

California Estuary Monitoring Workgroup's Estuary Portal

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Morro Bay Estuary

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Morro Bay is 2300 acres of mud flats, eel-grass beds, tidal wetlands and open water. The bay is the receiving basin for the runoff from 48,000 acres of watershed. ...

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QUESTIONS ANSWERED ?

- [What is an estuary?](#)
- [Where are California's estuaries?](#)
- [How healthy is the SF Estuary?](#)
- [What is being done to restore the SF Estuary?](#)
- [How can I be part of the solution?](#)

An estuary is a partly enclosed body of water where fresh water coming down the [rivers](#) mixes with salt water from the sea. A range of coastal landforms fit this description, including [bays](#), [lagoons](#), [harbors](#), [inlets](#), and [wetlands](#). There are many types of estuaries in California, including [bar-built](#), [open river mouths](#), and [perennially tidal](#) estuaries. Estuaries are among the most productive ecosystems on earth. They provide rich feeding grounds for coastal fish and migratory birds, and spawning areas for fish and shellfish. They are also important in maintaining the quality of coastal waters. Estuaries are amongst the most heavily populated areas throughout the world, with about 60% of the world's population living along estuaries and the coast. As a result, estuaries are suffering degradation by human impact .



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QUESTIONS ANSWERED

- What is an estuary?
- Where are California's estuaries?
- How healthy is the SF Estuary?
- What is being done to restore the SF Estuary?
- How can I be part of the solution?

There are hundreds of estuaries in California, including **Santa Monica Bay, Morro Bay, San Francisco Bay** and Smith, Klamath, Mad, Noyo, Eel, and **Russian** Rivers. It is the goal of this California Estuaries Portal to include comparable information on each of these estuaries, but initially, this Portal is focused on California's largest estuary, the San Francisco Bay-Delta.

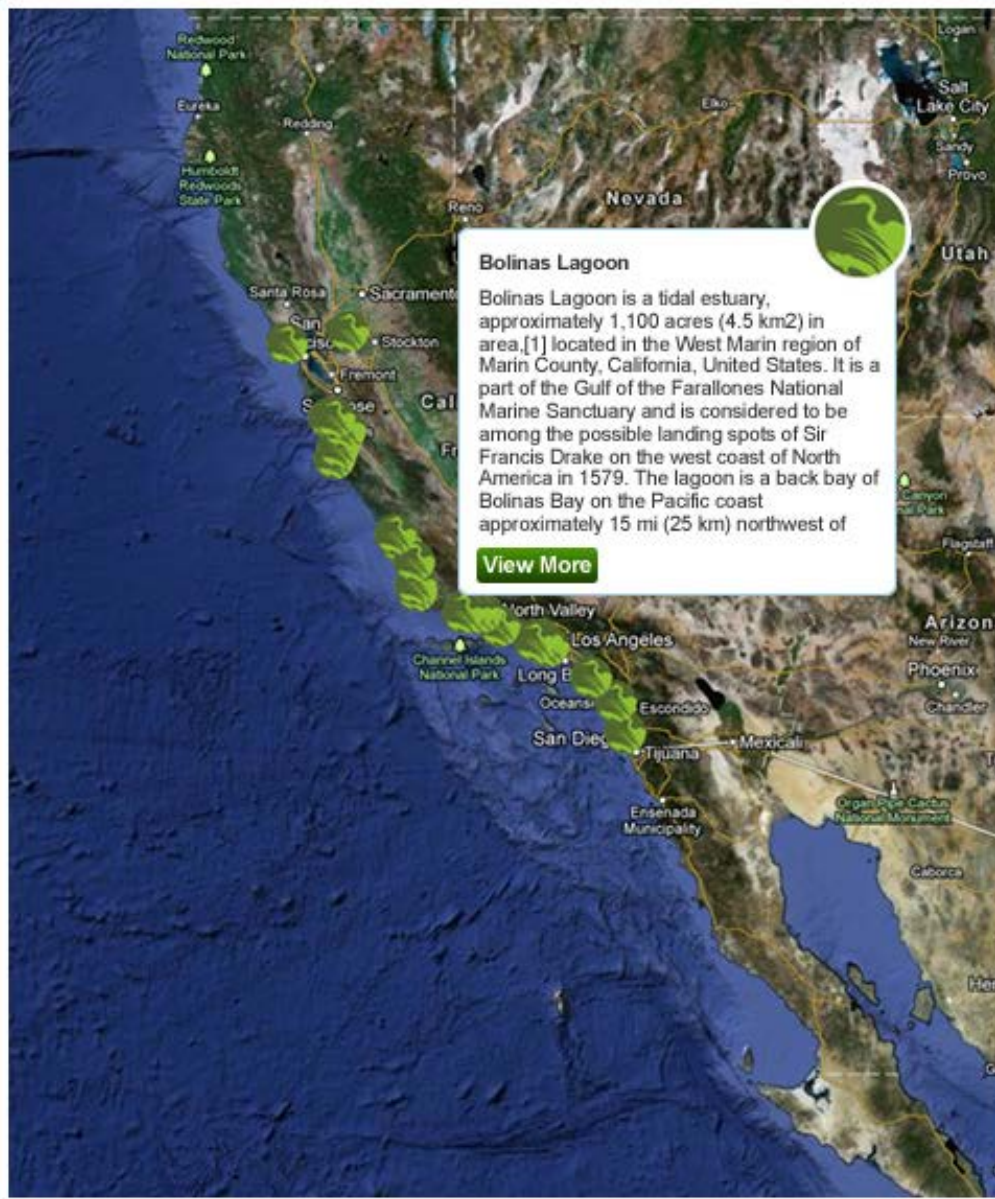


Where are California's Estuaries?

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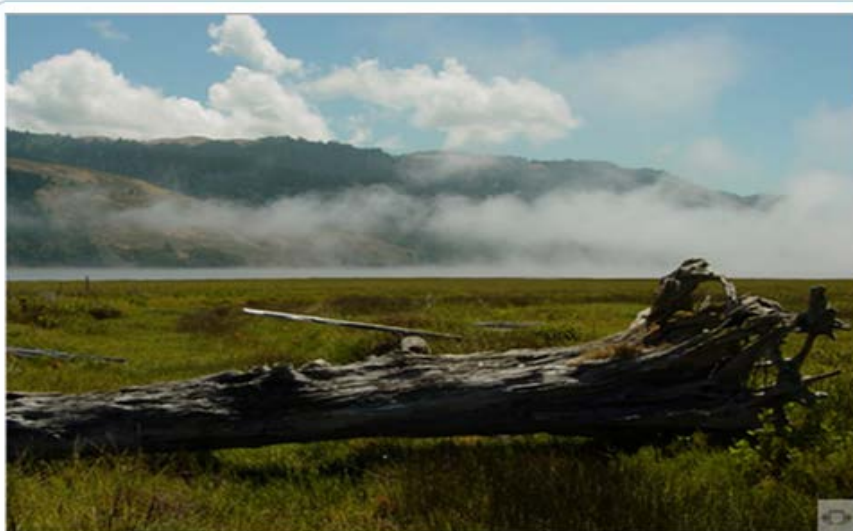
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Why Should I Care About Bolinas Lagoon?

