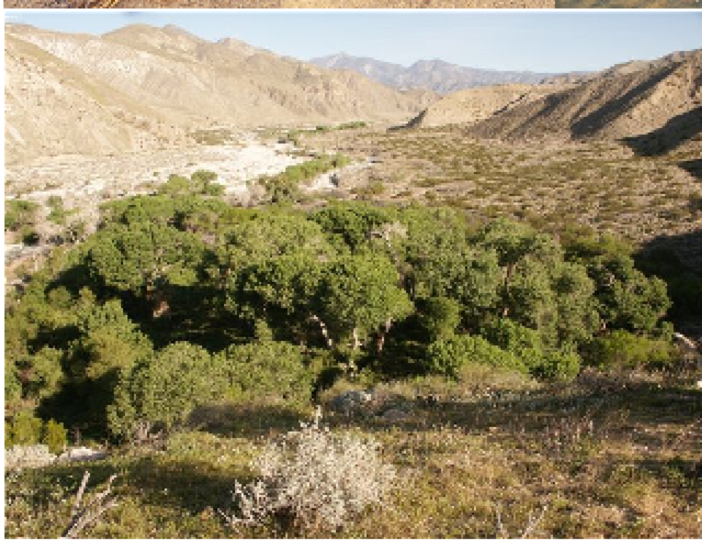
Coachella Valley
Multiple Species Habitat Conservation Plan/
Natural Community Conservation Plan






Monitoring Program

Draft Monitoring Protocols
for the Desert Wetland Communities and Covered Species

Prepared for the

Coachella Valley Conservation Commission

June 2009

Coachella Valley's Multiple Species Habitat Conservation & Natural Community Conservation Plan

Monitoring Protocols for the Desert Wetland Communities

Including:
Mesquite Hummocks
Mesquite Bosque
Desert Saltbush Scrub
Southern Arroyo Willow Riparian Forest
Sonoran Cottonwood Willow Riparian Forest
Southern Sycamore-Alder Riparian Forest
Freshwater Marsh
Cismontane Alkali Marsh
Desert Fan Palm Oasis Woodland
Arroweed Scrub

And Covered Species whose distributions are wholly contained therein:
Arroyo Toad (*Bufo microscaphus)*
California Black Rail (*Laterallus jamaicensis*)
Crissal Thrasher (*Toxostoma crissali*)
Desert Pupfish (*Cyprinodon macularius*)
Least Bell's Vireo (*Vireo bellii pusillus*)
Southern Yellow Bat (*Lasiurus ega*)
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
Summer Tanager (*Piranga rubra*)
Yellow Warbler (*Dendroica petechia*)
Yellow-breasted Chat (*Icteria virens*)
Yuma Clapper Rail (*Rallus longirostris yumanensis*)

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30 June 2009

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COMMUNITY DESCRIPTIONS

Desert wetland communities covered under the Coachella Valley's MSHCP/NCCP include: Mesquite Hummocks, Mesquite Bosque, Desert Saltbush Scrub, Desert Sink Scrub, Southern Arroyo Willow Riparian Forest, Sonoran Cottonwood Willow Riparian Forest, Southern Sycamore-Alder Riparian Forest, Freshwater Marsh, Cismontane Alkali Marsh, Desert Fan Palm Oasis Woodland, and Arrowweed Scrub. The position of each of these communities within the plan area depends on the interaction of water supply (surface or groundwater, perennial or ephemeral surface flow, flow rates, and whether the surface flows are confined to a narrow channel or spread over a broader area) and levels of salinity. Many of these communities are associated with earthquake fault zones. A conceptual model of how water supply and salinity interaction gradients result in defined communities is shown in Figure 1.

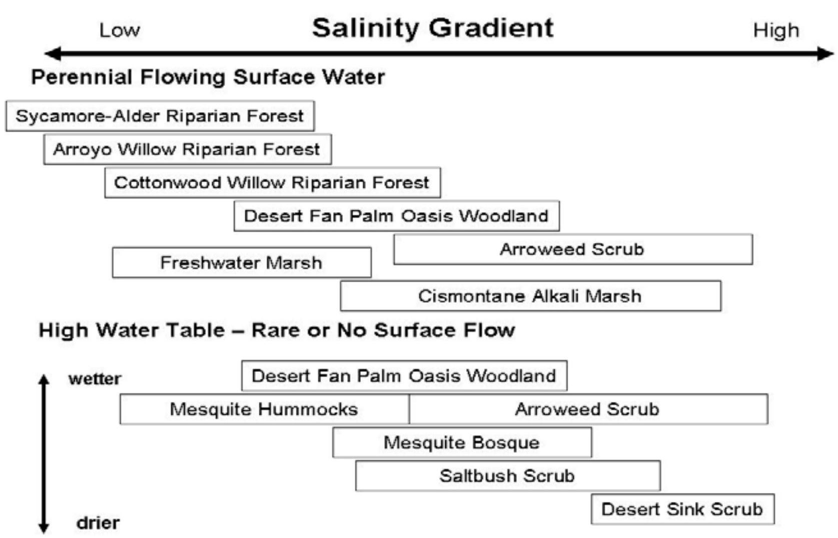


Figure 1. A conceptual model of how water supply and salinity interaction gradients result in defined communities.

A model of covered community- species relationships is shown in Figure 2. Individual community-specific descriptions (Holland 1986, Coachella Valley Mountains Conservancy 2000), roughly in order of their salinity tolerances, include:

Desert Sink Scrub – high salinity, high groundwater table soils with *Allenrolfea occidentalis* and *Sueda torreyana* as dominant shrubs. *Atriplex* can be a minor component. Flat-tailed horned lizards, *Phrynosoma mcallii,* may occur in this community in the Dos Palmas area, but the soils can be too salty for their primary prey, harvester ants.

Desert Saltbush Scrub – A community with a high groundwater table but no regularly occurring surface water. Soil salinity levels range from 0.2-0.7%. *Atriplex polycarpa* is a typical dominant shrub, with *A. canescens* as a common associated species. Covered species that occur within this community include flat-tailed horned lizards, and Le Conte's thrasher, *Toxostoma lecontei*.

Arrowweed Scrub – Occurs on wet soils with high salinity, often adjacent to palm oases and/or cismontane alkali marsh communities. Dominated by *Pulchea sericea*. Crissal thrashers, *Toxostoma crissali*, and yellow-breasted chats, *Icteria virens,* sometimes use this community.

Mesquite Bosque – High groundwater, seasonally wet, high to moderate salinity soils dominated by dense or open stands of screwbean mesquite, *Prosopis pubescens*. Crissal thrashers utilize this community.

Desert Fan Palm Oasis Woodland – Occurs on moderately saline, very wet soils that may include surface water. The desert fan palm, *Washingtonia filifera* is a major component, often in homogeneous stands, or sometimes associated with Fremont cottonwood, *Populus fremontii*, willow species, *Salix* spp. and mesquite, *Prosopis* spp. Palms tolerate fire, but fire results in substantial loss of wildlife habitat value when the palm skirts are removed, and an overall loss in woody plant species richness. Southern yellow bats, *Lasiurus ega*, are believed to be somewhat if not wholly restricted to palms with intact skirts. When cottonwoods and willows are present this community provides habitat for the suit of covered riparian birds as well.

