MEASURING CONSERVATION DELIVERY EFFECTIVENESS IN AN EVOLVING LANDSCAPE

Phase I - Section VI: Special Status Species

Developed by the San Francisco Bay Joint Venture Science Subcommittee

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The SFBJV Science Coordinator designed and compiled the information presented in this document section. She accepts the responsibility of accurately reflecting the information provided by all participants.

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VI. Status & Trends - Special Status Species

The San Francisco Bay Joint Venture (SFBJV) region wetland and shoreline habitats are critical for many resident and migratory species, including a growing number of threatened or endangered species. The SFBJV conservation delivery actions aimed at expanding available wetland habitats directly align with many special status species[1] recovery goals, and will provide benefit to these imperiled species. Special status species found within the habitat types outlined in the SFBJV Implementation Plan (2001) are the focus of this section of the SFBJV Monitoring & Evaluation (M&E) Plan (see partial species list in *Appendix 1*).

The special status species section is to determine an overall framework for the assessment of 1) the status and trends of imperiled species in the context of how SFBJV conservation, enhancement, or restoration implementation actions affect them at the project and at the regional scales, and 2) the effective and efficient appraisal of the impacts of projected environmental changes to inform future management actions and conservation planning priorities.

At this time, this Plan section is not designed to present a detailed monitoring program with schedules and protocols, data management specifics, and other concrete details. Instead it is to establish an initial framework that will provide priority actions and general guidance to SFBJV partners in the assessment of habitat extent, and the status and trends of special status species as sensitive indicators of habitat condition, and the effects of SFBJV conservation, enhancement, or restoration implementation actions at the project, regional and Flyway scales. More detailed needs and actions will be developed throughout Phase II of the M&E planning process (see *Next Steps* section below).

This Special Status Species Section Currently Provides:

- A set of prioritized monitoring and evaluation objectives addressing general questions of habitat quantity, SFBJV contribution, population abundance and species richness trends of special status species at the project and regional scales within the SFBJV region;
- A suite of prioritized and general recommendations for further research needs, monitoring and evaluation metrics, protocols, and data repositories for integration with existing monitoring and evaluation programs, as relevant to various target special status species;
- Information on key partners and existing monitoring programs to integrate with or compare to.

[1] Special status species area defined as species that have been listed as endangered or threatened under the ESA or CESA, or deemed of special concern by other entities, such as the California Department of Fish & Game or the California Native Plant Society.

Focus Team Process & Participants

In a series of in-person meetings and phone conferences, the special status species focus team established focus-specific M&E and research objectives, relevant metrics, protocols, and data repositories, key partners, and existing programs for potential integration. All M&E Plan focus teams convened on May 26, 2011 for a daylong professionally facilitated workshop to vet and identify the top priorities of the identified monitoring, evaluation and research objectives. Focus team participants included:

Name	Affiliation
Albertson, Joy	US Fish & Wildlife Service - San Francisco Bay NWR Complex
Gluesenkamp, Daniel*	Calflora and BAEDN
Liu, Leonard*	PRBO Conservation Science
Nur, Nadav	PRBO Conservation Science
Robinson-Nilsen, Caitlin	San Francisco Bay Bird Observatory
Salzman, Barbara*	Marin Audubon Society
Sloop, Christina	*Team Coordinator*, San Francisco Bay Joint Venture
Steers, Robert*	National Park Service
Strong, Cheryl *	US Fish & Wildlife Service - San Francisco Bay NWR Complex
Taylor, Karen	California Department of Fish & Game
Williams, Andrea*	Marin Municipal Water District and BAEDN
Woo, Isa	US Geological Survey
Wood, Julian	PRBO Conservation Science

*Participated in prioritization of objectives at May 2011 workshop.

Focal Habitats and Species

The wetland habitats for the suite of considered focal special status taxa in the SFBJV region include:

SF Bay and Coastal Estuaries & Dunes: Diving ducks: Surf Scoter (*Melanitta perspicillata*), Greater Scaup (*Aythya marila*), and Lesser Scaup (*Aythya affinis*), Canvasback (*Aythya valisineria*); Water birds: Double-crested Cormorant (*Phalacrocorax auritus*), Salmonid species: Steelhead (*Oncorhynchus mykiss;* Central CA Coast & Central Valley population segments), Coho (*Oncorhynchus kisutch;* Central CA Coast ESU), Chinook (*Oncorhynchus tshawytscha;* Sacramento winter & spring run ESUs); Other Fish: Green sturgeon (*Acipenser medirostris*), Longfin Smelt (*Spirinchus thaleichthys*), Delta Smelt (*Hypomesus transpacificus),* Beach Layia (*Layia carnosa*), Pink sand verbena (*Abronia umbellata* ssp. *breviflora*) Tidestrom's lupine *(Lupinus tidestromii),* Monterey spineflower (*Chorizanthe pungens* var *pungens*), Robust spineflower *(Chorizanthe robusta* var *robusta*), Marin bent grass *(Agrostis blasdalei* var *marinensis (=A. blasdalei)).*

Creeks, Streams, Ponds and Riparian Ecosystems (coastal and Bay watersheds): Salmonid species (Steelhead, Coho, Chinook), Red-legged frog (*Rana aurora draytonii*), Foothill Yellow-legged frog (*Rana boylii*), Freshwater shrimp (*Syncaris pacifica*), Western Pond Turtle (*Emys marmorata*).

