The San Francisco Bay Joint Venture Monitoring & Evaluation Plan

MEASURING CONSERVATION DELIVERY EFFECTIVENESS IN AN EVOLVING LANDSCAPE

Phase I - Section II: Net Landscape Change

Developed by the San Francisco Bay Joint Venture Science Subcommittee

October 2011

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II. Habitat Quantity - Net Landscape Change

Regional wetland area is one of the main mechanisms to assess conservation delivery impact and effectiveness throughout the San Francisco Bay Joint Venture (SFBJV) region. By calculating the acreage accomplishments of conservation activities, balanced by concurrent losses, we can assess the "net landscape change," or balance of gains and losses over time as an indicator of success. Therefore, regularly evaluation of the net change in wetland habitat extent will indicate the continued impact of SFBJV conservation delivery activities in supporting target species despite projected environmental and land use changes over time.

The total amount of wetland habitat within the SFBJV region has been severely diminished compared to historical levels, and the condition of what remains ranges from highly compromised to relatively intact (SFEI 1992; Biodiversity Action Plan for Sonoma County 2010; Bay Area Open Space Council 2008; California's Wildlife Action Plan 2007). The projected impacts of future land use- and climate-induced changes to habitat extent will provide additional challenges for SFBJV area wetland systems and organisms. Anthropogenic wetland conversion and sea level rise, for example, will continue to diminish regional wetland habitat quantity and landscape-level connectivity with serious ramifications for associated birds and other wildlife (SFBJV 2008, Knowles 2010; Ackerly et al. in press, Micheli et al. in press).

To counteract the trend of wetland loss, wetland habitat restoration activities have increased dramatically in the region since the inception of the Baylands Habitat Goals (Goals Project 1999) and the SFBJV in the last decades. The SFBJV Implementation Plan (2001) outlines clear goals for the area of wetland habitat to be protected, enhanced, and restored throughout the SFBJV region (see also M&E Plan *Introduction & Overview, Figure 3*). Specific wetland habitat types are classified in the SFBJV Implementation Plan (2001, Figure 1).

In order to regularly assess accomplishments by SFBJV partners in habitat conservation, restoration, enhancement, and SFBJV regional progress towards wetland habitat goals of 200,000 acres during a 20-year period, a SFBJV habitat project tracking system was built and implemented. This online SFBJV project database, developed and maintained by Ducks Unlimited, is password accessible to all SFBJV partners and interested parties at cjvp.ducks.org .

The database tracks acreage changes of the main habitat classes, San Francisco Bay (SFB) habitats, seasonal wetlands, creeks and lakes, uplands and agricultural lands, over time to clearly measure the progress towards the SFBJV Implementation Plan's (2001) habitat quantity goals. The main classes are further broken down by subclasses (e.g., SFB habitat types include tidal flat, tidal marsh, lagoon, beach, salt pond, and subtidal, including shallow bay and deep bay, Figure 1).

The system records habitat acreage accomplishments in real-time, whenever a project activity is updated from the planning or implementation phase to the completed phase. In this database, each project is composed of individual habitat activities, which includes a specific habitat, a conservation action and the water regime. For instance, an activity may include the restoration of 100 acres of tidal marsh with

a full tidal water regime. The same project may also include a second activity such as the enhancement of an adjacent 50 acres of upland grassland with no managed water regime. An associated geographic information system (GIS) allows partners to map projects, perform queries and generate maps to save for use in reports and presentations.

The current system to track SFBJV progress towards its habitat goals is a system designed to record the final restored habitat at a site. In a new effort to track net landscape change on SFBJV project sites, the online database is being updated to record the habitat type on each site prior to conservation activities. This ability to track pre-project habitat conditions will help assessment of net landscape change of SFBJV projects. Besides project-specific net landscape change, the regional scale changes to wetland habitats outside of SFBJV projects need to be assessed using other available region-wide datasets.

