Sea Grant California

Sea Grant News

JUNE 2009

Coastal Science Serving California

SEPTIC TANKS AFFECTING COASTAL WATER QUALITY

Stanford / K. Yamahara

Stanford graduate student Nick de Sieyes installs a monitoring well at a Northern California beach.

PALO ALTO – California Sea Grant researchers have strong evidence that septic tanks in Northern California are leaking nitrogen and phosphate into coastal waters that can trigger algal blooms.

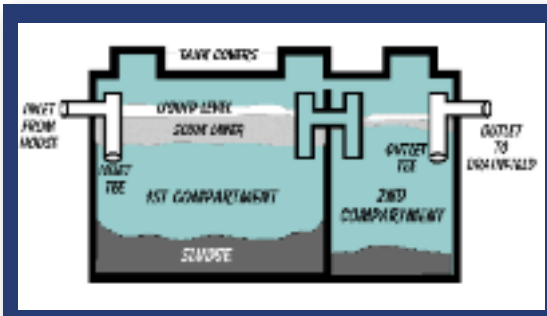
In the journal *Limnology and Oceanography*, they report finding elevated levels of these "nutrients" in the surf zone during periods of high groundwater flows to the beach.

Following one of these freshwater pulses, they observed a four-day elevation in chlorophyll-a levels—a proxy for phytoplankton concentrations. Though it is extremely difficult to attribute any single algal bloom to the presence of higher than normal nutrient levels, the general link between nutrification and algal blooms is widely recognized for both marine and freshwater ecosystems.

"Our project is one of the first in California to show definitively that septic tanks can affect coastal water quality through submarine groundwater discharge," says Alexandria Boehm, an environmental engineering professor at Stanford University.

Most research on septic systems has focused on their effects on terrestrial ecosystems, Boehm explains. The value of this project is that it shows they can also impact marine ecosystems via polluted groundwater discharging directly to the ocean.

In theory, the nutrient spikes detected in Northern California could have come from polluted creeks or runoff. This, however, is not what the scientists believe is happening because their fieldwork was conducted in summertime when, they say, groundwater is the only source of freshwater to the coast.



Schematic of a septic system. *Michigan State University Extension*

Fertilizers spread on lawns and crops could also potentially be sources of the nutrients they detected. Again, however, scientists rule out this possibility because of the concomitantly high levels of human fecal indicator bacteria detected in groundwater samples collected between the septic systems and shoreline.

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Stanford/A. Boehm

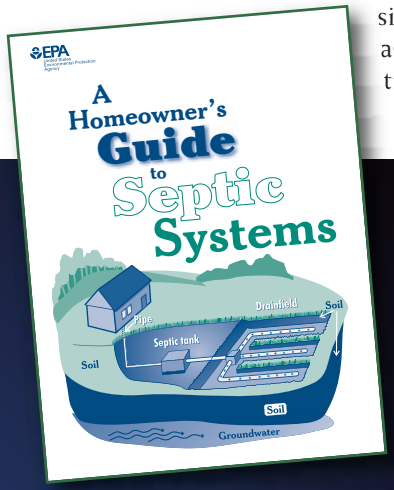
The Stanford team: professor Ali Boehm (upper left), with (clockwise) summer intern Eric Foote, graduate student Nick de Sieyes, graduate student Kevan Yamahara, and Ken Willis, Boehm's husband.

Interestingly, bacteria counts in beach water samples did not rise and fall with changes in groundwater fluxes, suggesting the beach aquifer removes pathogens, says Stanford doctoral student, Nicholas de Sieyes, the lead author of the journal article. "Some of our current research is focusing on this point."

From a scientific perspective, the researchers were not surprised to find a link between septic systems and beach water quality. "It is what we expected," Boehm says.

The unanticipated discovery was the way in which tidal cycles modulate freshwater fluxes to the coast. Indeed, their prediction was that fresh groundwater flows would peak during spring tides, when the tidal forces of the sun and moon reinforce each other. Instead, the greatest pulses of exiting groundwater occurred during neap tides, when weak tidal forcing results in minimal differences between high and low tides.

In particular, they measured a fresh groundwater discharge rate of 1.2 to 4.7 liters per minute per meter during neap tides, compared with .1 to .5 liters per minute per meter during spring tides. During neap tides, nitrogen levels rose 35 percent, phosphate levels 27 percent and silicate levels 14 percent, as compared with spring tide measurements.



Their technical explanation for the pattern is outlined in detail in their peer-reviewed work. The gist of it is that ocean water fills the beach aquifer during high spring tides, creating a sort of hydraulic mound in front of fresh groundwater. During low tides, all of this saltwater must drain back to sea before fresh groundwater can begin to exit. During neap tides, the absence of a formidable hydraulic mound results in a greater release of fresh groundwater to the beach during low tide, hence their results.

All of the fieldwork, which will continue into the summer of 2009, was conducted at Stinson Beach in Marin County because of the community's interest in protecting its beach water quality.

"We don't think our findings are unique to Stinson Beach," de Sieyes says, noting that septic systems are common along coastal counties north of San Francisco, as well as in more densely populated areas such as Morro Bay, Malibu, Rincon and Los Osos.