Tidal Marshes & Associated Upland Ecotones: Salt marsh harvest mouse (*Reithrodontomys raviventris)*, California Clapper Rail (*Rallus longirostris obsoletus*), Black Rail (*Laterallus jamaicencis coturniculus*), Song Sparrow subspecies (*Melospiza melodia* ssp. *samuelis* (San Pablo Bay); ssp. *pusillula* (Alameda); ssp. *maxillaris* (Suisun Bay)), San Francisco Common Yellowthroat (*Geothlypis trichas sinuosa*), Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum)*, Soft bird's-beak *(Cordylanthus mollis ssp. mollis),* California sea-blite *(Suaeda californica),* Lyngbye's sedge *(Carex lyngbyei),* Burrowing Owl (*Athene cunicularia*); San Joaquin dune beetle (*Coelus gracilis*).

Salt Ponds & Islands/levees: Western Snowy Plover (*Charadrius alexandrinus nivosus*), California Least Tern (*Sterna antillarum browni*).

Seasonal Wetlands (moist grasslands, diked wetlands & vernal pools): California tiger salamander (*Ambystoma californiense*), Red-legged frog (*Rana aurora draytonii*), Vernal Pool tadpole shrimp (*Lepidurus packardi*) Vernal pool fairy shrimp (*Brachinecta lynchi*); Endangered vernal pool plants: Sonoma sunshine (*Blennosperma bakeri*), Sebastopol meadowfoam (*Limnanthes vinculans*), Burke's goldfields (*Lasthenia burkei*), Contra Costa goldfields (*Lasthenia conjugens*), Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha)*; Mt. Tam Thistle (*Cirsium hydrophilum* var. *vaseyi*) and Harlequin lotus (*Lotus formosissimus*).

Performance Targets

The SFBJV Implementation plan (2001) does not include specified performance targets for special status species, except for diving duck species (see Waterfowl section for more details). Special status species are addressed through recovery plans or by other particular targets. Some of the documents listing existent recovery targets for the SFBJV region by special status species are shown in Appendix 1.

Monitoring and Evaluation Objectives

Priority M&E Objectives and Associated Metrics & Protocols

Summarized below are the highest priority M&E objectives the special status species focus group identified based on several criteria:

1) Ease of implementation;
2) Long-term importance;
3) A natural "early" step;
4) Usefulness for managing or modeling;
5) Ability to help manage JV "effectiveness"; and
6) Cost-effectiveness.

These criteria were assigned scores from 1-5 (lowest to highest value) by each participant. Final scores were averaged across participants and the top three priority objectives are listed here:

Priority M&E Objective 1: *Regional Status Database with Report Template & Decision Support Capability.* Over the next 5-10 years, develop and maintain a regional open access focal special status species monitoring data repository with online reporting templates for easy use as regional decision support tools. To be utilized by existing special status species status monitoring programs.

- *Example Databases to integrate with:* Calflora[2], CADC[3], CNDDB/BIOS[4], SFBJV project database[5]
  - *Considerations:* Reduce precision of sensitive species location; Support local California Native Plant Society chapters in developing "locally rare" plant lists.[6]

Priority M&E Objective 2[7]: *Habitat Quantity and SFBJV Contribution.* Every five years, determine how much focal special status species habitat is available by evaluating the net change in area of species-specific habitat types throughout SFBJV region, and determine the relative contribution of SFBJV activities.

- *Metric:* Change in area of special status species-specific habitat types
- *Protocol:* Net Landscape Change analysis (GIS, bathymetry, BAARI, JV project database)
  - *Considerations:* GIS needs to be tied to habitat quality (need index), and population density

Priority M&E Objective 3a: *Presence/Absence/Distribution Inventory.* Annually (or as appropriate) over the next 10 years, assess project-specific and regional special focal status species population size, presence/absence and distribution trends. Utilize open access database (above) for data repository, analysis, and decision support.

- *Metrics:* Abundance/density, Presence/Absence, Distribution, Density, Cover, Biomass, Location, Identification, Survival, Reproduction
- *Protocol:* Too many to list here (e.g., point counts, call counts, area searches, etc.).
  - *Considerations:* Integration of compliance-based presence/absence data needed.

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[2] Calflora: http://www.calflora.org/
[3] CADC: California Avian Data Center http://www.prbo.org/**cadc/**
[4] CNDDB: California Natural Diversity Database http://www.dfg.ca.gov/biogeodata/cnddb/; BIOS: Biological Information & Observation System: http://bios.dfg.ca.gov/
[5] SFBJV project database: http://cjvp.ducks.org/cajv/cajvlogin.cfm
[6] Once developed, those species listed as "locally rare" are by law included in the CEQA process.
[7] This objective links directly with prioritized objectives in the net landscape change section module.

Additional M&E Objectives

Here is a non-ranked listing of additional objectives for monitoring and evaluation of SFBJV program effectiveness, addressing remaining key questions for special status species status and habitat management at the project and regional scales within the SFBJV region.

SPECIES STATUS AND TRENDS

- Clapper Rail Population Trends, Project & Regional Scale - Assess the impact of *Spartina* invasive hybrid eradication and native *Spartina foliosa* re-vegetation activities[8] on California Clapper Rail abundance and demography [vital rates], if possible, at a regional (Bay-wide) scale[9].
- Population Trend Estimates; Project & Regional Scale – Every five years, assess special status species population size trends, or at minimum continued presence, from regionally available monitoring data.
- Breeding Population Estimates; Project & Regional Scale - Annually, monitor populations to determine status and distribution during breeding season.
- Breeding success Estimates; Project & Regional Scale – Annually, monitor special status species breeding success if breeding in the JV regions. [*Consideration: Cost, permits, and level of difficulty to get near targets may make this hard to implement*]

HABITAT FUNCTION

- Functional Habitat Attributes; Project & Regional Scale – Every 3-5 years, measure the availability and condition of habitat attributes (i.e. in the context of habitat evolution) necessary for species-specific survival and reproduction - nutrients, food/prey resources, mates or pollinators in time and space. Assess the availability and quality of refugia, shelter, roosting, and nesting sites in time and space.
- Habitat use Patterns; Project & Regional Scale – Annually, for a minimum of five years, assess spatial and temporal patterns of habitat use for target special status species.