Mesquite Hummocks – Occurs in areas of low to moderately saline, high groundwater or where groundwater is forced to near the surface along earthquake faultlines as clumps of honey mesquite, *Prosopis glandulosa*. Crissal thrashers, along with round-tailed ground squirrels, *Spermophilus tereticaudus*, can find habitat within this community.

Cismontane Alkali Marsh – This community occurs when moderately saline, low gradient surface water flow is not confined to a narrow channel, and emergent sedges and rushes can form a dense mass of vegetation up to 2 m in height. Yuma Clapper Rail (*Rallus longirostris yumanensis*) and California Black Rail (*Laterallus jamaicensis*) find preferred habitats in this community.

Coastal and Valley Freshwater Marsh – Similar to the cismontane marsh except water is less saline and vegetation is taller, up to 4-5 m. Yuma Clapper Rail and California Black Rail find preferred habitats in this community.

Sonoran Cottonwood Willow Riparian Forest, Southern Arroyo Willow Riparian Forest, and Southern Sycamore-Alder Riparian Forest – Three similar communities, functionally differing primarily in the composition of dominant tree species. These communities have the least salt tolerances of any of the wetland group. All can provide habitat for arroyo toads (*Bufo microscaphus*), least

Bell's Vireos (*Vireo bellii pusillus*), southwestern willow flycatchers (*Empidonax traillii extimus*), summer tanagers (*Piranga rubra*), yellow warblesr (*Dendroica petechia*), and yellow-breasted chats (*Icteria virens*), although the arroyo toad and tanager are more likely to occur in the southern sycamore-alder community.

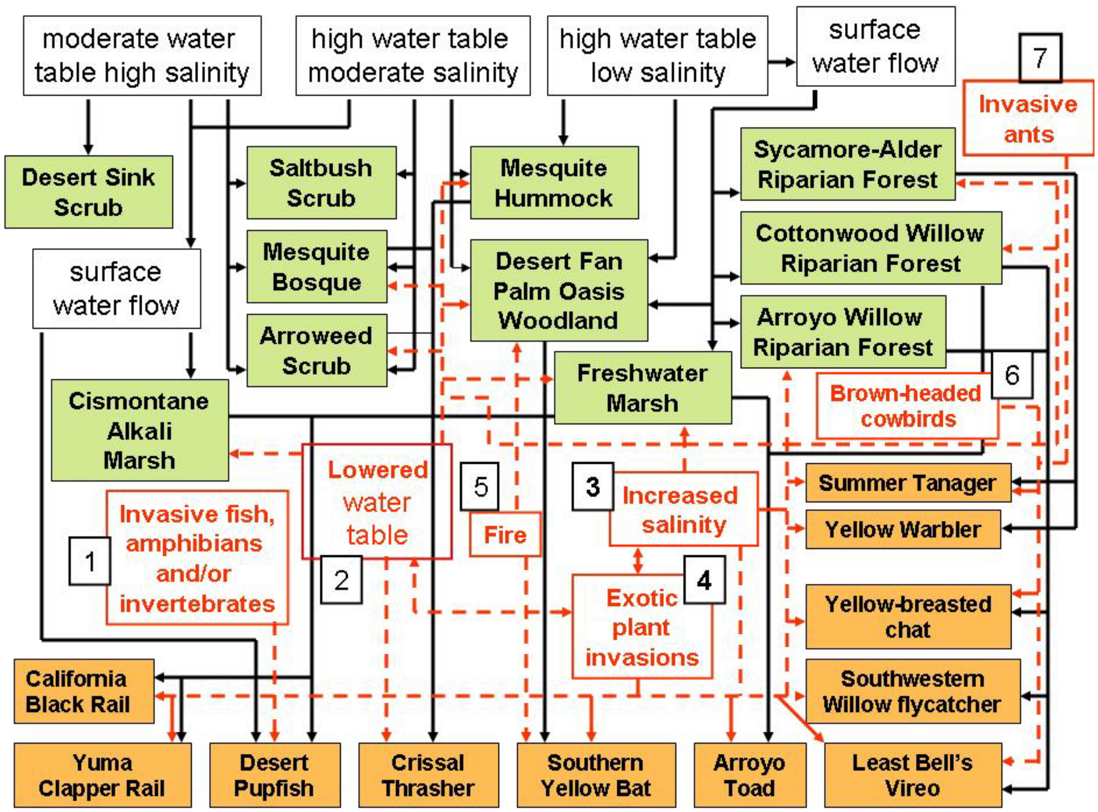


Figure 2. Water/salinity impacts on community type and species-community associations along with potential stressors (red boxes and red, dashed connecting lines). Numbers align with research questions and monitoring objectives.

INITIAL RESEARCH QUESTIONS (TO BE ADDRESSED WITH MONITORING DATA)

The following research questions are aimed at assessing the risk that potential stressors pose to the integrity and sustainability of the desert wetland communities and associated species covered under the MSHCP/NCCP. Answers to these questions will identify, prioritize and direct appropriate management responses. Numbers align with stressors identified in the conceptual model (Figure 2) but do not denote level of priority.

Community-level questions:

- **(2&3)** Salinity and availability of water dictate which of the desert wetland communities occur at a given location and thus what species will be able to find suitable habitat there. What are the spatial extents of each of the desert wetland communities? How dynamic and what is the trajectory of those distributions?
- **(2&3)** What is the range of salinity and groundwater depths characterizing each community?
- **(2&3)** What are the thresholds or tipping points of salinity and groundwater depth when communities begin to shift in character from one wetland community to another?
- **(2&3)** What is the source of change in salinity or groundwater that could bring a community to the tipping point of shifting from on community to another? To what extent does the lining of the Coachella canal, changing agricultural practices, tectonic shifts in fault zones, salt cedar densities, and/or climate change (precipitation inputs) impact salinity and groundwater levels?
- **(1&7)** Where are the occurrences and the spatial extent of invasive animal species within the desert wetland communities? Those invasive species include red fire ants, *Solenopsis invicta*, Argentine ants, *Linepithema humile*, crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. How dynamic are those distributions? What variables influence those dynamics?
- **(1)** What distances from source areas serve as barriers to colonization by invasive animal species? What are the vectors of new "inoculations" of invasive species?
- **(1)** What is the effectiveness of control methods (time/effort/cost/success/recurrence time) for these invasive species?
- **(2&3)** How does salinity and groundwater depth impact the success of restoration efforts of native plant community composition? – Do they affect patterns of native vegetation recruitment?
- **(2, 3&4)** How does salinity and groundwater depth impact invasibility?
- **(2, 3&4)** Do invasive plant species impact salinity and groundwater depths?
- **(4)** Where do non-native invasive plant species occur within the wetland communities and what is their spatial extent? Those invasive species include but are not limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,*
- **(4)** What are the trajectories in the occurrence and abundance of invasive species in each of the wetland communities?

