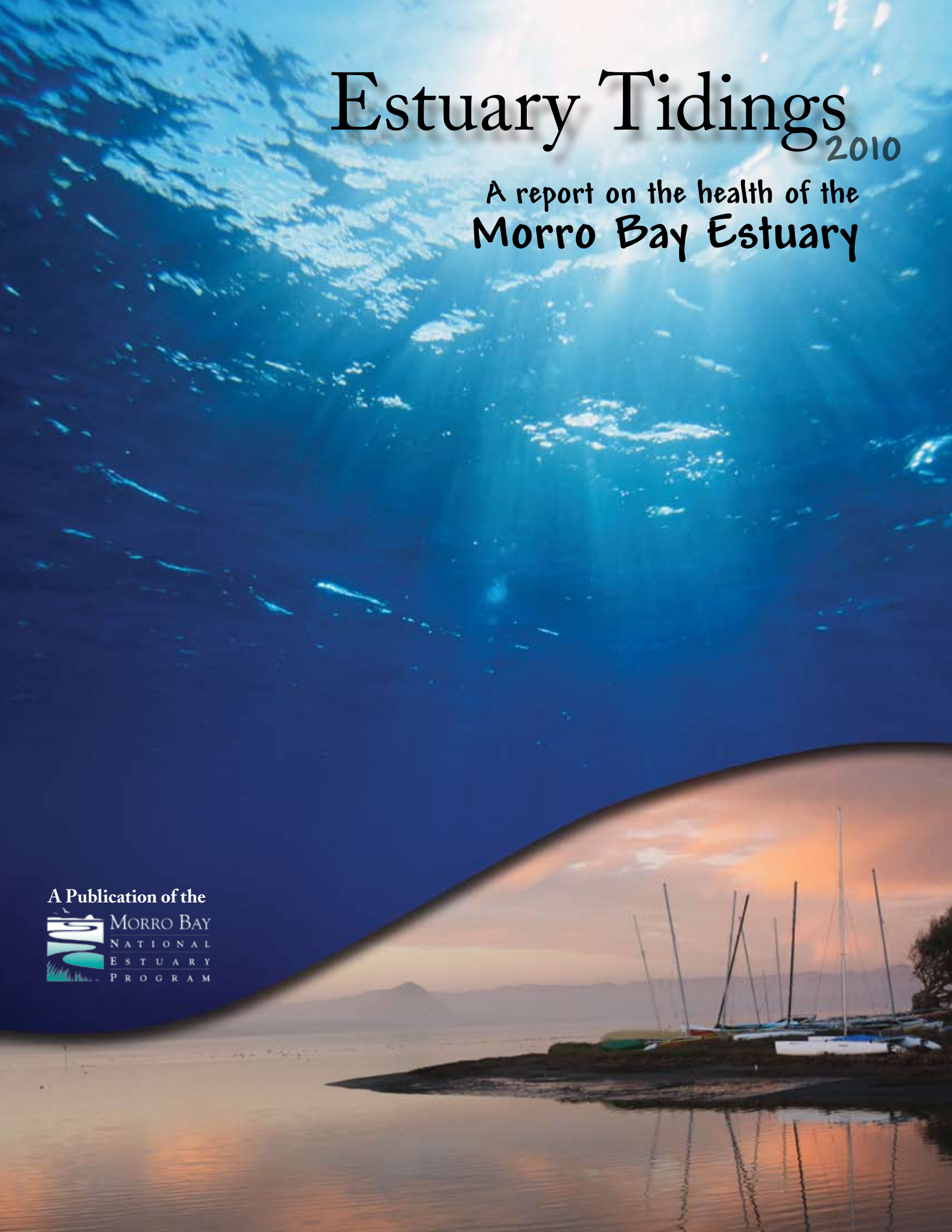
Estuary Tidings 2010

A report on the health of the Morro Bay Estuary



A Publication of the

Morro Bay National Estuary Program

How Healthy is the Estuary?

Morro Bay is a remarkable place drawing thousands of visitors each year for its scenic beauty. The bay is home to a wide range of wildlife and provides for human recreation and industry, but is this ecosystem healthy? Morro Bay's ability to support these ecological and social uses, both now and into the future, hinges on its environmental health.

This report examines the estuary's health by breaking it down into eight specific questions. The answers provide an indication of the ecosystem's health today, and with continued monitoring, will provide important information about environmental trends while guiding efforts to protect and restore this special place.

Photo by Dean Sullivan

Indicator Questions in This Report

Why is the Health of the Morro Bay Estuary Important?

Morro Bay is an estuary, a place where freshwater from creeks mixes with the ocean's salty tides

Healthy estuaries are among the most productive environments on earth. Like other wetland and coastal habitats, many estuaries have been lost or severely degraded by intensive urban development. Morro Bay is one of the largest and least disturbed estuaries remaining in central and southern California. Its sheltered waters, salt marshes and eelgrass beds provide rare and important habitat for a diverse array of fishes, birds, shellfish, and other life. The estuary is also a center of activity for people and contributes significantly to our local economy. The bay, a working harbor, supports commercial and sport fishing as well as recreational boating. More than 25,000 people make their homes along the bay's shore and thousands more visit each year to take in its beauty and participate in fishing, boating, bird watching and hiking.

What is a Watershed?

The Morro Bay Watershed is a network of streams and creeks, which drains rainfall and other freshwater from 48,000 acres of land into the estuary.

The watershed can also be a source of sediment and pollution for the estuary. Each rainstorm brings a wash of water over the landscape that can carry loose soil, oil, pesticides and herbicides, fertilizer and bacteria into the creeks and bay. Therefore, what happens in the watershed greatly impacts the health of the estuary.

Is the bay clean enough to support commercial shellfish farming?

Yes, in designated, operating harvest areas

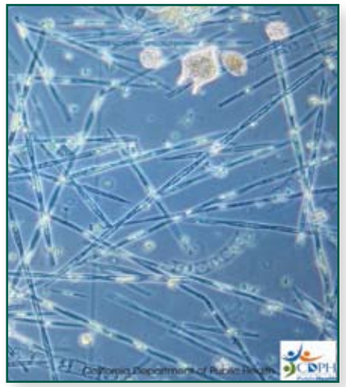
Three shellfish parcels exist in Morro Bay. Of these three, two are partially closed to shellfish harvesting due to historically elevated bacteria levels or due to a lack of water quality data. The California Department of Public Health (CDPH) regulates shellfish growing areas to ensure that they meet regulatory standards for clean water. CDPH has concluded that bay waters are clean enough to support commercial shellfish farming in portions of the three parcels. Temporary closures are necessary immediately following rainfall events, during harmful plankton blooms, and at certain times of year historically associated with poor water quality.

Potential risks within growing waters include the presence of disease-causing bacteria, viruses and protozoa. Waters are regularly monitored for fecal coliform, whose presence indicates that fecal contamination may have occurred. Since bivalve shellfish are filter feeders, pollutants in the water can become temporarily concentrated in shellfish and cause illness in humans who eat them. Growers work closely with CDPH to ensure that shellfish are only harvested when the waters in which oysters grow are clean.

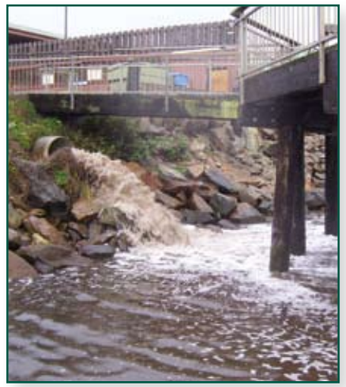
Shellfish farms like the one shown above operate in Morro Bay through leases with the California Department of Fish and Game. Production has varied over the years, with peaks occurring during World War II, in the late 1950s and again in the mid-1960s when nearly 250,000 pounds of shucked oyster meat was produced. Market demand has since changed and oysters are sold fresh, altering how production is measured. In 2006, 800,000 oysters were harvested in Morro Bay.

What Causes Temporary Closure of Shellfish Growing Waters?

Shellfish growing areas may be temporarily closed due to various water quality impairments.



Naturally-occurring blooms of some toxic strains of plankton can temporarily render shellfish harmful to humans or marine mammals who eat them.