ENVIRONMENTAL CHALLENGES

- Disturbance and Predation Levels; Project Scale - Monitor the levels of anthropogenic disturbance and nuisance predators[10] and measure related impacts on special status species populations.
- Contaminant Bio-Availability; Project Scale - Determine and regularly monitor functional threshold levels of known bio-available contaminants in time and space (i.e. Least Terns)

[8] To be implemented according to the existing Bay-wide *Spartina* revegetation plan (Invasive *Spartina* project).
[9] This objective links directly with prioritized M&E and general research objectives in the invasive species section module.
[10] This objective links directly with research objectives outlined in the invasive species section module.

Recommended Metrics

Here we provide recommendations for relevant monitoring metrics to be used in the various special status species assessment contexts:

Vertebrates: Abundance or density, presence/absence, frequency, distribution, survival, reproduction, movement (i.e. using telemetry), body condition, survivorship into different age/stage classes, response to threats.

Plants: Abundance, cover, density, distribution, flower production/seed set, rate of spread.

Habitat: habitat size, structure, connectivity, nest site availability (particularly in context of rising sea levels), shelter, food abundance, contaminant load, disturbance frequency, exotic or nuisance competitors, vegetation processes such as colonization, establishment, spread to integrate physical processes with plant responses.

Threats:

- Invasive species: Abundance or density, distribution (see also Invasive species section); Contaminants: biomarkers of exposure and effect, survival, reproductive success,
- Climate Change: sea level rise response, phenology change, distribution change,
- Habitat loss: reduction in habitats due to development and habitat conversions.

Description of some of the above metrics:

- Population abundance (per unit area) or density – Need long-term comprehensive surveys of special status species and invasive species threats to assess trends.
- Local and regional distribution – Assess via banding and radio-marking studies.
- Survival – A long-term (winter and annual) monitoring program can also help evaluate effects of contaminants, prey availability on survival.
- Nest success – Determination of numbers of nests hatched and chicks fledged.
- Age/Stage – Assessment of changes in age/stage ratios to determine the ratio of juveniles to adults over time and space.
- Body condition (morphometrics, mass, fat content, etc.) - A long-term monitoring program can help evaluate vertebrate condition in the context of changing habitats and prey availability/quality and also may have applicability to contaminant effects.
- Foraging behavior - This would be relatively inexpensive to implement as a long- term program and can help determine habitat quality for special status species by comparing for example, how many hours a day individuals are foraging and foraging intensity (e.g. dive to pause ratios for diving birds) among different regions.
- Stable isotope analyses – These can help determine source of diet and changes over time
- Biomarkers of exposure and effect – Use of CYP1A or gene expression measurement in blood to measure contaminant levels of mercury, selenium, cadmium, and other organic and emerging contaminants (especially in species that feed on fish) in waterfowl and relevant food sources to compare to threshold levels to be established.
- Phenology – This is a way to uncover potential climatic and cross-seasonal effects if 'before' baseline data are available.

Recommended Protocols

Below is a listing of some of the existing protocols for SFBJV target species population status assessment. This list should be expanded in future planning phases.

- Black Rail
- California Clapper Rail[11]
- Wetland birds
- California red legged frog
- Salt Marsh Harvest Mouse
- Salmonids
- California tiger salamander
- Endangered vernal pool plants

Research & Information Needs

Priority Research & Information Needs

The entire Special Status Species team did not complete their conversation about ranking research priorities. However, the prioritizations here reflect the rankings of three team members who submitted their top three choices at the May 16, 2011 workshop. The objectives they selected are below; the first two received 2 votes, while the rest only received 1 vote each. The focus team will continue to work on prioritizing and implementing high priority research and information needs for special status species in planning phase II.

Priority Research Need 1: *Projected Habitat Loss and Conversion Trends; Regional Scale.* Evaluate special status species-specific scenarios of expected future suitable wetland-type loss or conversion due to sea level rise, development, restoration and other likely land use changes.

- Model impacts of continued habitat loss and conversion on special status species;
- Model impacts of habitat conversions for specific benefit to special status species on other species.

Priority Research Need 2[12]: *Climate Change – Regional Impacts; Regional Scale.* Evaluate the projected impacts to special status species persistence from climate change. Assess and monitor effects of sea level rise & other projected impacts on relevant special status species (e.g., endangered tidal marsh species).

Priority Research Needs 3: *Invasive or Nuisance Species Impact[13]; Regional Scale.* Determine the effects of invasive or nuisance species (i.e. invasive *Spartina*, California Gull, red fox, raccoons, feral cats, etc.) on relevant special status species.

[11] Protocol is currently being updated for SFB area.
[12] This objective links directly with research objectives outlined in the invasive species section module.
[13] This objective links directly with research objectives outlined in the invasive species section module.

Additional Research & Information Needs

In the context of creating and maintaining suitable habitats for special status species, here is a list of additional unranked research and information needs by focal theme:

HABITAT QUANTITY

- Habitat Availability; Regional Scale. Determine amount of habitat necessary to maintain current population abundance levels and recovery objectives for target special status species.

