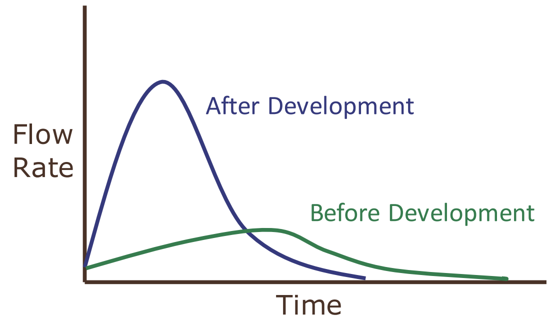
Hydromodification

A Fact Sheet from the Southern California Coastal Water Research Project

March 2013

What Is Hydromodification?

“Hydromodification” refers to alterations in natural watershed hydrology associated with changes in land use or cover. Conversion of the open landscape to features such as roads, buildings, houses, sidewalks, parking lots, flood control channels, and agricultural fields modifies runoff patterns, causing rainfall to run off into streams more quickly with higher energy, and large flow events to occur more frequently.



Hydromodification Effects

Changes in runoff, as well as reduced sediment transport into the stream from surrounding land, cause stream channels to erode. The eroded sediments may transport pollutants and/or deposit in downstream habitats such as bays and estuaries.

Why Is Hydromodification a Concern?

Modified hydrology and erosion are two primary causes of degraded biological communities in streams. Many management programs focus on improving water quality; however, managing water quality and hydrology together is a more effective approach to restoring long-term stream health. Beyond biological effects, hydromodification also reduces groundwater recharge and may impact houses, roads, bridges, pipelines, and other structures.

Hydromodification in Southern California

In southern California, hydromodification is exacerbated by rugged topography (steep elevation changes over short distances), naturally erodible soils, periodic intense precipitation events, and frequent wildfires. These factors cause the region’s streams to be particularly sensitive, and even small rain events can potentially bring about substantial damage.

Management Measures

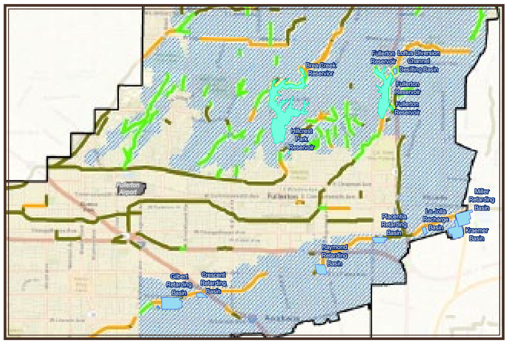
Vegetated swales allow parking lot runoff to infiltrate on-site.

Hydromodification effects can be minimized through land-use planning, low-impact development, and runoff controls. These preventative measures are often more cost-effective than trying to remediate the effects after they occur.

SCCWRP collects data and develops tools to help assess and manage hydromodification at a watershed level.

Watershed Characterization

SCCWRP has collected a large data set on physical stream conditions in southern California. These data were used to recalibrate national models for predicting stream flow at ungauged sites and national models describing relationships between land use and channel erosion. The data also provide a scientific foundation for local predictive modeling.



Tools for Risk Mapping and Field Screening

Because of variability in individual streams and watersheds, land cover alone cannot predict hydromodification risk. Working with partners, SCCWRP recently developed screening tools to assess hydromodification susceptibility. First, GIS analyses are applied to map higher-risk areas in a watershed. Next, a field-based assessment method based on readily observable indicators and intuitive decision trees characterizes the susceptibility of individual stream channels.

Predictive Modeling, Decision Support, and Monitoring Design

Decision Matrix for: Upper Watershed, Low Sensitivity of Downstream Habitat

Channel Susceptibility	Expected Change in Runoff: *High*	*Medium*	*Low*
High	Aggressive	Aggressive	Moderate
Medium	Moderate	Moderate	Moderate
Low	Moderate	Low	Low

Degree of Flow Control Needed: Aggressive, Moderate, Low

SCCWRP and partners developed a multifaceted guidance framework for hydromodification modeling and management. This framework supports decisions about appropriate actions based on the degree of hydromodification risk and downstream habitat sensitivity, and enables tailored solutions for each unique reach of a watershed. Guidelines for a watershed monitoring program help managers evaluate the effectiveness of management actions over time.

Management Applications

SCCWRP's existing guidance materials can be applied to protect against hydromodification and address legacy effects throughout watersheds. Because surface water regulatory programs in California are moving toward setting goals for biological condition, future work will focus on tools that connect physical hydromodification processes to changes in biological communities.

