6.4 Monitoring and Adaptive Management Plan

The Monitoring and Adaptive Management Plan (MAMP) is an integral component of the MSHCP Amendment's conservation strategy. Data collected and analyzed through the MAMP informs whether or not the permittees are complying with their incidental take permit, progress is being made towards achieving the BGOs, the conservation program is effective at minimizing and mitigating impacts, and if adjustments are needed to improve the conservation strategy through adaptive management (USFWS 2016). Additionally, the MAMP is designed to assess the status of Covered Species, natural communities, and ecosystem processes within the Plan Area. Each component of monitoring is designed with purpose and to inform MSHCP Amendment management decisions.

Monitoring is conducted for three purposes: 1) baseline, 2) compliance, and 3) effectiveness. Baseline monitoring is conducted, as needed, to establish the conditions at the time of the start of the permit. However, additional baseline data may need to be collected as the conservation strategy is modified over time. Baseline monitoring is not intended to be comprehensive, but rather to provide targeted information to assess changes to natural systems or species populations over time. The need for baseline data is evaluated relative to existing information and monitoring efforts.

Compliance monitoring serves to ensure that permittees are complying with permit terms and conditions, the MSHCP Amendment document, and associated Implementation Agreement. Compliance may address implementation of avoidance, minimization and mitigation measures; specific reporting requirements of the permits; tracking levels of incidental take of Covered Species; and progress towards achieving BGOs.

Effectiveness monitoring is focused on evaluating how natural systems and Covered Species are responding to the management actions taken through the conservation strategy, and whether progress is being made towards achieving the BGOs. Monitoring and management approaches for individual Covered Species are included and further monitoring protocol details are presented in the appendices.

Adaptive management is an approach to addressing uncertainty in natural resources management (USFWS 2016). The process entails identifying areas of uncertainty, exploring alternative approaches to meeting management objectives, implementing alternatives, monitoring to learn about the outcomes of management actions, and using results to update knowledge and make further adjustments to management actions as needed (Williams et al. 2009). Adaptive management will be utilized when monitoring indicates goals or objectives may not be achieved and there is uncertainty on the corrective actions necessary to ensure success and achievement of the BGOs. As such, the adaptive management process relies on the monitoring results and iteratively shapes the monitoring approach, which is why these two elements of the conservation strategy are presented together in this section.

The reporting of monitoring results is described in the next section of the conservation strategy, section 6.5 Reporting.

6.4.1 Monitoring Plan

The monitoring plan is organized by BGO to ensure that monitoring efforts have a clear and specific purpose. Table 6-1 above lists each BGO, any applicable supporting objectives, avoidance and minimization measures related to the objective, monitoring and timing considerations related to each BGO as further described below in this section, and the associated reporting requirements. In some cases, more than one objective is associated to one monitoring approach. Monitoring for some of the objectives pertain to compliance, others pertain to effectiveness, and some pertain to both compliance and effectiveness. If baseline monitoring is required, this is described in the monitoring approach narrative.

Depending on the objective, monitoring may occur across the entire Plan Area or just within the Reserve System. The scale of the monitoring is described in the monitoring approach narrative. Although monitoring across the Plan Area provides a broader understanding of species and habitat status and regional trends, the DCP cannot access all land across the Plan Area and monitoring funding is limited. Therefore, monitoring is typically conducted within the Reserve System or in an otherwise targeted manner to document success towards achieving the BGOs. If monitoring results indicate significant population declines or habitat degradation within the Reserve System, additional monitoring may be initiated outside of the Reserve System to help identify causes contributing to decline and degradation and determine whether adaptive management may be needed. The Science Advisory Panel will review the monitoring data and recommend if monitoring data outside the Reserve System should be pursued.

Monitoring data will be collected by either DCP staff or external contractors. Specific details on data collection methods will be determined at the beginning of the monitoring effort. Future modifications to the monitoring methods should be made if necessary, in consultation with DCP staff and the independent Science Advisory Panel to ensure continuity of monitoring results.

All data will be stored by the DCP and will be available to other Permittees. The analysis of monitoring results for reporting purposes can occur at any time, but at a minimum will be annual for habitat conversion or other incidental take measurements and every five to ten years as part of the Adaptive Management Report for other analyses to serve as a benchmark for conservation progress and to inform progress towards achieving BGOs, as further described in section 6.4.2.

6.4.1.1 Habitat Monitoring

Habitat monitoring is conducted to ensure the Conservation Strategy achieves the BGOs related to habitat quality for Covered Species. Habitat monitoring includes invasive species monitoring, habitat quality monitoring, and covered plant species sediment source habitat monitoring.

6.4.1.1.1 Invasive Species Monitoring

Non-native invasive plant species can alter ecosystem processes, such as nutrient cycling, hydrologic cycles, frequencies of wildfires, and erosion and sediment deposition (Powell 1999, Bossard et al. 2000). Common and non-native animal species may also thrive in disturbed or otherwise marginal habitats and can harm Covered Species through predation, competition, and displacement. In the Mojave Desert, invasive plants such as red brome (*Bromus madritenis* ssp. *rubens*), Mediterranean grass (*Schismus barbata*) and mustards, including Sahara mustard (*Brassica tournefortii*) and African malcomia (*Malcomia africana*), have increased the size and frequency of wildfires (TNC 2007, Fusco et al. 2019). The Argentine ant (*Linepithema humile*) is a problematic invasive species in desert uplands, where it can indirectly affect food resources for native wildlife. Proliferation of common ravens is also a threat as they are effective predators of

desert tortoise and other desert wildlife. In riparian areas, common invasive plants include tamarisk/salt cedar (*Tamarix ramosissima*), Eurasian water milfoil (*Myriophyllum spicatum*), giant Salvinia (*Salvinia molesta*), and hydrilla (*Hydrilla verticillata*) (Las Vegas Wash Project Coordination Team 2009).