POPULATION STATUS AND TRENDS[14]

- Species Population Dynamics, Life History & Movement; Regional Scale. Investigate population dynamics, life history, and movement of special status species by implementing or continuing banding and marking studies.
- Population Viability; Regional Scale. Conduct population viability analyses for metapopulations of relevant special status species in or near JV project sites.
- Conservation Strategy Efficacy; Regional Scale. Assess effectiveness of various conservation efforts for special status species in the JV region.
- Metapopulation Dynamics; Regional Scale. Research metapopulation dynamics of relevant special status species (i.e. red-legged frog, CA Tiger salamander).
- Population Trends – Salt Marsh Harvest Mouse; Regional Scale - Determine Salt marsh harvest mouse population estimates (beyond capture indices) for use in trend analysis.
- Vertebrate Ecology & Habitat Use; Regional Scale - Conduct research to better understand the ecology of relevant vertebrate special status species including use of uplands, dispersal habits, and overland movements.
- Diet and Energy Requirements, Regional Scale – Study the diet and energy requirements of special status species and evaluate the nutritional content of common prey species.
- Dispersal Capabilities; Regional Scale - Characterize dispersal capabilities of relevant special status species and the environmental and habitat characteristics necessary for movement.

HABITAT FUNCTION

- Habitat Monitoring Plans; Project & Regional Scale. Develop and implement a comprehensive habitat monitoring plan for each target special status species, including nesting islands to determine their effectiveness to support existing goals and adaptive management of target organisms.
- Habitat Use Patterns; Regional Scale. Determine factors affecting choice of locations for roosting, loafing, and feeding during breeding and post-breeding and winter migratory seasons for bird special status species.
- Testing Habitat Manipulations; Project Scale. Conduct experimental manipulations of habitat to determine requirements for creation and restoration of special status species habitat.

[14] All population status & trend analysis should be analyzed by and linked to habitat types.

REPRODUCTION

- Nest Site Availability; Regional Scale. Identify potentially suitable nesting sites for bird special status species and investigate special status bird species nest site requirements.
- Disturbance to Roosting & Breeding; Regional Scale. Identify factors causing special status bird species colony disruption and nest site abandonment.
- Enhanced Nest Sites; Regional Scale. Investigate methods to enhance special status bird species nest sites in potential breeding habitat.
- Testing Nest Site Construction; Project Scale. Investigate methods to construct adequate special status bird species nesting sites in potential breeding habitat.

ENVIRONMENTAL CHALLENGES

- Climate Change Impact; Regional Scale.[15] Determine how much special status-specific suitable habitat (by habitat type) will likely be available at 5, 10, 20, 50 years into the future considering various projected sea level rise, restoration implementation and development scenarios.
- Invasive Species Effects; Regional Scale.[16] Establish the site-specific threats posed to special status species from invasive species
- Water Quality Impacts on Fish; Regional Scale - Determine the frequency and impacts of low dissolved oxygen in wetlands throughout the region on special status fish species.
- Contaminant Thresholds; Regional Scale. Determine effects of and develop specific thresholds for environmental pollutants found at JV project sites on special status species' survival and reproductive success. Include emerging contaminants.
- Mosquito Fish Impacts; Regional Scale. Conduct research on the effects of mosquito fish (*Gambusia affinis*) on relevant freshwater special status species and determine alternatives to mosquito fish use.
- Nuisance Species Ecology; Regional Scale.[17] Conduct research on the ecology and distribution of exotic or nuisance species directly threatening special status species
- Grazing Management Impacts; Regional Scale - Determine the effects of livestock waste on special status species in wet meadow grasslands, diked wetlands or vernal pools
- Grazing Management Thresholds; Regional Scale - Determine grazing thresholds that ensure optimum habitat suitability for special status species found in wet meadow grasslands, diked wetlands or vernal pools

[15] This objective links directly with research objectives outlined in the climate change section module.
[16] This objective links directly with research objectives outlined in the invasive species section module.
[17] This objective links directly with research objectives outlined in the invasive species section module.

Data Management

A regional open access focal special status species monitoring data repository with online reporting templates for easy use as regional decision support tools should be developed, and utilized by existing special status species status monitoring programs. Collective standardized data sharing protocols should be developed for the SFBJV region and linked to this new regional database and relevant existing national databases. A useful way of storing collective data is to create a common metadata website that provides relevant information on the data, shows the spatial extent of the data on a map, data format and ease of transfer, and includes disclaimers about data availability and allowed uses. This approach lets data owners decide whether to post entire datasets, or to just provide their metadata information and allow others to request a full dataset directly from the source, specifying intended use.

An existing portal for this proposed online forum is in development via the San Francisco Bay Conservation Commons. This metadata approach still allows datasets to reside in different and secure databases, and after standard data conventions are developed and followed, will enable easy transfer. Development of clear protocols on the rights and responsibilities of data sharing will only help this process of collaboration.

Special status species population and habitat status monitoring data should be contributed directly, or be linked via metadata portals to online repositories, such as:

Migratory Bird Data Center, California Avian Data Center and Avian Knowledge Network, Integrated South Bay Avian Database, California Department of Fish and Game BIOS and California Natural Diversity Databases, Calflora database, and Inventory & Management program databases of the Fish & Wildlife Service-NWR and National Park Service.

These may be further linked with other programs to enable larger-scale assessment of local changes across a broader climatic gradient.