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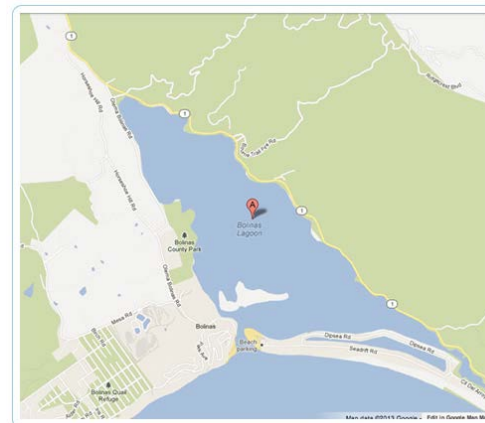
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Bolinas-Lagoon-solin-1.jpg

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Bolinas Lagoon is a tidal estuary, approximately 1,100 acres (4.5 km²) in area,[1] located in the West Marin region of Marin County, California, United States. It is a part of the Gulf of the Farallones National Marine Sanctuary and is considered to be among the possible landing spots of Sir Francis Drake on the west coast of North America in 1579.

The lagoon is a back bay of Bolinas Bay on the Pacific coast approximately 15 mi (25 km) northwest of San Francisco. The trough in which the lagoon sits was formed by the San Andreas Fault which runs directly through it. The lagoon is separated from the main bay by a small spit of land, known as Stinson Beach, and the sand bar that encloses this lagoon is full of beachgoers and surfers on hot days, seeking to escape the heat and the urban Bay Area. California Route 1, the Shoreline Highway, runs along the eastern edge of the lagoon.

Bolinas Lagoon is on the list of wetlands of international importance as defined by the Ramsar Convention for the conservation and sustainable utilization of wetlands.

Portions of the lagoon are included in Bolinas Lagoon County Park, and the western shore is part of the Golden Gate National Recreation Area.

The lagoon has a 16.7 square miles (43 km²) watershed;[1] streams and canyons feeding into it include: Wilkins Gulch, Pike County Gulch, Audubon Canyon, Picher Canyon, Volunteer Canyon, Morses Gulch, McKinnan Gulch, and Stinson Gulch. Kent Island is located in the lagoon.

Duxbury Reef State Marine Conservation Area lies offshore from Bolinas. Like an underwater park, this marine protected area helps conserve ocean wildlife and marine ecosystems.



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Ecology

The San Francisco Estuary (SF Estuary) is a valuable ecological and economic resource. It is the largest estuary on the west coasts of North and South America with its watershed draining more than 40% of California's surface area. Prominent physical features of the estuary include San Francisco, San Pablo, and Suisun Bays and Carquinez Straight to the west, and the Sacramento-San Joaquin River Delta to the east. The SF Estuary provides drinking water for 25 million Californians, irrigation water for 4.5 million acres of farm land, and habitat for more than 750 species of plants, fish, and wildlife, including several endangered and threatened aquatic and terrestrial species.

Two-thirds of the State's salmon pass through the estuary, and at least half of the Pacific Flyway migratory water birds rely on the wetlands, mudflats, and shoreline areas in the estuary.

Economics

The SF Estuary is a global tourist destination for aquatic recreation such as boating, fishing, surfing, and swimming from beaches and in bays as well as hiking and biking along shorelines with inspiring natural beauty. The region attracts and supports a vibrant economy including Silicon Valley, the international hub of the high-tech industry, commercial and recreational fisheries, diverse agricultural production that feeds California and the world, three large commercial ports, water supply infrastructure, and major highway, railroad, and energy line corridors.

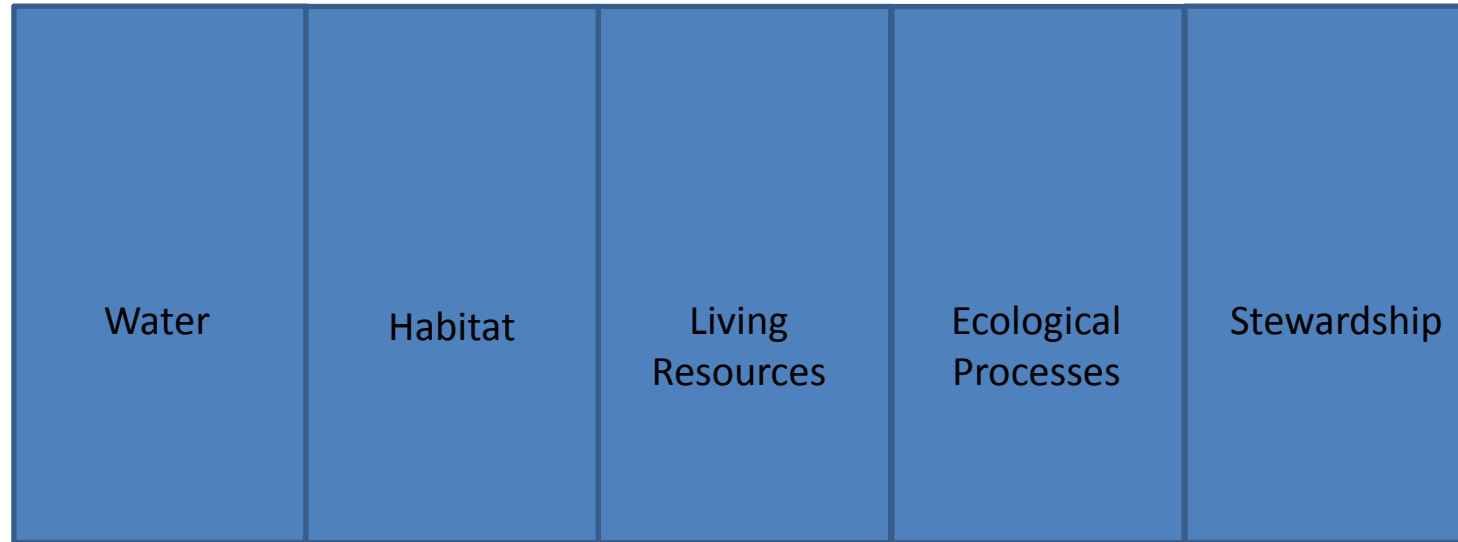
Even though the SF Estuary is such a valuable resource, it is confronted with a broad range of [challenges](#). Knowledge about the SF Estuary is developing at a rapid pace, and a list of recently released and critical documents can be found [here](#) for interested readers.



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The health of an estuary can be assessed using various key attributes. This Portal uses the same key attributes that were used in the 2011 [“The State of the San Francisco Bay”](#) report: water, habitat, living resources, ecological processes, and stewardship. The initial focus here is on a robust evaluation of Living Resources using this [concept](#), and the other key attributes under development.