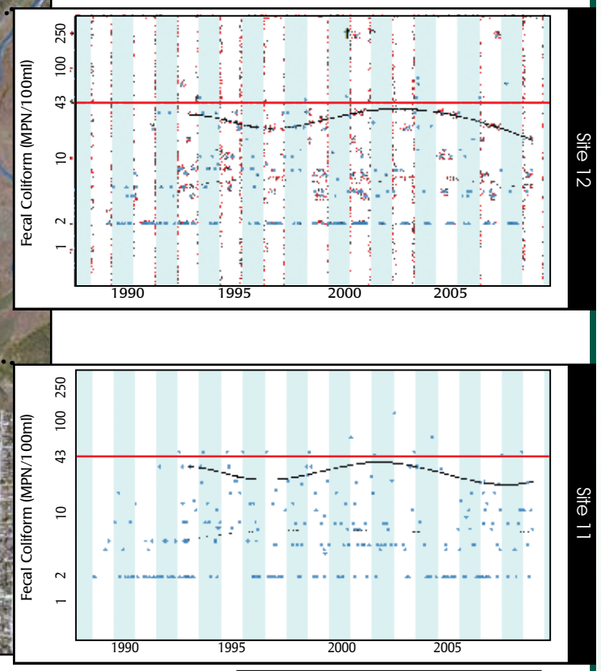


As rainwater moves over urban areas, it carries pollutants such as oil, heavy metals, and pet waste untreated into our waterways.

Illegal discharges and sewage spills also contribute to bay bacteria levels.

Where Can Shellfish Be Grown for Commercial Harvesting?

The graphs below illustrate the long-term trends in bacteria levels at two of the 14 regularly monitored sites. Blue dots represent bacteria concentrations of tests conducted while growing areas were open for harvest. The majority of the data (represented by the black line) must remain below the regulatory limit (represented by the red line) for growing waters to remain open.*



The map above shows established shellfish harvesting parcels. Harvesting is not currently allowed in the cross-hatched areas on the map either due to elevated bacteria levels or to a lack of water quality data. In open areas (shown in green), growers are allowed to harvest shellfish when water testing indicates that the water is clean. Open areas may be temporarily closed due to rainfall, seasonal closures or other impacts.

Legend

- Closed Areas
- Open Areas
- Bacteria Monitoring Site
- Highways
- Creeks

• CA Department of Public Health, bacteria data from 1989 to 2008. Fecal coliform data was analyzed for this report using a regression analysis model rather than the estimated 90th percentile calculation conducted by CDPH for the purposes of classifying shellfish growing waters. CDPH conducts a running analysis of the past 30 samples to determine the status of growing waters. Our analysis was not intended to verify the classification status of the growing waters but rather to document the trend in bacteria data over time.

*The 90th percentile of the data (represented by the black line) must be below the regulatory limit of 43 MPN/100 mL (represented by the red line). The data must also meet a geomean criteria (represented by the dotted line) of 14 MPN/100mL.

Photo credit: Oyster farm by Neal Maloney, Plankton courtesy CA Dept of Public Health, Stormwater outfall from MBNEP, Boats courtesty iStockphoto.com

Is Morro Bay safe for swimming?

Yes, in most areas

Are creeks safe for recreational contact?

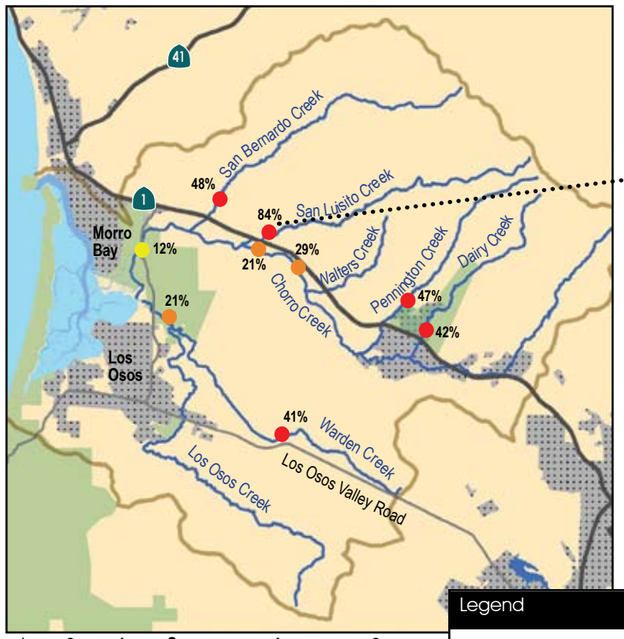
Not consistently

Most of the bay sites monitored for bacteria showed levels safe for swimming. However at some sites in the back bay, bacteria levels were above the recommended threshold in 10 to 20% of samples collected. The majority of creek sites posed a safety risk in at least 20% of samples collected.

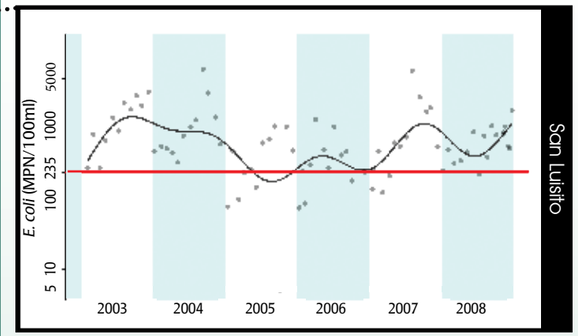
Bacteria, viruses and protozoa can cause illness in humans, who may ingest water while swimming. "Indicator" bacteria like *E. coli*, found in the intestines of warm-blooded animals, help to assess whether water is contaminated with fecal material. The presence of these indicator organisms do not necessarily mean that serious pathogens are present, nor does it pinpoint the source, which could be wild animals, humans, or domestic animals such as cattle, cats or dogs.

People and pets use the bay for a variety of recreational activities like paddleboarding, kayaking and swimming.

Bacteria in Creeks



The map above shows nine watershed sites that are monitored monthly for bacteria by Estuary Program volunteers. The color of each dot represents the percent of samples collected at the site when bacteria levels were too high for safe swimming.*



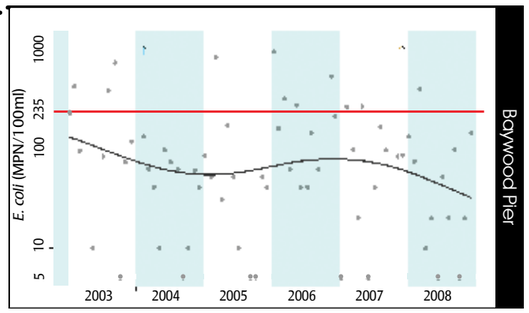
San Luisito Creek exceeded safe recreational contact limits (235 MPN/100 mL, represented by the red line) in 84% of the samples. To address these consistently elevated levels, the Estuary Program partnered with a private landowner to install 9,000 feet of fencing on both sides of the creek to exclude cattle. Estuary Program volunteers will conduct monitoring to detect changes to bacteria levels.

Bacteria in the Bay

The map above shows seven bay sites that are monitored monthly for bacteria. The color of each dot represents the percent of samples collected at the site that exceeded recommended criteria for safe swimming.**

Heal the Bay, the environmental group that compiles the statewide beach report card, advises staying out of the water for at least three days following a rainstorm.

At Baywood Pier, below, a number of test results exceeded the limit for safe swimming (235 MPN/100 mL, represented by the red line). Among the shoreline sites, Baywood Pier had the highest number of exceedences (19% of samples).



*All samples used in these analyses were collected and analyzed by Estuary Program volunteers. Data was compared to a value of 235 MPN/100 mL for a single sample, which is from EPA's Ambient Water Quality Criteria for Bacteria published in 1986. While this criteria value is not yet a regulatory standard in our region, it is the recommended level for safe recreational contact when *E. coli* is used as the indicator species. Thus, any measured values that exceed this level are of concern.

**Bay data was compared to a screening value adapted from the freshwater criteria. This value is not a regulatory standard but rather a level of concern recommended by EPA. Since *E. coli* is known to be sensitive to salt water, data from the bay are likely an underestimation of bacteria levels.
Photos by Mike Baird.

Does water quality in creeks and bay support fish and aquatic life?

Yes, habitats are healthy in most areas, but some are degrading

Healthy habitat encompasses many considerations, including chemical, physical and biological factors.

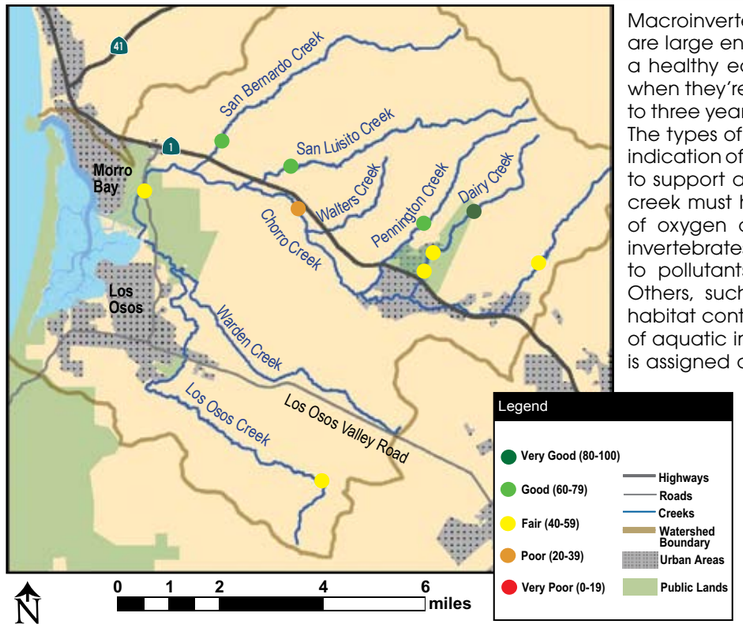
The estuary is home to many species of fish, shellfish, and other aquatic animals. These animals breathe oxygen, just as we do. The available oxygen in the water is called dissolved oxygen. Low levels of dissolved oxygen in the water can be stressful and even deadly to fish and other animals. In some parts of the bay, limited tidal flushing and nutrient over-enrichment contribute to the problem.