Existing Programs and Tools

- *Diving Ducks (Surf Scoter, Lesser and Greater Scaup, Canvasback)* – USGS (Vallejo) researchers are examining population status, and are conducting carrying capacity and energetics modeling of diving duck species in SF Bay and beyond.
- *California Clapper Rail* - A Bay-wide monitoring collaborative is in existence (PRBO, NWR, EBRPD, DFG, ISP; Liu & Wood 2011). The SFB California Clapper Rail sampling protocol is currently being revised so it is compatible with the North American Marsh Bird Monitoring Protocol (Conway 2009). Other rail species are included in the survey protocol (i.e., California Black Rail [*Laterallus jamaicencis coturniculus*], Virginia Rail [*Rallus limicola*], and Sora [*Porzana carolina*]).
- *California Black Rail* - USGS has conducted Black Rail mercury research and telemetry. UC Berkeley is conducting genetics research in partnership with USGS. Ongoing Black Rail work continues with existing datasets for climate change modeling and food web assessments.

- *Salt marsh harvest mouse* – Site-specific surveys exist to help evaluate restoration success but current surveys are not yet coordinated Bay-wide. Current protocols are based on a capture index, not population, yet population estimates would be more rigorous.
- *Western Snowy Plover* – SFBBO and the National Wildlife Refuge & DFG monitor all the nesting Western Snowy Plovers within the interior of the Bay from March –Sept annually and conduct one winter survey in January. Western Snowy Plover are also monitored in coastal JV areas by NPS & PRBO and are coordinated by use of similar protocols. Annual meetings are held for information exchange for winter & breeding season counts, the only regional coordination. Nest monitoring, banding etc. are conducted by SFBBO and land managers. SFBBO and San Jose State University are investigating recreational disturbance to nesting Snowy Plovers.
- *California Least Tern* - USFWS monitors the Alameda California Least Tern colony according to an existing survey protocol. USFWS is assisted by PRBO, Golden Gate Audubon Society, and Friends of San Pablo Bay NWR.
- *Tidal Marsh Sparrows - Melospiza melodia* ssp. *samuelis* (San Pablo Bay); ssp. *pusillula* (Alameda); ssp. *maxillaris* (Suisun Bay)) – PRBO Conservation Science conducted a study that is the first to systematically examine the distribution and productivity of tidal marsh Song Sparrows and Common Yellowthroats on a long-term basis at a broad scale. http://www.prbo.org/cms/135 . Takekawa et al (2006) performed Population Viability Analyses on Song Sparrows.
- *San Francisco Common Yellowthroat* - This species is part of the PRBO Conservation Science study on SF Bay tidal marshes http://www.prbo.org/cms/135
- *Pacific red-legged frog* – This species is monitored on a project-specific basis, as permits require for either restoration or mitigation. National Park Service and EBRPD have done some monitoring on their lands.
- *California Tiger Salamander (CTS)* – Sonoma County Water Agency biologist David Cook annually monitors remnant populations of CTS throughout the Santa Rosa Plain in Sonoma County.
- *Salmonids (Steelhead, Chinook, Coho)* – DFG & NOAA NMFS programs –
- *Center for Ecosystem Management and Restoration* (CEMAR) has identified promising locations for steelhead restoration in tributaries of the San Francisco Estuary. CEMAR's steelhead restoration program is also addressing key problems limiting restoration.
- *Napa County Resource Conservation District* – Napa RCD conducts salmon spawner surveys (also called salmon carcass surveys) of the number of spawned salmon carcasses, redds, and live adults. This information is useful to determine which species are spawning in the watershed, and the relative abundance and distribution of carcasses, redds, live fish. Surveyors recover and record marked fish for mark studies, and collect tissue samples for genetic analysis. The Napa RCD has also operated a rotary screw trap annually since 2009 in the main stem Napa River to count and measure steelhead and salmon smolt production, and identifies preferred spawning habitat areas.
- *Salmon Protection and Watershed Network (SPAWN)* biologists and trained volunteers monitor coho populations within the Lagunitas watershed, water temperature and quality, and conduct riparian habitat restoration, silt reductions, and remove barriers to fish passage.

- *Sonoma County Water Agency* biologists monitor the effects that changes in river management related to the Russian River Biological Opinion have on salmon and steelhead populations over time by operating facilities designed to detect the movement of these fish out of tributaries and into the lower river. Follow-up efforts to capture fish that may reside for extended periods in the estuary will also provide information on growth.
- *Green Sturgeon* – Josh Isreal and Pete Klimely at University of California, Davis and others have conducted studies of green sturgeon in SF Bay. It is unclear if there is ongoing monitoring (see http://www.sfei.org/cb/greensturgeon/, also http://www.dfg.ca.gov/delta/projects.asp?ProjectID=STURGEON).
- *Long-fin smelt* – A number of investigators have conducted studies of long-fin smelt in SF Bay. It is unclear if there is ongoing monitoring (see http://www.sfei.org/cb/greensturgeon/, also http://www.dfg.ca.gov/delta/data/BayStudy/CPUE_map.asp?syear=2011&survery=1).
- *Delta smelt* – The Department of Fish & Game is conducting monitoring of Delta Smelt in the Delta and upper San Francisco Bay (SFB). Scientists at the Romberg Tiburon Center are conducting studies on the Influence of Prey Abundance and Composition on Spawning Migrations of Delta Smelt. DFG biologists are assessing feeding habits of adult Delta smelt in winter and spring.
- *Suisun Thistle* – Rush Ranch NERR conducts monitoring.
- *Vernal Pool Endangered Plants (Sonoma Sunshine, Burke's Goldfields, Sebastopol meadowfoam)* – Citizen-science annual population status monitoring program coordinated by the Laguna de Santa Rosa Foundation in partnership with the Milo Baker chapter of the California Native Plant Society.
- *Rare Plant Inventory online system* - Recently built by Calflora for the California Native Plant Society (CNPS), provides improved access to California Natural Diversity Database (CNDDB) and CNPS rare plant information. The updated website has advanced mapping tools and highlights the comprehensive information in the CNPS Rare Plant Inventory.