The DCP will work with Clark County Vector Control and other appropriate agencies/entities to develop an Early Detection Rapid Response Program for County lands and right of ways within the first 3 years of MSHCP Amendment implementation (Objective 2D). Additional agencies or groups for collaboration may include the Nevada Weed Management Association and other stakeholders in the Southern Nevada Cooperative Weed Management Area. The Early Detection Rapid Response Program will include invasive species monitoring methods and response protocol for newly identified invasive or potentially invasive species establishing outside of landscaped areas. Existing database tracking tools such as Early Detection and Distribution Mapping System (https://www.eddmaps.org/) or other collaborative tools will be used as part of the Early Detection Rapid Response Program to engage the public and land managers in identifying and tracking invasive species. To assess progress towards Objective 1A, invasive plant species cover in the Reserve System will be evaluated in the first three years of MSHCP Amendment implementation to establish baseline conditions. The baseline conditions will be used to measure change in cover relative to baseline over time. Monitoring method and details will be included in a Weed Management Plan, which will be developed and approved within two years of the completion of baseline invasive plant surveys to address management of invasive plant species on Reserve System lands. Management actions will be included in the Annual Progress Report and any additional details as required by the Weed Management Plan.

6.4.1.1.2 Habitat Quality

Habitat suitability models were developed for Covered Species and are to be reviewed and updated every 10 years. These suitability models provide information on the distribution of potential suitable habitat for Covered Species in the Plan Area using the best scientific data available. These models are included in the habitat quantification methods to assess habitat quality for take and mitigation estimations and tracking. These methods are described in Chapter 5, and more detail specific to the Reserve System is provided in Section 6.3.

Per Objectives 1B, 1C, and 2A, the habitat quantification methods will be utilized to inform management of Covered Species habitat, evaluate the quantity and quality of riparian habitat in the Reserve System relative to impacts from Covered Activities in the Plan Area, and to measure the overall quantity and quality of suitable habitat for Covered Species in the Reserve System over time. The habitat quantification results for the Reserve System shown in Table 6-3 provide the baseline suitable habitat quantity and quality for the Reserve System. To meet Objective 1B and 1C, the values in Table 6-3 (Section 6.3) need to be similar to or increased from the baseline. For Objective 2A, the source data and methods for both the habitat suitability models and habitat quantification methodology will be reviewed every 10 years to determine if revisions are necessary including incorporation of current occurrence datasets, roads, development boundaries, additional LiDAR datasets for riparian ecosystems, or other new data determined to influence habitat quality for a specific Covered Species or group of Covered Species.

The habitat quantification assessment reviews habitat quality at the landscape scale. In order to provide site specific assessments and measure improvements in habitat quality as a result of restoration actions, the habitat uplift tracking system described in Section 6.X will also be utilized to measure and credit changes in habitat quality within the Reserve System. Habitat uplift tracking will be included in the Annual Progress Reports. Together the habitat quantification assessment

and habitat uplift tracking will be used to analyze success towards achieving Objectives 1B and 1C and results included in the Ten-Year Monitoring Report.

6.4.1.1.3 Covered Plant Species Habitat

Psammophile species, including threecorner milkvetch and sticky buckwheat require loose sandy soils in order to grow. Sediment sources for threecorner milkvetch and sticky buckwheat will be identified within the first year of MSHCP Amendment implementation and included in the Annual Progress Report (Objective 2C). Once identified, impacts by Covered Activities to these areas are to be avoided, to the extent feasible, depending on the Permittee's authority and jurisdiction. If avoidance is not practical, minimization and mitigation measures should be implemented to the extent practicable. The Ten-Year Monitoring Report will include identification of sources, protection status, and impacts to these habitats over time.

Additionally, the extent of occupied and potentially suitable habitat for gypsophile species will be monitored relative to baseline conditions and ongoing development impacts every two years, and results will be included in subsequent Annual Progress Reports, to assess achievement of Objective 2F. Species habitat suitability models developed for the MSHCP Amendment will be the focus of monitoring for these species.

6.4.1.1.4 Connectivity

To meet Objective 2E, the DCP will identify corridors that are high priority for connectivity and genetic exchange for non-volant wildlife Covered Species (desert tortoise, Gila monster, and desert pocket mouse) within the first three years of MSHCP implementation. Key corridors for plant Covered Species such as for seed dispersal will be identified within the first five years. These key corridors will be incorporated into updates of the habitat quality assessment described in Chapter 5 and Section 6.3 to address habitat quality value of these areas.

A Connectivity Management Plan will be created in the first three years of MSHCP Amendment implementation. The Connectivity Management Plan will incorporate existing science and data, identify known connectivity issues and potential fixes, outline monitoring to track before and after improvements are implemented, and identify data gaps that could be a focus of research efforts. Connectivity or other movement models may be included as additional ways to monitor and document improvement. The Science Advisory Panel will review the Connectivity Management Plan every ten years and revise it if new science or data for identification of issues or monitoring efforts should be included. This review will ensure the best available science and commercial data informs monitoring efforts. Completion of connectivity improvement projects will be included in Annual Progress Reports in the year conducted. Ten-Year Monitoring Reports will summarize all improvements made within the previous ten years, any additional details/changes as described in the Connectivity Management Plan, and the results of the Science Advisory Panel review of the Connectivity Management Plan. Although impacts that may be authorized by other agencies that ultimately impair the functionality of connectivity areas are outside of the purview of the Connectivity Management Plan and MSHCP Amendment, these impacts and their causes will be noted in Annual Progress Reports, where applicable.

6.4.1.2 Species Monitoring

Species monitoring is conducted to ensure effectiveness of the Conservation Strategy and Covered Species populations are stable or increasing within the Reserve System lands (Objectives 3A, 3B, and 3C) relative to baseline conditions. A species-specific monitoring plan may include a variety of different methods to measure species occupancy and population trends.

Some species (e.g., threatened and endangered species) have specific survey protocols that must be followed to accurately assess occupancy and trends. Several species (or groups of species) may be monitored simultaneously using a single survey method. Species surveys will be conducted to sample each of the Reserve System lands (SMAs and private reserve lands) in which habitat for the species is present. The following sections describe recommended methods for baseline and ongoing monitoring of Covered Species and Table 6-5 categorizes them by the general habitat they occupy, and the monitoring method used. Final long-term monitoring protocols will be developed for each species or group of species and peer-reviewed by the Science Advisory Panel within the first 18 months of MSHCP Amendment implementation as identified in the table below. Following collection of baseline data, survey frequency will be conducted based upon species and associated monitoring approaches, on a five to ten year schedule. Any survey results will be reported in Annual Progress Reports during the same year the survey is conducted, and Ten-Year Monitoring Reports will include a summary of survey results and an analysis of population trends in the Reserve System. Any additional data noted in species monitoring protocols will also be included. Survey schedule may be adjusted initially after baseline data is completed to prevent all species from having concurrent survey or monitoring schedules (efforts staggered among years).