Similarly, healthy creeks and riparian habitat are vital components of thriving ecosystems. The Estuary Program monitors the habitat quality of the creeks each spring. The data collected examines plant communities, creek erosion, water quality and aquatic invertebrate communities. These data are compiled into a scoring system that indicates the health of the riparian ecosystem.

Calineuria, or Golden Stonefly

An additional concern for aquatic habitats is a new category of pollutants known as emeging contaminants. We use many chemicals, pharmaceuticals and personal care products in our daily lives. Many of these are not completely removed during the wastewater treatment process, and these chemicals may ultimately end up in our natural waterways. The impact of these contaminants is not fully known, and researchers are working to better understand this broad category of pollutants.

The Secrets of the Flies: What Can We Learn About Water Quality?



Macroinvertebrates are organisms without a backbone that are large enough to see with the naked eye. They require a healthy ecosystem during the portion of their lifecycle when they're in the water. This can vary from three months to three years, and some, like snails, never leave the water. The types of macroinvertebrates found in a creek give an indication of water quality over a broad time frame. In order to support a diverse population of macroinvertebrates, a creek must have cool, clean water with adequate levels of oxygen and pool and riffle habitat. Some types of invertebrates, such as stoneflies, are extremely sensitive to pollutants and can't survive in polluted waterways. Others, such as worms and snails, are tolerant of poor habitat contaminated with pollutants. Based on the types of aquatic invertebrates found in the sample, each creek is assigned a score. A high score indicates that the creek habitat is healthy and well- balanced.*

Each spring, Estuary Program volunteers venture out into local creeks to assess habitat quality, erosion indicators and water quality as well as collect a sample of aquatic macroinvertebrates.

Dissolved Oxygen in the Bay

Estuary Program volunteers kayak to seven bay sites in the early morning hours to measure dissolved oxygen (DO) at the time of day when it is typically the lowest. The average DO levels for each year are depicted on the map. Sites in the northern end of Morro Bay consistently maintain levels of DO that are healthy for wildlife. Areas in the back bay maintain high DO concentrations during the winter, but not the summer. This is likely attributable to limited tidal flushing, nutrient enrichment and other factors.

*Scores were determined based on the Southern California Index of Biological Integrity developed by the Aquatic Bioassessment Laboratory of the California Department of Fish and Game.

SLOSEA array photo by John Penvenne.

SLOSEA

The San Luis Obispo Science and Ecosystem Alliance (SLOSEA) is a collaborative group of scientists, resource managers and stakeholders studying the Morro Bay Estuary and adjacent coastal zone who are housed at Cal Poly's Center for Coastal Marine Sciences. SLOSEA's ecosystem-based management approach focuses on a healthy, resilient coastal ecosystem that provides for thriving and interacting populations of plant, animal and human communities.

Water quality stations, like the one above, provide a constant data stream to SLOSEA scientists and can be viewed on their website at www.SLOSEA.org

Nonylphenol, a chemical used in many common products, is an emerging pollutant that SLOSEA scientists are examining. Scientists have identified significant concentrations of nonylphenol in water and sediments samples in the bay and have observed the chemical in goby fish living in the estuary. The gobies have developed tumors and anatomical abnormalities that could be correlated to exposure to the chemical. Successive studies of other marine wildlife have shown increased levels of nonylphenol as well, though at levels lower than in the gobies. Nonylphenol does not appear to be a direct threat to humans.

SLOSEA researchers have also found the chemical in other regions, indicating that it is common in coastal waters. Continued efforts will determine whether the chemical is a concern for aquatic life in the amounts currently allowed under U.S. law, and will establish a water quality observatory in Morro Bay enabling modeling and predictions about the movement of pollutants within the ecosystem.

Does Morro Bay support healthy eelgrass beds?

Yes, after declines in the 1990s, eelgrass acreage has shown continued recovery

Eelgrass is a flowering plant that forms underwater meadows in sheltered marine environments. Eelgrass beds are a scarce and important habitat, providing food and shelter for many fish and invertebrates. Overwintering black brant geese rely on eelgrass as their primary food source in Morro Bay. Eelgrass is recognized as a good indicator of ecosystem health because it is sensitive to poor water quality.

Morro Bay's eelgrass beds are recognized as being among the largest and least impacted of remaining eelgrass beds in central and southern California.

The warty sea cucumber, (above) can move at top speeds of 12 feet in an hour. Their diet consists of detritus (small particles of organic matter) and small organisms in the mud. Sometimes called the "earthworms of the sea," they take up food particles from the ocean floor much as earthworms cultivate the soil. In areas where they have been overfished, the seafloor becomes hard and is no longer viable habitat for other sea creatures. In some parts of the world, sea cucumbers are in high demand as a food and as medicine. (Source: Monterey Bay Aquarium)

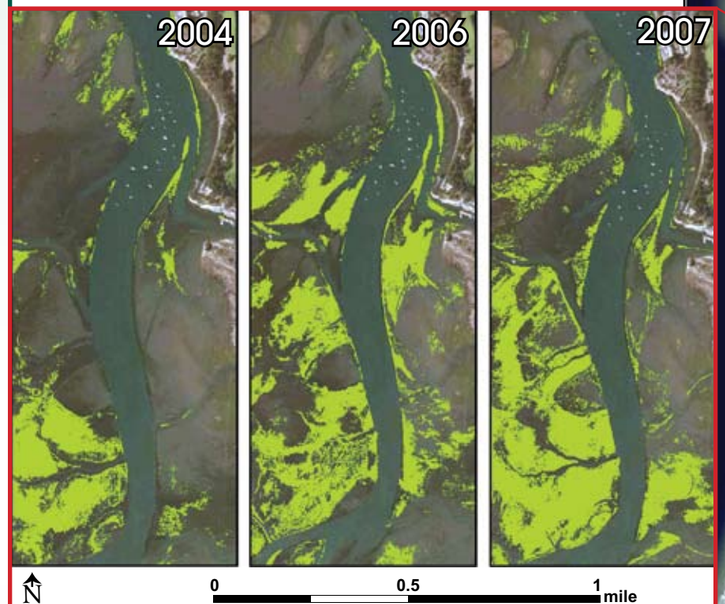
While not uncommon in Morro Bay, it is unusual to spot a horn shark in exposed eelgrass. Horn sharks prefer to hide in crevices, caves, seagrasses and kelp in shallow water. They're not graceful swimmers as most sharks are, and are even known to use their pectoral fins to crawl on the seafloor and over rocks. They hunt at night. searching for invertebrates like sea urchins and crabs, as well as small fishes.

Females lay spiral egg cases and wedge into them crevices to keep the egg cases in place. The egg will take between six and nine months to hatch. (Source: Monterey Bay Aquarium)

The kelp crab is typically found in kelp beds and in shallow pools with abundant algae or sea grass cover. Their habitat ranges from Alaska to Baja California. Adults grow to nearly five inches long. The crabs feed primarily on kelp and algae, but if those foods are scarce, they will eat other food such as barnacles and mussels. (Sources: University of Michigan Museum of Zoology Diversity Website, enature.com)

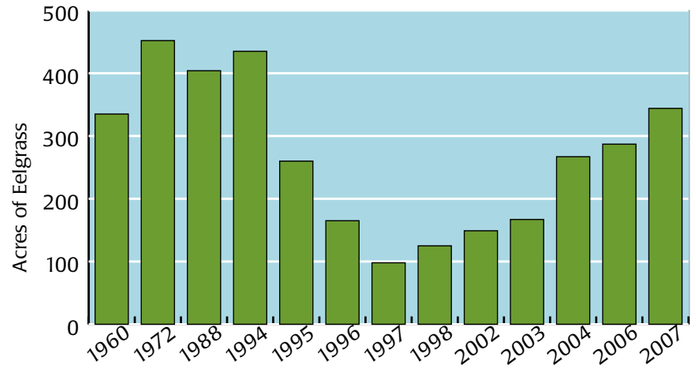
Baywide Eelgrass Extent Map

The Estuary Program monitors the extent of Morro Bay's eelgrass beds through periodic bay-wide mapping using a combination of aerial imagery and field verification.* The 2007 eelgrass map revealed 344 acres of eelgrass growing throughout Morro Bay. Comparison with previous maps indicated that the eelgrass beds on the western side of the main channel are expanding.