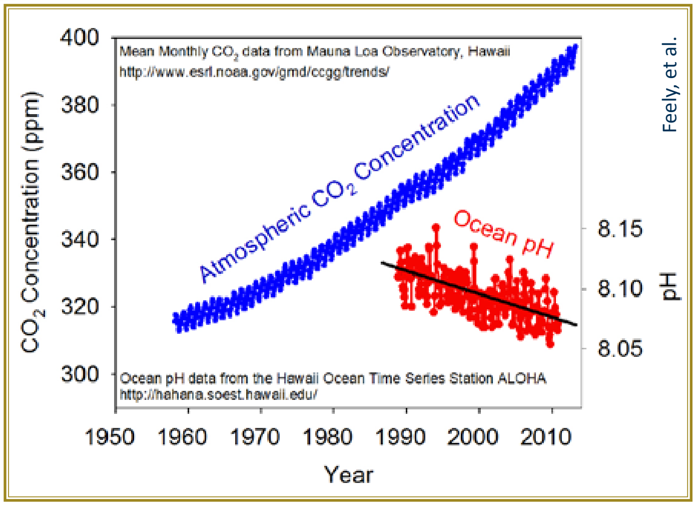
Ocean Acidification

A Fact Sheet from the Southern California Coastal Water Research Project

July 2013

What Is Ocean Acidification?

Ocean acidification refers to an increase in the acidity of Earth's oceans, as measured by pH. This change in acidity drives a number of other changes in ocean chemistry, such as reduced availability of shell-forming minerals (carbonate ions), with potential effects on marine ecosystems.

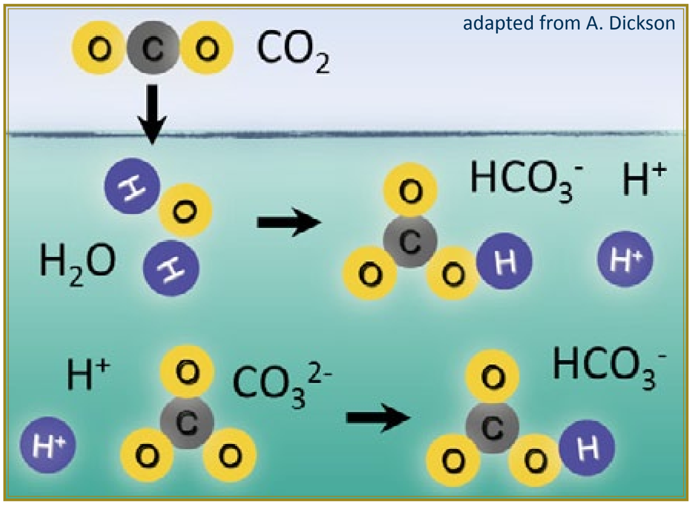


Long-term observational data from Hawaii show increasing atmospheric carbon dioxide (CO_2) concentrations and increasing ocean acidity (declining ocean pH).

What Causes Ocean Acidification?

Human activities have increased the concentration of carbon dioxide (CO_2) in the earth's atmosphere. When CO_2 dissolves in seawater, it produces more hydrogen ions (lowering pH) and fewer carbonate ions (CO_3^{2-}). The US West Coast is particularly susceptible to ocean acidification because local circulation patterns and prevailing winds cause deep, colder waters with greater acidity to periodically upwell into shallow waters.

While ocean acidification is primarily driven by atmospheric CO_2 inputs, scientists are exploring whether local influences, such as nutrient inputs from land activities, contribute to the problem. Excess nutrient inputs can fuel algal blooms, which create more dissolved CO_2 when the algae die. Discerning the relative importance of these and other local factors will require additional research.



CO_2 dissolution in water produces hydrogen ions (H^+). In addition to increasing acidity, excess hydrogen ions react with free carbonate ions (CO_3^{2-}) forming more bicarbonate (HCO_3^-).

What Are the Effects?

Shell-forming organisms require carbonate ions (CO_3^{2-}) to build their exoskeletons, and ocean acidification reduces the availability of these ions in ocean waters. The shellfish industry was one of the earliest to suffer ocean acidification effects; fewer mature oysters are produced because the larvae have difficulty forming shells and surviving to adulthood.

Changes in ocean carbon chemistry have the potential to affect many other physiological and ecosystem processes beyond shell formation. Organisms at risk from a high-CO_2 environment include some corals that build critical reef habitats and certain types of plankton that form the base of the marine food web.

SCCWRP plays an important regional role in improving monitoring capacity for the US West Coast and evaluating the role of different acidification causal factors.

Monitoring Network

SCCWRP participates in the California Current Acidification Network (C-CAN), an interdisciplinary collaboration dedicated to advancing the understanding of ocean acidification and its effects on biological resources along the US West Coast. C-CAN is currently working to standardize ocean acidification monitoring and data management practices to ensure data comparability and quick public access.

A 2010 ocean acidification workshop at SCCWRP led to the formation of C-CAN.

Monitoring Technology

As a pilot effort during the 2013 Southern California Bight Regional Monitoring Program (Bight '13), SCCWRP will apply C-CAN protocols to improve ocean acidification monitoring. More advanced monitoring capacity will allow compilation of data sets that describe trends in both physiochemical ocean patterns and biological outcomes.