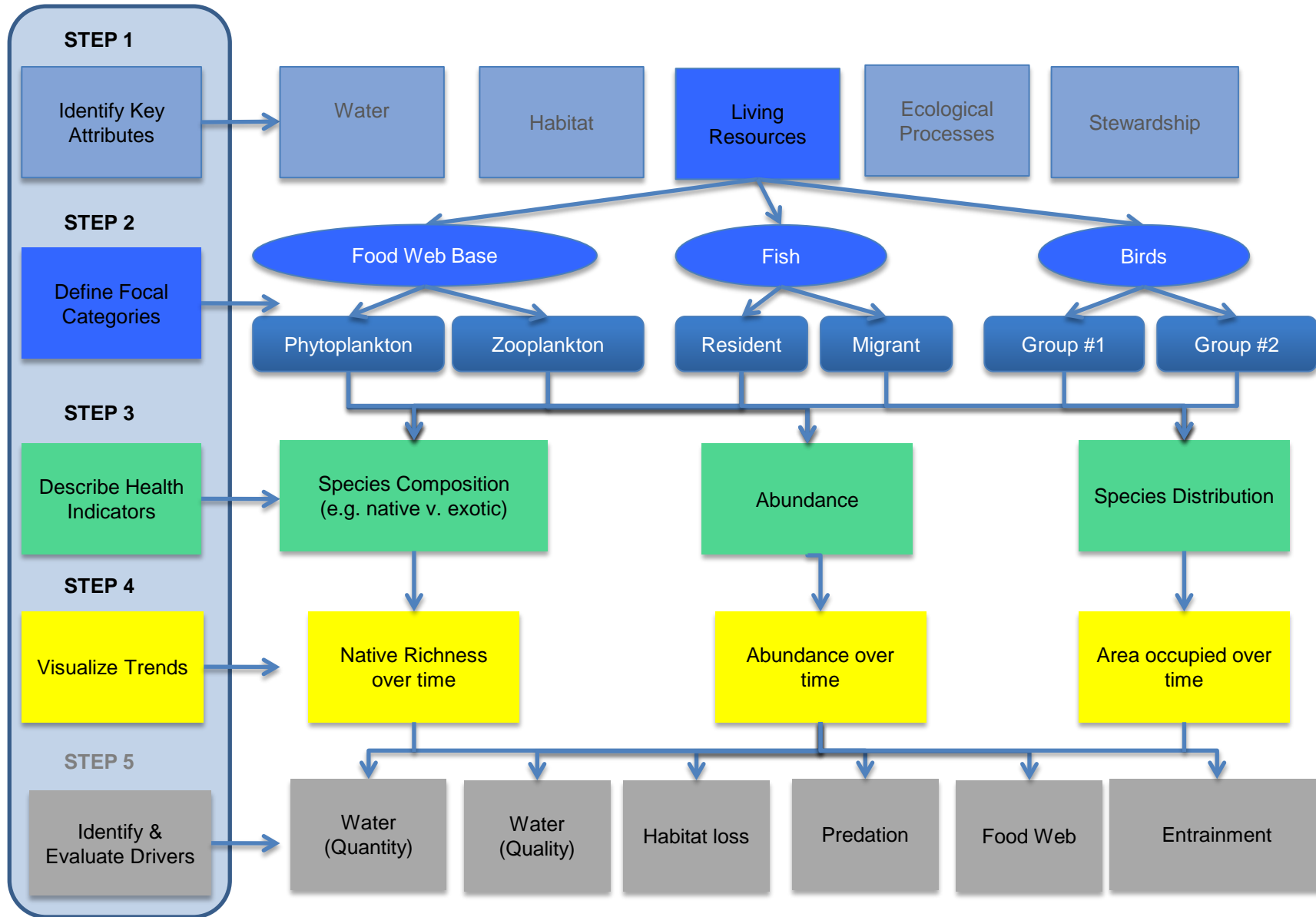


How to Determine the Health of Living Resources?

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How Can You Determine the Health of Living Resources?

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Pictures of living resources that you can click on to get to details



QUESTIONS ANSWERED

- [How Healthy is the Base of the SF Estuary?](#)
- [How Healthy are SF Estuary Fish?](#)
- [How Healthy are SF Estuary Birds?](#)
- [How can I be part of the solution?](#)

Healthy estuaries support diverse and resilient populations of living resources dominated by native species and broadly distributed across different habitats ([SOTB Report 2011](#)). These living resources include birds, [fish](#), and the base of the [food web](#). The San Francisco Estuary supports a huge and diverse number of native and non-native species. Population trends differ for various species and are affected by environmental conditions. Environmental conditions include both human-induced and naturally occurring elements such as: amount, timing and quality of freshwater inflows, habitat extent and quality, ecological processes, pollution and resource management. Global climate change will also affect species populations in the future as sea levels and temperatures rise, further constricting habitat availability and suitability for many species.

To evaluate the health of these living resources, scientists identified [health indicators](#) (measures of health relevant to data sets available for the estuary) for the SF Bay (SOTB 2011)

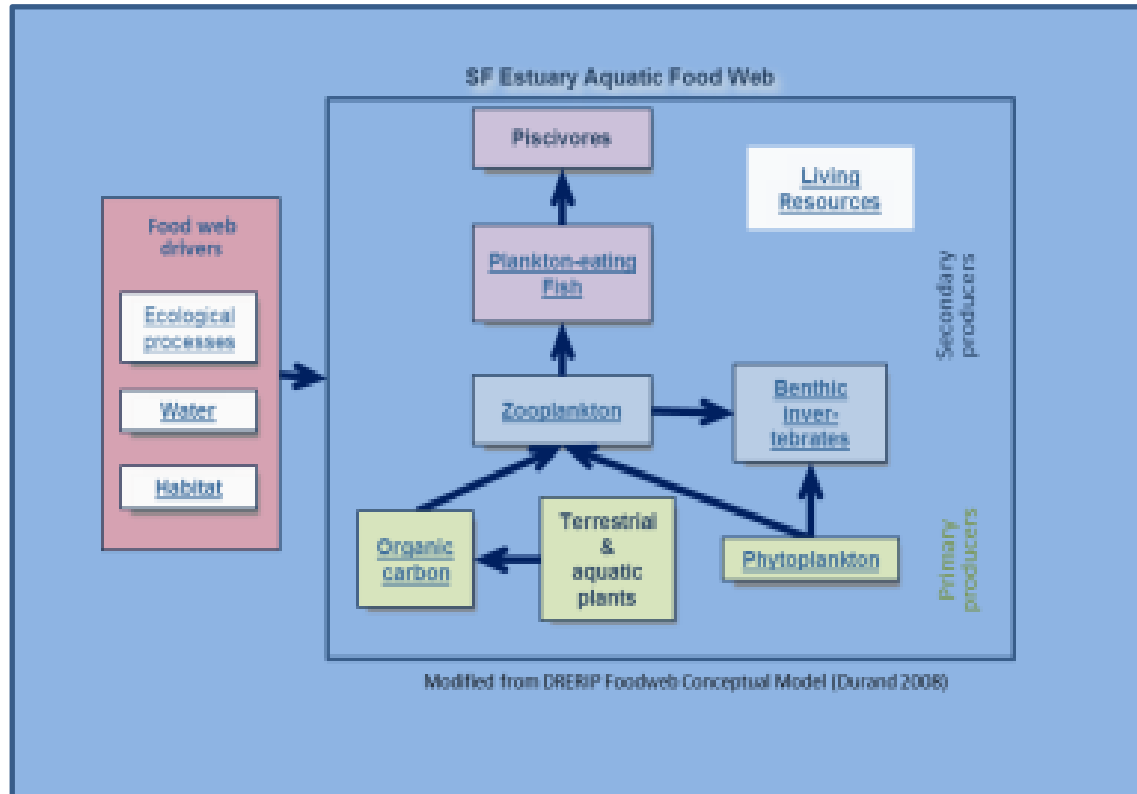


What is the Base of the Food Web and How Healthy is it?

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The base of the food web includes primary producers like [phytoplankton](#) that use nutrients, metals, and sunlight to grow and replicate. [Zooplankton](#) and other invertebrate primary consumers then feed on them to grow and reproduce. The health of phytoplankton and zooplankton can be used to determine the health of the base of the food web.



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Phytoplankton

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The astonishing diversity of phytoplankton is visible only under a microscope. One trait all phytoplankton share, however, is chlorophyll—the green pigment that converts energy from the sun into fo ...

Images / Video



QUESTIONS ANSWERED

- ➔ What are Phytoplankton & why are they important?
- ➔ How and where are Phytoplankton measured in SFE?
- ➔ What are SFE Phytoplankton trends?
- ➔ What are the issues of concern in SFE?
- ➔ What is being done to improve the health of Phytoplankton in SFE?

