Sea Grant California

Sea Grant News

AUGUST/SEPTEMBER 2009

Coastal Science Serving California

Not POND SCUM but GREEN GOLD

Fish Farm Empties Its Ponds to Grow Algae for Biofuels

MECCA, CA – San Diego-based Kent SeaTech, once the world's largest producer of hybrid striped bass, recently sold the last of its fish to enter the highly speculative but potentially lucrative race to commercialize algal biofuels.

The company, now called Kent BioEnergy, said its decision to leave the fish-growing business was based purely on economics. It now seeks to expand its pilot algal production facility in Mecca in the Coachella Valley, at the same site where, over the course of three decades, it raised about 50 million pounds of its trademark "California farmed striped bass."

"We are still in the aquaculture business," says Jim Carlberg, vice president of operations at Kent BioEnergy. "We are just growing algae instead of fish."

Carlberg cites a number of operational expenses that eventually made staying afloat farming fish impossible. Feed costs doubled, he says. Airfreight to the East Coast tripled; seafood imports flooded the market; energy and water costs soared. All the while fish prices remained level.

"There was no profit margin," says Carlberg, who has collaborated on several Sea Grant aquaculture research projects over the years, the most recent of which sought to develop a vaccine for the problematic fish disease, *Streptococcus iniae*.

"It was that simple, and it was nothing unique to us, or to California, or to anywhere in the developed world."

The last two years of the company's existence as Kent SeaTech, the farm tried raising tilapia to sell to local Asian markets. When this failed (the live market wasn't large enough), the company turned to algae.

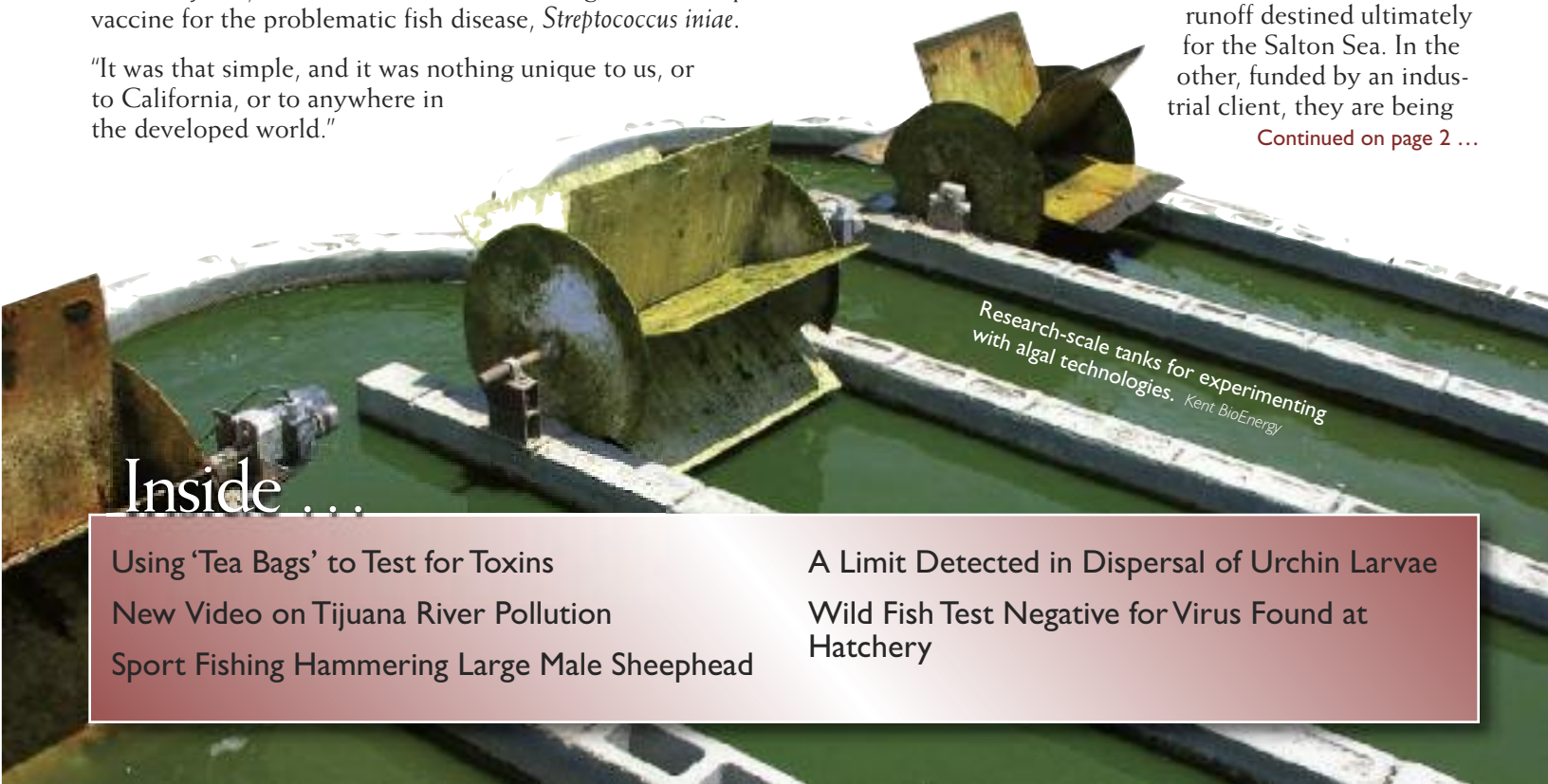
The idea is not as far flung as it might seem, says Greg Schwartz, a senior scientist at Kent BioEnergy, who was hired eight years ago to oversee the company's algal operations.