Table 6-5. Summary of Monitoring Methods and Status for 30 MSHCP-covered Species*.

Common Name	**Scientific Name**	**Monitoring method**
Golden eagle	*Aquila chrysaetos*	Point count/passive acoustic
Western burrowing owl	*Athene cunicularia hypugaea*	Point count/passive acoustic
Yellow-billed cuckoo	*Coccyzus americanus*	Protocol survey[b]
Southwestern willow flycatcher	*Empidonax traillii extimus*	Protocol survey[c]
Gilded flicker	*Colaptes chrysoides*	Point count/passive acoustic
Loggerhead shrike	*Lanius ludovicianus*	Point count
Ridgway's rail	*Rallus obsoletus yumanensis*	Protocol survey[d]
Bendire's thrasher	*Toxostoma bendirei*	Point count
LeConte's thrasher	*Toxostoma lecontei*	Point count
Arizona Bell's vireo	*Vireo bellii arizonae*	Point count
Mammals		
Desert pocket mouse	*Chaetodipus penicillatus*	Species-specific[a]
Townsend's big-eared bat	*Corynorhinus townsendii*	Passive acoustic
Spotted bat	*Euderma maculatum*	Passive acoustic
Reptiles		
Desert tortoise	*Gopherus agassizii*	Occupancy survey

Common Name	Scientific Name	Monitoring method
Banded Gila monster	*Heloderma suspectum cinctum*	Species habitat model and assessments[a]
Invertebrates		
Mojave poppy bee	*Perdita meconis*	Species-specific[a]
Monarch	*Danaus plexippus*	Species-specific[a]
Plants		
Sticky buckwheat	*Eriogonum viscidulum*	Species-specific[a]
Las Vegas bearpoppy	*Arctomecon californica*	Species-specific[a]
Threecorner milkvetch	*Astragalus geyeri* var. *triquetrus*	Species-specific[a]
Alkali mariposa lily	*Calochortus striatus*	Species-specific[a]
Blue Diamond cholla	*Cylindropuntia multigeniculata*	Species-specific[a]
Silverleaf sunray	*Enceliopsis argophylla*	Species-specific[a]
Forked (Pahrump Valley) buckwheat	*Eriogonum bifurcatum*	Species-specific[a]
Las Vegas buckwheat	*Eriogonum corymbosum* var. *nilesii*	Species-specific[a]
Sticky buckwheat	*Eriogonum viscidulum*	Species-specific[a]
White-margined beardtongue	*Penstemon albomarginatus*	Species-specific[a]
Parish's phacelia	*Phacelia parishii*	Species-specific[a]
St George blue-eyed grass	*Sisyrinchium radicatum*	Species-specific[a]
Joshua tree	*Yucca brevifolia*	Species-specific[a]

[a] Species-specific methods depends on each species. See discussion in text for general methods. Detailed monitoring methods to be developed within the first 18 months of MSHCP implementation.

[b] See Halterman et al. (2016) for survey protocol details.

[c] See Sogge et al. (2010) for survey protocol details.

[d] See Conway (2009) for survey protocol details.

6.4.1.2.1 Golden Eagle (Aquila chrysaetos)

Golden eagle nesting is anticipated to be extremely rare in the Plan Area and impacts are restricted to foraging habitat. Monitoring for golden eagle shall be focused on foraging habitat in the Reserve System and will utilize species-specific habitat models and occasional habitat assessments. Habitat assessment data and survey frequency will be established in final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.2 Burrowing Owl (Athene cunicularia hypugaea)

Surveys for burrowing owls shall be located within identified suitable habitat in the Reserve System, according to existing models. Survey routes and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation, but will entail multiple survey visits within the breeding season. Surveys will include examination of burrows for signs of owls and at least once every five years provide updated maps of suitable burrows to understand burrow availability. Winter surveys may also be conducted between December 1 and January 31 to determine whether wintering birds are present. Surveys will be conducted annually for 3 years to provide baseline data on the species in the Reserve System, and then will be conducted once every 5 years thereafter.

6.4.1.2.3 Yellow-Billed Cuckoo (Coccyzus americanus)

Yellow-billed cuckoos are difficult to detect during traditional avian surveys; therefore, protocol-level surveys must be conducted to adequately detect the species. Protocol surveys will be conducted covering all riparian habitat properties in the Reserve System. The USFWS-approved survey protocol (Halterman et al. 2016) consists of surveying a minimum of four times during the breeding season: once between June 15 – July 1, twice between July 1 – July 31, and once between July 31 – Aug 15. There is a minimum of 12 and a maximum of 15 days between surveys at a site. Surveys are conducted using call-playback methods in suitable or potentially suitable cottonwood-willow habitat. A survey station should be established in each patch of potentially suitable habitat > 5 ha and >300 m from the nearest other patch. The number of survey stations depends on the amount of potentially suitable breeding habitat but should be high enough to allow for robust statistical inference on the proportion of occupied survey sites on riparian Reserve System lands. Station locations should be determined prior to June 15 and the same survey stations should be surveyed in consecutive years, where possible. Surveys for the yellow-billed cuckoo and southwestern willow flycatcher may not be conducted simultaneously (i.e., each species requires a separate survey effort). Surveyors must attend a training session and hold the appropriate state and federal permits to conduct the surveys. See Halterman et al. (2016) for survey protocol details. For new land acquired in the Reserve System, surveys will be conducted annually for 3 years to provide baseline data on the species in the Reserve System. Following completion of baseline data collection, surveys will be conducted once a year.

6.4.1.2.4 Southwestern Willow Flycatcher (Empidonax traillii extimus)

Southwestern willow flycatcher must follow the USFWS-approved survey protocol (Sogge et al. 2010). Protocol surveys will be conducted covering all riparian habitat properties in the Reserve System. Surveys consist of a minimum of three surveys during the breeding season: once between May 15 – May 31, once between June 1 – June 24, and once between June 24 – July 17. Surveys must occur a minimum of 5 days apart. Surveys should occur in suitable or potentially suitable breeding habitat and should be conducted from within, rather than adjacent to, the patch of potentially suitable habitat. The number of survey sites depends on the amount of potentially suitable breeding habitat but should be high enough to allow for robust statistical inference on the proportion of occupied survey sites on riparian Reserve System lands. Surveys for yellow-billed cuckoos and southwestern willow flycatchers may not be conducted simultaneously (i.e., each species requires a separate survey effort). Surveyors must attend a training session and hold the appropriate state and federal permits to conduct these surveys. Surveyors should be experienced at differentiating calls and appearance of similar species, such as other Empidonax flycatchers. Consult Sogge et al. (2010) for additional details on survey methods and descriptions of potentially suitable habitat. For new land acquired in the Reserve System, surveys will be

conducted annually for 3 years to provide baseline data on the species in the Reserve System. Following completion of baseline data collection, surveys will be conducted once a year.