The Net Landscape Change section of the SFBJV Monitoring and Evaluation Plan (M&E Plan) is to help expand and integrate current SFBJV database capabilities to utilize new data layers and link to other existing databases to provide a long-term evaluation framework for assessing the relative quantity of SFBJV habitat delivery and other landscape change beyond the footprint of SFBJV projects. One of these new tools for utilization is the Bay Area Aquatic Resource Inventory (BAARI), recently developed by the San Francisco Estuary Institute (SFEI) in the context of the Wetland Regional Monitoring Program (WRMP).

The BAARI provides a wetland and riparian base map for a large part of the SFBJV area region (excluding the SFBJV Russian River and Sonoma county coast regions) using standardized methods, featuring highly detailed Bay Area aquatic features that include all wetlands, open water, streams, natural channels, unnatural ditches, tidal marshes and flats, and riparian areas. The BAARI can be used to track detailed changes in the extent and condition of aquatic habitat, necessary to evaluate the net change (gain and loss) in landscape scale wetland type extent, and so measure the contributions of SFBJV conservation delivery activities (protection, restoration, enhancement) at regular intervals.[1]

At this time, this Plan section is not designed to present a detailed habitat evaluation program with schedules and protocols, data management specifics, and other concrete details. Instead it is to establish an overall framework that will provide general guidance to SFBJV partners in the assessment of habitat extent, and the effects of SFBJV conservation, enhancement, or restoration implementation actions. More details will be developed throughout phase II of the M&E planning process (see *Next Steps* section below).

[1] The BAARI Standards And Methodology For Stream Network, Wetland And Riparian Mapping manual (SFEI 2011) outlines the crosswalk between BAARI, California Wetlands Portal (includes Bay Area Wetland Tracker), and the National Wetland Inventory standard (Cowardin 1979) wetland classifications. Relevant mapping and Quality Assurance and Quality Control scales for BAARI spatial analyses are: 1:5000 for non-tidal wetlands, 1:2500 for tidal wetlands, and small non-tidal wetlands, including vernal pools and seeps and springs, and wetlands defined as less than 0.01 ha (100 sq; SFEI 2011). BAARI does not permit zooming in to a scale < 1:2,500 to identify the presence or absence of wetland features, but after a wetland feature is located and classified, the BAARI editor can zoom in to a scale $\leq$ 1:1000 for digitization (SFEI 2011).

This *Net Landscape Change* Section Currently Provides:

I. A general framework to help assess the effectiveness of SFBJV conservation delivery projects in the context of net wetland habitat quantity change at the landscape scale.
II. An outline of evaluation objectives addressing key needs for wetland type quantitative analysis within the SFBJV Region.
III. Recommendations for further research needs, evaluation metrics, protocols, and data repositories, and for integration with existing evaluation programs.

Focus Team Process & Participants

In a series of in-person meetings and phone conferences, the net landscape change 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 include:

Name	Affiliation
Cayce, Kristen*	San Francisco Estuary Institute
Fulfrost, Brian*	South Bay Salt Pond Habitat Mapping
Gandesbery, Tom*	State Coastal Conservancy
Grenier, Letitia	San Francisco Estuary Institute
Klochak, John	US Fish & Wildlife Service - Coastal Program
Petrik, Kevin*	Ducks Unlimited
Schaefer, Nancy*	Conservation Land Services for the Upland Habitat Goals
Scoggin, Sandra*	San Francisco Bay Joint Venture
Sloop, Christina	*Team Coordinator*, San Francisco Bay Joint Venture
Valoppi, Laura	U.S. Geological Survey
Ward, Kristen*	Golden Gate National Recreation Area

*Participated in prioritization of objectives at May 2011 workshop.

Target Habitats and Species

Focal wetland types outlined in the SFBJV Implementation Plan (2001) include: tidal flat, tidal marsh, lagoon, beach, (managed, restored, or production) salt pond, diked wetland, agricultural bayland, moist grassland (including vernal pool complex), lake, creek and riparian zone (Figure 2.1), as well as associated upland and subtidal ecotones and habitats. Relevant target species are outlined throughout the *Monitoring Focus* modules of this Plan, and include waterfowl, shorebirds & waterbirds, riparian land birds, and special status species.