In the '70s, Kent SeaTech was raising algae to feed zooplankton that were, in turn, raised to feed fish too young for commercial pellets. Algae were later grown to neutralize ammonia waste in fish effluent. The algae mop up toxic forms of nitrogen excreted by fish, making it possible to recirculate water longer.

The company then partnered with agricultural engineer David Brune at Clemson University in South Carolina to patent a process for removing algae from the water column to meet federal water-quality standards on aquaculture effluent.

Both of the projects underway at Kent BioEnergy are spin-offs of technologies developed to manage and conserve water at the former fish farm, Schwartz says. In one, funded by the state of California, algae are being used to soak up nitrogen in agricultural runoff destined ultimately for the Salton Sea. In the other, funded by an industrial client, they are being

Continued on page 2 …



Research-scale tanks for experimenting with algal technologies. Kent BioEnergy

Inside . . .

Scientists Rely on 'Tea Bags' to Test for Toxins

SANTA CRUZ – A new tool for tracking algal toxins is under development at UC Santa Cruz.

The tool resembles a tea bag filled with sand and, like a tea bag, is soaked in water. The grains in the sac, though, are actually tiny porous resin beads that selectively absorb domoic acid, a naturally occurring neurotoxin that causes amnesic shellfish poisoning in people and seizures in marine mammals.

Raphael Kudela, a phytoplankton ecology professor at UC Santa Cruz, envisions hanging the resin-filled sachets off piers and wharfs in California to continuously track nearshore dissolved toxin levels, similar to what is being done through sentinel "mussel watch" programs.

"What we have done is produce a passive, quantitative man-made sentinel mussel," Kudela says. "But unlike a real mussel, our mussel is not sensitive to salinity extremes or vulnerable to red tides."

The artificial mussel also differs from a real mussel in that it does not filter the diatoms that contain the toxin. Instead, it absorbs that small fraction of the toxin that leaks from the cells into the water.

Top: Sea lion affected by domoic acid.
Photo credit unknown

Left: The sachets contain resin beads that absorb algal toxins.
UC Santa Cruz/Meiling Roddam

The next step in the Sea Grant project is to place the resin sachets into water samples treated with cell-lysing compounds, which would liberate the domoic acid within diatoms, allowing for a tally of the total domoic acid content of the water sample.

"Organisms are not drinking domoic acid, they are ingesting cells that contain it," Kudela says, explaining his interest in further developing the resin-based technique.

… continued from page 1

added to the liquid that drains from landfills to remove nutrient pollution.

The company now hopes to build out its algal operations into a demonstration-scale biofuels and remediation facility.

"We know how to grow algae and we know how to harvest it," says James Levin, director of the company's molecular research. "There are a couple of major research areas that have to be tackled to make algal biofuels economically plausible for us, or anyone. One is to develop algal strains with a significantly higher lipid content. The other is to develop low-cost techniques for extracting oil from the cell."