6.4.1.2.5 Ridgway's Rail (Rallus obsoletus yumanensis)

Marsh birds such as the Yuma Ridgway's rail are difficult to detect during standard point count surveys, so playback recordings are used to elicit responses from cryptic marsh birds that may be present at a given site. The North American Marsh Bird Survey Protocol (Conway 2009) provides a standardized protocol methodology to be used for surveying Yuma Ridgway's rails in marsh habitats. This USFWS-approved survey protocol consists of conducting a minimum of three surveys early in the breeding season, prior to the vocalization of that years' young, to obtain counts of adults present during the breeding season. A survey route should be established with the number of point locations per route determined by the time it takes for a surveyor to complete these routes within the rails' most vocal periods of the day (i.e., two hours surrounding sunrise and two hours surrounding sunset). Point locations should be a minimum of 400 meters apart; points closer than 400 meters risk the possibility of call broadcasts at one point affecting the distribution of birds at adjacent points. Following completion of baseline data collection, surveys will be conducted once a year. For a detailed discussion on survey methods, see Conway (2009). Survey routes will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.6 Other MSHCP-Covered Bird Species

Other MSHCP Amendment-covered bird species include the Arizona Bell's vireo (*Vireo bellii arizonae*), gilded flicker (*Colaptes chrysoides*), loggerhead shrike (*Lanius ludovicianus*), Bendire's thrasher (*Toxostoma bendirei*), and LeConte's thrasher (*Toxostoma lecontei*). Arizona Bell's vireo occur in cottonwood-willow habitat and associated desert washes composed of shrubby woodland habitat, such as mesquite, oak, and non-native tamarisk. Gilded flickers are found in open desert scrub with a Joshua tree component, while the shrike and thrashers are found in various open desert scrub and blackbrush habitats.

Surveys for these species should be conducted according to standard point count survey and/or passive acoustic methods (Ralph et al. 1995, Rosenstock et al. 2002, MacKenzie 2006) in suitable or potentially suitable habitat within Reserve System lands. Survey stations should be established in suitable habitat, spaced a minimum of 250 m apart. Point count methods allow for the estimation of species occupancy or abundance/density estimation (e.g., distance sampling, count regression models, N-mixture modeling incorporating imperfect detection [Royle 2004]). A sufficient number of point count stations should be determined on Reserve System lands to allow for robust statistical inference. Multiple visits, separated by a minimum of 5 days, should be made to each station during the general bird breeding season (early-mid April through mid-June). Surveys in the Reserve System will be conducted annually for 3 years to provide baseline data, and then once every 5 years thereafter. In the event that surveys for these species are entirely passive acoustic, surveys in the Reserve System will be conducted annually for 3 years to provide baseline data, and then once every 3 years thereafter. Survey stations and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.7 Desert Tortoise (Gopherus agassizii)

Various methods have been used to sample desert tortoise populations across their range. Sampling desert tortoises, however, is challenging due to their low capture probability as related to their fossorial life history, cryptic nature, and patchy spatial distribution. Previous desert tortoise

survey methods include belt transects, occupancy (Zylstra and Steidl 2009, Zylstra et al. 2010, Harju and Cambrin 2019), study plots of varying size (1 mi2, 1 km2, 1 ha) (Keith et al. 2008), and line-distance sampling (Anderson et al. 2001, Averill-Murray and Averill-Murray 2005).

Occupancy modeling determines the proportion of habitat within an area that contains evidence of a focal species (MacKenzie et al. 2002). It uses detection/non-detection data to estimate species occurrence, and explicitly recognizes that the probability of detection on a single survey may be less than one. The advantages to using occupancy to sample desert tortoise are that it has been previously used in this region and there is an established method and data set to compare to. It can provide both abundance/density and presence/absence data. Previous research on occupancy indicates that it had sufficient power to detect moderate levels of population change within 20 years' time (Zylstra et al. 2010, Erb et al. 2015, Harju and Cambrin 2023). The disadvantages of using occupancy are that there are statistical challenges when detection probability is extremely low, and it generally provides only a coarse level of inference (e.g., it does not provide robust demographic information, although it can provide abundance/density estimates). Initial analysis of data from the BCCE have shown that occupancy sampling can detect changes in desert tortoise populations in the focal area when sampling design is planned appropriately (Harju 2019).

Occupancy modeling is the preferred method for use in monitoring desert tortoise in the Reserve System. Plot design and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.8 Gila monster (Heloderma suspectum cinctum)

Gila monster is a rarely observed species and standardized survey protocol has not been developed. Monitoring for Gila monster shall be focused on ensuring suitable habitat is maintained in the Reserve System and will utilize species-specific habitat models and occasional habitat assessments. Habitat assessment data and survey frequency will be established in final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation. The survey capabilities will be reviewed every 5 years, and protocols may be modified to include presence/absence or population level surveys should non-invasive techniques such as environmental DNA sampling be developed in the future.

6.4.1.2.9 Desert Pocket Mouse (Chaetodipus penicillatus)

The desert pocket mouse occurs throughout Clark County in sandy soils of creosote bush and saltbush communities, mesquite bosques, desert washes, and warm desert scrub. Historic records for this species are limited. Surveys for this species shall involve live trapping and should focus on known historic locations in the Reserve System where habitat remains and in ecosystems where modeling identified high suitability, including Mojave Desert Scrub, Desert Riparian, Salt Desert Scrub, and Mesquite/Acacia. Surveys will be conducted annually for 3 years to provide baseline data on the species in the Reserve System, and then will be conducted once every 5 years thereafter. Trap line locations and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.10 Townsend's Big-Eared Bat (Corynorhinus townsendii) and Spotted Bat (Euderma maculatum)

The two MSHCP-covered bat species (Townsend's big-eared bat, spotted bat), utilize a wide variety of habitats within the Plan Area from forested areas to riparian corridors and open desert scrub for foraging. Both species may use buildings for day or maternity roosts, but spotted bats

typically prefer crevices within cliff faces for roost sites and Townsend's big-eared bats typically are found in large open caves or abandoned mines and tunnels.

