lands?
- Are pesticides negatively affecting populations?
- Is disturbance a limiting factor?

Monitoring Options

We identified three options for the white-faced ibis monitoring program. Option 1 is to continue monthly surveys on reserve and non-reserve lands. Option 2 is to continue the monthly reserve and non-reserve land surveys, but to limit them primarily to the breeding season and a few winter months. In addition, the South Basin portion of the non-reserve lands survey would be discontinued, as there have been no detections of white-faced ibis in this area for several years. Option 3 would be to implement a research program to systematically answer some of the management questions outlined above.

Option 1

The advantages of implementing Option 1 are as follows.

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It will continue to add to an extensive dataset that provides information on long-term trends in species relative abundance.

The disadvantages of implementing Option 1 are as follows.

- It is more costly than Option 2.
- Survey effort in some months provides little information of value.

Option 2

The advantages of implementing Option 2 are as follows

- It meets most of the requirements for monitoring outlined in the NBHCP, including the requirements to survey on reserve and non-reserve lands and track population trends.
- It provides data to determine if management threshold limits have been met.
- It may provide the data needed to help refine the design and management of the reserve system if some of the potential management actions outlined above are implemented.
- It reduces costs relative to Option 1.

The disadvantages of implementing Option 2 are as follows

- It will interrupt a dataset that has been collected continuously since 2005 and may therefore decrease its value.

Option 3

The advantages of implementing Option 3 are as follows

- It would address some of the questions about how to successfully encourage white-faced ibis to nest on reserve lands.
- It would improve our knowledge of how to successfully create white-faced ibis habitat in the Basin.

The disadvantages of implementing Option 3 are as follows.

- It does not meet the requirement in the NBHCP to track population trends of covered species.
- It does not provide the information necessary to determine when/if management threshold limits are met.
- It will terminate a dataset that has been collected continuously since 2005 and may therefore decrease its value.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for less cost than the current monitoring program, with only a minor decrease in the value of the data. We also recommend that site-specific management plans incorporate the creation of habitat for white-faced ibis and specific goals for white-faced ibis habitat.

Pacific Pond Turtle

Pacific pond turtle (*Actinemys marmorata*) is a small to medium-sized turtle with a range limited to the west coast of the United States and Mexico. Pond turtles occur in both permanent and intermittent waters, including marshes, streams, rivers, ponds, and lakes. They favor habitats with large numbers of emergent logs or boulders, where they aggregate to bask. Terrestrial habitat is also important for pond turtles. Many turtles overwinter out of water. Pacific pond turtles are omnivorous, consuming fish, tadpoles, frogs, carrion, filamentous algae, lily pads, andtule and cattail roots. Females deposit eggs in terrestrial habitats as are as 0.8 km (0.5 mile) from the nearest water. Threats include loss of habitat and potential competition from nonnative introduced species such as red-eared sliders (*Trachemys scripta elegan*), which compete with native Pacific pond turtles for food, egg-laying sites, and basking sites.

Monitoring Results

Formal surveys for Pacific pond turtle have not been conducted. Rather, they are noted incidentally during surveys for other covered species. However, detections have increased over time, and they have now been detected on every reserve with created marsh habitats. Because Pacific pond turtles occur in riverine habitats and linear water conveyance features, they are likely to freely disperse into and out of the Basin, and the colonization of all created marsh habitats indicate that populations are expanding. Smaller individual Pacific pond turtles are now regularly observed basking on top of traps set for giant gartersnakes.

Potential Management Actions

The following list of potential management actions were developed for the Pacific pond turtle population in the Basin.

- Provide basking habitat in the form of downed logs and trees in aquatic habitats in created marshes.
- Control or eliminate red-eared sliders.
- Reduce or eliminate the use of pesticides, particularly insecticides.
- Minimize disturbance in created emergent marsh habitats.

Management-Oriented Hypotheses and Questions

- Do red-eared sliders outcompete Pacific pond turtles?
- What are the characteristics of nesting habitat that can be reproduced on reserve lands?
- Are pesticides negatively affecting populations?
- Is disturbance a limiting factor?

Monitoring Options

We identified three options for the Pacific pond turtle monitoring program. Option 1 is to continue monthly surveys on reserve and non-reserve lands. Option 2 is to continue the monthly reserve and non-reserve land surveys, but to limit them primarily to the breeding season and a few winter months. In addition, the South Basin portion of the non-reserve lands survey would be discontinued, as there have been no detections of Pacific pond turtles in this area for several years except for those in Fisherman's Lake adjacent to the Rosa tract. Option 3 is to implement a research program to systematically answer some of the management questions outlined above.