In recognition of the potential environmental implications for beach, ocean and river ecosystems, the California legislature has directed the State Water Resources Control Board to establish regulations on septic systems. California and Michigan are the nation's only two states without statewide regulations on septic systems.

Critics of the proposed changes cite a lack of data showing septic systems contribute to actual water-quality problems.

"I think it's really important for people to know that we've quantified the impact of septic systems on the coastal ocean at one location, that there were documentable effects on groundwater and coastal water quality and that, in general, on-site wastewater treatment is indeed an important environmental concern and may require additional regulatory attention," de Sieyes wrote in an email exchange.

Surfers have a reputation for braving the ocean during "red tides" and beach closures. The surfing community has become an active advocate for protecting coastal water quality.

Wikipedia/Mila Zinkova

California and Michigan are the nation's only two states without statewide regulations on septic systems.

Michigan State University Extension

Schematic of septic system and how waste enters groundwater.

Bigger, Better SUPER ABS

MOSS LANDING – Feeding cultured red abalone a diet that includes small amounts of red seaweed makes for bigger, redder "super abs."

CSG/C. Johnson

California Sea Grant biologists report that red abalone fed a 95-to-5 percent mix of brown to red seaweed grew a staggering 25 percent faster than animals fed only brown seaweed.

"Red algae is like feeding your kids vitamins," explains Thew Suskiewicz, a graduate student at Moss Landing Marine Laboratories who worked on the project. In the wild, red abalone are grazers that feed on drifting pieces of all kinds of macroalgae. "We are basically making their diet closer to what it would be in nature."

The higher growth rate was based on a year-long study of about 23,000 abalone between the ages of two and three at the Monterey Abalone Company, a grow-out facility in Monterey Harbor that raises abalone in submerged wire cages hung beneath the wharf. Growth rates were measured every few weeks, following the industry standard of sorting animals by shell diameter.

CSG/C. Johnson

Above: A "super ab" on a red seaweed diet has a brightly colored shell.

Left: Red abalone in a grow-out cage at the Monterey Abalone Company.

In addition to making abalone bigger, red algae also resulted in more vibrant, deeply saturated shell colors.

Perhaps more significantly, a group of restaurateurs, food critics and marine biologists invited to a red abalone tasting at the swank Highlands Inn in Carmel preferred "super abs" nearly 4-to-1 over red abalone fed a diet of giant kelp. Texture was cited as the main reason for the preference.

The Monterey Abalone Company is hoping to expand its current red and brown seaweed garden to reap the benefits of red algae and to help it secure year-round access to abalone food.

Mike Graham, the ecologist at Moss Landing Marine Laboratories who led the study, will also begin experimenting with methods for preserving seaweed for winter, when heavy surf can rip apart wild beds making kelp cutting impossible or dangerous.

CSG/C. Johnson

Red algae cultured on ropes in Monterey Harbor.

Highland Inn's executive chef Mark Ayers prepares red abalone for a tasting event.

CSG/C. Johnson

Surf Candy!

Ghost shrimp imported from Washington and purchased at a Los Angeles County bait shop.

CSU Long Beach/B. Pernet

Free-swimming fishes in the surf-zone adore noshing on ghost shrimp. This is why anglers bait their hooks with the same delectable crustaceans. But, what are the ecological risks of importing ghost shrimp from the Pacific Northwest to bait buckets in California?

LONG BEACH – Sea Grant biologists report that ghost shrimp from Washington appear genetically indistinguishable from their counterparts living naturally in Southern California.

Translation: California anglers who dump their bait buckets into coastal waters are probably not going to pollute the genetic profile of local ghost shrimp.

The conclusion is based on mitochondrial DNA analyses of two genes from specimens collected between San Diego and central Washington.

Neotrypaea californiensis, the scientific name of the species in question, is genetically homogenous along the West Coast, says project leader CSU Long Beach professor Bruno Pernet. There are no apparent genetic differences between northern and southern populations.

CSU Long Beach/B. Pernet

The little volcano holes are ghost shrimp burrows.

Is this a surprise?

No, says co-investigator James Archie, a geneticist also at CSU Long Beach.

Marine species with long larval periods are often genetically homogenous over large geographical regions, Archie says. Ghost shrimp have a larval period of six to eight weeks, compared with about a week for common marine snails, chitons and limpets.

At issue now is whether imported ghost shrimp might introduce new parasites to California.

Bruno Passarelli, a CSU Long Beach graduate student, is now investigating this question by testing the temperature tolerances of Pacific Northwest parasites to warmer California conditions.

Worrying about parasites might seem like a stretch, but it is a realistic concern. "We have seen first hand the problems caused by a parasite from Asia, possibly introduced via ballast water," he says. The parasite is blamed for a decline in the burrowing shrimp, *Upogebia pugettensis*, in Washington.

Why care about ghost shrimp genetics and the spread of their parasites?

CSU Long Beach/B. Pernet

Two common ghost shrimp parasites that could be spread by the release of imported ghost shrimp: the isopod *Ione cornuta* (left) and nematode (Ascarophis sp.).