Both bat species would be most efficiently monitored using an occupancy approach via passive acoustic monitoring during summer (i.e., during the breeding season; Weller 2008). It may be advantageous to conduct surveys in late fall or early spring to document their use of Reserve System lands during the seasons between breeding and hibernation in addition to the breeding season survey. Newer passive acoustic bat call recorders are programmable and battery-powered and therefore can be left in the field for extended durations. The results are stored on the unit and can be downloaded for species assessment of each recorded call using commercially available call analysis software (e.g., Sonobat, Analook, or Kaleidoscope Pro). Results should be then manually vetted by a biologist experienced in identification and analysis of bat calls in the western U.S. It may be useful to align bat survey methods with the North American Bat Monitoring Program (Loeb et al. 2015) for data-sharing capabilities.

A series of fixed sampling stations has been found to be more effective at estimating spatial heterogeneity in bat species occurrence than continuous walking surveys (Stahlschmidt & Brühl 2012, Loeb et al. 2015). Thus, a series of fixed-location stations will be set up within the riparian and desert upland ecosystems. By surveying the same locations in multiple years, comparisons of changes in occupancy can be made while removing the effect of noise derived from sample site variability. Sampling stations will be located randomly or systematically random such that the diversity of ecosystems throughout the Reserve System are sufficiently sampled and all acoustic detectors are at least 2 km apart. There is also the potential that grid cells (10 km x 10 km) selected by the North American Bat Monitoring Program (Loeb et al. 2015) fall within Clark County reserve lands and could be used as sampling stations to monitor bats across multiple years. The added benefit of using these grid cells is that the data collected would be added to a larger database that is monitoring bat species nationwide (Loeb et al. 2015).

The final number of sampling stations will consider the costs of purchasing, deploying, and analyzing the survey results balanced with the conservation value of detecting the MSHCP Amendment- covered bat species. Additionally, a single passive acoustic recorder can be deployed at multiple sample sites throughout a given year. Recent research at the Ash Meadows National Wildlife Refuge found that 2-5 survey nights were needed to detect 40-60% of bat species that occurred at a single sample station (Skalak et al. 2012). Thus, for example, 5 acoustic recorders could be deployed for 5 nights at each sample station over a period of four weeks, leading to 20 sample stations each surveyed for 5 nights. Acoustic recorders will be deployed for the entire night in order to capture "rare" species that only call or forage during a narrow nightly window (e.g., just before dawn; Skalak et al. 2012). Acoustic recorders will be deployed for 2-5 nights at each sample station to balance capturing more "common" species with the cost of exhaustively sampling for rare species (e.g., 32 nights; Skalak et al. 2012). Analysis of acoustic recorder data will follow standard occupancy analysis methods that account for imperfect detection (e.g., package 'unmarked' in Program R). Environmental covariates (e.g., temperature, moon phase, wind speed, etc.) and date should be considered as potential covariates on detection probability.

For any survey stations for which baseline data does not exist such as in SMAs, a minimum of 2 years of data will be collected to provide a baseline. After baseline data have been collected, sampling will occur once every 5 years at each survey station. Survey stations and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.11 Mojave Poppy Bee (Perdita meconis)

Within the Plan Area, the current known range of the Mojave poppy bee is restricted to the Lake Mead National Recreation Area and adjacent BLM lands. This species is range-limited by the availability of suitable host plants (poppies in the genera *Arctomecon* and *Argemone*), and the presence of suitable nesting substrate (gypsum soils with intact cryptogamic crusts). Adults are active for only a few weeks in the weeks in the spring, when host plants are blooming; surveys will be conducted when adults are active as other life stages occur underground. During the bloom period of the host plant species (typically mid-March through the end of May), populations known to host Mojave poppy bee should be observed for floral visitors every two weeks until the bloom period has ended. Either via human observation or video surveillance, visitation rate by Mojave poppy bee will be calculated as number of visits/number of flowers/ observation time (Portman et al. 2018). Observation periods will be conducted only when adults are active, on sunny mornings with low winds and temperatures above 14 ºC, when adults are typically observed to begin flying (Portman et al. 2018). Since prepupae can enter prolonged diapause in response to unpredictable weather conditions (Danforth 1999), surveys will be conducted in years with sufficient rainfall for host plants to bloom. Comparisons of adult floral visitation rates between years can be used to determine overall population trends. Survey areas and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.12 Monarch (Danaus plexippus)

Suitable breeding habitat for monarch butterflies has been modeled across the western United States with habitat associations for the western spring migration occurring in parts of Nevada, including areas within Clark County (Dilts et al. 2019). Breeding habitat for monarch butterflies within the Plan Area is in regions where its larval host plant species, milkweed (*Asclepias spp.*), are abundant. Previous analyses of monarch distributions have demonstrated high associations with habitat along rivers (Dingle et al. 2005) and suggest riparian corridors and the adjacent habitat will be important zones for monitoring within the Plan Area.

All life history stages of the monarch butterfly occur during the spring and summer months in regions of Nevada and no overwintering populations have been observed. Monitoring surveys will therefore be conducted during the breeding season (April through October) when monarchs are most abundant. Visual survey monitoring plots will target each life history stage and monitoring plots will be randomly selected within suitable habitat where milkweed and nectaring plants are present. Visual survey methods will be a modified Pollard walk (Pollard 1977) along a transect to count the number of adult monarchs occurring within 5 meters of the transect line on either side (Cariveau et al. 2019, Kinkead et al. 2019). Behavioral observations (e.g. nectaring, mating, egg laying) will be recorded. Milkweed plants encountered on the transect will also be investigated and the number of monarch eggs and larvae, including instar stage, per milkweed plant will be recorded. Visual surveys for these life stages should be adjusted based on the abundance of milkweed plants in a plot to account for potential aggregations of eggs and larvae within some areas and not others (Zalucki & Kitching 1982). A minimum of 2 years of data will be collected to provide a baseline. After baseline data have been collected, sampling will occur once every 5 years. Survey areas and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.13 Joshua Tree (Yucca brevifolia)