Eelgrass grows in a narrow elevation range. The beds near the State Park Marina have expanded in some areas and declined in others over the past several years. Poor water clarity, heavy boat traffic and sedimentation may have caused some of the decline.

How Has Morro Bay Eelgrass Acreage Changed Over Time?



From 1960-1994, eelgrass acreage was relatively stable, and records indicate that between 350 and 500 acres of eelgrass beds grew in Morro Bay. During the summer of 1994, the Highway 41 fire burned a large area of the Morro Bay watershed, and the subsequent El Niño rainstorms resulted in major erosion. The large volume of sediment buried some of the eelgrass beds and led to a severe decline in eelgrass acreage. Stressed eelgrass beds are vulnerable to a variety of natural threats that led to several years of decline during the 1990s.**

Recent eelgrass mapping efforts indicate that Morro Bay beds are making a slow recovery. The continuing expansion is a positive indicator for the health of Morro Bay.

*Multi-spectral imagery captured at low tide reveals slight differences in the reflection signature of different marine plants. These signatures are analyzed to distinguish between eelgrass and different types of algae in Morro Bay. Select areas are then analyzed on foot or by kayak to verify the accuracy of the map. The mapping process takes several months to complete. This process is currently underway to create a fall 2009 eelgrass map.

** Data sources for eelgrass acreage: CA Department of Fish and Game—1960 & 1972; John Chestnut—1988-1998; MBNEP—2002-2007
Photos by MBNEP staff.

Are important habitats being protected, enhanced and restored?

Yes, over 3,000 acres of habitat have been protected and over 400 acres have been restored or enhanced

The estuary and watershed are comprised of many diverse habitats that are critical to the survival of native plants and animals, including some species found nowhere else in the world. Healthy, intact habitat provides a home for these species, protects water quality in our creeks and estuary, and preserves the scenic beauty and recreational opportunities that draw residents and visitors alike to Morro Bay.

Habitat loss and degradation occurs through poorly planned development, poor land management, invasive exotic species and pollution. Habitats which may appear protected, such as salt marshes and eelgrass beds, can be degraded or even destroyed by excess sediments and other pollutants traveling downstream. Four strategies are employed to address these threats.

Conservation Agreements

Conservation agreements are a voluntary and cost effective approach to protecting land from development, keeping land in private hands and preserving traditional uses such as family farming and ranching. The Estuary Program, its partners, and the Maino family formed a conservation agreement to protect the 1,860-acre Maino Ranch, limiting future development while ensuring that ranching and farming continue. The ranch's key location between the city of Morro Bay and the rural Chorro Valley makes this agreement especially important for protecting the watershed from future urban sprawl.

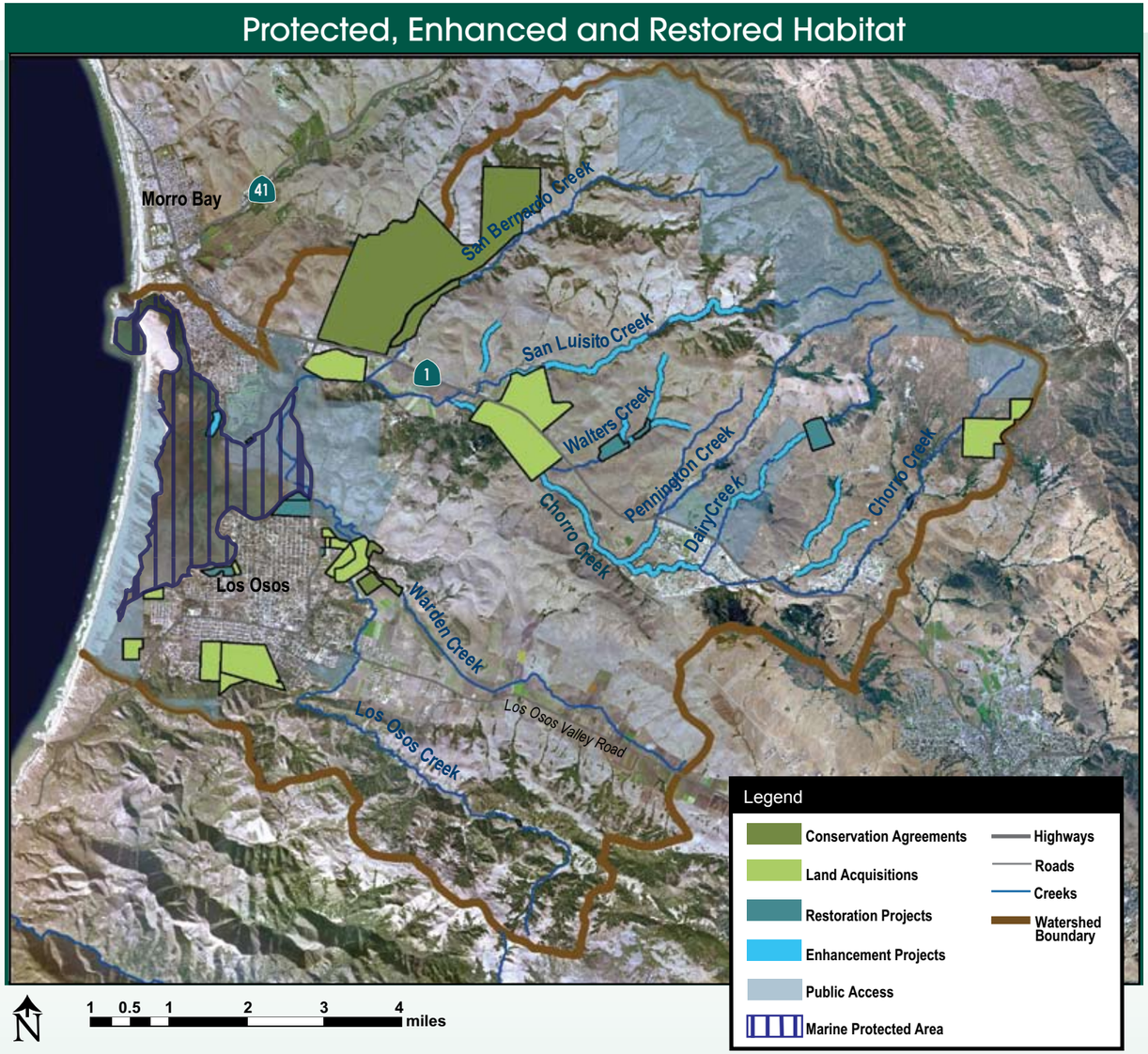
Land Acquisitions

Land purchases are considered when an area contains rare habitat, hosts endangered species, or plays a critical role in protecting water quality. More than 1,100 acres have been purchased in the Morro Bay watershed since 1995.

Much of this effort has been led by the Partners for the Conservation of the Los Osos Coastal Dunes who have made great progress towards creating a Los Osos Greenbelt, a protected arc of rare dunes habitat. The greenbelt provides wildlife corridors, protects habitat for wildlife and plants, provides community walking and hiking trails, and ensures that future generations can enjoy access to these lands. Also, in 2003 the Estuary Program helped arrange the purchase of the 580-acre Hollister Peak Ranch, now under the ownership of the California Department of Fish and Game, known as the Chorro Creek Ecological Reserve.

Restoration Projects

Biological communities interacting with their physical environment are called ecosystems. They evolve over thousands of years and are dependent on these interactions. Human activity can sometimes destroy or alter these ecosystems to the point that they no longer function correctly. Restorationists attempt to reestablish these interactions. In 2008, the Estuary Program and its partners completed this type of project on Walters Creek. During the 1940s, the lower portion of the creek suffered severe manipulation by the U.S. military who straightened the creek channel and placed five large berms across the creek to create a small arms artillery range. Restoration of the site involved removing these berms from the creek and establishing a more natural, meandering channel with corresponding floodplains. A massive re-vegetation effort was also made, jump starting the growth of plant communities indicative of healthy central coast streams. By restoring the creek's physical structure and reintroducing members of the original biological community, Walters Creek is on its way to becoming a healthy, functioning stream once again.



Enhancement Projects

Enhancements improve current conditions to protect ecosystem health and typically require fewer resources than restoration. Examples of enhancement measures include removing invasive species, installing riparian fencing, or reducing groundwater extraction to increase stream flow. The Estuary Program has been working with land owners to build fences that exclude cattle from creeks. This enhancement action will reduce bacteria and pathogens flowing into waterways and eventually the estuary. Reducing grazing pressure on riparian vegetation allows riparian growth and recovery, offering healthier habitat for fish and wildlife. Another recent enhancement effort removed over 30 deteriorating vessels from the bay. When vessels deteriorate, they can release toxic chemicals into the water negatively impacting the health of the estuary and requiring costly clean-up efforts.