Primary production (carbon fixation through photosynthesis) by phytoplankton is one of the key processes that influence water quality in the estuary. Phytoplankton are small, free-floating organisms that occur as unicellular, colonial, or filamentous forms (Home and Goldman 1994). Phytoplankton can affect pH, dissolved oxygen, color, taste and odor, and under certain conditions, some species can develop noxious blooms resulting in minimal deaths and human illness (Carmichael 1981). In freshwater, the cyanobacteria (blue-green algae) are responsible for producing toxic blooms, particularly in waters that are polluted with phosphates (van den Hoek et al. 1995)

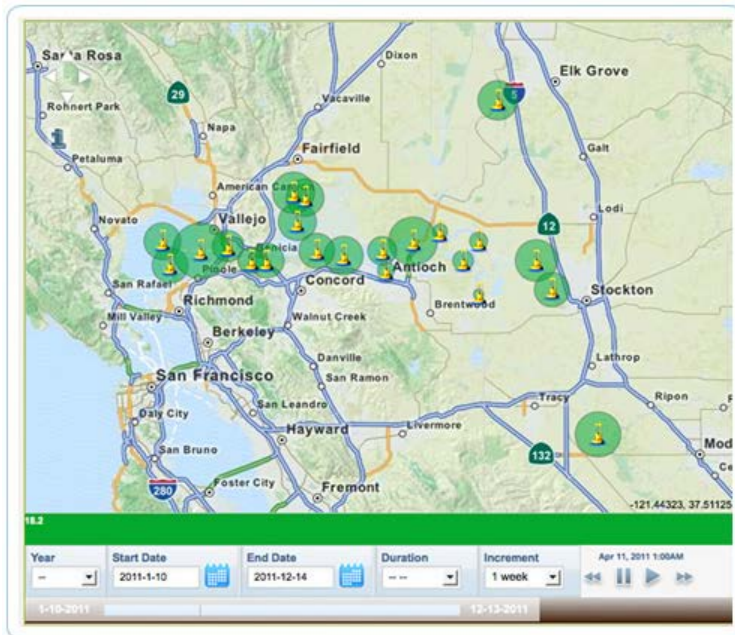
In addition to being an important food source for zooplankton, phytoplankton species assemblages can be useful in assessing water quality (Gannon and Stemberger 1978). Due to their short life cycles, phytoplankton respond quickly to environmental changes; their standing crop and species composition are indicative of the quality of the water mass in which they are found (APHA 1998). However, because of their transient nature, patchiness, and free movement in a river- and tidally-influenced environment, the utility of phytoplankton as water quality is limited and should be interpreted in conjunction with physiochemical and other biological data (APHA 1998). Learn more about how phytoplankton are measured in the SF Estuary [here](#).

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Chlorophyll a and pheophytin samples are collected monthly at 13 sites throughout the upper estuary using a submersible pump from one meter below the water's surface. Samples were analyzed according to [Standard Methods](#) (APHA 1998) by Bryte Laboratory. In addition to monthly, discrete sampling, 9 shore-based automated sampling stations use [fluorescence](#) to determine Chlorophyll a concentrations.



Watch how Chlorophyll a changed across the SFE from month to month during 2011.

[Click here to start animation with 2011 monthly time series data on map to the left](#)

Phytoplankton / chlorophyll a are dynamic: measurements change constantly as phytoplankton cells grow and divide, or are consumed or die, and as they are carried along with downstream freshwater flows, and in and out with the tides. In the animation to the left, the size of the monthly mean chlorophyll measurements is represented by the relative size of the circles.

In some parts of the Estuary, chlorophyll a is consistently low, in others it is consistently high, and at some stations there are strong seasonal trends, with strong peaks in winter or in spring/summer

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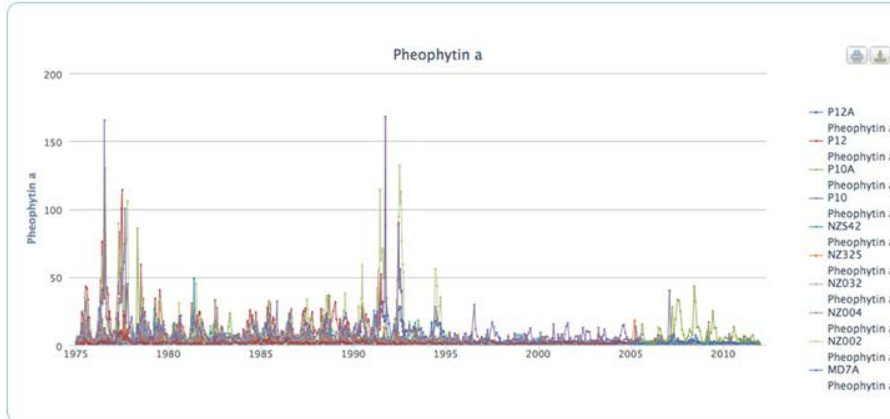
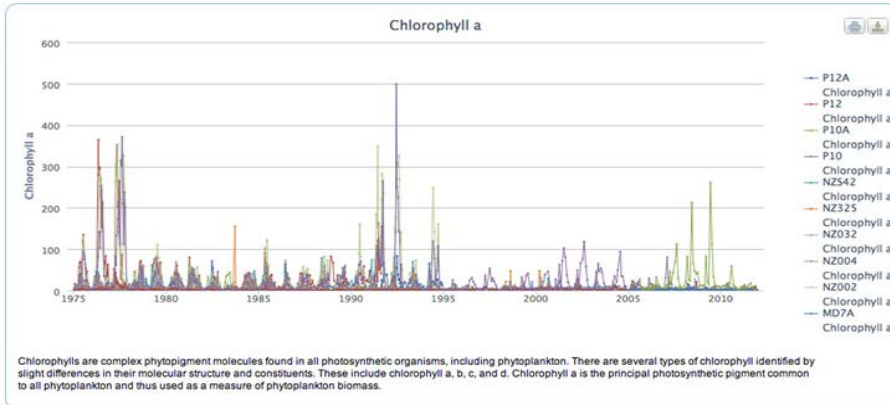
»»» What are the issues of concern in SFE?

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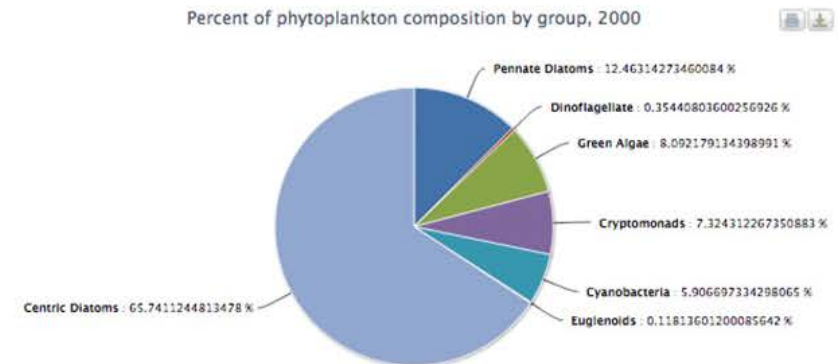
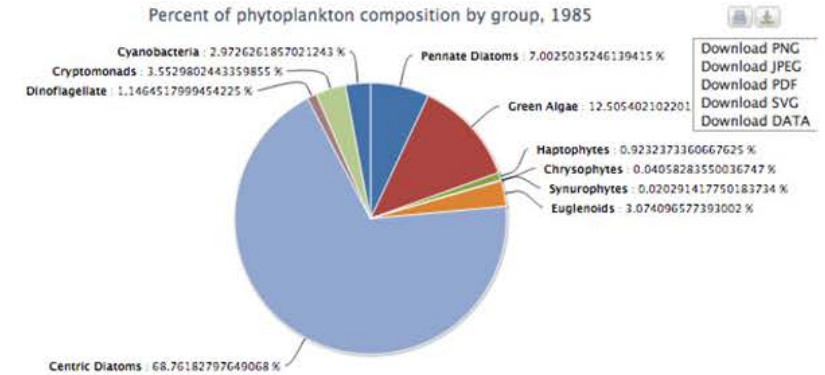
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Chlorophyll a and pheophytin trends over time are shown below**QUESTIONS ANSWERED**

➔ What are Phytoplankton & why are they important?