Joshua trees are widespread and abundant where they occur throughout the Plan Area, in Blackbrush, Mesquite/Acacia, middle to upper Mojave Desert Scrub, lower Pinyon-Juniper, and

lower Sagebrush Ecosystems. This species is slow-growing and long-lived; therefore, monitoring of population trends will include a combination of monitoring of distribution, plant survival, and population age structure. Species distribution could be determined by a number of methods depending on the accessibility of locations in which Joshua tree is growing, including low- level drone surveys to map the areal extent of populations, line-point intercept, canopy gap intercept, and multi-scale quadrats. Percent survival will be measured by monitoring tagged individuals along established transects over time. Age structure will be determined by sampling heights of trees through similar line transect sampling, as change in height over time can be predicted by a point-intercept equation (Gilliland et al. 2006). Recruitment will be evaluated by establishing and monitoring permanently marked demographic study plots (Esque et al 2010). Use of drone or other remote sensing technology will also be reviewed for efficacy across the Reserve System. The baseline distribution of Joshua trees within the Reserve System will be mapped within the first year. Long-term monitoring transects will then be established in each SMA containing this species, and surveys will be conducted a minimum of every 5 years focusing on population survival and age structure. Transect locations and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.2.14 Other Plants (12 Species)

The status of MSHCP-covered plant species populations should be monitored to ensure compliance with Objective 3A and identification of essential populations for protection (Objective 3C). Additionally, in order to assess progress towards Objective 1E, the status of acquisitions, restoration and enhancement of Pahrump Valley buckwheat habitat will be tracked relative to impacts to this habitat.

The additional 12 MSHCP-covered plants for monitoring include sticky buckwheat (*Eriogonum viscidulum*), Las Vegas bearpoppy (*Arctomecon californica*), threecorner milkvetch (*Astragalus geyeri* var. *triquetrus*), alkali mariposa lily (*Calochortus striatus*), Blue Diamond cholla (*Cylindropuntia multigeniculata*), silverleaf sunray (*Enceliopsis argophylla*) forked [Pahrump Valley] buckwheat (*Eriogonum bifurcatum*), Las Vegas buckwheat (*Eriogonum corymbosum* var. *nilesii*), sticky buckwheat (*Eriogonum viscidulum*), white-margined beardtongue (*Penstemon albomarginatus*), Parish phacelia (*Phacelia parishii*), and St. George blue-eyed grass (*Sisyrinchium radicatum*). At this time little is known about the location or ecological needs of these plant populations within the Plan Area or Clark County, although surveys are planned and additional data may be available prior to start of implementation of the MSHCP Amendment. If and when these populations are located in the Reserve System lands, quantitative methods shall be developed. It is critical that flexibility and care be used in developing the monitoring plan, as several Covered Species are likely to occur in sensitive areas (e.g., high coverage of biological crusts), thus monitoring methods may require a light footprint. For example, low- level drone surveys may be sufficient to map the areal extent of populations of MSHCP Amendment-covered plant species. Useful quantitative methods include line-point intercept, canopy gap intercept, and multi-scale quadrats. Qualitative methods could include photo points and general indicators of desert upland ecosystem health. Multi-year comparisons of abundance can be used to estimate population trends for these species. Survey locations, methods, and sampling frequency will be detailed in a final monitoring protocol to be developed within 18 months of MSHCP Amendment implementation.

6.4.1.3 Engagement and Oversight

In order to ensure compliance with Objectives 1D, 2B, 4A and 4D, DCP will document their annual process for reviewing all restoration projects and a subsample of permitted projects, for engaging

key partner agencies in the review of projects on jointly-managed land, and for ensuring that projects are following best practices for protecting and managing Covered Species. DCP will also document the distribution of educational material, upkeep of signage and the number of patrol hours conducted in annual reports per Objectives 4B and 4C. The requirement for project designs of Covered Activities to minimize indirect effects will also be adopted into County Code and will be monitored and enforced by Code Enforcement. To the extent that monitoring and enforcement for this objective is covered by Code Enforcement, the DCP will not be required to do additional monitoring for the activities discussed in this paragraph.

6.4.2 Adaptive Management Plan

Adaptive Management is a tool for addressing uncertainty in the conservation and management of Covered Species and their habitat (USFWS 2016). Uncertainties could pertain to factors like ecosystem function, effectiveness of management actions, occupancy, survey approaches, models, or changed climatic conditions. Adaptive Management is the process of identifying problems, designing and implementing strategies, monitoring and evaluating results, and then adjusting the approach to addressing the problem as necessary and improve outcomes over time (USFWS 2016). For example, adjusting the approach could entail changes to avoidance and minimization measures, updating models, or a different monitoring method. Adaptive Management is integrated with the Monitoring Plan because it entails evaluating monitoring results and making programmatic decisions based on those results, which may in turn result in changes to the Monitoring Plan itself.

The Adaptive Management Evaluation process occurs every ten years and the Adaptive Management Action process is implemented as necessary actions or changes are identified, based on the evaluation. The Adaptive Management Action process continues until actions have proven successful in resolving or improving upon an issue. It may be necessary to modify or increase the frequency of monitoring efforts pertaining to the action, as needed.

Within each ten-year evaluation period there are annual reports and analysis of monitoring data that can occur at any time. The Adaptive Management Reports capture the findings of the Science Advisory Panel's review of recent MSHCP Amendment projects, reports and datasets. The Science Advisory Panel analyzes land use trends, habitat loss, the effectiveness of management actions towards meeting BGOs, and population trends and ecosystem health. Recommendations are made for DCP implementation, to improve elements of the MSHCP Amendment. More in-depth analysis occurs as part of the Adaptive Management Evaluation process including quantification and reporting focused on progress towards the achievement of BGOs.

This Adaptive Management Plan provides the basis for determining the success of conservation actions in achieving the BGOs and maintaining or increasing populations of Covered Species and their habitats. Adaptive Management of individual projects is not directly described in this plan, but guidance is provided in Appendix E.

6.4.2.1 Targets and Triggers for MSHCP Covered Species and Habitat

A key component of Adaptive Management is evaluating the species population monitoring results in relation to pre-defined targets and triggers. This process provides additional information on the effectiveness of the conservation strategy and safeguards against the possibility that Covered Species fare poorly in spite of successful implementation of the MSHCP Amendment.