Bight '13 will use this type of mooring for ocean acidification monitoring.

Investigating Causal Factors

SCCWRP is gathering data to help scientists determine the relative contribution of local and global factors to acidification. Critical to causal model development, these data characterize rates of algal nutrient uptake, algal decay, and nutrient cycling. SCCWRP is also coordinating a workshop to facilitate the coupling of physical and biogeochemical ocean models.

SCCWRP staff members process water samples to study how nutrient-rich wastewater affects ocean ecosystems.

Management Applications

While ocean acidification is a global phenomenon, SCCWRP's research and monitoring activities will help determine if local actions can be taken to mitigate effects in the Southern California coastal region. In addition, the California Ocean Protection Council recently formed an expert panel that includes two SCCWRP scientists. The panel will review the available science and provide technical guidance for statewide policy development.

Marine Debris

A Fact Sheet from the Southern California Coastal Water Research Project

September 2013

Debris Effects

Marine debris, including trash, negatively affects coastal recreation areas and aquatic habitats. It also directly harms wildlife. Debris can:

- Remain in the environment for decades or longer;
- Entangle, strangle, smother, or be ingested by wildlife;
- Reduce aesthetic appeal and safety of coastal recreation areas; and/or
- Require costly cleanup.


Bill MacDonald/Algalita Marine Research Institute


Heal the Bay


NOAA

Debris Sources

Most debris consists of small items from land-based sources, such as pre-production plastic pellets, cigarette butts, plastic containers, and styrofoam packing material. Even so, the issue historically centered on ocean-based debris, such as discarded fishing gear, as well as large, highly visible items such as shopping carts, appliances, tires. Common debris transport pathways include direct dumping, accidental release on land or water, and movement through the ocean, rivers, and storm drains.

Great Pacific Garbage Patch

Media outlets have popularized the idea of a "Great Pacific Garbage Patch"— a remote area of the ocean likened to the size of Texas where debris from the entire North Pacific region collects due to natural ocean circulation patterns. While it is striking to find land-based debris more than 1,000 miles from shore, it is not altogether accurate to characterize debris concentrations in the North Pacific Gyre as a "patch" or a single floating mass. In fact, average debris density in this area is about one-third that found in coastal waters.

Plastic Debris

Plastic poses a special concern because it takes so long to degrade in the environment. In addition, ingested plastic debris may cause both physical effects and contaminant exposure. Coastal wildlife often mistake small plastic fragments for food, and organic compounds in plastics can adsorb and concentrate toxic contaminants from the environment or be toxic themselves.

Japanese Tsunami Debris

Debris in Southern California usually comes from nearby sources; however, some debris from Japan's 2011 earthquake and tsunami has or will reach the US West Coast over the next several years. Although this debris will not arrive in a single mass or transmit radioactivity, it will add to the existing load of debris washing up on Southern California beaches and may transport invasive species from abroad.

SCCWRP collects data to characterize the type and abundance of debris throughout coastal Southern California, from watersheds to the ocean.

Debris Characterization

SCCWRP helped develop standardized methods to characterize the amount and type of debris in beach and open ocean areas during regional surveys in the late 1990s and North Pacific Gyre studies in the early 2000s. More intensive studies of the most common debris item (pre-production plastic pellets) followed in 2009 and 2012, examining their distribution relative to land-based sources. These studies provide an important baseline to monitor changes in marine debris type and abundance over time.

SCCWRP researchers sift beach sand (top) to sample debris smaller than 5 mm (left).

Regional studies monitor both organisms and debris in trawl samples from the ocean floor.

Regional Monitoring

The Southern California Bight Regional Monitoring Program has examined debris trawled from the ocean floor about once every five years beginning in 1994. Some SCCWRP member agencies monitor debris more often and report results to their respective Regional Water Quality Control Boards.

2013 Bight Regional Monitoring Program (Bight '13)

Bight '13 will bring together multiple organizations involved in debris research, outreach, and cleanup as well as monitoring, regulation, and source control to document debris types and abundances in Southern California coastal watersheds, beaches, and nearshore zones. In addition to linking upstream and ocean debris, Bight '13 will gather new information not examined in previous Bight surveys, such as a) plastic debris abundance, type, and distribution in/on marine sediments; b) characterization of plastic ingestion in fish; and c) debris abundance and distribution in wadeable streams not currently monitored by the Southern California Stormwater Monitoring Coalition.

Debris Management Measures

SCCWRP's marine debris research helps inform state-, city-, and county-level policy actions that reduce key debris sources. Such policies often ban or restrict the use of items, such as cigarettes, take-out containers, or single-use plastic bags, that tend to end up as debris in the environment. Research also helps determine where best management practices to reduce debris transport would be most effective.

For more information on SCCWRP research, visit: **www.sccwrp.org**.