The University of California recently announced the creation of a regional center for algal biotechnology with both academic and commercial partners, including Kent BioEnergy.

"A lot of people are coming out of the woodwork on this," says Mike Massingill, vice president of systems engineering at the company. "To hear them all, you'd think they have been working on algal biofuels for 20 years. What we are betting on is that they have not done anything before on a commercial scale."

Kent BioEnergy

Illustration of some of the microalgae species that have potential as sources of renewable energy.

"We are still in the aquaculture business. We are just growing algae instead of fish."
– Jim Carlberg, vice president of operations at Kent BioEnergy

New Video Calls Attention to Growing Pollution Problems of Tijuana River

Shifting Baselines in the Tijuana Tide is a new 5-minute video from the Shifting Baselines Ocean Media Project addressing ocean conservation problems from the highly polluted Tijuana River.

The video (available in English and Spanish) is a co-production with California Sea Grant, USC Sea Grant and Wildcoast. The Annenberg Foundation, The Keith Campbell Foundation for the Environment and USC Wrigley Institute for Environmental Studies provided partial funding, and Surfrider Foundation is assisting with outreach and distribution.

"The Tijuana River is one of the worst sources of ocean pollution in North America," says the writer and director of the film, Tyler Carlisle. "It's a problem that is currently caught up in a cross-border blame game as the large-scale problems continue to go unaddressed."

Guillermo Buelna

The border fence extends into coastal waters between Mexico and the United States.

Tijuana Estuary Coastal Training Program

Pervious pavers being installed in Tijuana.

The video presentation (www.csgc.ucsd.edu) is intended to help local conservation efforts communicate more effectively the current situation. More than 60 percent of Tijuana's raw sewage flows directly into the river, through the Tijuana River Estuary and into the ocean. Local beach-goers pay the price for the problem; beaches nearest the Tijuana River mouth are closed an average of 200 days a year. A bit further north around the Imperial Beach pier, the average is about 50 days.

The video encourages viewers to join local efforts to curb the overall pollution and runoff problem.

The on-going Shifting Baselines Ocean Media Project (www.shiftingbaselines.org) brings together ocean conservationists and filmmakers to communicate the problems to wider audiences. It is based at the Scripps Institution of Oceanography and has more than 20 partner groups, including co-founders Scripps and Surfrider Foundation.

Beach closure due to contaminated water.
Credit: Katarzyna Balug

Sport Fishing Targeting Large Male Sheephead

Overfishing Triggers Sex Change in Females

SANTA BARBARA — Large male sheephead are rare off Catalina Island, the most visited of the Channel Islands, and the reason is likely sportfishing, scientists report.

The absence of large males, ironically, is reducing the number of eggs produced by females.

"We see lots of tiny, midget males, which is not the case historically," says UC Santa Barbara postdoctoral researcher Scott Hamilton.

THE EXPLANATION?

"We believe sportfishing has selectively removed "trophy" fish, which for sheephead means the males almost exclusively," says UC Santa Barbara researcher Jennifer Caselle, the lead investigator of the California Ocean Protection Council-funded project. CSU Long Beach biologists Chris Lowe and Kelly Young are co-investigators.

Commercial fishing targets smaller, solid-red females that command the highest prices in the live Asian finfish markets.

The problem, ecologically speaking, with removing large males is that it triggers sex change in small females. All sheephead are born female and switch to male as they age and grow larger – a life-history characteristic known as sequential hermaphrodism or, more precisely, protogynous hermaphrodism.

Early sex change is a double blow for egg production, as females spend less of their life producing eggs and because older, bigger females produce exponentially more eggs.

The scientists report that female sheephead off Catalina in 2007 switched sex at ages as young as five and at "standard lengths" as short as 24 centimeters, while the youngest, smallest males observed that year off San Nicolas Island were 9 years and 40 centimeters respectively. In 1980, when scientists say San Nicolas was relatively unexploited, sex change occurred between the ages of 13 and 14 and at lengths of about 48 centimeters.

Wikipedia/Tomás Castelazo

A male California sheephead at a fish market in Ensenada, Baja California, México.