Performance Targets

Conservation specific (protection, enhancement, restoration) acreage goals by SFBJV sub-region are outlined in the SFBJV Implementation Plan (2001). The accounting of annual acreage additions and water regime changes by SFBJV activities in these categories represents the primary mechanism for the SFBJV to evaluate conservation delivery effectiveness, and significant strides have been made in the past decades towards outlined goals (See Table 1 in Introduction & Overview section for more information). In order to more closely link habitat quantity to target species needs, it is recommended that a more closely linked analysis of habitat type availability be undertaken to better inform suitable habitat availability status by target organism.

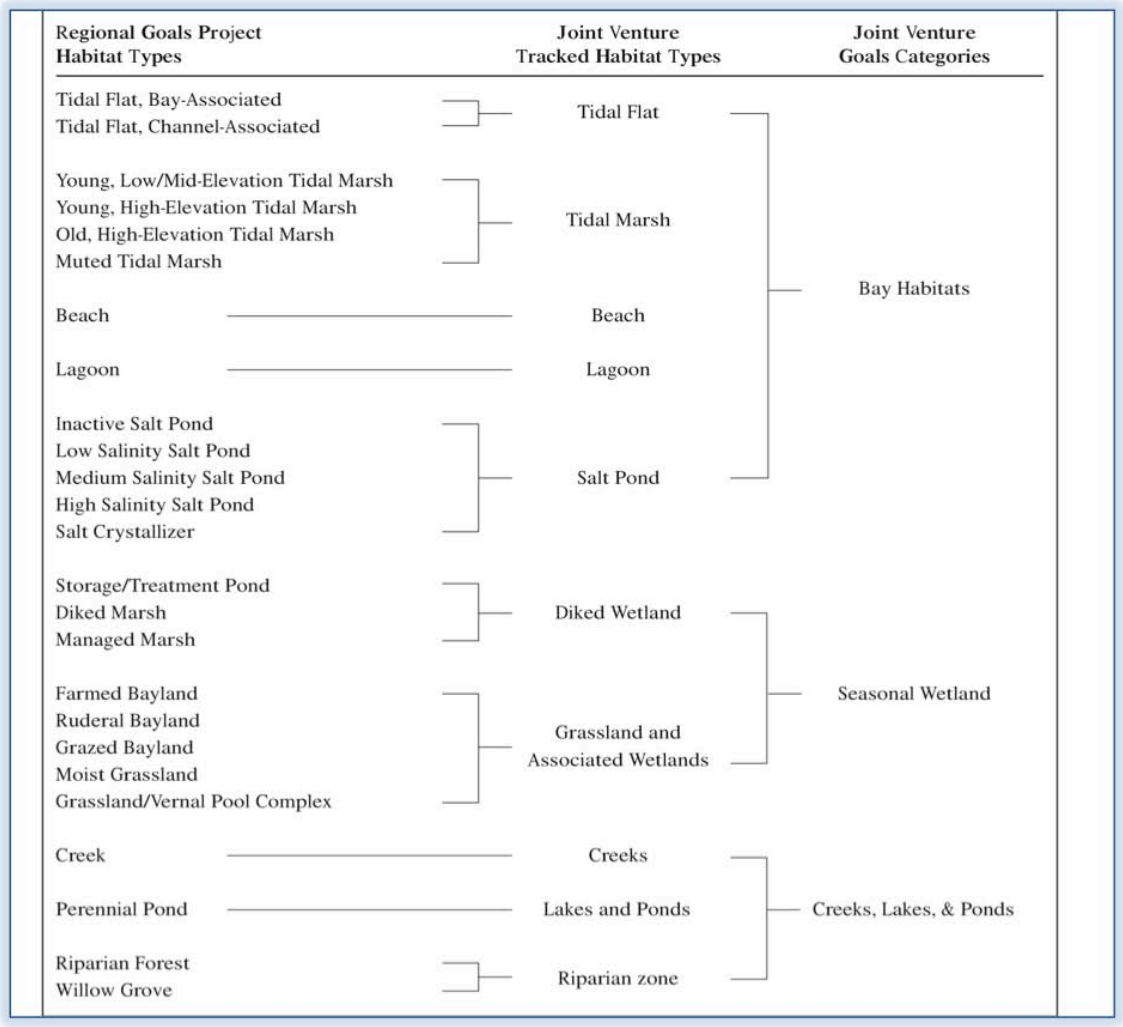

Figure 2.1: San Francisco Bay Joint Venture wetland habitat classifications (Source: SFBJV 2001).