"Ghost shrimp are like earthworms except more active," Pernet says. "A single square meter of mudflat can have 450 ghost shrimp. Burrows may descend a foot or more."

"Because they are constantly excavating these burrows, and because they are constantly pumping water through them, they have a profound effect on a habitat's physical structure and geochemistry," he says. "They are also important prey species for many fish. We want to know their populations are healthy and what environmental conditions support healthy numbers."

New Online Searchable Database of Marine Laws

PALO ALTO – All of the laws pertaining to the management of the California Current ecosystem now exist in a single, searchable online database, publicly accessible through the Governance of the California Current Large Marine Ecosystem Website at www.cclme.org.

The massive compilation project—1,466 state, federal and international laws were included in the database—will hopefully help ocean stakeholders identify gaps, overlaps and inconsistencies in marine governance as it relates to the California Current ecosystem.

"The database allows you to explore different approaches in managing the same resource across jurisdictions," says its creator, Julia Ekstrom, a former researcher and graduate student in marine policy at UC Santa Barbara, now a postdoctoral scholar at Stanford University. "You can also see which agencies have responsibility over whatever topics you are interested in and through what laws."

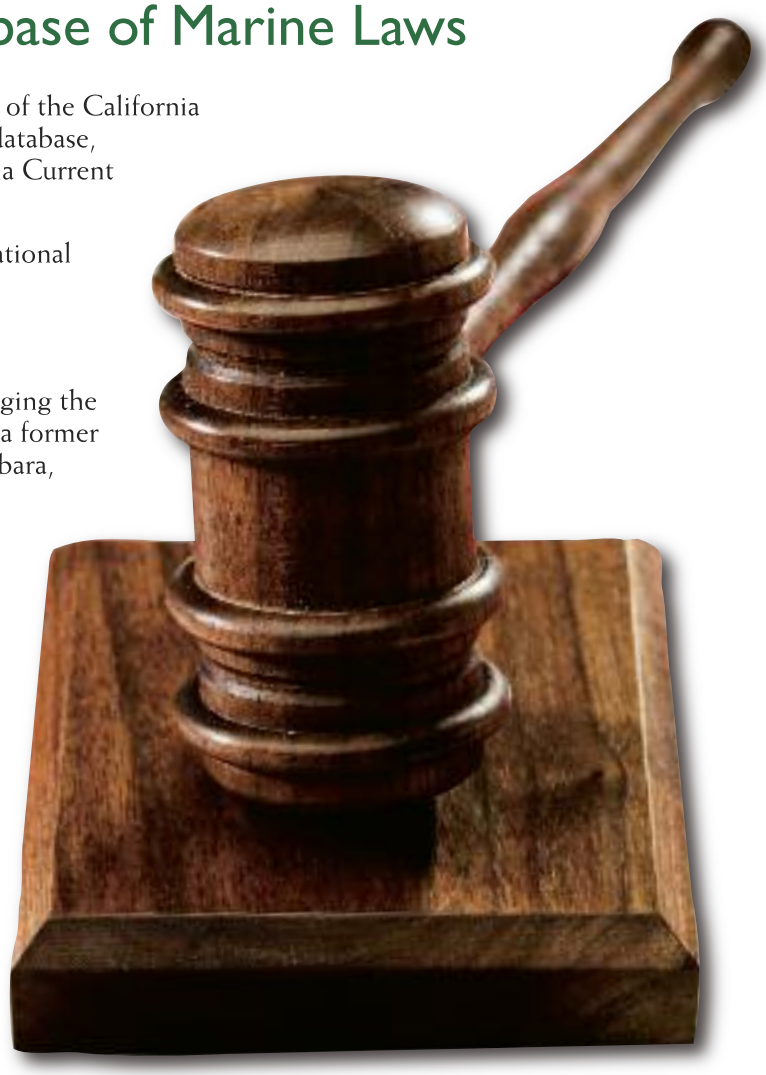
The Website, which continues to be updated, allows users to perform keyword searches to find state and federal statutes and/or regulations with the keyword in their text. Bar charts show the number of laws under the jurisdiction of each relevant federal and state agency. State laws in Washington, Oregon and California are included in the digital library.

Stanford/J.Ekstrom

Geographical scope of the California Current Large Marine Ecosystem.

Articles in the journal *Marine Policy* explain how to use the database to analyze overlap and gaps in ocean laws.

The California Ocean Protection Council and California Sea Grant are funding this project.



Governance of the California Current Large Marine Ecosystem Website:

http://www.cclme.org

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UC 2009
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Sea Grant News

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UC ANR/A. Eicher

NEW PUBLICATION!

Stop the Spread of Dwarf Eelgrass

UC ANR/A. Eicher

A new educational brochure, "Stop the Spread of Dwarf Eelgrass," is now available through California Sea Grant and the California Department of Fish and Game.

The brochure explains the value of native eelgrass meadows, the ecological problems posed by invasive dwarf eelgrass and ways to distinguish dwarf eelgrass from native seagrasses such as Pacific eelgrass, widgeon grass and surfgrass.

A printable PDF of the brochure can be downloaded at the California Sea Grant Website at **http://www.csgc.ucsd.edu** by entering the search term "eelgrass."