Changes in Phytoplankton Species Composition over time: The Fall of Diatoms and Rise of Toxic Cyanobacteria

Larger phytoplankton, including some kinds of diatoms, are an important food source for the zooplankton that are favored by native fishes including **delta smelt**. In many parts of the SFE, diatoms have decreased, or larger, single-celled species have been replaced by smaller, chain-forming species. And cyanobacteria, some of which can produce toxins, have been increasing in portions of the SFE. [Click here for the full story.](#)



Percent of phytoplankton composition by group, 2005



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Phytoplankton

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The astonishing diversity of phytoplankton is visible only under a microscope. One trait all phytoplankton share, however, is chlorophyll—the green pigment that converts energy from the sun into fo ...

Images / Video



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Zooplankton are typically tiny animals found near the surface in aquatic environments. They include copepods, mysids and jellyfish. Some zooplankton are native to the Delta (e.g. copepods like *Diaptomus spp.*, *Eurytomora affinis*, and *Acartia spp.*) and others have been introduced (e.g. copepods like *Limnoithona sinensis*, *Psuedodiaptomus forbesi*, and *Oithona davisae*).

Zooplankton are important food organisms for larval, juvenile, and small fishes, including delta smelt, juvenile salmon, striped bass, and small splittail. Some native zooplankton prefer freshwater (e.g. *Diaptomus spp.*), some prefer low salinity (e.g. *Eurytemora affinis*), and others prefer high salinity zones (e.g. *Acartia spp.*), so their presence and abundance can indicate water types. Learn more about how zooplankton are measured in the SF Estuary [here](#).

What are the Different Types of Fish in the SF Estuary and Why are they Important?

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Pelagic Fish



A severe decline of four pelagic (open-water) Delta fishes has become the concern for many scientists and resources agencies recently. Delta smelt (native), longfin smelt (native), threadfin shad (introduced) and juvenile striped bass (introduced) are collectively known as the POD (Pelagic Organism Decline) species.

Anadromous Fish



Anadromous (fish born in freshwater, migrate to salt water for most of their life, and migrate back to freshwater to spawn) species of major interest in the SF Estuary include commercial, sport and regulated fish, such as [Chinook salmon](#), [steelhead](#), and [sturgeon](#). Other non-native anadromous fish are present in the ecosystem such as introduced [striped bass](#) and American shad, and have historically been important fisheries since their introductions in the late 1800s.

Many of these native and non-native anadromous species populations abundance indices have declined precipitously in the latter part of the 20th century. Among the four formerly robust runs of Chinook salmon spawning in the Sacramento-San Joaquin River system, all are classified as endangered, threatened or species of concern. The Sacramento fall-run Chinook abundance remains substantial and provides for sport and commercial fisheries in most years.

Bay Fish

[Images of species](#)[Images of species](#)[Images of species](#)

Bay species of major interest include

QUESTIONS ANSWERED

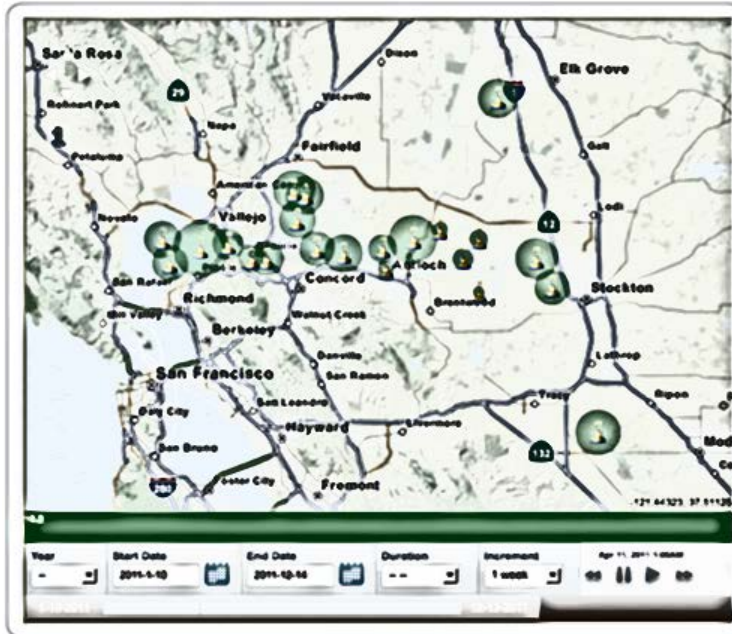
- What are the different types of fish in the SF Estuary and why are they important?
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- What is being done to improve the health of fish in the SF Estuary?

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The California Department of Fish and Wildlife and US Fish and Wildlife Service survey fish in the SF Estuary with many different types of equipment at different times of the year. These surveys include the [Otter Trawl](#), [Spring Kodiak Trawl](#), [Spring midwater Trawl](#), [Fall Midwater Trawl](#), [beach seining](#)...



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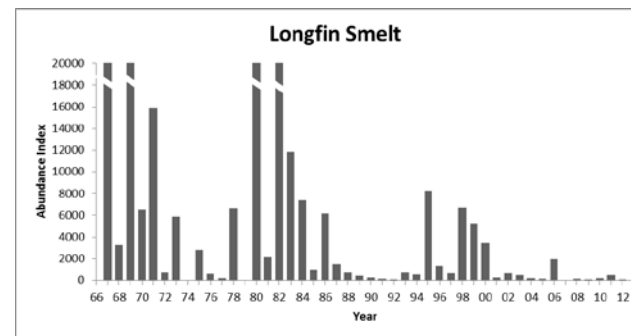
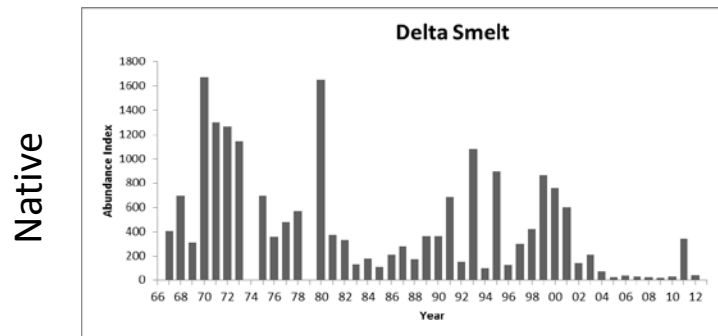
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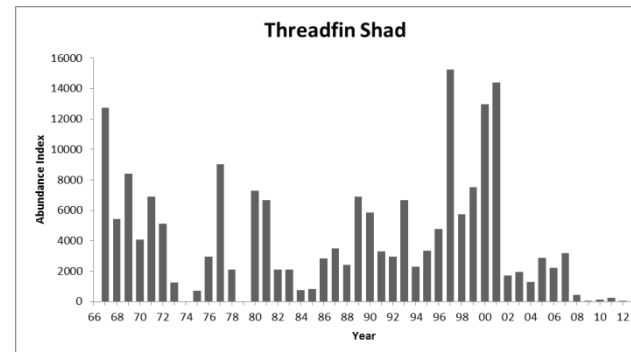
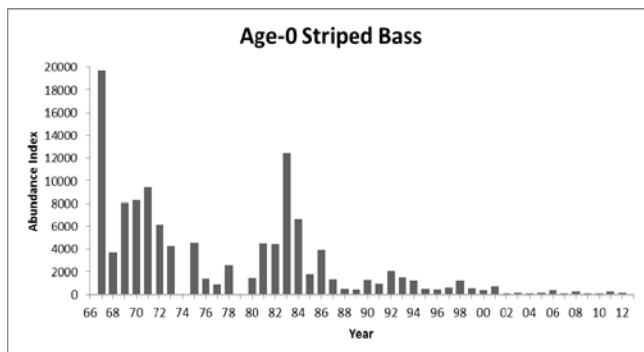
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Pelagic Fish