Key Partners

- Calflora – The Calflora database provides a user friendly interface for reporting or viewing occurrences of rare plants in the SFBJV area, including all plant occurrences in CNDDB, the CCH, and others reported by botanists and citizen scientists. Additional resources include a collection of site-specific checklists, a library of other life history and taxonomic information, and thousands of photos that are useful for identification, outreach, and training staff.
- Center for Ecosystem Management and Restoration (CEMAR) – CEMAR conducts a program on Salmonid restoration in the SF Bay region, and has applied for grant funding to implement a smolt trapping program in Bay tributaries. The initial watersheds would be Coyote Creek, Sonoma Creek, and the Napa River. If the program is funded, local partners with CEMAR will do the trapping and CEMAR will put data on the Web, as well as expand the program into more watersheds over the course of a couple of years.
- Department of Fish and Game (DFG) – DFG scientists are monitoring Western Snowy Plover, Salt marsh harvest mouse, and California Clapper Rail (CLRA) populations on their lands. DFG has done extensive Salt marsh harvest mouse surveys in Suisun.
- East Bay Regional Parks District (EBRPD) – EBRPD conducts marsh bird surveys along East and Central SFB, including CLRA.

- Invasive Spartina Project (ISP) – The Invasive *Spartina* Project manages annual monitoring of CLRA in collaboration with DFG, EBRPD, FWS-NWR, and PRBO to assess potential impacts of invasive *Spartina* removal in tidal marshes throughout SFB.
- Laguna de Santa Rosa Foundation (LF) – Annual citizen science monitoring program, managed by the LF, under way since 2007 to assess status of endangered vernal pools plants (Sonoma sunshine, Burke's goldfields, Sebastopol meadowfoam).
- Napa County Resource Conservation District – Napa RCD conducts salmon spawner surveys in Napa River, Napa Creek, Heath Canyon Creek, Redwood Creek, and other streams as funding permits. The Napa RCD has also operated a rotary screw trap annually since 2009 in the main stem Napa River to count and measure steelhead and salmon smolt production.
- National Estuarine Research Reserve (NERR) - SF Bay NERR scientists conduct Suisun Thistle monitoring at their Rush Ranch site.
- National Park Service (NPS) - NPS scientists are conducting year-round sampling at Point Reyes National Seashore (PORE) and Golden Gate National Recreation Area (GOGA) that provides abundance data on spawning Coho, number of juveniles produced in the stream, and number of smolt to estimate juvenile survival in park streams.
- NOAA - National Marine Fisheries Service (NMFS) - The NMFS is conducting periodic stream surveys throughout SF Bay area tributaries.
- PRBO Conservation Science – PRBO scientists are monitoring California Clapper Rails throughout SF Bay in collaboration with DFG, NWR, EBRPD (on their lands), and ISP.
- Salmon Protection and Watershed Network (SPAWN) - SPAWN biologists and trained volunteers monitor coho populations within the Lagunitas watershed, water temperature and quality, and conduct riparian habitat restoration, silt reductions, and remove barriers to fish passage.
- San Francisco Bay Bird Observatory (SFBBO) – SFBBO scientists are monitoring the SFB's Western Snowy Plovers.
- *Sonoma County Water Agency* – SCWA scientist David Cook is monitoring Sonoma County populations of the California Tiger Salamander in vernal pools that serve as breeding pools for this species. SCWA has also been active in Russian River stream surveys of salmonids http://www.scwa.ca.gov/fisheries/.
- US Fish & Wildlife Service -National Wildlife Refuge System (FWS-NWR*)* – NWR biologists are monitoring California Clapper Rails throughout SF Bay in collaboration with DFG, East Bay Regional Parks District, ISP, USGS, Save the Bay, and PRBO. FWS also surveys Least Terns in Alameda, and Salt marsh harvest mouse populations at San Pablo Bay NWR.
- US Geological Survey - Western Ecological Research Center (USGS-WERC) - USGS scientists are monitoring California Clapper Rail and Salt marsh harvest mouse populations in the North Bay

Next Steps - A Phased Approach

In this first planning phase, each M&E Plan focus section features priority objectives and references supporting information determined by the SFBJV science sub-committee. This information will be utilized in planning phase II to secure implementation funding for the outlined priority objectives, and as a basis for further Plan development to continue to refine and integrate the overall Plan objectives as our knowledgebase evolves. Phase III will evaluate and incorporate additional conservation goals and target performance objectives into an upcoming revision of the SFBJV Implementation Plan (originally released in 2001). We therefore consider the M&E Plan a "living document" that will change over time with continually refined and focused content. For more details on the planning phases, please refer to the Introduction & Overview section of this plan under *Planning Phases – A "Living Document."*

Future Challenges For Special Status Species Related Monitoring And Research Include:

- Linking effects of conservation delivery actions to special status species status.
- Determining appropriate management strategies and desired outcomes relevant to target habitats.
- Refining monitoring objectives with focus on measuring conservation or management action impact or progress against specified outcomes relevant to special status species recovery.
- Maximizing integration with other regional and national special status species conservation and recovery initiatives.

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Appendices

Appendix 6.1: Detailed information about performance targets and recovery planning information for some SFBJV region target special status species.