Monitoring & Evaluation Objectives

Priority M&E Objectives and Associated Metrics, Protocols & Challenges

Summarized below are the highest priority objectives the Net Landscape Change 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 SFBJV "effectiveness"; and
6) Cost-effectiveness.

Priority M&E Objective 1: *Net Change in Habitat Quantity.* Throughout the SFBJV region, evaluate the net change in the area of wetland habitat types at regular time intervals, utilizing the following metrics. Also assess habitat change in the context of specific target species or functional group use.

- Total wetland acreage by habitat type, subregion, and as relevant to individual target species or functional groups (e.g., shorebird guild),
- Overall protected wetland acreage (including SFBJV contribution and mitigation wetlands) by habitat type, subregion, and as relevant to individual target species or functional groups (e.g., shorebird guild),
- Percentage and length of "natural" channels vs. engineered/modified channels
- Seasonality of wetland or creek
    - Area parsed out by water regime or a proxy for this.

Priority M&E Objective 2a*: *SFBJV Contribution to Habitat Gain.* At regular intervals, evaluate the relative acreage contribution of SFBJV projects to the extent of suitable habitat types, utilizing the following metrics:

- Total wetland acreage by habitat type, subregion, and as relevant to individual target species or functional groups (e.g., shorebird guild),
- Overall protected wetland acreage (including SFBJV contribution and mitigation wetlands) by habitat type, subregion, and as relevant to individual target species or functional groups (e.g., shorebird guild),
- Currently protected wetland acreage through SFBJV actions by habitat type and sub-region, and as relevant to individual target species or functional groups (e.g., shorebird guild),
- Percentage and length of "natural" channels vs. engineered/modified channels

* Priorities 2a & 2b were ranked equally.

Priority M&E Objective 2b: *Connectivity.* At regular intervals, determine the level of landscape scale connectivity between habitat types and assess nearest neighbor relationships of habitats situated in proximity to each other across the region, utilizing the following metrics:

- Edge to area ratio (functionality)
- Patch size distribution
- Nearest neighbor analysis
- Adequate buffer zone area and percent connectivity with complimentary adjacent habitat (refer to other groups to determine what is complimentary)
- Area and location of infrastructure (levees. culverts, etc.) barriers or impediments to connectivity

Priority M&E Objective 3: *Habitat Condition.* At regular intervals, assess regional wetland habitat type condition relevant to supporting target organism needs, utilizing protocols that allow maximum comparability with other regional efforts (e.g. WRMP, NPS and NWR Inventory & Monitoring program protocols, Bird monitoring protocols), and the following metrics:

- Minimum habitat patch size and minimum patch distance requirements by target species
- Extent and distribution of refugia habitats (i.e. high tide areas for marsh species)
- Proportion of habitats with infrastructure impediments
- Forage/roosting/nesting area proximity by target species
- Extent (acreage and distribution) of noxious invasive species
- Natural and/or anthropogenic disturbance frequency

Target Organism Specific Objectives[2]

Here we outline net landscape change related M&E objectives specified in target species monitoring focus sections:

Waterfowl:

- Priority M&E Objective 1: *Habitat Quantity & SFBJV Contribution.* Every five years, evaluate the net change in the extent and distribution of diving and dabbling duck habitats throughout the SFBJV region, and evaluate the regional contribution and effect of SFBJV projects and habitat restoration/enhancement to suitable habitat use by diving and dabbling ducks, respectively.

Riparian Land Birds:

- Priority M&E Objective 1: *Habitat Quantity & SFBJV Contribution.* Every five years, evaluate the net change in the extent (acreage) and distribution of riparian habitats throughout the SFBJV region, and determine the relative contribution of SFBJV activities.