Is the bay filling in at an unnatural rate?

Yes, sedimentation of the bay has been accelerated by man-made disturbances within the watershed

Estuaries gradually fill as part of a natural geologic process, but this process has been accelerated as much as ten times the natural rate in Morro Bay. One study indicates that the source of 50% of current marsh sediment is from human disturbance within the watershed.* Not only is the bay receiving more sediment from the watershed, but it is also experiencing reduced tidal flushing and circulation that historically transported sediment out of the bay. This happened when the Morro Rock causeway and jetty were constructed at the harbor entrance. It has been estimated that the estuary could lose all of its open-water and inter-tidal habitat within 300 to 400 years.**

For the past 60 to 70 years, sediment transported from the watershed into the bay has raised the elevation of tidal and sub-tidal flats. Although the ecologically significant salt marsh is expanding its territory, it is converting habitats from shallow, sub-tidal flats and eelgrass beds to intertidal mudflats and marshes. If the current trend continues, the existing patch-work of habitats within the bay may shift away from a marine-estuarine habitat towards a salt marsh wetland, freshwater riparian habitat.

Stopping It at the Source - Erosion Within the Watershed

Preventing or limiting erosion in the watershed is the first step in slowing excessive sedimentation of the bay. Erosion rates can be reduced in a variety of ways, such as repairing eroded stream banks or improving land management practices on farms and ranches. The recently completed restoration effort on Walters Creek, a tributary to Chorro Creek, is one example where sources of erosion were repaired through restoration techniques. Over the years, the Estuary Program and partners have embarked on similar projects, such as the Upper Los Osos Creek Restoration Project and the Camp San Luis Obispo Dairy Creek Upslope Erosion Project. The most cost effective solution to limiting erosion is implementing best land management practices. One beneficial soil conservation practice installs livestock fencing along creeks. Minimizing livestock access to creek banks allows deep-rooted plant communities to thrive, strengthening banks. The Coastal San Luis Resource Conservation District, an Estuary Program partner, has spearheaded improved management on private farms and ranches in the watershed.

Salt Marsh Expansion in the Last 125 Years

During heavy rain events, eroded soil from brushland, rangeland, cropland and urban areas is carried through Chorro and Los Osos Creeks and deposited into Morro Bay. This sedimentation has caused the salt marsh to double in size over the last century.

The Estuary Program will continue to monitor changes in the estuary using bathymetry surveys and recently established stations to track sediment deposition.

This image shows salt marsh expansion from 1881 to 2007. The 1881 marsh extent was derived from historic U.S. coast survey topographic sheets. The other years were created from historic aerial photographic mosaics.+

Catching It Downstream - Accessing Floodplains

Another approach to controlling sediment involves capturing suspended sediment from creeks on floodplains. Old land management practices encouraged farmers to straighten creek channels and construct levees along banks so that surrounding fields would be protected from flood damage. This practice changed the natural system where creeks are allowed to flood, water velocity slows, and sediments are deposited on floodplains. Floodplain restoration projects capture sediments before they enter the bay and provide important habitat for birds and wildlife. The Los Osos Creek Wetland Reserve and the Chorro Flats Enhancement Project are examples of restored floodplains. It is estimated that the Chorro Flats project has prevented over 225,000 tons of sediment from reaching the bay.§

* U.S. Department of Agriculture, Soil Conservation Service. 1989. Erosion and Sediment Study Morro Bay Watershed.

** Haltiner, J. 1988. Sedimentation Processes in Morro Bay, California. Phillip Williams and Associates.

§ Coastal San Luis Resource Conservation District 2000. Final Chorro Flats Report.

+ Obtained from the Central Coast Wetlands GIS Project (www.centralcoastwetlands.org)

Are the bird populations that depend on bay habitat stable?

Yes, most populations appear stable over the last 15 years, however, brant and snowy plovers require continued monitoring

Global and national studies suggest that many bird populations have been greatly reduced in the last 100 years and that habitat loss is a key factor. The Morro Bay watershed and estuary provide a home for more than 200 species of birds and are an important stop on the Pacific Flyway. Most of the bird species that depend on the bay are migratory. Morro Bay, designated an Important Bird Area by the National Audubon Society, is important to the survival of these birds.

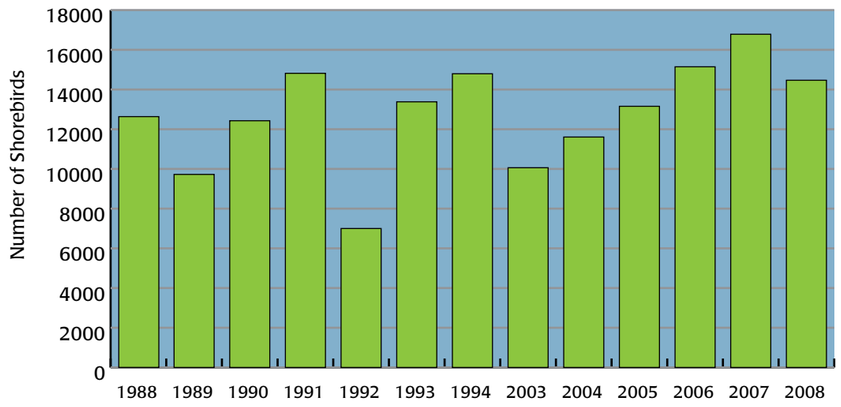
The number of brant geese using the estuary, however, is much lower than in the mid-1900s, and the geese have declined throughout California during this same period. The Morro Bay sandspit also provides critical habitat to the western snowy plover, which is making a slow recovery throughout California.

Monitoring of bird populations provides information about how individual species of birds are faring and serves as an indicator of habitat quality.

Brant geese are so thorough in their consumption of eelgrass that they leave the beds looking as if they've been mown to an even height. Above, the first visitors of the season start the job while marbled godwits forrage during low tide.

Shorebird Abundance in Morro Bay

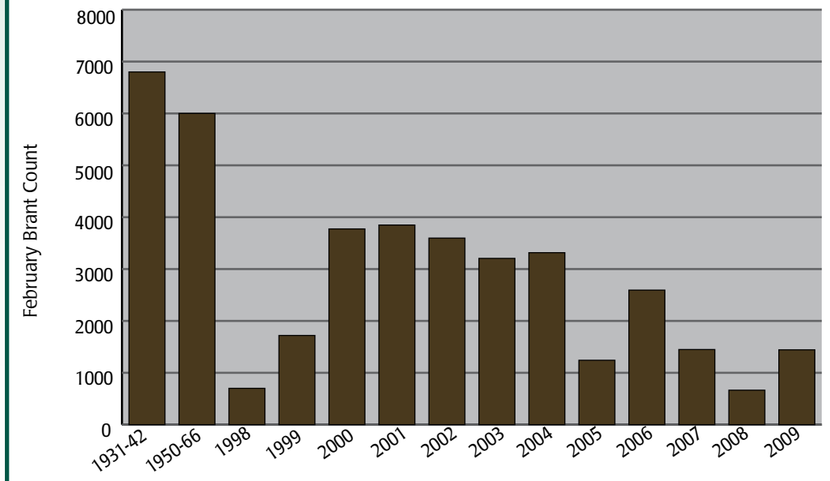
Shorebirds consist of many species of small to medium-sized birds whose habitat includes open shoreline. Generally, they have fairly thin bills and long legs. Curlew, above, are one of the many shorebirds. A total of 41 species of shorebirds have been observed in Morro Bay.



Each fall, local birders come together to conduct counts of shorebirds on the bay, sand spit and Morro Strand in an effort that has gone on since the late 1980s. The graph shows the total counts for each of the surveys. Birders identify an average of 21 species during the counts, a value which remained relatively stable over the years. The data shows a trend of relatively stable shorebird populations on Morro Bay.