- **(4)** How does disturbance frequency and intensity (flooding, fires, ORV trespass) impact the ability of invasive plant species to become established in wetland communities?
- **(4&5)** To what extent do invasive species impact the occurrence of fire in these wetland communities and how does fire impact the invasibility of those exotics?
- **(5)** What is the recolonization rate by native species into wetland communities after fire?

MONITORING OBJECTIVES

MSHCP/NCCP goals include protecting the sustainability of the desert wetlands along with populations of covered species that find suitable habitats within those communities. Monitoring objectives need to provide data to support that goal by answering the research questions listed above. In order to fully understand the risk that stressors (Figure 2) pose to the conservation goal, monitoring objectives should include the following (numbers align with those in Figure 2 and in the research questions):

Community-level objectives:

- **(1, 2 & 3)** For sites being managed for desert pupfish or arroyo toads, water depth, flow rate and salinity will be additional metrics measured. Collecting data for each of these metrics will occur at permanent plots located randomly within the community types, the number of plots will be based on within community heterogeneity as determined through preliminary sampling. These variables will initially be re-sampled on each of the plots every three years; the time between repeated surveys should be adjusted based on the rates of change measured (high rates of change would call for more frequent surveys). For restoration and active management efforts, the same variables should be measured, but repeated annually until the perennial plant cover and composition within the restoration sites are within the range of values measured within intact portions of that community.
- **(2&3)** Create a baseline map of the current condition and extent of the wetland communities. This can be accomplished using current high resolution satellite imagery coupled with ground-truthing. Accurate polygons depicting the location and extent of each of the communities will be defined as GIS layers. This shall be repeated with new/current satellite imagery initially every five years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping).
- **(2&3)** Groundwater levels and salinity are likely to change within the plan area due to many stressors, ranging from groundwater over drafting, tectonic activity, eliminating leakage along the Coachella canal, changing irrigation practices due to reduced water

availability and higher costs, climate change, fire, and the effect of invasive species such as salt cedar (Fig 2). Even though the effects may be similar, the management response, if any, will differ based on the source stressor. Within each community, on randomly located plots, or centrally located within a cluster of permanent plots, depth to groundwater, groundwater salinity, and soil salinity and water stable isotope signatures will be quantified.

- **(1)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include red fire ants, *Solenopsis invicta*, Argentine ants, *Linepithema humile*, crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping).
- **(2, 3&4)** On permanent, randomly located plots located in each of the wetland communities, woody-perennial plant species richness and cover will be quantified every five years. For restoration/management plots, surveys will occur annually until species richness and cover values are within the variances measured on the undisturbed communities.
- **(4)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include but are not limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,* Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping). These data will also feed into the objectives of the low desert weed management area (NRCS).

With the data generated through these monitoring objectives each of the key community questions should then be able to be addressed, protection goals for the wetland communities should be able to be quantified, and land managers will have the information necessary to carry out tasks aimed at reducing the source and/or effect of stressors.

Suggested Monitoring Protocols

Desert Wetland Communities Bird Associations

For both accuracy and subsequent statistical analyses, we believe circular plots are the preferred technique for surveying birds. The methods for this technique are described in more detail elsewhere (Reynolds et al. 1980, DeSante 1981). Several of the bird species included here are listed as endangered, and so appropriate permits, when necessary, need to be acquired prior to conducting surveys. Circular plots should be used in marsh habitats for Yuma clapper rail (*Rallus longirostris yumanensis*) and California black rail (*Laterallus jamaicensis*), in mesquite and palm oases for crissal thrasher (*Toxostoma crissali*), and in riparian habitats for least Bell's Vireo (*Vireo bellii pusillus*), southwestern willow Flycatcher (*Empidonax traillii extimus*), summer tanager (*Piranga rubra*), yellow warbler (*Dendroica petechia*), and yellow-breasted chat (*Icteria virens*). Count points should be identified/located prior to the surveys. These points will also serve as the center of the permanent vegetation and arthropod survey plots described above. Points should be distributed within the identified community type either randomly or regularly (after beginning at a random point), separated at a sufficient distance so as not to count the same individuals from adjacent points. The number of points will vary with the size of the community polygon and the detection distance of the species being surveyed.

At each point a surveyor should stand quietly for at least one minute before initiating the count. After the one minute rest period the surveyor can then begin counting all birds for a 15 minute count period. In marsh habitat surveying for the rail species, recorded playbacks of both of the rails' calls will be played for one minute at the beginning and at the 10 minute mark of the 15 minute count period. Because using tapped calls to solicit responses is an "active" rather than passive detection approach, surveyors will need to acquire any needed federal or state permits. Surveyors need to be adept at identifying all local species by sight, by song and by call notes. They need to also be able to accurately estimate distances to a singing/calling bird. To assess and improve bird survey skills, a mandatory 1-2 week training period should proceed each count period. For determining detectability for each species, the count period can be divided into intervals, with each species and each individual tallied separately for each period. Also, a second surveyor can count the same points, separated from the first count by at least 30 minutes. Data collected for each count at each point should include the number of individuals and their estimated distance form the survey point for all bird species. Each point should be surveyed four times during the birds' breeding season. The timing of breeding varies considerably, with hummingbirds breeding is in January-March, other resident species breed from March through May, earlier migrants breeding from April through June, and late migrants, such as the southwestern willow Flycatcher, don't arrive until late May or June. Consequently counts need to be staggered to overlap with peak activity/and or detectability for each species; one round of counts in March, April, May and in June should suffice.

The objectives here are to both detect bird occupancy levels as well as identify correlates of occupancy or absence such as cowbird parasitism, invasive plant species, invasive ant species, insect abundance and species richness, vegetation structure and composition. Each of these are variables that could be manipulated to achieve management and conservation goals, but understanding the influence they have in driving species' occupancy is a critical first step. Landscape variables should also be included in multivariate correlation analyses. Landscape variables are less subject to management manipulation but may have an over-riding influence on the occurrence of wetland community birds. Such variables include the extent of the community type within set distances of the survey point, the width and/or edge character of the community at the survey point, and the distance to water. These variables can be quantified from satellite image-GIS analyses.

UC Riverside's Center for Conservation Biology conducted a pilot study of riparian community bird occurrences within the Plan area from 2002-2004. Over that three year period 18 separate riparian community sites were surveyed and 116 points were surveyed (averaging slightly more than six points per site). Survey points were spaced approximately 200 m apart. The following is a description of the methods used in that study:

"Point counts were conducted between sunrise and 0900 hours. During point counts, observers stood quietly on or near the location of a point and recorded detections of the target species (identifications by sight or sound) during a 15-minute count period. Non-target species were also noted before, during, or after the counting period; however, detection of non-target species was a secondary goal because of its potential interference with the detection of target species. We employed a double-observer method at all 15 sites. For the double-observer method, two observers conducted counts at each point count location on the same day but at slightly different times. The second count was conducted within 30 minutes of the first count. The first observer (Observer 1) went to Point 1 while the second observer (Observer 2) waited at a distance of approximately 200 m or more away from Point 1. When Observer 1 was finished counting at Point 1, he/she radioed to Observer 2 to progress to Point 1, and Observer 1 progressed to Point 2. The two observers progressed through all of the points in this manner, with Observer 2 trailing Observer 1. At the end of the survey, observers compared observations to estimate the total number of individual birds actually present at the site. For future statistical analyses of detectability of riparian birds using these counting methods, the 15-minute count period was divided into four intervals, and we recorded whether species were detected in the first (0-3:00), second (3:00-5:00), third (5:00-10:00), or fourth (10:00-15:00) interval. Additionally, we recorded the distance estimated to the nearest meter from the observer/point to each bird detected, and whether initial detection was made visually, or by call or song. Detection information and locations of target species relative to the point coordinates were documented on point count data forms."