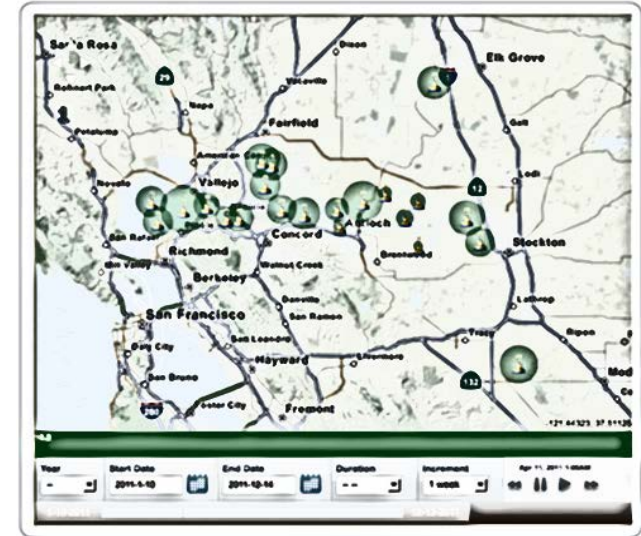
The California Department of Fish and Wildlife, under the auspices of the Interagency Ecological Program, monitors open-water (pelagic) fishes in the Delta. The Fall Midwater Trawl Survey (FMWT) has sampled annually since its inception in 1967, with the exceptions of 1974 and 1979. The FMWT was initiated to determine the relative abundance and distribution of age-0 striped bass in the estuary, but the data have also been used for other upper estuary open-water species, including Delta smelt, longfin smelt, threadfin shad, American shad, and splittail. The FMWT abundance indices for Delta smelt, longfin smelt, age-0 striped bass, and threadfin shad are presented below. Abundance trends vary among these species; however, the abundance indices for all four species rapidly declined to record low levels around 2002. In 2005, the Interagency Ecological Program formed a Pelagic Organism Decline Management Team to evaluate the potential causes of the declines. [More here.](#)



Native



Non-Native



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- What are the issues of concern in the SF Estuary?
- What is being done to improve the health



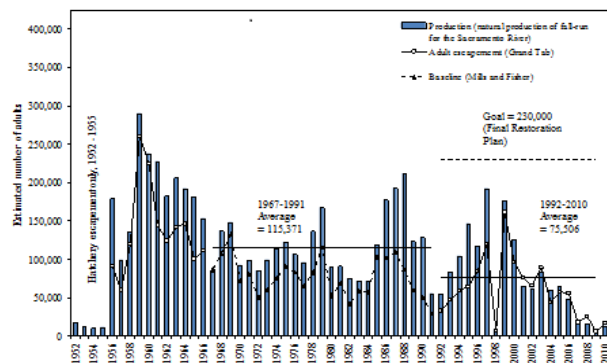
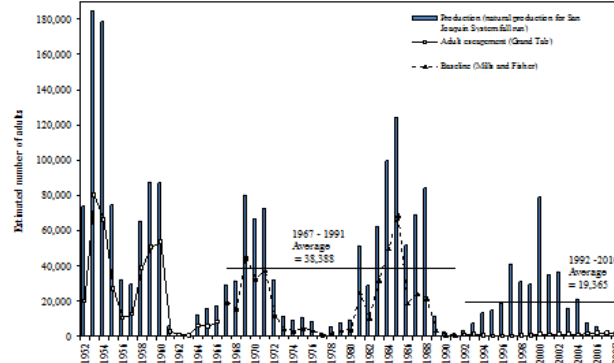
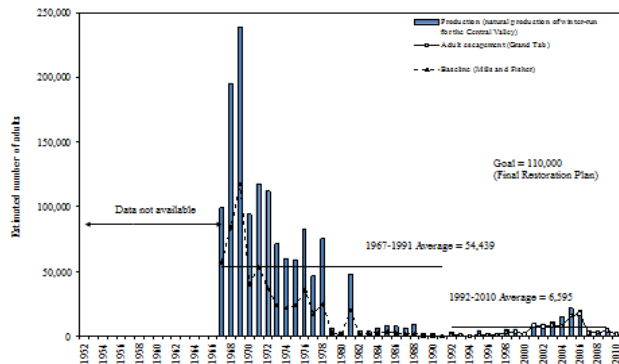
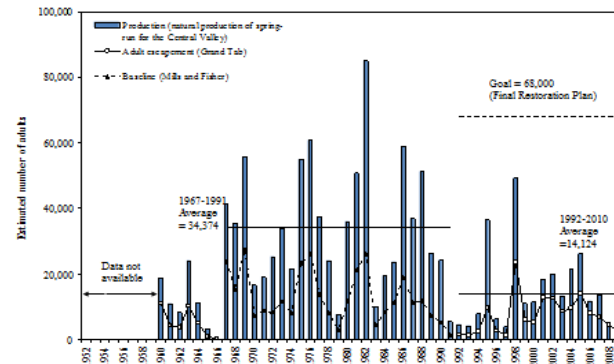
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Anadromous Fish

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Fall-Run Chinook Salmon – Sacramento System**Fall-Run Chinook Salmon – San Joaquin System****Winter-Run Chinook – Central Valley Rivers and Streams****Spring-Run Chinook Salmon – Central Valley Rivers and Streams**

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What are SF Estuary Fish Trends (part 3)?

Bay Fish

The State of the San Francisco Bay Report (2011) summarized fish indicators associated with the health of the San Francisco Bay and said the following:

“Based on the Fish Index and its component indicators, the health of the San Francisco Bay has declined since the 1980s in all regions except Central Bay, near the Golden Gate. The decline is most severe in Suisun Bay, the upstream region of the Estuary heavily influenced by the amounts, timing and quality of freshwater inflows from the Bay’s Sacramento-San Joaquin watershed.

Since 1993, when the CCMP (Comprehensive Conservation and Management Plan) called for recovery of and reversing the declines of estuarine fish and wildlife species, none of the Bay fish communities in any part of the Bay have improved. Instead six native fish species that rely on the Bay have been listed under the federal and/or state Endangered Species Acts.