What We Measured: Shorebird Counts, Plover Nesting Success & Brant Populations

Brant Winter Populations in Morro Bay

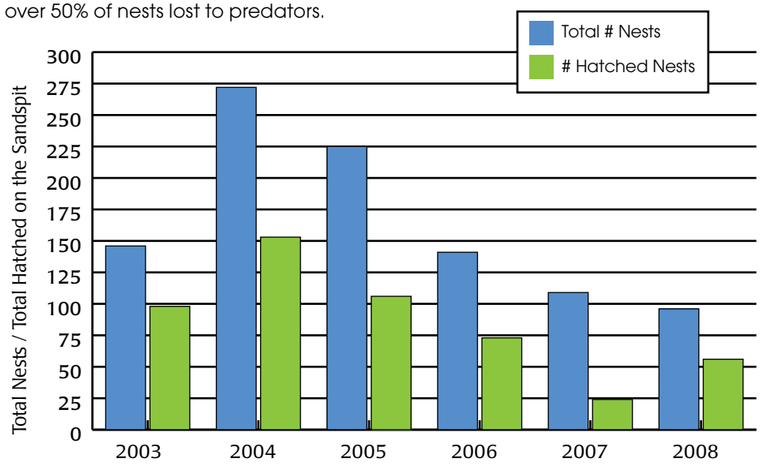


This graph compares the average number of Brant counted in Morro Bay each February. Counts were taken during mid-winter when Brant numbers typically peak in the area. The data show a downward trend that reflects a loss of habitat and has led California Department of Fish and Game to list brant as a species of special concern.

Brant are small dark geese that spend their summer nesting season in the Northern Arctic. They migrate up to 11,000 miles annually to spend winters in Morro Bay and other coastal areas as far south as Baja California. The geese feed almost exclusively on eelgrass, and Morro Bay offers the migrating birds some of the last remaining significant eelgrass beds in southern California.

Snowy Plover Populations in Morro Bay

Since 2002, California State Parks has been installing seasonal fencing on the Morro Bay sandspit during plover nesting season to protect sensitive habitats. State Parks plover monitors walk the sandspit several times each week to check for nests and hatchling plovers. The El Niño event in 2004 is believed to have positively influenced nesting success that year. 2007 was a tough year for plovers on the sandspit with over 50% of nests lost to predators.



The western snowy plover is a sparrow-sized shorebird, well-camouflaged for nesting on beaches. The breeding season lasts from early spring through mid-fall, with females laying eggs in depressions in the sand. The eggs hatch nearly a month later, and the chicks are on their own a month after. Loss of habitat, disturbance by humans or animals, and predation by animals such as skunks, raccoons and crows have led to such a decline in plover numbers that this bird has been protected under the Endangered Species Act since 1993.

- Data sources for brant data: J. Moffittt—1931-1942; CDFG—1950-1966; John Roser—1998-2009
- Data sources for shorebird survey: Local volunteers in conjunction with Point Reyes Bird Observatory—pre-2003; MBNEP—2003-2008.
- Data sources for plover data: Annual Report for the Western Snowy Plover at San Luis Obispo Coast District in 2008, from CA State Parks

Photos of brant geese, plover and shorebirds by Mike Baird. Photo of brant in eelgrass by MBNEP.

Does the estuary and watershed support a healthy population of steelhead trout?

No, viable steelhead habitat exists, but persistant problems contribute to population decline

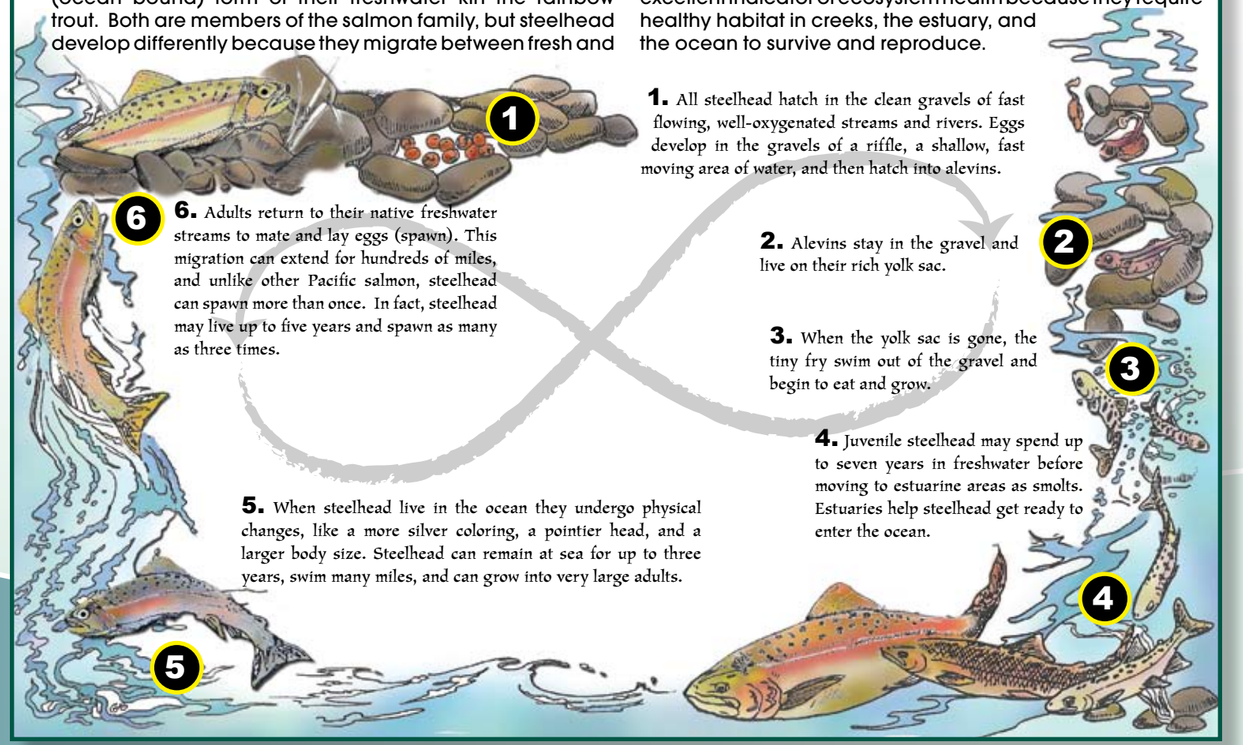
Steelhead populations have decreased compared to historic levels on the central coast and within the Morro Bay watershed, leading to the population's designation as federally threatened. Over time, demands on water systems have heightened many factors that challenge steelhead survival. Typically, these limiting factors center on the species access to adequate habitats – those with cold water, food, and protection from predators.

Multiple factors influence viable steelhead habitat. Water utilities within the watershed and the estuary reduce stream flow and alter water temperatures. In many creeks, road crossings and dams restrict fish passage, blocking adult migration to headwater tributaries and limiting juveniles' movement to marine habitats. Buildings and roads built on steep hill slopes accelerate erosion and fine sediment deposition in creek beds, which can drastically decrease egg survival, food availability and juvenile growth. Development along stream banks and floodplains reduces bank stability and impairs the natural function of the creek system. The continued spread of invasive plants and aquatic species has further degraded creek habitat for steelhead, particularly rearing juveniles.

Research and habitat restoration are critical in understanding what factors limit the Morro Bay steelhead and restoring them to a viable population.

Steelhead Life Cycle

Steelhead (*Oncorhynchus mykiss*) are the anadromous (ocean bound) form of their freshwater kin the rainbow trout. Both are members of the salmon family, but steelhead develop differently because they migrate between fresh and saltwater environments. This life cycle makes steelhead an excellent indicator of ecosystem health because they require healthy habitat in creeks, the estuary, and the ocean to survive and reproduce.



1. All steelhead hatch in the clean gravels of fast flowing, well-oxygenated streams and rivers. Eggs develop in the gravels of a riffle, a shallow, fast moving area of water, and then hatch into alevins.