Summary results of that pilot study are shown below in Figure 4.

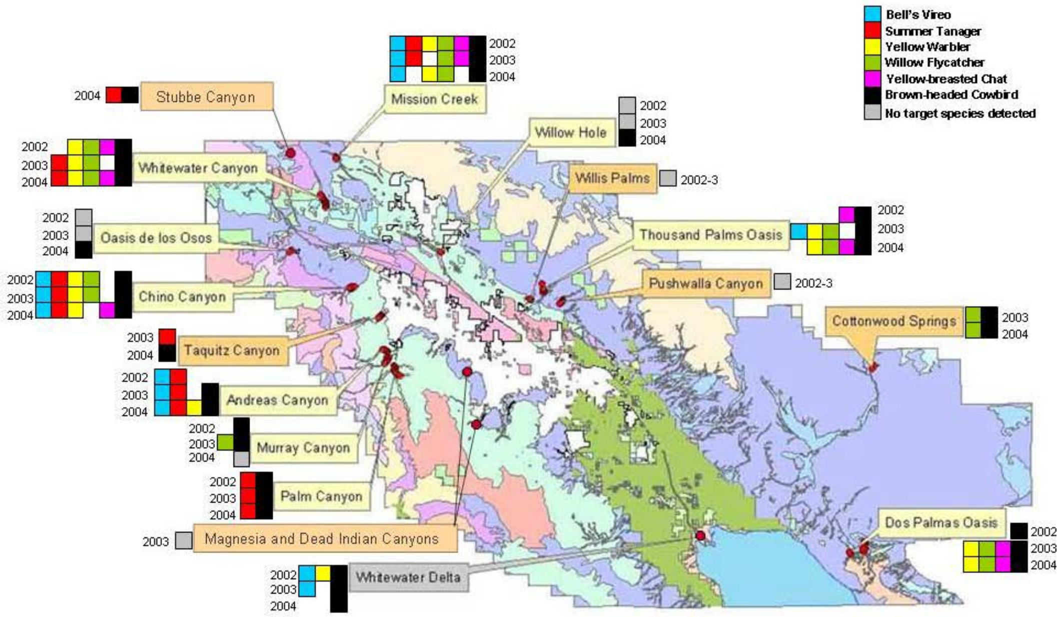


Figure 4. Occupancy patterns of target bird species in the Coachella Valley, 2002-2004.

Pertinent desert wetland birds research/monitoring questions and objectives (numbers correspond to Figure 2):

<u>Questions:</u>

- **(1, 2, 3, 4, 5, 6 & 7)** What resources/stressors drive population dynamics of bird species occurring within desert wetland communities? This is a key to understand and partition the sources of variance resulting from the stressors identified in Figure 2.
- **(1)** What distances from source areas serve as barriers to colonization by invasive animal species? What are the vectors of new "inoculations" of invasive species?
- (7) What effect do exotic ants have on the occupancy and reproductive success of nesting riparian birds or arroyo toads? If there is an effect, is it through the depletion of native arthropod prey, or through ant predation on nestlings?
- **(1)** What is the effectiveness of control methods (time/effort/cost/success/recurrence time) for these invasive species?
- **(2&3)** What are the thresholds or tipping points of salinity and groundwater depth when communities begin to shift in character from one wetland community to another?
- **4)** Where do non-native invasive plant species occur within the wetland communities and what is their spatial extent? Those invasive species include but are not limited to,

salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,*

- **(4)** To what extent do invasive plant species impact the occurrence of native bird species within the wetland communities?
- **(4)** How does disturbance frequency and intensity (flooding, fires, ORV trespass) impact the ability of invasive plant species to become established in wetland communities?
- **(6)** What are the drivers and stressors of nesting success in riparian birds, including least Bell's vireos, summer tanagers, or yellow-breasted chats (the covered riparian birds that nest in the plan area)? Is the current level of brown headed cowbird nest parasitism impacting breeding success and recruitment?
- **(6)** Does cowbird trapping significantly reduce levels of nest parasitism?

Objectives:

- **(1&6)** For sites being managed for desert wetland community birds, conduct surveys of avian species composition and arthropod community composition. For sites where exotic species control (including cowbirds) is undertaken, surveys should be annual and an assessment of reproductive success should occur. After three years, if there is small between-year variance, then surveys could be conducted every three years.
- **(2&3)** Create a baseline map of the current condition and extent of the wetland communities. This can be accomplished using current high resolution satellite imagery coupled with ground-truthing. Accurate polygons depicting the location and extent of each of the communities will be defined as GIS layers. This shall be repeated with new/current satellite imagery initially every five years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping).
- **(2&3)** Groundwater levels and salinity are likely to change within the plan area due to many stressors, ranging from groundwater over drafting, tectonic activity, eliminating leakage along the Coachella canal, changing irrigation practices due to reduced water availability and higher costs, climate change, fire, and the effect of invasive species such as salt cedar (Fig 2). Even though the effects may be similar, the management response, if any, will differ based on the source stressor. Within each community, on randomly located plots, or centrally located within a cluster of permanent plots, depth to groundwater, groundwater salinity, and soil salinity and water stable isotope signatures will be quantified.
- **(2, 3&4)** On permanent, randomly located plots located in each of the wetland communities, woody-perennial plant species richness and cover will be quantified every five years. For restoration/management plots, surveys will occur annually until species

richness and cover values are within the variances measured on the undisturbed communities.

- **(4)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include but are not limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,* Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping). These data will also feed into the objectives of the low desert weed management area (NRCS).

Southern Yellow Bats

Southern yellow bats, *Lasiurus ega*, are associated with desert fan palm communities, and are the only bat species covered under this conservation plan. As the effort to record the occurrence of this species along with any other bat species using that community is the same, we recommend conducting a community-level bat survey. Surveys for bats should follow the protocols described above for birds, including using the same survey points when they occur in the appropriate natural community. Surveys could occur anytime throughout the warm months as long as winds are light. There are, however, a couple important exceptions; surveys will be conducted at night, and bat detections will be made via their ultrasonic-species specific vocalizations (eg. Weller 2008). There are several products available for detecting bat vocalizations such as "anabat" or "sonobat". This technology (i.e. anabat/sonobat) lends itself to remote sensing where multiple recorders can be deployed throughout the selected sites and allowed to record all night. Such technological approaches should be investigated and employed if deemed cost effective.

Alternative survey approaches include nocturnal mist netting. This can yield positive occurrence data when there are isolated pools or other water sources that focus bat activity and facilitate stretching nets across or near such features. However isolated open water does not occur at each potential site, and not catching a bat does is not equivalent to their being absent.