Targets and triggers are assessed relative to species and habitat-specific monitoring results, which are tied to specific BGOs. This assessment occurs as part of the Adaptive Management

Evaluation process, every ten years. Targets are the explicit and quantifiable desired state of Covered Species populations and their habitats. Successfully achieving targets means the suite of conservation actions have been thoroughly successful at improving the populations of Covered Species and their habitats. Triggers are the explicit and quantifiable undesired state of Covered Species populations and their habitats (e.g., population declines).

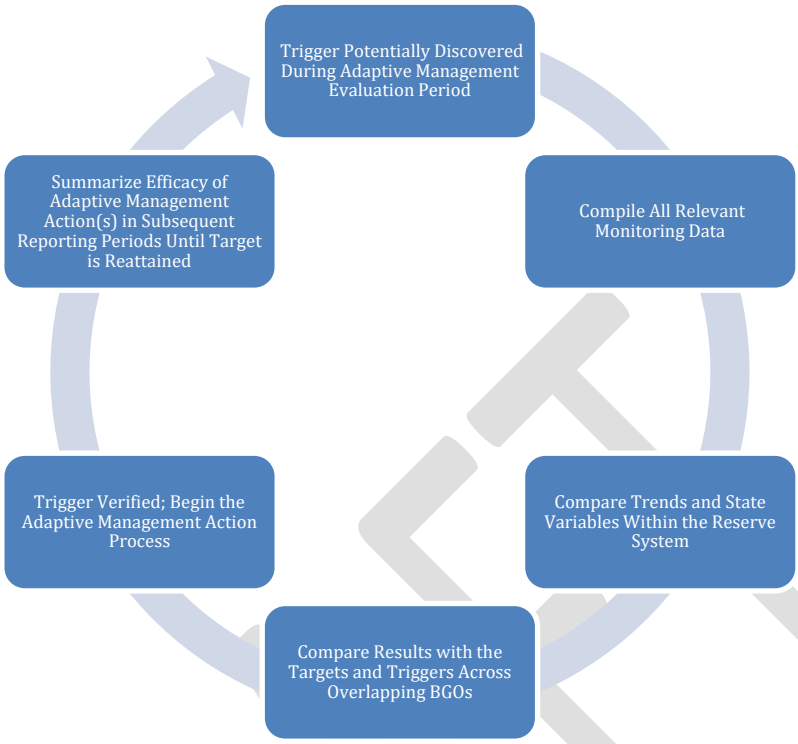
For each target and trigger, the evaluation process should involve the following steps: 1) compile all relevant monitoring data, 2) conduct appropriate statistical analysis to compare trends and state variables within the Reserve System, 3) compare results with the associated targets and triggers, 4a) if a target is achieved, no action is required, or 4b) if a trigger has been met, begin the Adaptive Management Action process, and 5) through the Adaptive Management Action process, collect information and identify factors contributing to current results and trends, evaluate and implement alternative approaches for achieving the BGOs related to that trigger and target, monitor results related to that BGO to determine whether or not the alternative is resulting in improved outcomes. The Adaptive Management Action process also may involve engaging stakeholders to evaluate the reasons behind the failure and strategies for improvement.

There are several caveats to consider when assessing the monitoring data. First, conservation projects conducted to-date occur at multiple spatial scales. Some projects only occur within the Reserve System lands, and their benefits are expected to be realized within the Reserve System. Other projects occur without a specific spatial scale (e.g., public information and education) and their benefits may occur over the entire Plan Area. Second, long term trends in habitat and populations of Covered Species are influenced both by local processes (e.g., development, restoration, etc.) and regional processes (e.g., long-term drought cycles). Thus, if a trigger is met, a critical component of the Monitoring Plan is the capacity to initiate assessment of the status of populations and habitats both within and outside the Reserve System to quantify the impact of the conservation actions as nested within the larger impacts of regional factors. Third, both plant and animal populations can experience time lags in their response to conservation actions, particularly for long-lived species with low reproductive rates such as the desert tortoise, therefore, it is expected to take multiple years to see the realized benefits of conservation actions.

Table 6-6 below provides a list of all Covered Species and habitats, the related objective, and the associated targets and triggers. Objectives 1D, 2B, 4A, 4B, 4C and 4D, which are discussed in the Engagement and Oversight monitoring section 4.2.1.3 above are not included in Table 6-6 because defining specific targets and triggers is not useful for the evaluation of these objectives. Whether or not these objectives are being achieved can be answered by a simple “yes” or “no.” These objectives will be reviewed as part of the Adaptive Management Evaluation process and reporting.

Figure 6-X summarizes the Adaptive Management Evaluation process outlined in this subsection and will vary temporally by BGO. For example, attaining targets or triggers for Objectives 1A and 2D would be known within the initial ten-year Adaptive Management Evaluation period due to the development of the Early Detection and Rapid Response Program and Weed Management Plan within the first two years of the MSHCP Amendment. Conversely, longer-term, species-specific population triggers identified under Objective 3A may not be apparent, especially for desert tortoise, until future Adaptive Management Evaluation periods occur.

Figure 6-X Adaptive Management Evaluation Cycle.



6.4.2.2 Stakeholder Involvement

Regular constructive stakeholder involvement is critical to the success of both the monitoring and adaptive management portions of this plan. Stakeholders may have insight into species ecology, strengths and weaknesses of existing monitoring methods, or emerging monitoring methods. Stakeholders may also prove invaluable in the adaptive management process, particularly if the adaptive management action process must be initiated. They can identify causes of problems and potential projects and solutions to remedy undesired conditions of species and their habitats. Incorporating stakeholder involvement can thus improve the overall quality and effectiveness of the MAMP.

Table 6-6. Covered Species and Habitat Monitoring and Associate Targets and Triggers.