Shorebirds and Waterbirds:

- Priority M&E Objective 1: *Habitat Quantity & SFBJV Contribution.* Every five years, evaluate the net change in the extent and distribution of shorebird and waterbird habitats throughout the SFBJV region, and determine the relative contribution of SFBJV activities.

Special Status Species

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

Habitat types and edge-to-edge ratios to assess by target groups are as follows:

WATERFOWL

- *Diving duck indicator species:* Tidal flat (when inundated), (managed, restored, or production) salt pond, subtidal, including vegetated areas such as eelgrass, widgeon grass, etc.), tidal sloughs, lagoons, coastal ocean, freshwater marsh, ponds, creeks;
- *Dabbling duck indicator species:* Tidal marsh, (managed, restored, or production) salt pond, islands & levees, subtidal - including vegetated areas such as eelgrass, widgeon grass, etc.), tidal sloughs, lagoons, freshwater marsh, ponds, creeks;

SHOREBIRDS & WATERBIRDS

- *Shorebird indicator species:* Tidal flat, tidal marsh, tidal slough, lagoon, beach, open bay, (managed, restored, or production) salt pond, levees, diked wetland;
- *Waterbird indicator species:* Tidal marsh, tidal slough, lagoon, beach, open bay, (managed, restored, or production) salt pond, levees, diked wetland;

RIPARIAN LAND BIRDS : *Riparian landbird indicator species:* Riparian creeks & streams;

SPECIAL STATUS SPECIES: *Specific special status species*: Wetland habitat types as outlined in special status species subsections and recovery or management plans.

[2] These objectives link directly to prioritized objectives outlined in the various target organism focus section modules.

Recommended Metrics

- Total existing wetland acreage by type and/or region
- Wetland acreage of protected, restored, or enhanced areas by type and/or region.
- Wetland acreage of protected, restored, or enhanced areas by type and/or region through SFBJV actions
- Suitable wetland acreage for future protection, restoration or enhancement by type and/or region
- Habitat change by type at 5-yr interval to see how conservation activities are keeping up with the overall trend. For example we're conserving xx acres, but we're losing xx times 2 due to development.

Recommended Protocols

Methods outlined in the BAARI Standards And Methodology For Stream Network, Wetland And Riparian Mapping manual (SFEI 2011) are recommended for the needed spatial analyses.

Research & Information Needs

Priority Research Need 1: *Regional Historical Datasets*. Develop or acquire appropriate geo-referenced datasets of wetland extent prior to 2010, not covered by the Bay Area Aquatic Resource Inventory, National Wetland Inventory (NWI, USFWS [1972-2007]), National Hydrography Dataset (NHD, USGS [varies]), EcoAtlas Modern (SFEI [1997]), and EcoAtlas Historical (SFEI [c. 1850]).

Priority Research Need 2[**]: *SFBJV Database Enhancements.* Expand SFBJV project database for landscape change metrics and GIS capabilities, and integrate with BAARI in order to allow net change reporting in database interface.

Priority Research Need 3: *Habitat Hot Spots & Connectivity; Regional Scale.* Determine and map habitat type extent and outline hotspots for target organism use. Evaluate the level of connectivity between habitat types considering adjacent, linked, similar, identical habitat types across the region.

[**] Priorities 2a, 2b & 2c were ranked equally.

Additional Research and Information Needs

Here we list additional research and information needs for assessing net landscape change at the regional scale:

- Expand BAARI Datasets; Regional Scale – Expand current BAARI geo-referenced datasets to cover Russian River and Sonoma coastal regions for analysis capability of entire SFBJV region.
- Habitat Classification; Regional Scale - Implement annual, pre- and post conservation delivery classification of habitat types, and carry out periodic sampling/assessment of habitat quality using standard methods.
- Future Planning; Regional Scale - Utilize gained information on wetland type extent changes at various scales to identify and prioritize future projects.
- Riparian Acreage Targets and Monitoring Scheme; Regional Scale[3] – In concert with the development of population targets, revise riparian acreage targets as well. Expand the scope of the riparian acreage targets to include urban and rural settings. Develop a system for monitoring the gain *and* loss of riparian acreage.
- Forecast Change; Regional Scale – Evaluate scenarios of the expected future habitat type specific area loss or conversion due to sea level rise, development, restoration and other likely land use changes.
- Habitat Migration; Regional Scale – Assess the extent and rate of "habitat migration" or the spatial movement of habitat types due to climate change impacts.