2. Alevins stay in the gravel and live on their rich yolk sac.

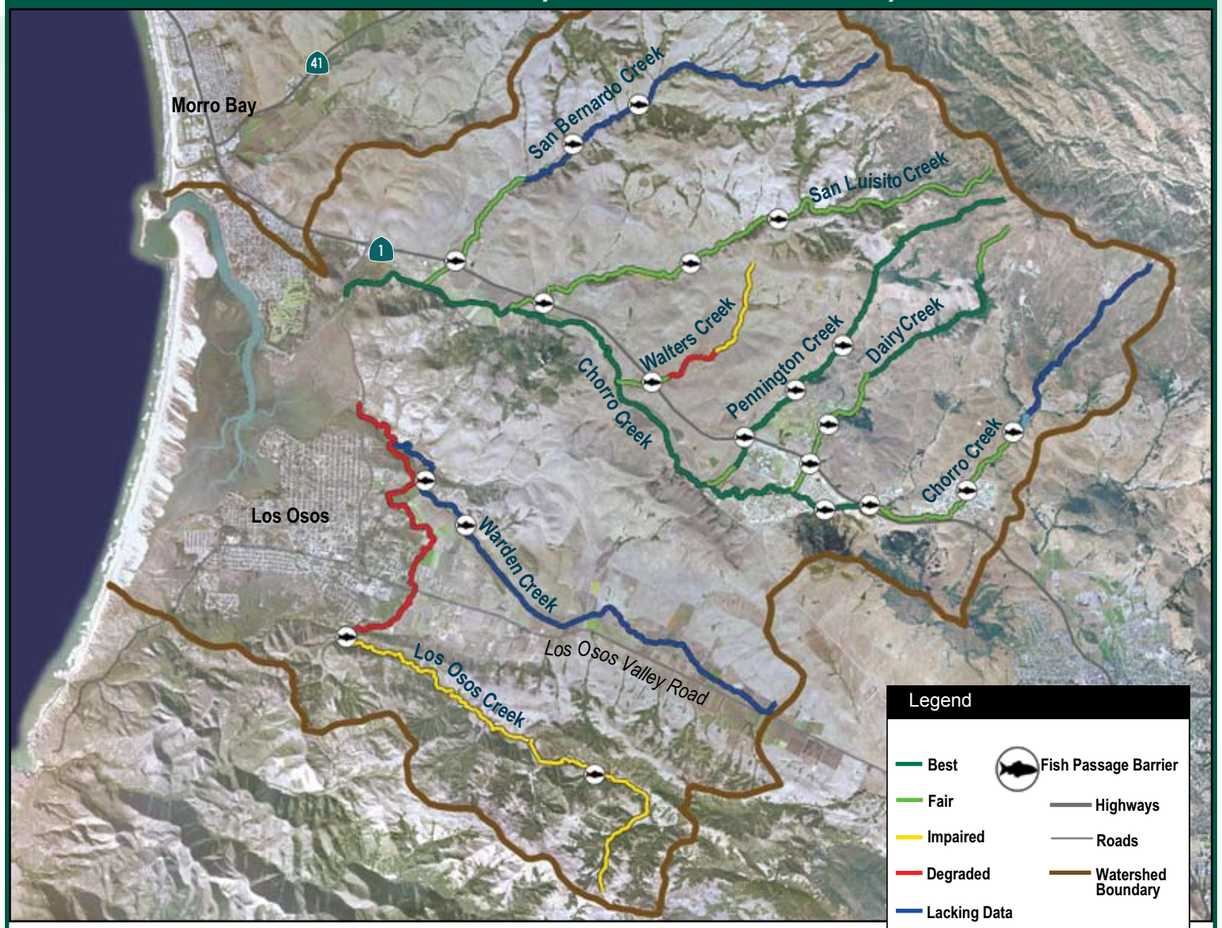
3. When the yolk sac is gone, the tiny fry swim out of the gravel and begin to eat and grow.

4. Juvenile steelhead may spend up to seven years in freshwater before moving to estuarine areas as smolts. Estuaries help steelhead get ready to enter the ocean.

5. When steelhead live in the ocean they undergo physical changes, like a more silver coloring, a pointier head, and a larger body size. Steelhead can remain at sea for up to three years, swim many miles, and can grow into very large adults.

6. Adults return to their native freshwater streams to mate and lay eggs (spawn). This migration can extend for hundreds of miles, and unlike other Pacific salmon, steelhead can spawn more than once. In fact, steelhead may live up to five years and spawn as many as three times.

Steelhead Habitat Quality Within the Morro Bay Watershed



The amount and quality of stream habitat controls the number of juvenile and adult steelhead that can be supported in the watershed. In 2009, the Estuary Program organized a group of local fisheries biologists* to compile their specialized knowledge of creek habitat quality in the watershed. By reviewing previous studies, creek assessments, and volunteer monitoring data, the team developed a grading system that rated each stream's habitat quality into low, medium, and high ratings. They evaluated stream flow, dissolved oxygen content, water temperature, habitat complexity, substrate composition, cover types, pool depths, canopy cover, bank vegetation, and exotic species presence, and then gave each parameter a weighted value. They also looked at known barriers in the watershed to see where passage to habitat is restricted. By assessing the factors that limit steelhead survival, the Estuary Program can better understand where restoration is needed in the watershed.

Adult southern California steelhead.

* Included biologists from MBNEP, CA Dept of Fish and Game, CA Conservation Corps and the City of San Luis Obispo. Illustration adapted from *Salmon and Trout Go to School: An Illustrated Manual for Hatching Salmon and Trout Eggs in Classroom Aquarium-Incubators.* Steelhead photo by Matt Stoeker.

Where the Rubber Meets the Road

Pavement and Pollution

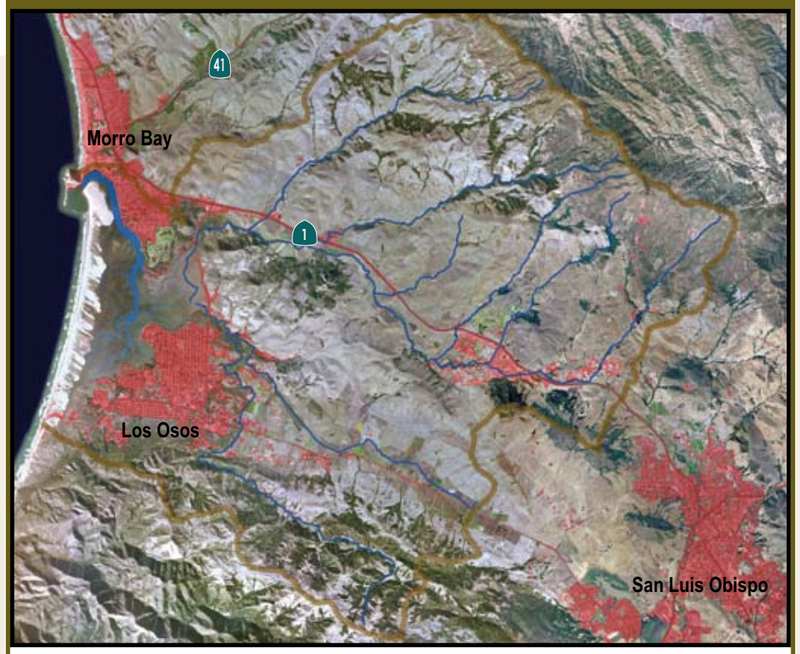
- **An oil leak in your automobile**
- **Over-fertilizing your lawn**
- **Forgetting to pick up after a pet**

When taken individually, these things seem small, but added together they can create a major pollution problem. Efforts which began in the 1970s addressed many of the country's water pollution issues such as industrial facilities and sewage. Today, the major threat to our waterways is the runoff generated when rainfall or snowmelt travel over the ground, carrying with it sediment, bacteria, oil, trash, fertilizers and other pollutants. These eventually end up in our creeks, lakes, rivers, bays and oceans.

In natural areas that are not impacted by human activities, rainfall and snowmelt are able to infiltrate into the ground or flow naturally to waterways such as rivers, lakes and streams. The degree to which water can soak into the ground is called imperviousness.

As urbanization occurs and natural soils are replaced with buildings, roads and parking lots, the amount of impervious surface increases. Rather than soaking into the ground, storm runoff carries with it pollution that is eventually deposited into our natural waterways.

Impervious Surface in the Watershed



This rendering of the Morro Bay watershed illustrates areas of highly impervious surfaces, shown in red. Concentrations of impervious surface changes flow dynamics for a region. The close proximity of these regions to the estuary is a point of concern.

Based on U.S. Geological Survey's National Land Cover Characterization 2001 database which measured a range of reflectivity data. The above image is for illustration purposes only. Threshhold limits for determination of imperviousness based on observation only.

Studies have shown the direct relationship between impervious surface and the habitat quality of a waterway. As impervious area in surrounding areas reaches 10 to 20%, a waterway experiences negative impacts on stream habitat quality, temperature, streambank erosion, and diversity of aquatic insects, amphibians and fish.

You Make the Difference

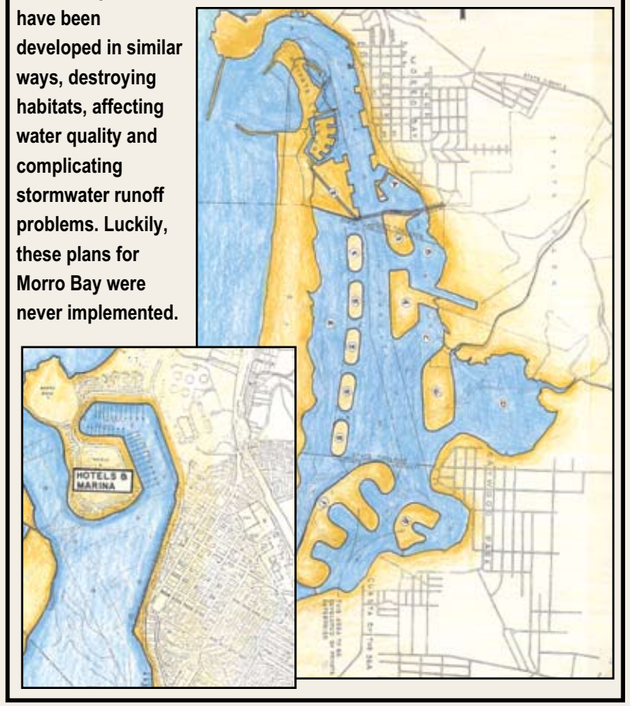
Some of the changes we need to make in order to prevent polluted stormwater runoff are the responsibility of governmental agencies and municipalities, such as managing land to reduce soil erosion, regulating development and enacting erosion control ordinances. However each one of us can play an important role by taking steps to be a "good neighbor" to our local waterways:

- Keep litter, pet wastes, leaves, and debris out of street gutters and storm drains – these outlets drain directly to our waterways.
- Apply lawn and garden chemicals sparingly and according to directions —never before a rainstorm!
- Dispose of used oil, antifreeze, paints, and other household chemicals properly, not in storm sewers or drains.
- Clean up spilled brake fluid, oil, grease, and antifreeze. Do not hose them into the street where they can eventually reach local streams.
- Control soil erosion on your property by planting ground cover and stabilizing erosion-prone areas.
- Have your septic system inspected and pumped, at a minimum, every 3-5 years so that it operates properly.
- Purchase household detergents and cleaners that are low in phosphorous to reduce the amount of nutrients discharged into our streams and coastal waters.