Birds	
California Clapper Rail (*Rallus longirostris obsoletus*) - ENDANGERED	*Draft Tidal Marsh Recovery Plan* http://www.fws.gov/sacramento/es/tidal_marsh_ecosystem_recovery.htm *Downlist Criteria:* Central/Southern SF Bay Recovery Unit: 1,185 birds; min 8,400 acres of tidal marsh habitat San Pablo Bay Recovery Unit: 936 birds; min 10,400 acres Suisun Bay Recovery Unit: 100 birds; min 5,000 acres
Black rail (*Laterallus jamaicencis coturniculus*) – STATE THREATENED	*No performance targets existent at this time*
California Least Tern (*Sterna antillarum browni*) - ENDANGERED	Revised California Least Tern Recovery Plan 1985 1985 *Recovery Criteria:* CA population level of 1,200; sufficient habitat to support at least 1 viable tern colony (defined as consisting of a minimum of 20 breeding pairs with a 5-year mean reproductive rate of at least 1.0 young fledged per year per breeding pair) at each of the 20 coastal management areas (including SF Bay – goal 3 colonies).
Western Snowy Plovers (*Charadrius alexandrinus nivosus*) - THREATENED	Western Snowy Plover Recovery Plan 2007 Population target: 500 individuals breeding within the SF Bay, and 500 breeding adults along coasts of Sonoma to Monterey Counties, California.
Song sparrow subspecies (*Melospiza melodia* ssp. *samuelis* (San Pablo Bay); ssp. *pusillula* (Richmond);	*No performance targets existent at this time*
San Francisco Common Yellowthroat (*Geothlypis trichas sinuosa*)	*No performance targets existent at this time*
Burrowing Owl (*Athene cunicularia*)	*No performance targets existent at this time*
Mammals	
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) ENDANGERED	Draft Tidal Marsh Recovery Plan Downlist Criteria: Downlist Criteria: Central/Southern SF Bay Recovery Unit: min 6,400 acres of tidal marsh habitat with 14 viable habitat areas (VHA), with outlined capture efficiencies (CE) of: 40% of VHAs with CE of 5.0 or greater = **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts San Pablo Bay Recovery Unit: min 4,400 acres of tidal marsh habitat with 19 viable habitat areas, with capture

	efficiencies as outlined above (underlined) Suisun Bay Recovery Unit: min 5,000 acres of tidal marsh habitat with 21 viable habitat areas, with capture efficiencies as outlined above (underlined)
Fish	
Steelhead *(Oncorhynchus mykiss) SPECIES OF CONCERN*	Performance targets or recovery plan not existent for Central CA Coast population segment. - Prioritized management tasks have been outlined by watershed.
Coho *(Oncorhynchus kisutch)* - ENDANGERED	Draft Recovery Plan for Central California Coho to be finalized *Recovery aim:* Return Coho salmon to a level of sustained viability, while protecting the genetic integrity of both the Southern Oregon-Northern California Coast (SONCC) ESU and the California Central Coast (CCC) ESU
Chinook *(Oncorhyncus tshawytscha)* ENDANGERED	2007 Federal Recovery Outline available for the Sacramento River ESU. Successful Chinook spawning has been documented in the Napa River since at least 2001 (and I believe there are reliable data for other bay area streams including the Guadalupe River and Sonoma Creek). However, it is not clear whether the run in Napa River is self-sustaining or consists of a stream of stray fish from Central Valley rivers.
Green sturgeon *(Acipenser medirostris) – THREATENED*	No recovery information is available yet for the North American Green sturgeon, U.S.A. (CA) Southern Distinct Population Segment
Long-fin Smelt *(Spirinchus thaleichthys) THREATENED*	No performance targets specified. Listed as threatened in 2010, no recovery plan at this time
Delta Smelt *(Hypomesus transpacificus) THREATENED*	No performance targets specified. Listed as threatened in 1993, no recovery plan at this time
Pacific Herring *(Clupea pallasii)*	Only Southern Alaska DPA is an ESA candidate species at this time. SF Bay population is on watch list.
Amphibians	
Red-legged frog *(Rana aurora draytonii) - ENDANGERED*	Red legged Frog Recovery Plan outlines recovery actions, outlines recovery actions, such as: *Track status and recovery of California red-legged frog populations per recovery unit and propose delisting where appropriate.*
Foothill Yellow-legged frog *(Rana boylii) - THREATENED*	No performance targets specified. No Recovery Plan is available for this species.
California Tiger salamander *(Ambystoma californiense) – THREATENED* – Central Valley *ENDANGERED* - Sonoma County & Santa Barbara ESUs	Recovery Plan in development; 2005 Santa Rosa Plain Conservation Strategy provides mitigation ratios but has not been implemented
Invertebrates	
Freshwater shrimp *(Syncaris pacifica)- ENDANGERED*	California Freshwater Shrimp (Syncaris pacifica Holmes) Recovery Plan 1998 1998 1998 1998
Vernal Pool tadpole shrimp *(Lepidurus packardi)*	Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon 2005 2005