[3] Wetland and Riparian Areas Protection Policy is beginning the process in which to define "riparian". Knowing the riparian needs based on population targets and species would benefit the policy development.

Additional Considerations & Suggestions by the Focus Team

- The existing technology more accurately measures some habitat types over others.
- Managers and planners don't "speak" the Cowardin classification.
- Implement a process for "requiring" accurate habitat information and maps.
- Mid-level detail in the SFBJV chart can be cross-walked with BAARI.
- The California Wetland Portal - Wetland tracker requires additional information than the SFBJV wetland categories. SFEI is implementing an effort to crosswalk BAARI, National Wetland Inventory, SFBJV, and other classifications to make sure the net landscape change analysis results in valid comparisons.
- Need nexus with SFBJV or project/program indicators.
- Need to underscore ecosystem services of wetlands.
- Need methods to characterize habitat quality in relation to quantity (e.g., California Rapid Assessment Method (CRAM) which is currently updated by a University of California, Davis student for better use with wetlands)
- Promote these program needs with universities in order to recruit students to help provide some of the identified needed research or tools.
- Use historical (pre-European settlement) data to identify remnant wetlands (historical natural wetlands that still remain) for potential restoration/preservation opportunities.

Data Management

Net landscape change analyses will be performed utilizing both the SFBJV project tracking system and BAARI methods and other relevant GIS interfaces. Resulting maps and GIS layers will be made accessible online via the SFBJV website, and relevant reports will be available every five years.

Existing Programs and Tools

- SFBJV project and spatial database, managed by Ducks Unlimited. This database is also linked to the California Avian Data Center and Avian Knowledge Network managed by PRBO Conservation Science and the Cornell Lab of Ornithology.
- BAARI, managed by the SFEI.
- EcoAtlas – Contains historical and modern views of SFB Baylands, managed by SFEI
- USGS – Digital elevation (LiDAR) database & other resources (see Appendix 1 & 2).
- Wetland Tracker – Although not as detailed as the JV project database on a project by project level, this tool identifies other specific wetlands and mitigation sites that are do not specifically contribute to net increase toward JV habitat goals.

Key Partners

- Ducks Unlimited – Developed and maintains the SFBJV Project Database and performs required spatial analyses.
- San Francisco Estuary Institute – Developed BAARI and Baylands EcoAtlas.
- US Geological Survey – USGS provides a large LiDAR dataset for the region. Sources of bathymetric/LiDAR data are: http://pubs.usgs.gov/of/2007/1169/; 2004 Topographic LiDAR Data for South Bay Open-File Report http://pubs.usgs.gov/of/2005/1284/; A variety of aerial photographs, satellite images, and remote sensing resources available at: http://www.usgs.gov/pubprod/aerial.html (Also, see Appendices for additional information on spatial tool sources).

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 aims for net landscape change related monitoring and research include:

- Linking effects of conservation delivery in habitat area to target organism stability, and habitat resilience in the context of projected global change impacts,
- Updating the SFBJV habitat classification to better reflect habitat evolution related changes (i.e. salt pond change to managed or other pond type), and include ecotonal/transitional habitats, and subtidal habitats in estuaries and nearshore marine areas.
- Linking examination of local and regional habitat extent of wetlands to Pacific flyway, and subtidal habitats to the Pacific coast scales.
- Developing monitoring objectives to underscore ecosystem services of wetlands, associated uplands, and subtidal habitats.
- Determining appropriate evaluation time frames and implementation strategies,
- Expanding assessment capabilities to the entire SFBJV region, including areas not currently covered by BAARI, as well as to subtidal habitats
- Maximizing integration with other regional wetland habitat assessment initiatives.