Pertinent southern yellow bat research/monitoring questions and objectives (nos. correspond to Figure 2):

<u>Questions:</u>

- **(1, 2, 3, 4, 5&6)** What resources drive population dynamics of southern yellow bats as well as other bat species occurring within desert wetland communities? This is a key to understand and partition the sources of variance resulting from the stressors identified in Figure 2.

- **(4&5)** To what extent do invasive species impact the occurrence of fire in these wetland communities and how does fire impact the invasibility of those exotics?

Objectives:

- **(5)** Create a baseline assessment of the occurrence or southern yellow bats in palm oases within the MSHCP/NCCP conservation areas. Compare oases that have never burned with those that have a known burn history. Repeat every three years; the time between repeated surveys should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping). When oases are burned begin annual surveys for up to 10 years or when until yellow bat occurrence values are within the variances measured on the undisturbed communities.

Arroyo Toads

The arroyo toad, *Bufo microscaphus,* has a very limited range within the Plan area, recently known only from Whitewater Canyon, and its current occurrence there needs verification. Survey protocols for arroyo toads can follow very closely those described above for riparian birds, again using the same survey points whenever possible. As with the bat surveys the primary difference is the surveys would occur at night. Recommended USFWS survey protocols are available and should be adhered to: http://www.fws.gov/ventura/speciesinfo/protocols_guidelines/docs/arroyotoad/arroyotoad_surveyprotocol.pdf. Adult arroyo toads call in the spring when nighttime temperatures reach 12-14° C; for our area that would be March-April. The toads can be very sensitive to noise and disturbance so surveys along creeks, and movement between survey points should be done quietly, avoiding any direct contact with the water or the toads. Another method includes daytime surveys for tadpoles. The tadpoles are distinctive but not so much so that they can be positively identified without handling. Since this species is federally and state protected, no handling or disturbance can occur without appropriate permits.

Pertinent arroyo toad research/monitoring objectives and questions (numbers correspond to Figure 2):

Questions:

- **(1, 2, 3, 4, 5&6)** What resources drive population dynamics of arroyo toads? This is a key to understand and partition the sources of variance resulting from the stressors identified in Figure 2.

- **(1&7)** Where are the occurrences and the spatial extent of invasive animal species within the desert wetland communities? Those invasive species include red fire ants, *Solenopsis invicta*, Argentine ants, *Linepithema humile*, crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. How dynamic are those distributions? What variables influence those dynamics?
- **(1)** What effect do the exotic fish, amphibians and invertebrates have on arroyo toads? Does that effect change with different combinations of invasive species present?
- **(1 & 7)** What effect do exotic ants have on the occupancy and reproductive success of arroyo toads? If there is an effect, is it through the depletion of native arthropod prey, or through ant predation on young toads?

Objectives:

- **(1)** For sites being managed for arroyo toads, assess the occurrence toads along with invasive, non-native fish, amphibians, ants and snails annually.
- **(1)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include red fire ants, *Solenopsis invicta*, Argentine ants, *Linepithema humile*, crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping).
- **(1, 2 & 3)** For sites being managed for arroyo toads, water depth, flow rate and salinity will be additional metrics measured. Collecting data for each of these metrics will occur at permanent plots located randomly within the community types. Plots will initially be re-sampled every three years; the time between repeated surveys should be adjusted based on the rates of change measured (high rates of change would call for more frequent surveys). For restoration and active management efforts, the same variables should be measured, but repeated annually until the perennial plant cover and composition within the restoration sites are within the range of values measured within intact portions of that community.

Desert Pupfish

Desert pupfish, *Cyprinodon macularius*, have been regularly surveyed by the California Department of Fish and Game within the southern Coachella Valley and surrounding the Salton Sea for over a decade. The survey methods presented here reflect their experience and expertise. Data derived from these methods result in an estimate of occupancy within a given body of water or reach of a flowing stream. That said, the methodology will result in a measure of number of pupfish captured per effort, and so under controlled surveys (similar time of year, time of day, temperatures) may represent a relative abundance estimate.

The suggested survey protocol for desert pupfish includes using standard minnow traps. Standard Gee's minnow traps are typically set for approximately two hours during the day, and the exact soak time is recorded to the nearest quarter-hour. The minnow traps need to be placed so that their openings are completely below the water surface. Traps are baited with fish-flavored canned cat food (about 1.5 ounces) placed in perforated plastic bags. The number of traps set in a particular water body depends on habitat size and heterogeneity, as well as accessibility; approximately one trap per five meters of accessible shoreline should suffice. All captured fish and crayfish are identified, counted and released. The general size range of captured pupfish is recorded, as well as the sex ratio when possible and feasible. The presence of other species, such as nonnative snails, is recorded. In habitats where traps fail to capture pupfish, pupfish presence may be documented by observation and dip net. A YSI 85 instrument is used to record basic water quality parameters (temperature, dissolved oxygen, conductivity, specific conductivity, salinity). A Garmin GPSmap 60Cx is used to document pupfish capture sites and/or observations.

Once the minnow trap is removed from the body of water being surveyed, the trap needs to be immediately submerged in a bucket filled with water from the same body of water being surveyed. Utmost care should be taken to limit the stress on any pupfish captured in the trap. The minnow trap should be opened while submerged in the bucket and removed leaving its contents in the bucket. The contents should first be visually inspected and quantified to the extent possible. If closer examinations are required to verify identifications, or if fish are too numerous to quantify otherwise, then fish should be carefully removed with a small dip net. After quantifying the trap contents, desert pupfish should be gently released back into the body of water being surveyed.

The entire contents of the minnow trap should be quantified to species or genus; crayfish and aquatic snails clinging to the minnow trap exterior should be included in the tally of species surveyed. Data from each trap should be recorded separately so that data can be summarized as mean/variance for each species/trap effort.

Pertinent desert pupfish research/monitoring objectives & questions (numbers correspond to Figure 2):

Questions:

- **(1, 2, 3, 4, 5 & 6)** What resources drive population dynamics of desert pupfish populations? This is a key to understand and partition the sources of variance resulting from the stressors identified in Figure 2.
- **(1)** Where are the occurrences and the spatial extent of invasive animal species within the desert wetland communities? crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. How dynamic are those distributions? What variables influence those dynamics?
- **(1)** What distances from source areas serve as barriers to colonization by invasive animal species? What are the vectors of new "inoculations" of invasive species?
- **(1)** What effect do the exotic fish, amphibians and invertebrates have on desert pupfish? Does that effect change with different combinations of invasive species present?
- **(1)** What is the effectiveness of control methods (time/effort/cost/success/recurrence time) for these invasive species?
- **(1)** For aquatic systems, a potential invasive species control method could be to temporarily dry wetlands where water management is possible. What is the effect on native species (pupfish, and rails) of temporarily drying wetlands?
- **(4)** What are the trajectories in the occurrence and abundance of invasive species in each of the wetland communities?
- **(2, 3&4)** How does salinity and groundwater depth impact invasibility?
- **(2, 3&4)** Do invasive plant species impact salinity and groundwater depths?
- **(4)** Where do non-native invasive plant species occur within the wetland communities and what is their spatial extent? Those invasive species include but are not limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon*,

Objectives:

- **(1)** For sites being managed for desert pupfish assess the occurrence of pupfish along with invasive, non-native fish, amphibians, ants and snails annually.
- **(1, 2 & 3)** For sites being managed for desert pupfish, water depth, flow rate and salinity will be additional metrics measured. Collecting data for each of these metrics will occur at permanent plots located randomly within the community types, the number of plots will be based on within community heterogeneity as determined through preliminary sampling. These variables will initially be re-sampled on each of the plots every three years; the time between repeated surveys should be adjusted based on the rates of change measured (high rates of change would call for more frequent surveys). For

restoration and active management efforts, the same variables should be measured, but repeated annually until the perennial plant cover and composition within the restoration sites are within the range of values measured within intact portions of that community.