	Protect two SE SFB occurrences
Vernal pool fairy shrimp *(Brachinecta lynchi)*	Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon 2005 2005 Protect two Napa River occurrences
Plants	
Soft bird's-beak *(Cordylanthus mollis ssp. mollis)*	Draft Tidal Marsh Recovery Plan Downlist Criteria: Downlist Criteria: Minimum inhabited (preserved) area: 3,000 in Suisun Bay Area and 1,000 in San Pablo Bay over 5 years (5,000) Median # of plants (minimum): 3,000 *in each population* over 5 years (not below 500 for 2 cons. years) Other criteria found in Draft Recovery Plan
Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*	Draft Tidal Marsh Recovery Plan Downlist Criteria: Downlist Criteria: Minimum inhabited (preserved) area: 2,000 over 5 years (4,000) Median # of plants (minimum): 3,000 *total* over 5 years (if not discrete *populations*, then 5,000 total). Third largest *population* must have median of 300 individuals (not below 800 for 2 cons. years) Other criteria found in Draft Recovery Plan
California sea-blite *(Suaeda californica) - ENDANGERED*	Draft Tidal Marsh Recovery Plan Downlist Criteria: Downlist Criteria: Minimum inhabited (preserved) area: 3 locations in San Francisco Bay must be on preserved lands (no minimum acreage) Median # of plants (minimum): 1,500 *total* over 5 consecutive years in San Francisco Bay Other criteria found in Draft Recovery Plan
Sonoma sunshine *(Blennosperma bakeri) - ENDANGERED*	No Recovery Plan; Santa Rosa Plain Conservation Strategy provides mitigation ratios but has not been implemented
Sebastopol meadowfoam *(Limnanthes vinculans) - ENDANGERED*	No Recovery Plan; Santa Rosa Plain Conservation Strategy provides mitigation ratios but has not been implemented
Burke's goldfields *(Lasthenia burkei) - ENDANGERED*	No Recovery Plan; Santa Rosa Plain Conservation Strategy provides mitigation ratios but has not been implemented
Many-flowered navarretia *(Navarretia leucocephala ssp. plieantha) - ENDANGERED*	Santa Rosa Plain Conservation Strategy provides mitigation ratios but has not been implemented provides mitigation ratios but has not been implemented provides mitigation ratios but has not been implemented provides mitigation ratios but has not been implemented
Contra-costa goldfields *(Lasthenia conjugens)*	Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon 2005 2005 Protect 90% of occurrences to downlist; 100% of occurrence to delist.

Appendix 6.2: Detailed listing of monitoring and research needs for *some* focal special status species taken from respective recovery plans. This should will be expanded in future planning phases.

California Least Tern (taken from Recovery Plan):

- Monitor populations to determine status, distribution, and progress of management during breeding season
- Determine breeding success
- Investigate population dynamics, life history, and movement of terns by banding and marking
- Determine effects of environmental pollutants found at JV project sites on special status species survival and reproductive success. Develop relevant contaminant thresholds
- Determine factors affecting choice of locations for roosting, loafing, and feeding during breeding and post-breeding seasons
- Determine amount of habitat necessary to maintain current populations and recovery objective
- Identify potentially suitable nesting sites
- Identify factors causing colony disruption and nest site abandonment
- Investigate nest site requirements
- Investigate methods to enhance nest sites in potential breeding habitat
    - Investigate methods to construct adequate nesting sites in potential breeding habitat

Western Snowy Plover (taken from Recovery Plan):

- Monitor populations to determine status, distribution, and progress of management during breeding season
- Determine breeding success
- Develop and implement a program to monitor habitat condition and threats at all breeding and wintering sites.
- Identify, prioritize and carry out investigations on control of predators.
- Identify components of high-quality brood rearing habitat
- Identify, prioritize and carry out studies on the effects of human recreation on western snowy plovers.

California Red-legged frog (taken from Recovery Plan):

- Develop a population monitoring program
    - Conduct qualitative assessments of known populations
    - Conduct quantitative assessments of representative populations
- Conduct population viability analyses for metapopulations
- Research metapopulation dynamics
- Conduct research to better understand the ecology of this species including use of uplands, dispersal habits, and overland movements
- Investigate contaminants issues
- Conduct research on the effects of mosquito fish and determine alternatives to mosquito fish use

- Conduct research on the ecology of exotic species
- Determine genetic and ecological relationships between *R. aurora draytonii* and *R. aurora aurora*
- Determine whether distinct vertebrate population segments are identifiable for the California red-legged frog
- Conduct experimental manipulations of habitat to determine requirements for creation and restoration
- Determine the effects of livestock waste
- Determine grazing thresholds that ensure optimum habitat suitability

California Freshwater Shrimp - *Syncaris pacifica* (taken from Recovery Plan):

- Develop & implement a routine and comprehensive habitat monitoring plan
- Develop a routine and comprehensive population monitoring plan for shrimp
- Implement a population monitoring plan.
- Develop a database to collect, store, analyze, and exchange monitoring information
- Assess effectiveness of various conservation efforts for shrimp.
- Develop and implement survey-training programs for biologists.
- Characterize shrimp dispersal capabilities and the environmental and habitat characteristics necessary for movement.

The San Francisco Bay Joint Venture is a partnership of public agencies, environmental organizations, the business community, local governments, and landowners working cooperatively to protect, restore, increase, and enhance wetlands and riparian habitat in the San Francisco Bay Watersheds. We bring an ecosystem and collaborative approach to developing and promoting wetland and riparian habitat conservation throughout the Bay Area.

The Joint Venture Management Board

Nonprofit and Private Organizations

Bay Area Audubon Council
Bay Area Open Space Council
Bay Planning Coalition
Citizens Committee to Complete the Refuge
Ducks Unlimited
National Audubon Society
Pacific Gas & Electric Company
PRBO Conservation Science
Save the Bay
Sierra Club
The Bay Institute

Public Agencies

Bay Conservation and Development Commission
California State Coastal Conservancy
California Department of Fish and Game
California Resources Agency
Contra Costa Mosquito and Vector Control District
National Fish and Wildlife Foundation
NOAA National Marine Fisheries Service
Natural Resources Conservation Service
SF Bay Regional Water Quality Control Board
San Francisco Estuary Partnership
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
Wildlife Conservation Board

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