Decades of scientific research have identified the causes for the declines: degraded open water and marsh habitats, impaired water quality, reduced food availability, and increasing prevalence of harmful non-native species”

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

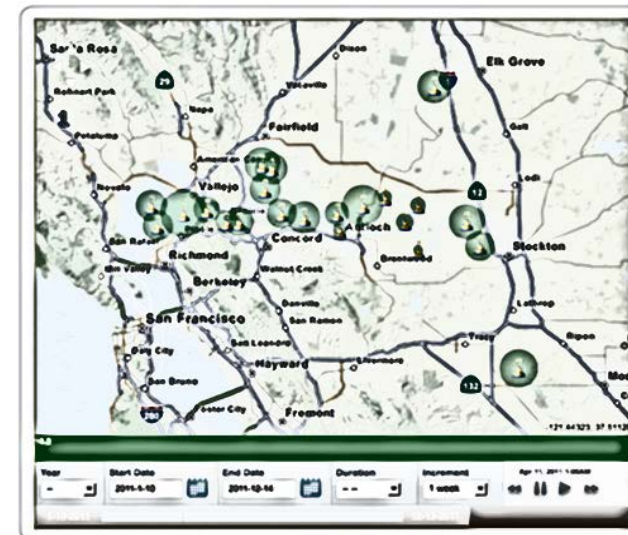
ESTUARIES

- Stressors
- Laws, Regulations & Standards
- Research
- Monitoring Programs, Data Sources & Reports
- Restoration & Management

Graphs like p. 44 of SOTB

QUESTIONS ANSWERED

- What are the different types of fish in the SF Estuary and why are they important?
- How and where are fish surveyed in the SF Estuary?
- What are SF Estuary fish trends?
- What are the issues of concern in the SF Estuary?
- What is being done to improve the health of fish in the SF Estuary?



Watch how Chlorophyll a changed across the SFE from month to month during 2011.

[Click here to start animation with 2011 monthly time series data on map to the left](#)

Phytoplankton / chlorophyll a are dynamic: measurements change constantly as phytoplankton cells grow and divide, or are consumed or die, and as they are carried along with downstream freshwater flows, and in and out with the tides. In the animation to the left, the size of the monthly mean chlorophyll measurements is represented by the relative size of the circles.

In some parts of the Estuary, chlorophyll a is consistently low, in others it is consistently high, and at some stations there are strong seasonal trends, with strong peaks in winter or in spring/summer



How Can You Determine the Health of Water?

- [Cal/EPA](#)
- [Natural Resources Agency](#)
- [About the California Water Quality Monitoring Council](#)

ESTUARIES

- [Stressors](#)
- [Laws, Regulations & Standards](#)
- [Research](#)
- [Monitoring Programs, Data Sources & Reports](#)
- [Restoration & Management](#)

QUESTIONS ANSWERED

- [Why are water quality and quantity important?](#)
- [How and where are water quality and quantity measured in the SF Estuary?](#)
- [What are SF Estuary water trends?](#)
- [What are the issues of concern in the SF Estuary?](#)
- [What is being done to improve water in the SF Estuary?](#)



How Can You Determine the Status of Habitat?

- [Cal/EPA](#)
- [Natural Resources Agency](#)
- [About the California Water Quality Monitoring Council](#)

ESTUARIES

- [Stressors](#)
- [Laws, Regulations & Standards](#)
- [Research](#)
- [Monitoring Programs, Data Sources & Reports](#)
- [Restoration & Management](#)

QUESTIONS ANSWERED

- Why are habitat location, type, quality, and quantity important?
- How can habitat be measured in the SF Estuary?
- What are SF Estuary habitat trends?
- What are the issues of concern in the SF Estuary?
- What is being done to improve habitats in the SF Estuary?



How Can You Determine the Status of Ecological Processes?

- [Cal/EPA](#)
- [Natural Resources Agency](#)
- [About the California Water Quality Monitoring Council](#)

ESTUARIES

- [Stressors](#)
- [Laws, Regulations & Standards](#)
- [Research](#)
- [Monitoring Programs, Data Sources & Reports](#)
- [Restoration & Management](#)

QUESTIONS ANSWERED

- [Why are ecological processes important?](#)
- [What ecological processes are being measured in the SF Estuary?](#)
- [How are SF Estuary ecological processes trending?](#)
- [What are the issues of concern in the SF Estuary?](#)
- [What is being done to improve ecological processes in the SF Estuary?](#)



What Types of Stewardship Support a Healthy Estuary?

- [Cal/EPA](#)
- [Natural Resources Agency](#)
- [About the California Water Quality Monitoring Council](#)

ESTUARIES

- [Stressors](#)
- [Laws, Regulations & Standards](#)
- [Research](#)
- [Monitoring Programs, Data Sources & Reports](#)
- [Restoration & Management](#)

QUESTIONS ANSWERED

- Why are habitat location, type, quality, and quantity important?
- How can habitat be measured in the SF Estuary?
- What are SF Estuary habitat trends?
- What are the issues of concern in the SF Estuary?
- What is being done to improve habitats in the SF Estuary?



What Laws, Regulations, and Standards Protect the SF Estuary?

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

ESTUARIES

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- Laws, Regulations & Standards
- Research
- Monitoring Programs, Data Sources & Reports
- Restoration & Management

Laws regulations and policies that protect estuaries include those that are associated with freshwater (click to connect to Streams Rivers & Lakes portal

[\[http://www.waterboards.ca.gov/mywaterquality/eco_health/streams/improvement/\]](http://www.waterboards.ca.gov/mywaterquality/eco_health/streams/improvement/)),

surrounding land, including tidal wetlands, managed and seasonal wetlands, and riparian habitat (click to connect with Wetlands Portal:

[\[http://www.waterboards.ca.gov/mywaterquality/eco_health/wetlands/improvements/regulations.shtm\]](http://www.waterboards.ca.gov/mywaterquality/eco_health/wetlands/improvements/regulations.shtm)), coasts and oceans (click to connect with Oceans portal).

California's estuaries, and the organisms that live in them, are protected by many federal and state laws, regulations, and policies designed to prevent further degradation and destruction. Regulations protect ecological services and benefits derived from estuaries as well as protecting special status fish, wildlife and plants and their habitats, vegetation communities, wetland extent, water quality, and beneficial uses. Each law and regulation has been put into place over many decades to address different resource and habitat protection needs, with responsibility for enforcement assigned the appropriate government agencies. Understanding the different laws and the agencies that enforce them is necessary for a complete picture of estuary protection in California and the United States.

Water quality standards are an effective tool available to protect the overall health of estuaries in California and the functions they provide, including shoreline stabilization, nonpoint source runoff filtration, wildlife habitat, and erosion control, which directly benefit adjacent and downstream waters. Water quality standards, including designated uses, criteria, and anti-degradation policies can provide a sound legal basis for protecting estuarine resources through State water quality management programs. Other regulations protect wetlands within the estuaries from damage, filling, or destruction through planned construction activities. Several additional programs safeguard estuarine integrity, whether directly and indirectly, by preventing changes to important populations of plant and animal species and their habitats.

In addition to enforcing regulations, the United States and California have set an overarching goal to prevent further decline of wetlands through a "no net loss" approach, a goal recommended by the National Wetlands Policy Forum in 1987 and adopted in 1989. Other mechanisms for wetland protection include acquiring land in high priority areas, integrating knowledge of wetland resources into land use planning, mitigating the effects of construction activities (wetland creation or restoration in one area to account for destruction in another area), and creating disincentives for conversion of wetlands to other land uses. For example, state transportation agencies, such as Caltrans, are required to be in compliance with regulations pertaining to wetlands and to implement the state and federal policies of "no net loss" of wetlands. As a result of these policies, disturbances or impacts to wetlands due to transportation projects are compensated through the creation, restoration, enhancement, and/or preservation

[Click for information on San Francisco Estuary – specific laws regulations and policies](#)

QUESTIONS ANSWERED

- [What is an estuary?](#)
- [Where are California's estuaries?](#)
- [How healthy is the SF Estuary?](#)
- [What is being done to restore the SF Estuary?](#)
- [How can I be part of the solution?](#)



What Federal Laws, Regulations, and Standards Protect the SF Estuary?