- **(1)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include crayfish, *Procambarus clarkii*, bullfrogs *Rana catesbeiana*, leopard frogs, *R. berlandieri*, exotic snails, *Melanoides* spp. and various exotic fish species. Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping).
- **(2&3)** Groundwater levels and salinity are likely to change within the plan area due to many stressors, ranging from groundwater over drafting, tectonic activity, eliminating leakage along the Coachella canal, changing irrigation practices due to reduced water availability and higher costs, climate change, fire, and the effect of invasive species such as salt cedar (Fig 2). Even though the effects may be similar, the management response, if any, will differ based on the source stressor. Within each community, on randomly located plots, or centrally located within a cluster of permanent plots, depth to groundwater, groundwater salinity, and soil salinity and water stable isotope signatures will be quantified.
- **(2, 3&4)** On permanent, randomly located plots located in each of the wetland communities, woody-perennial plant species richness and cover will be quantified every five years. For restoration/management plots, surveys will occur annually until species richness and cover values are within the variances measured on the undisturbed communities.
- For pupfish refugia populations, periodic translocations (approx. every 5-10 yrs) will be conducted to ensure genetic heterogeneity and reproductive fitness.

Soil/Water Salinity - Water Chemistry - Groundwater Depth

Using a hand-held Hanna Instruments Soil/Liquid Conductivity meters (or similar device) determine salinity levels in both open water and in soils. For determining sources/ages of ground water: stable isotope analysis. Install piezometers on permanent plots or within clusters of permanent plots within a community polygon.

Pertinent research/monitoring questions and objectives (numbers correspond to Figure 2):

Questions:

- **(2&3)** Salinity and availability of water determine which of the desert wetland communities occur at a given location and thus what species will be able to find suitable habitat there (Figure 1). What is the spatial extent of each of the desert wetland communities? What is the trajectory of those communities?
- **(2&3)** What is the range of salinity and groundwater depths characterizing each community?
- **(2&3)** What are the thresholds or tipping points of salinity and groundwater depth when communities begin to shift in character from one wetland community to another?
- **(2&3)** What is the source of change in salinity or groundwater that could bring a community to the tipping point of shifting from on community to another? To what extent does the lining of the Coachella canal, changing agricultural practices, tectonic shifts in fault zones, salt cedar densities, and/or climate change (precipitation inputs) impact salinity and groundwater levels?
- **(2&3)** How does salinity and groundwater depth impact the success of restoration efforts of native plant community composition? – Do they affect patterns of native vegetation recruitment?
- **(2, 3&4)** How does salinity and groundwater depth impact invasibility?
- **(2, 3&4)** Do invasive plant species impact salinity and groundwater depths?

Objectives:

- **(2&3)** Groundwater levels and salinity are likely to change within the plan area due to many stressors, ranging from groundwater over drafting, tectonic activity, eliminating leakage along the Coachella canal, changing irrigation practices due to reduced water availability and higher costs, climate change, fire, and the effect of invasive species such as salt cedar (Fig 2). Even though the effects may be similar, the management response, if any, will differ based on the source stressor. Within each community, on randomly located plots, or centrally located within a cluster of permanent plots, depth to groundwater, groundwater salinity, and soil salinity and water stable isotope signatures will be quantified.

Perennial-Woody Plants

Permanent, randomly located plots will be 10m x 20m rectangles, following plot size and shape used by Stromberg et al. (2007). Plot centers will be random with respect to the community polygon, or in the case of restoration/management activities, random within the bounds of those activities. Where streams or moving water is present, the long axis of the plot will be parallel to that stream; otherwise the long axis will be oriented north-south. Plot corners will be marked with stakes to facilitate relocation in subsequent years. Plot centers will serve as the center for circular plot bird, arroyo toad and southern yellow bat surveys. Using a line intercept down middle of the long length of a permanent plot (see Figure 3), quantify the percentage cover of live woody vegetation, by species. Where vegetation structure data are desired stratify line intercept levels at 0-1 m, 1-2 m, 2-4 m, and > 4 m.

Pertinent research/monitoring questions and objectives (numbers correspond to Figure 2):

<u>Questions:</u>

- **(4)** Where do non-native invasive plant species occur within the wetland communities and what is their spatial extent? Those invasive species include but are not limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,*
- **(4)** What are the trajectories in the occurrence and abundance of invasive species in each of the wetland communities?
- **(4)** To what extent do invasive plant species impact the occurrence of species within the wetland communities?
- **(4)** How does disturbance frequency and intensity (flooding, fires, ORV trespass) impact the ability of invasive plant species to become established in wetland communities?
- **(4&5)** To what extent do invasive species impact the occurrence of fire in these wetland communities and how does fire impact the invasibility of those exotics?
- **(5)** What is the recolonization rate by native species into wetland communities after fire?

<u>Objectives:</u>

- **(2&3)** Create a baseline map of the current condition and extent of the wetland communities. This can be accomplished using current high resolution satellite imagery coupled with ground-truthing. Accurate polygons depicting the location and extent of each of the communities will be defined as GIS layers. This shall be repeated with new/current satellite imagery initially every five years; the time between repeated
- **(2, 3&4)** On permanent, randomly located plots located in each of the wetland communities, woody-perennial plant species richness and cover will be quantified every five years. For restoration/management plots, surveys will occur annually until species richness and cover values are within the variances measured on the undisturbed communities.
- **(4)** Create a baseline GIS map of the current extent of exotic, invasive animal species within the MSHCP/NCCP conserved areas. Those invasive species include but are not

limited to, salt cedar, *Tamarisk ramossisima*, giant reed, *Arundo donax*, fountain grass, *Pennisetum setaceum*, Bermuda grass, *Cynodon dactylon,* Surveys to create this map shall be repeated initially every three years; the time between repeated mapping should be adjusted based on the rates of change measured (high rates of change would call for more frequent mapping). These data will also feed into the objectives of the low desert weed management area (NRCS).