Recommendations

We recommend implementing Option 2. This option has the best chance of meeting all the requirements of the NBHCP for less cost than the current monitoring program, with only a minor decrease in the value of the data. We also recommend that site-specific management plans incorporate the creation of habitat for Pacific pond turtle and specific goals for Pacific pond turtle habitat.

Other Covered Species Not Known to Occur in the Basin

There are several species covered under the NBHCP that are not known to occur in the Basin. Aleutian cackling goose (formerly Aleutian Canada goose) and bank swallow have not been detected in the Basin during 11 years of avian surveys. California tiger salamander, western spadefoot, and vernal pool crustaceans are not known to occur in the Basin. Vernal pool habitats occur in just a few spots on private lands at the extreme eastern edge of the Basin, but formal surveys have not been conducted. None of the covered plants species have been detected in the Basin.

Formal surveys have not been conducted and we are not proposing any changes to monitoring with respect to these species.

Monitoring Noxious Weeds and Land Cover Types

One aspect of the biological effectiveness monitoring program that touches on all covered species is monitoring the distribution and abundance of land cover or habitats types over time, and potential threats to those habitats. Such threats include conversion from rice or row and field crops to orchard, vineyards, or other incompatible crop types; conversion to urban landscapes; and the invasion of habitats by noxious, invasive, or otherwise undesirable plant species.

Landscape-scale land cover monitoring is conducted annually across the entire Basin, including reserve lands, to track the distribution and abundance of land cover or habitat types throughout the Basin and to facilitate the assessment of connectivity between important habitat elements for covered species.

Reserve-scale floristic surveys are conducted annually to detect (and then track) populations of covered plants and to detect (and eradicate or minimize) invasive plant species that can decrease habitat values for covered species.

Monitoring Options and Recommendations

We are proposing to continue habitat and land cover mapping in nonagricultural land cover types using only the current protocols. Surveys for noxious weeds will no longer be conducted on agricultural preserve lands.

Literature Cited

Anderson, D. A., J. L. Dinsdale, R. Schlorff, K. Fien, S. Torres, C. Chun, and J. Estep. In preparation. Foraging Habitat Use Patterns of Swainson's Hawks in Agricultural Landscapes of the Central Valley, CA. U.C. Davis Wildlife Health Center and the California Department of Fish and Game.

Atkinson, A. J., P. C. Trenham, R. N. Fisher, S. A. Hathaway, B. S. Johnson, S. G. Torres, and Y. C. Moore. 2004. Designing monitoring programs in an adaptive management context for regional multiple species conservation plans. U.S. Geological Survey Technical Report. USGS Western Ecological Research Center, Sacramento, CA. 69 pages.

Babcock, K. W. 1995. Home Range and Habitat Use of Breeding Swainson's Hawks in the Sacramento Valley of California. Journal of Raptor Research 29:193–197.

Bechard, M. J. 1982. Effect of Vegetative Cover on Foraging Site Selection by Swainson's Hawk. Condor 84:153–159.Estep 1989, 2009;

City of Sacramento, Sutter County, and the Natomas Basin Conservancy. 2003. Natomas Basin Habitat Conservation Plan; Sacramento and Sutter Counties, California. Sacramento, CA.

England, A. S., M. J. Bechard, and C. S. Houston. 1997. Swainson's Hawk (Buteo swainsoni). In A. Poole and F. Gill (eds.), The Birds of North America, No. 265. Philadelphia, PA: The Academy of Natural Sciences and Washington, DC: The American Ornithologists' Union.

Estep, J.A. In preparation. Ecology of the Swainson's Hawk in the Central Valley of California.

Halstead, B. J., G. D. Wylie, and M. L. Casazza. 2010. Habitat Suitability and Conservation of the Giant Gartersnake (Thamnophis gigas) in the Sacramento Valley of California. Copeia 2010:591–599.Wylie et al. 2009

Frayer, W. E., D. D. Peters, and H. R. Pywell. 1989. Wetlands of the California Central Valley: Status and Trends: 1939-mid-1980s. U. S. Fish and Wildlife Service, Region 1, Portland, OR.

Soulé M. E. (ed). 1987. Viable populations for conservation. Cambridge University Press, Cambridge, UK

USFWS. 2016. Habitat Conservation Planning And Incidental Take Permit Processing Handbook (pp. 1–409).