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

ESTUARIES

- Stressors
- Laws, Regulations & Standards
- Research
- Monitoring Programs, Data Sources & Reports
- Restoration & Management

[Federal Endangered Species Act](#)



[Clean Water Act](#)



[Clean Water Act, Section 404](#)



[Farm Bill](#)



[Rivers and Harbors Act, Section 10](#)



[Coastal Zone Management Act](#)



[Other Federal Agency Programs](#)

[Executive Order 11990, "Protection of Wetlands"](#)

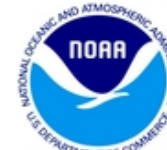


[Executive Order 11988, "Floodplain Management"](#)



[Click here for more detailed information on these Federal Programs](#)

[Click for information on San Francisco Estuary – specific laws regulations and policies](#)



QUICK LINKS

[California State Laws, Regulations, and Policies to Protect Estuaries](#)
[San Francisco Estuary – specific Laws, Regulations, and Policies](#)

What Federal Laws, Regulations, and Standards Protect the SF Estuary?

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

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Endangered Species Act



[Federal Endangered Species Act](http://www.fws.gov/endangered/laws-policies/index.html) [link to <http://www.fws.gov/endangered/laws-policies/index.html>]

The purpose of the Endangered Species Act (ESA), which was passed in 1974, is to protect and recover imperiled species and the ecosystems upon which they depend. It is administered by the U.S. Fish and Wildlife Service (**USFWS**) [link to <http://www.fws.gov/endangered/>] and the National Marine Fisheries Service (**NMFS**) [link to: <http://www.nmfs.noaa.gov/pr/laws/esa/>].

Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. For the purposes of the ESA, Congress defined species to include subspecies, varieties, and, for vertebrates, distinct population segments.

The **USFWS** [link to <http://www.fws.gov/endangered/>] has primary responsibility for enforcing the ESA in relation to protecting terrestrial and freshwater organisms. In California's estuaries, federally listed endangered and threatened species include Delta smelt, salt marsh harvest mouse, giant garter snake, light-footed clapper rail, California least tern, Western snowy plover, salt marsh bird's-beak, and California seablite.

NMFS [link to <http://www.nmfs.noaa.gov/pr/laws/esa/>], a division of the National Oceanic and Atmospheric Administration (NOAA), has the primary Federal responsibility for the conservation, management, and development of living marine resources and for the protection of certain marine mammals and endangered species on all public and private lands, under numerous federal laws. NMFS is responsible for the protection of anadromous fish [link to definition] listed under the Endangered Species Act, including Chinook and coho salmon, steelhead trout, and green sturgeon species that use California's estuaries [link to: <http://www.nmfs.noaa.gov/pr/species/esa/fish.htm>]

Clean Water Act



The [Clean Water Act](#) (CWA) is the primary federal law in the United States governing water pollution and regulating water quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972. Two agencies have primary responsibility for enforcement of the Clean Water Act: The [U.S. Army Corps of Engineers](#) (the Corps) and the U.S. Environmental Protection Agency (USEPA).

- One of the primary civilian missions of the [U.S. Army Corps of Engineers](#) is to manage the nation's waterways and wetlands. USACE activities include regulating activities in wetlands including issuing dredge and fill permits and authorizing the establishment of wetland areas. The Corps' also builds and

[Click for information on San Francisco Estuary – specific laws regulations and policies](#)





What Research is Being Performed in the SF Estuary?

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

ESTUARIES

- Stressors
- Laws, Regulations & Standards
- Research
- Monitoring Programs, Data Sources & Reports
- Restoration & Management

Many groups are conducting and funding original research in the San Francisco Estuary, including those listed below.

- Interagency Ecological Program
- San Francisco Estuary Institute
- State and Federal Contractors Water Agency
- SWAMP
- DSP - Fellows
- *Ecosystem Restoration Program* <http://www.dfg.ca.gov/ERP/>
- NSF
- NCEAS
- USGS <http://www.werc.usgs.gov/> (e.g., <http://www.werc.usgs.gov/Project.aspx?ProjectID=238>)
- *San Francisco National Estuarine Research Reserve System* <http://www.sfbaynerr.org/> and <http://www.yourwetlands.org/>
- *San Francisco Bay Joint Venture* <http://www.sfbayjv.org/>
- *PRBO Conservation Science – San Francisco Bay Program* <http://www.prbo.org/cms/609>
- *San Francisco Invasive Spartina Project* <http://www.spartina.org/>
- *University of California, Davis*
 - *(many labs to link to)*
- *University of California, Berkeley*
 - *Maggi Kelly lab* - <http://kellylab.berkeley.edu/carbon-sequestration-wetlands/>



What Monitoring Programs, Data Sources, & Reports are there for the SF Estuary?

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

ESTUARIES

- Stressors
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- Research
- Monitoring Programs, Data Sources & Reports
- Restoration & Management

Many groups are performing *ecosystem_monitoring* in the San Francisco Estuary, including those listed below. The [Central Valley Monitoring Directory](#) is a good source of metadata for much of the monitoring being performed in the Central Valley.

- Interagency Ecological Program
- San Francisco Bay Regional Monitoring Program
- Surface Water Ambient Monitoring Program
- Irrigated Lands Regulatory Program
- USGS <http://www.werc.usgs.gov/> (e.g., <http://www.werc.usgs.gov/Project.aspx?ProjectID=238>)
- DPR
- CDFW
- USFWS
- DWR salvage and Suisun
- BoR?
- San Francisco Bay Joint Venture <http://www.sfbayjv.org/>
- PRBO Conservation Science – San Francisco Bay Program <http://www.prbo.org/cms/609>
- San Francisco Invasive Spartina Project <http://www.spartina.org/>



Where Did we Find the Information Used for the SF Estuary Assessments?

For readers interested in more detail, you can find more from the links below. ([summaries and plans-link to EPA's page specifically for document repository](#))

Delta

- Delta Historical Ecology <http://www.sfei.org/DeltaHEStudy>
- The State of Delta Science http://www.science.calwater.ca.gov/pdf/publications/sbds/sbds_final_update_122408.pdf
- PPIC Reports
- ERP Conservation Strategy
- Delta Plan
- Delta Vision Foundation <http://www.sfei.org/DeltaHEStudy>
- EPA's SF Delta watershed map – [Erin check for other WS docs](#)
- Delta Atlas
- Delta Science Plan
- Pulse of the Delta
- Suisun Marsh Plan
- Creating an Adaptive Management Decision-Making Framework to Address Uncertainties in Delta Habitat Restoration: Tidal Marsh Productivity Exports, Aquatic Food Webs, and Delta Smelt (move to PMs page)
- POD Report

San Francisco Bay

- SFEP CCAMP Check-ups
- CCMP NEP ([Erin](#))
- Nat'l Est Coastal Conditions Report
- State of The Bay Report
- [State of the Birds Report](http://data.prbo.org/sfstateofthebirds/)
- Pulse of the Estuary
- State of the Estuary Report
- SF Habitat Goals Project <http://scc.ca.gov/2011/01/27/trio-of-habitat-goals-completed-for-9-county-bay-area/>

References used on this Estuaries website

[APHA] American Public Health Association, American Waterworks, and Water Environmental Federation. 1998. Standard Methods for the Examination of Water and Wastewater. 20th edition. Washington, D.C.: American Public Health Association.

Gannon, J. E. and R. S. Stemberger. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality.

- Cal/EPA
- Natural Resources Agency
- About the California Water Quality Monitoring Council

ESTUARIES

- Stressors
- Laws, Regulations & Standards
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- Restoration & Management