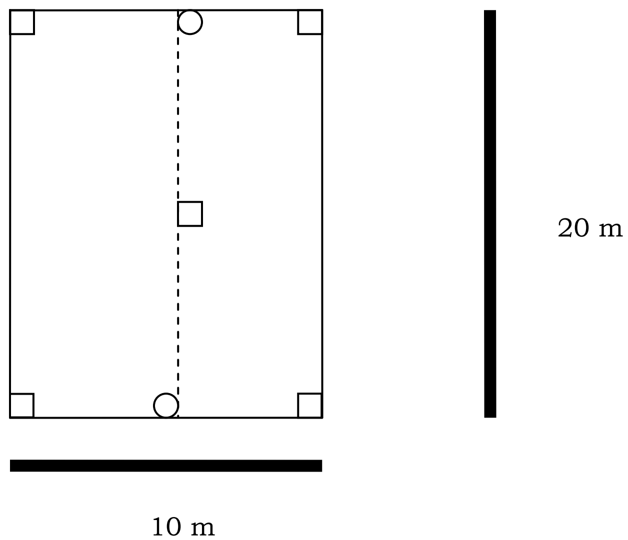


Figure 3. Permanent plot schematic. Small squares represent stakes marking the plot location; circles indicate recommended arthropod pitfall locations; dotted line shows the location a line-intercept vegetation transect.

Arthropods

Arthropods can be sampled with dry, un-baited pitfall traps. Previous sampling has shown April to be a peak activity period for the harvester ants, arthropod abundance and species richness, thus pitfall surveys will be confined to this month alone. The pitfall traps measure 11 cm wide at the mouth, 14 cm deep, 1.0 L in volume (Fabri-Kal Corp., model no. PK32T 21), and include a tight fitting funnel that inhibited the ability of the ants to escape once they had fallen into the trap. A board measuring 20 cm x 20 cm x 0.5 cm is placed over the pitfall trap and elevated 1-2 cm with three wooden blocks, providing shade and cover for the arthropods captured by the trap. Place two pitfall traps within each plot, one at each end and the third at the plot middle. Collect the contents within 24 hrs of opening the traps. Arthropod data are summarized as the mean number counted per species per pitfall per plot. All arthropods will be identified to the species level whenever possible, and voucher collections will be made for each species.

Pertinent research/monitoring objectives (numbers correspond to Figure 2):

- **(7)** What effect do exotic ants have on the occupancy and reproductive success of nesting riparian birds or arroyo toads? If there is an effect, is it through the depletion of native arthropod prey, or through ant predation on nestlings?
- **(1&6)** For sites being managed for desert wetland community birds, conduct surveys of arthropod community composition. For sites where exotic species control (including cowbirds) is undertaken, surveys should be annual and an assessment of reproductive success should occur. After three years, if there is small between-year variance, then surveys could be conducted every three years.

DATA ANALYSES

The survey protocols are structured so that all data fit into a landscape-ecosystem processes-community-population-stressors context. The data are thus able to be analyzed within this multi-scale context so that relationships can be identified that promote population sustainability, or alternatively spatial-temporal conditions that lead to downward spirals.

Unlike the aeolian sand communities where data have been collected for multiple years, for the most part there are not existing data sets to assess the accuracy of proposed methodologies, how landscape heterogeneity effects occupancy levels, or how species are distributed across these landscapes. The initial 2-5 years of surveys within the desert wetland communities will need to assess these questions so that the distribution and number of survey plots needed to model variables that correlate with population dynamics can be developed.

There is no *a priori* ability to know what scale is best to detect sensitivity to change, at a plot, a conservation unit (a reserve), a natural community, or across the entire landscape. A finer scale approach may aide in the early detection of negative impacts of environmental change; once such effects are apparent at a larger, community or landscape scale, management options to control those effects will likely be more difficult and costly. A monitoring framework should provide flexibility to analyze data at all of these scales.

Detecting change requires a time series analysis; using permanent plots to detect temporal change can make larger scale analyses susceptible to spatial autocorrelation where statistically significant levels of change may be confounded by plot-specific idiosyncrasies. Population levels within plots could be unrelated to the variables analyzed within the plot but be related to resources beyond the plot boundary. This issue can be addressed in several ways. First, test whether spatial autocorrelation is an issue by including spatial coordinates as covariates in any model. As an example, by using a logistic regression and including the permanent plot locations as a class variable you can determine if the plot locations explain a significant amount of the variance in the data; if so then spatial autocorrelation may be a problem. If a spatial autocorrelation problem is detected, then by accepting a greater chance of committing a Type II error, for instance by using a threshold of $p \leq 0.001$ (rather than the more traditional $p \leq 0.05$), potential problems associated with spatial autocorrelation can be avoided (Andrea Atkinson, pers. comm.).

Analysis tools can vary with the research questions being addressed and the background of the person conducting the analysis. We argue that basic question is not a relatively simplistic $N_{t^1} \neq N_{t^2}$ versus $N_{t^1} = N_{t^2}$ when determining whether there has been a change over time of a population, but rather what variable or variable set explains the variance observed in N over time and space. Populations change; the critical questions are what variables explain that change and especially in the case of a negative population shift, is there a negative trajectory that could lead to extinction. The question could be expressed as a linear regression $Y = \alpha + \beta_1 * X_1 + \beta_2 * X_2 + \beta_3 * X_3 \ldots$ where Y is the dependent variable (such as the variance in population size), α is the constant and β_i and X_i are the coefficient and independent, explanatory variables.

The use of continuous variables in a model often allows for greater levels of discrimination between a hypothesis and null hypothesis. With continuous data hypotheses can evaluated with parametric tests as long as all variables meet the assumption of homogeneity of variances. Environmental data are notoriously asymmetric in their distributions but can often be adjusted to meet this assumption by using a square root (x+1) transformation. When dependent data are categorical (i.e. presence or absence) and/or when the assumptions inherent in parametric tests cannot be met, then there are non-parametric test options. A logistic regression is such a non-parametric approach. Categorical dependent variables can be presence or absence, or can include subjective divisions of abundance (absent – low – medium – high). While the results lack the same power of hypothesis discrimination associated with continuous data/parametric tests, they still can provide valuable insights as to the independent variables' ability to explain the variance in the occurrence of the species being analyzed.

Regardless of the modeling tools being used to identify what variables explain the variance in the dependent variables, (linear regression, discriminant analysis, logistic regression, program MARK, niche modeling, etc), it is important to keep the number of independent variables in the model at or less than a 1-10 ratio with the total number of observations. Here observations = separate plots where data were collected, and so for every 10 plots just one independent variable should be added to the model. Violating this axiom, creating models where the number of independent variables exceeds this 1-10 ratio, runs the risk of over-fitting the model, in other words creating a model that explains only the patterns of abundance measured on the plots but with little ability to extrapolate to the regions outside of the plot boundaries.

The analysis objectives should be to 1) identify whether the populations of protected species are on a trajectory that could lead to extinction, and 2) what factors (independent variables) are driving that population change. Rather than a two-step process we argue that this should be accomplished with a single modeling approach, where the model identifies which independent variables explain the variance in the population of a target species. The relative importance of each independent variable included in the model should be partitioned so its relative importance can be determined. This approach provides a rich learning framework, providing biologists and managers with objective insights as to resource requirements and stressors for the species under their stewardship. With the stratified sampling approach, along with plots set along the temperature and precipitation gradients of the Coachella Valley, we can measure how species' requirements and stressors change by community and by their position along those gradients. The fine scale nature of surveying permanent plots allows us to identify the early onset of the effect of stressors and where appropriate have managers address those impacts.