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Appendix 2.1

Sources of Aerial Photographs and Images available from USGS (compiled by L. Valoppi)
http://www.usgs.gov/pubprod/aerial.html
Note: - indicates the availability of downloadable data at no charge.

Aerial Photographs and Images

Buy digital format on media: Online | Local center or by phone

National Aerial Photography Program (NAPP)	The National Aerial Photography Program (NAPP), is an interagency Federal effort coordinated by the USGS, which uses NAPP products to revise maps.
National High Altitude Photography (NHAP)	The National High Altitude Photography (NHAP) program, which was operated from 1980-1989, was coordinated by the U.S. Geological Survey as an interagency project to eliminate duplicate photography in various Government programs.
Digital Orthophoto Quadrangles (DOQ)	Digital images of aerial photos which combine the image characteristics of the photo with the georeferenced qualities of a map (1987 – present).
LIDAR: Light Detection and Ranging	**LIDAR** (Light Detection and Ranging) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target.
LIDAR Data Viewer	Interactive viewer with limited download capability
Scientific Committee on Antarctic Research (SCAR)	SCAR is charged with the initiating, developing and coordinating high quality international scientific research in the Antarctic region, and on the role of the Antarctic region in the Earth system.
Aircraft Scanners	Digital imagery acquired from several multispectral scanners on board NASA ER–2, NASA C–130B, and NASA Learjet aircrafts (1982 – 1995).
Historical Photographs	Aerial photos from a variety of sources (1939 – present).
Commercial Imagery	Status Graphics display of commercial imagery available through USGS.
USGS Commercial Data Purchases (UCDP) Imagery	The UCDP Imagery Collection consists of imagery from several commercial vendors. The UCDP supports the Commercial Remote Sensing Space Policy (CRSSP) by providing data to qualified users, primarily U.S. Federal agencies, at no cost for File Transfer Protocol (FTP) downloads or at a nominal cost for media.

Satellite Images

Buy digital format on media: Online | Local center or by phone Commercial distributors of value added data: Satellite Pricing Information: Specifications, formats and prices

ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer)	High-resolution (15- to 90-meter) multispectral data from the Terra satellite (2000 to present).
AVHRR (Advanced Very High Resolution Radiometer)	1-km multispectral data from the NOAA satellite series (1979 to present).
Hyperion and Advanced Land	10- to 30-meter multispectral and hyperspectral data from the Earth Observing-1 (EO-1) Extended Mission (2000 to present).

Imager (ALI)	
LANDSAT	Landsat satellites have been providing multispectral images of the Earth continuously since the early 1970's.
Landsat ETM+ (Enhanced Thematic Mapper Plus)	High-resolution (15- to 60-meter) multispectral data from Landsat 7 (1999 to present).
Landsat MSS (Multispectral Scanner)	80-meter multispectral data from Landsats 1 to 5 (1972 to 1992).
Landsat TM (Thematic Mapper)	30- to 120-meter multispectral data from Landsat 4 and 5 (1982 to present).
LDCM (Landsat Data Continuity Mission)	Multispectral data from the proposed Landsat Data Continuity Mission.
MODIS (Moderate Resolution Imaging Spectroradiometer)	Moderate-resolution (250- to 1000-meter) multispectral data from the Terra Satellite (2000 to present) and Aqua Satellite (2002 to present).
SRTM: Shuttle Radar Topographic Mission	SRTM data are used to generate a digital topographic map of the Earth's land surface with data points spaced every 1 arc second of latitude and longitude for the United States (approximately every 30 meters).
SRTM Data	Seamless "Finished" United States 1 Arc Second (~30 meters) and Global Coverage 3 Arc Second (~ 90 meters)
SIR-C (Spaceborne Imaging Radar C-band)	Imaging radar data (C-band and L-band) from two Space Shuttle missions (1994).
Declassified Satellite Images - Category 1	Photographic imagery from the CORONA, ARGON and LANYARD satellites (1959 to 1972).
Declassified Satellite Images - Category 2	Photographic imagery from KH-7 Surveillance and KH-9 Mapping system (1963 to 1980).
Commercial Imagery	Commercial imagery available through the USGS/EROS
USGS Commercial Data Purchases (UCDP) Imagery	The UCDP Imagery Collection consists of imagery from several commercial vendors. The UCDP supports the Commercial Remote Sensing Space Policy (CRSSP) by providing data to qualified users, primarily U.S. Federal agencies, at no cost for File Transfer Protocol (FTP) downloads or at a nominal cost for media.
Commercial Remote Sensing Data Contracts (CRSDC)	To search and order commercial imagery data available from aerial or satellite vendors (through the USGS)