Monitoring Plan Section	Monitoring Survey	Species/ Habitat	Related Objective	Target	Trigger
6.4.1.1.1 Invasive Species Monitoring	TBD[a]	Invasive Species	1A, 2D	No newly-established invasive plant species	Newly-established invasive plant species
			1A, 2D	Stable or decreasing cover of invasive plant species relative to baseline.	Increasing cover of invasive plant species relative to baseline.
6.4.1.1.2 Habitat Quality	Habitat Quantification Assessment	Riparian	1B	Stable or increasing riparian habitat quality and quantity across reserve lands during assessment period	Decreasing riparian habitat quality and quantity across reserve lands during assessment period
	Habitat Quantification Assessment	All Covered Species Habitats	1C, 2A	Stable or increasing habitat quality across reserve lands during the assessment period	Decreasing habitat quality across reserve lands during the assessment period
6.4.1.1.4 Connectivity	TBD[a]	Connectivity	2E	Stable or increasing connectivity across reserve lands during the assessment period	Decreasing connectivity across reserve lands during the assessment period
6.4.1.2 Species Monitoring	Occupancy sampling	Desert tortoise	3A	Stable or increasing metric across desert upland reserve lands during the assessment period	Decreasing metric across desert upland reserve lands during the assessment period
	Protocol survey	Yellow-billed cuckoo	3A	Stable or increasing detections during the breeding season across riparian reserve lands during the assessment period	Decreasing detections during the breeding season across riparian reserve lands during the assessment period
		Southwestern willow flycatcher			
		Western burrowing owl	3A	Stable or increasing detections during the breeding season across reserve lands during the assessment period	Decreasing detections during the breeding season across reserve lands during the assessment period
		Ridgway's rail	3A	Stable or increasing detections during the breeding season across marsh areas in reserve lands during the assessment period	Decreasing detections during the breeding season across marsh areas in reserve lands during the assessment period
	Point count	Gilded flicker	3A	Stable or increasing detections across reserve lands during the assessment period	Decreasing detections across reserve lands during the assessment period
		Loggerhead shrike	3A		
		Bendire's thrasher	3A		
		Le Conte's thrasher	3A		
		Arizona Bell's vireo	3A		
	Species-specific	Golden eagle	3A	Stable or increasing suitable foraging habitat in reserve lands during the assessment period	Decreasing suitable foraging habitat across reserve lands during the assessment period
		Gila monster	3A	Stable or increasing suitable habitat in reserve lands during the assessment period	Decreasing suitable habitat across reserve lands during the assessment period
		Desert pocket mouse	3A	Stable or increasing occupancy detections across reserve lands during the assessment period	Decreasing breeding detections across reserve lands during the assessment period

Monitoring Plan Section	Monitoring Survey	Species/ Habitat	Related Objective	Target	Trigger
	Passive acoustic	Townsend's big-eared bat	3A and 3B	Stable or increasing number of acoustic detections at sampling stations across reserve lands during the assessment period	Decreasing number of sampling stations with acoustic detections across reserve lands during the assessment period
		Spotted bat			
	Floral visitation rates	Mojave poppy bee	3A	Stable or increasing visitation rate in known areas of occurrence across reserve lands during the assessment period	Decreasing visitation rate in known areas of occurrence across reserve lands during the assessment period
	Visual encounter	Monarch butterfly	3A	Stable or increasing numbers of monarch adults, eggs, and larvae in survey areas across reserve lands during the assessment period	Decreasing numbers of monarch adults, eggs, and larvae in survey areas across reserve lands during the assessment period
6.4.1.1.3 Covered Plant Species Habitat and 6.4.1.2.11 Other Plants	Distribution, survival, and seedling recruitment	Joshua tree	3C	Stable or increasing metrics across desert upland reserve lands during the assessment period	Decreasing metrics across desert upland reserve lands during the assessment period
	Species-specific	Sticky buckwheat	2C, 3C	Sediment sources identified and impacts avoided as feasible within 3 years of implementation.	Sediment sources have not been identified and impacts are not being avoided to the greatest extent feasible within 3 years of implementation.
		Threecorner milkvetch	2C, 3C		
		Pahrump Valley buckwheat	1E, 3C	Essential occupied habitat has been acquired, restored or enhanced within 1 year of implementation.	Essential occupied habitat has not been acquired, restored or enhanced within 1 year of implementation.
		Gypsophile Species	2F	Non-federal development in areas of occupied and potentially suitable habitat has been limited to 9% of baseline within Plan Area.	Non-federal development in areas of occupied and potentially suitable habitat has exceeded 9% of baseline within Plan Area.
		Alkali mariposa lily	3A, 3C	Stable or increasing population metric across reserve lands during the assessment period, and essential populations of each species have been identified and protected	Decreasing metric across reserve lands during the assessment period, and essential populations of each species have not been identified or not protected
		Blue Diamond cholla	3A, 3C		
		Silverleaf sunray	3A, 3C		
		Las Vegas bearpoppy	3A, 3C		
		Las Vegas buckwheat	3A, 3C		
		Sticky buckwheat	3A, 3C		
		White-margined beardtongue	3A, 3C		
		Parish phacelia	3A, 3C		
		St. George blue-eyed grass	3A, 3C		

[a]To be decided: Final monitoring methods and sampling protocols to be developed within 18 months of MSHCP Amendment implementation.

[b]To be decided during the development of the Weed Management Plan and Early Detection Rapid Response Program. Some candidate species include red brome, Mediterranean grass, Sahara mustard, African malcomia, tamarisk/salt cedar, Eurasian water milfoil, giant Salvinia, and hydrilla.

6.4.2.3 Revisions to Monitoring and Adaptive Management Plan

The purpose of this document is to function as a handbook for designing and implementing the MSHCP Amendment monitoring and adaptive management process. However, Adaptive Management should be an active and engaged process and revisions to this MAMP may be warranted in the future. For example, new monitoring techniques or ecosystem indicators may be developed or the adaptive management evaluation or action processes may need to be revised. This document is therefore a 'living document' and should be reviewed, revised, and updated at least every ten years as part of the Adaptive Management Evaluation process. Revisions to this Plan and the rationale behind such revisions should be documented in Ten-Year Monitoring Reports.

The critical caveat altering this MAMP is that any future modifications to the monitoring methods be incorporated in such a way that all previous monitoring data is directly comparable to the new monitoring data. For example, new methods should be conducted simultaneously with old methods for more than one year to allow for statistical adjustment of any method-dependent biases in the resultant data (e.g., a comparison of relative abundance). If cost prohibits full spatiotemporal overlap of old and new monitoring methods, however, it should be noted that newly observed patterns in the monitored metric may be due to methodology, underlying changes in the population, or a combination of both. Therefore, it is strongly recommended that there is some temporal overlap, such as monitoring half of the sites using the old methodology and half of the sites using the new methodology for two years before using the new methodology at all sites. This will ensure continuity in the estimates of trends in species and their habitats.

Ch 6 References

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