LITERATURE CITED

Coachella Valley Mountains Conservancy 2000. Administrative review draft Coachella Valley multiple species conservation plan/natural communities conservation plan. Coachella Valley Association of Governments, Palm Desert, California

DeSante, D. F. 1981. A field test of the variable circular-plot censusing technique in a California coastal scrub breeding bird community. In, C.J. Ralph and M. Scott eds., Estimating numbers of terrestrial birds. Studies in Avian Biology No. 6, Cooper Ornithological Society.

Holland, R. F. 1986. Preliminary descriptions of the natural communities of California. State of California, the resources Agency, Department of Fish and Game, Natural Heritage Division, Sacramento, California.

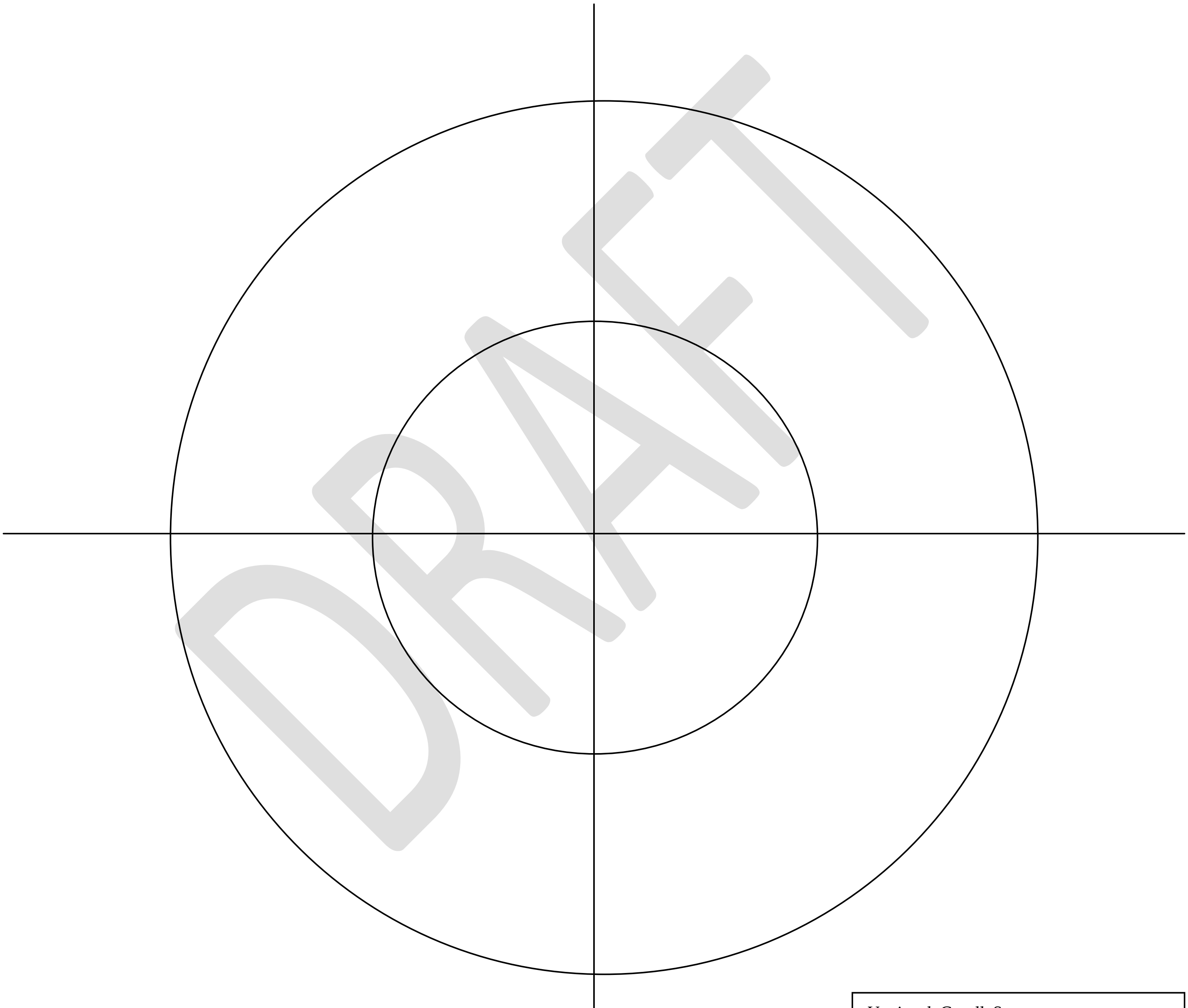
Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82:309-313.

Stromberg, J. C., T. J. Rychener, and M. D. Dixon. 2007. Return of fire to a free-flowing desert river: effects on vegetation. Restoration Ecology 15:1-12.

Weller, T. J. 2008. Using occupancy estimation to assess the effectiveness of a regional multiple-species conservation plan: bats in the Pacific Northwest. Biological Conservation 141:2279-2289.

APPENDIX 1- POINT COUNT DATA FORM: RIPARIAN BIRDS

Location ________________________ Date _____________Observer ______________________
Time Start_________Time End________ Point ____ of ______ Visit # ________
Temp (C) _______Wind _________________ Sky________________________
UTM (easting, northing)____



Fly-overs: ____
____

V=visual, C=call, S=song
Count for 15 min.
1=obs'd in 0-3 minute count period
2="" 3-5 min.
3="" 5-10 min.
4=""10-15 min.
Ring 1=25m, Ring 2=50m,
Outside Ring 2 is any detection >50m

RIPARIAN HABITAT ASSESSMENT FORM

Point location:___________________________ Date:___________ Observer: __________

	grade (0-3)	Description (distance from point; amount; quality)		
SURFACE WATER				

	Apx. total width	Apx. total length	% of 50m circle	% cov by veg
RIPARIAN HABITAT				
Description of riparian habitat (community type; quality)				

DOMINANT VEG SPECIES	% rel cov	Avg. height	Notes/other species:
1)			
2)			
3)			
4)			

	N	S	E	W
DENSIOMETER/PHOTOS				

HUMAN ACTIVITY	grade (0-3)	Description (recent/old activity; extent; in/near habitat)
trash/litter		
damaged/removed vegetation		
vehicle tracks/presence		
paved roads/structures		
human footprints/presence		
other (describe)		

OTHER DISTURBANCES	grade (0-3)	Description (recent/old damage; extent; in/near habitat)
cattle tracks/presence		
flood damage		
fire damage		
other (describe)		

INVASIVE NON-NATIVES	grade (0-3)	Description (species; extent; in/near habitat)
tamarisk		
arundo		
fountain grass		
other shrubs and trees		
other grasses and herbs		

LANDSCAPE (other habitat types <50m; known habitat types and disturbances 50m-1km; description):

OTHER NOTES:

(grades: 0=absent, 1=small amount, 2=moderate amount, 3=large amount or substantial)