What Morro Bay Might Have Become

These two renderings from 1962 show plans for Morro Bay. Had these plans been enacted, Morro Bay would be a very different place than it is today.

While it's somewhat amusing to imagine this level of development in the estuary and watershed, most of the wetlands in southern California have been developed in similar ways, destroying habitats, affecting water quality and complicating stormwater runoff problems. Luckily, these plans for Morro Bay were never implemented.



Estuary Program Volunteers Keep Watch

In Morro Bay, sampling of nonpoint source pollution by the Estuary Program and its volunteers shows that smaller communities are not immune to this problem. Recent sampling of storm-generated flows in Morro Bay detected the following:

- Dissolved copper was detected in stormwater runoff at 40 times the levels set by regulations to protect marine life.
- *E. coli* concentrations as high as 100 times the level safe for swimming were measured.
- Turbidity, a measure of the cloudiness of the water, was detected at nearly 40 times the level which can harm aquatic life.

Flows measured by "Urban Watch" volunteers show what is deposited into the bay during the dry season. Although the goal is for "nothing but rain down the drain," volunteers often detect flows in the storm drains during the long, dry summer months due to over-irrigation, vehicle washing and other activities. Although the volumes of these flows are small compared to a good winter storm, monitoring has shown these discharges to be fairly frequent. In weekly visits to check on storm drains between June and October of 2008, some drains had flow in them in nearly 90% of visits. These flows often contain cloudy water with high levels of nutrients and sediment.

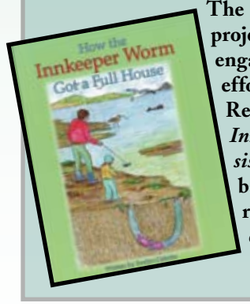
An Estuary Program volunteer gathers a sample of dry season flow that will be tested for a variety of pollutants that can cause water quality problems in the bay.

Morro Bay National Estuary Program

Estuary Program Projects

Protect • Restore • Understand • Educate

Community Grants Program



The Estuary Program awards funding for community-based projects that implement Morro Bay's conservation plan, and engage stakeholders, citizens and other organizations in the effort to protect and restore the estuary.

Recent grants helped publish the childrens' books *How the Innkeeper Worm Got a Full House*, at left, and *Kelp Condo Crisis* which teach families about special species that call the bay home. Another grant provided funding to remove and responsibly dispose of vessels that threatened to sink and contaminate the estuary, like the Restless C II, at right.

Invasive Species Action Plan

As global trade and travel increase, new species are being intentionally and unintentionally transported all over the world. These biological invasions are harming biological diversity worldwide. They threaten our environment, economy and human health. On the central coast we are experiencing this first-hand. From the invasive South African veldt grass taking over rare habitat in Los Osos to the invasive pikeminnow impacting our native steelhead trout, we are facing an onslaught of foreign invaders. To tackle these tough challenges, the Estuary Program and our partners are creating an Invasive Species Action Plan to combat this problem. The plan addresses key points of invasion by focusing on Prevention, Early Detection, Rapid Response, and Control & Management. For information on the progress of this important effort, visit www.mbnep.org.

Yellow star thistle is one of the problem plants that will be addressed

Keeping a Finger on the Pulse

morro bay volunteer monitoring

Tracking oxygen levels in the creeks, measuring bacteria levels in the bay, monitoring bay eelgrass beds – these and many other metrics serve as indicators of the health of the estuary and its watershed. Environmental monitoring increases our understanding of the connection between the land and the sea and the effect of human actions on these complex systems. The Estuary Program established a Volunteer Monitoring Program to support monitoring in the Morro Bay watershed. These citizen monitors come from all walks of life and each brings a unique perspective and set of skills to the program. Their tasks vary from collecting measurements from local creeks to conducting detailed lab work to peering through a microscope at tiny plankton. To learn more about the monitoring program efforts and to see volunteer-generated data, visit www.mbnep.org and click on the Volunteer link.

How healthy is the Morro Bay Estuary?

Conditions are stable in Morro Bay, however the estuary faces significant challenges to its health

Although Morro Bay faces fewer environmental challenges than many ecosystems, there is room for improvement, and ongoing efforts to protect and restore the estuary are critical to its continued health.

The eight indicator questions presented in this report, when examined individually and then assessed as a whole, indicate that conditions are mostly stable in Morro Bay. However, the estuary faces serious challenges in several areas:

- Steelhead, a central coast threatened species, face degraded habitat, passage barriers and other challenges to their survival.
- Bacteria levels in creeks are not consistently safe for swimming.
- Unnaturally rapid sedimentation threatens to accelerate salt marsh expansion while decreasing other important estuarine habitats.
- Habitat of all kinds, and the species dependent upon them, face continued threats from increased development here and throughout migratorial pathways.
- Concerns about emerging contaminants and climate change will require new indicator questions and further study.

Significant changes have taken place in the estuary and its watershed over the last decade. As impacts in the watershed, creeks and bay accumulate, we run the risk of harming this extraordinary place. The Estuary Program continues to monitor these indicators of environmental health and take action on those findings. With help from the community, future reports hope to show greater improvements to the health of the estuary.

What Is the Morro Bay National Estuary Program?

Morro Bay National Estuary Program

The Morro Bay National Estuary Program (known locally as the Estuary Program) is a local cooperative non-profit working to protect and restore the physical, biological, economic and recreational resources of the Morro Bay Estuary.

In 1995, Morro Bay was recognized as an estuary of national significance and was accepted into the National Estuary Program – one of only 28 nationwide. Since then, the Estuary Program has brought together citizens, scientists, elected officials, business owners, government representatives, landowners and other non-profit organizations to create a vision for the future of the estuary and a plan to achieve it. Our vision for a healthy estuary is a clean water body that supports both wildlife and human uses for current and future generations.

United States Environmental Protection Agency

How You Can Help Protect the Estuary

1. Keep a respectful distance from birds and wildlife when you are walking on the shore or kayaking. Use binoculars for observation.

2. Join a local environmental group such as Audubon, Small Wilderness Area Preservation, the Estuary Program, Central Coast Natural History Association or many others. Most groups offer an informative newsletter to their members that lists events and volunteer opportunities.

3. Clean up after your pets, and don't allow them to chase birds and other wildlife.

4. Learn more about the resources and ecosystem. The Morro Bay State Park Museum of Natural History, the Estuary Program's Estuary Nature Center and libraries are good places to start.

5. When landscaping, use native plants and plants that don't need a lot of irrigation and fertilizer.

6. Volunteer your time. There are many ways you can contribute and many organizations are looking for help.

7. Don't dump household pollutants like automobile oil, paint or household cleaners down storm drains. Remember, storm drains eventually empty into the estuary or the ocean.

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Morro Bay National Estuary Program

The Morro Bay National Estuary Program is a collaborative effort of many local partners working to restore, protect and preserve the health of the Morro Bay Estuary. Morro Bay Estuary was named an "Estuary of National Significance" in 1995, becoming one of 28 National Estuary Programs around the country. Financial and technical assistance from the U.S. EPA supports a small staff that works to implement the Estuary Program's Management Plan for the estuary.

The data used in the "Report on the Health of the Morro Bay Estuary" is the cumulative work of many organizations and agencies. Data sources are noted in each section. The data provided is for informational purposes only and is not intended to be used for regulatory or decision-making activities. While every effort has been made to ensure accuracy, correctness and timeliness of material presented, MBNEP and its partners assume no responsibility for errors and omissions, even if advised of the possibility of such damage. The Estuary Program thanks the many people that provided assistance in the development of this report.
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