Remote Sensing Resources

Aerial Photographs and Satellite Images	An online edition of the popular booklet that discusses some characteristics of aerial photographs and satellite images and the types of images that are available from the USGS.
Understanding Color-Infrared Photographs	Satellites and high-altitude aircraft equipped to record scenes of the Earth use both visible and invisible parts of the electromagnetic spectrum. Near-infrared light is invisible to the human eye, but adding it to these images allows scientists to "see" the surface of the Earth in other than natural colors. The result is "color-infrared" photography.
Looking for an Old Aerial Photograph	Suggestions on how to locate and obtain a wide variety of historical, remotely sensed photographs and images from a number of sources.

Understanding False-Color Composites	Satellites and high-altitude aircraft equipped to record scenes of the Earth use both visible and invisible parts of the electromagnetic spectrum. Near-infrared light is invisible to the human eye, but adding it to these images allows scientists to "see" the surface of the Earth in other than natural colors.
Declassified Intelligence Satellite Photographs	More than 800,000 high-resolution photos taken between 1959 through 1972 were made available by Executive Order of the President. These photos extend the record of changes in the land surface another decade back in time from the advent of the Landsat earth-observing satellite program.
Commercial Remote Sensing Space Policy (CRSSP)	This policy provides guidance for: (1) the licensing and operation of U.S. commercial remote sensing space systems; (2) United States Government use of commercial remote sensing space capabilities; (3) foreign access to U.S. commercial remote sensing space capabilities; and (4) government-to-government intelligence, defense, and foreign policy relationships involving U.S. commercial remote sensing space capabilities.

Other Image Collections

North American Landscape Characterization (NALC)	North American Landscape Characterization (NALC) data consists of Landsat Multi-Spectral Scanner (MSS) time-series triplicates that were acquired in 1973, 1986, and 1991 (+/- one year).
TerraLook	The Tri-Decadal Global Landsat Orthorectified data sets provide a pre-selected global coverage of the Earth's surface at three epochs of time (circa 1975, 1990 and 2000), which can be combined to create a time series of images. The ASTER data set is a very large archive (from 2000 to the present) of satellite images from which you may derive TerraLook images.
Multi-Resolution Land Characteristics 2001 (MRLC2001)	Multi-Resolution Land Characteristics 2001 (MRLC 2001) is a collection of terrain-corrected Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Landsat 5 Thematic Mapper (TM) scenes that have been acquired by the MRLC Consortium.
NASA Landsat Data Collection (NLDC)	Selected MSS and TM scenes (Landsats 1-5) from the NASA Landsat Data Collection (1975 to present).
Tri-Decadal Global Landsat Orthorectified Overview	An overview of the Tri-Decadal Global Landsat Orthorectified data collection, with links to single scene and mosaic data products

Image Galleries

Global Fiducial Library	The Global Fiducial Library is a long-term archive of images from U.S. National Imagery Systems which represents a long-term periodic record for selected scientifically important sites.
USGS Video and Image Gallery	The USGS Video and Image Gallery is our one-stop collection of videos, photography, and other imagery. All items in this gallery are considered public domain.
EROS Image Gallery	"Earth as Art" - images from aerial photography and satellites
Global Change	Landsat and other satellite images that show global change
Astrogeology Images	Maps and images of other planets
Mars Orbiter Images	Pictures from the Mars Global Surveyor and Mars Orbiter Camera
Space Acquired Photography	Photos taken from the International Space Station (ISS), Shuttle, Skylab, Gemini, and Apollo missions (1965 – present)

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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