"The fish keep getting smaller and they are changing sex earlier," Hamilton says. "The bright spot is that we are seeing a recovery off San Nicolas."

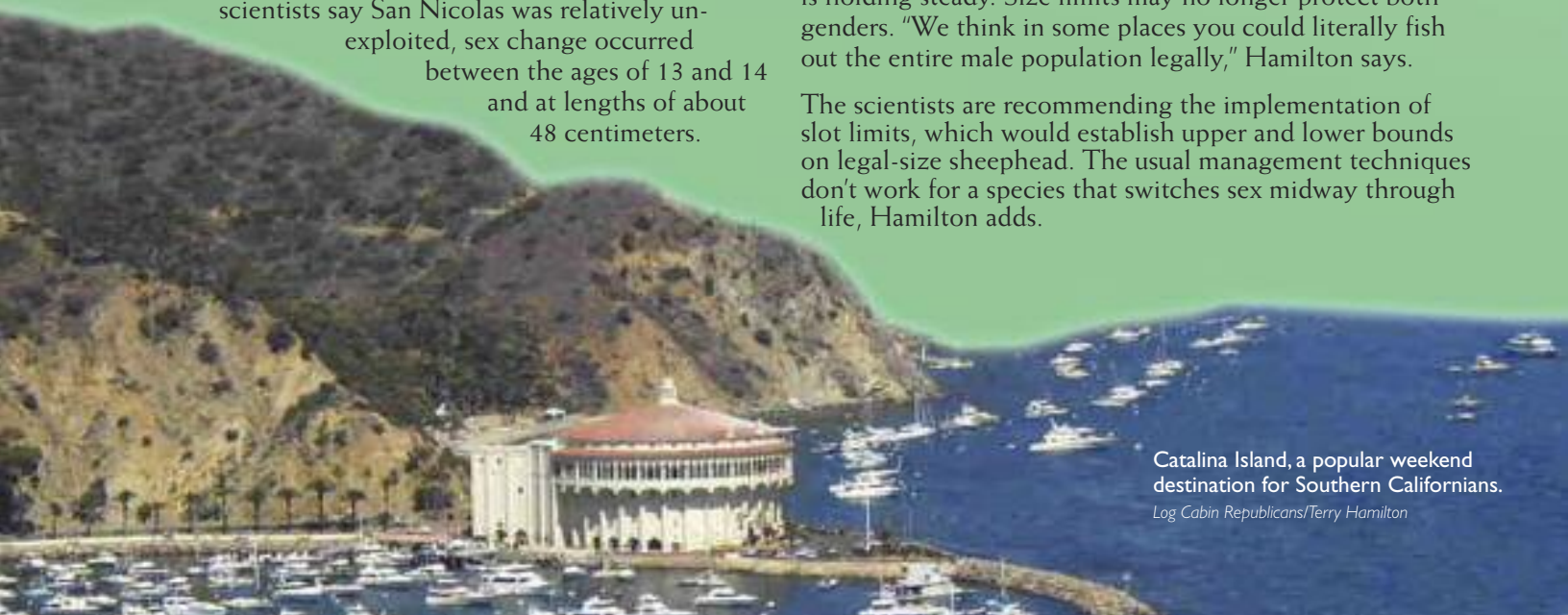
San Nicolas, besides being the most remote of the Channel Islands, is a Navy-controlled weapons-testing facility with greatly restricted access post 9-11. This, combined with rising fuel prices and new regulations on commercial fishing, has sharply reduced sheephead landings in the last decade.

In 1998, at the peak of the commercial sheephead fishery off San Nicolas, sex change was occurring at 7 and 8 years and at lengths of 30 centimeters, the scientists report.

"What we see is that the fish do come back once fishing pressure is reduced," Hamilton says.

The worry is for places like Catalina, where fishing pressure is holding steady. Size limits may no longer protect both genders. "We think in some places you could literally fish out the entire male population legally," Hamilton says.

The scientists are recommending the implementation of slot limits, which would establish upper and lower bounds on legal-size sheephead. The usual management techniques don't work for a species that switches sex midway through life, Hamilton adds.



Catalina Island, a popular weekend destination for Southern Californians.

Log Cabin Republicans/Terry Hamilton

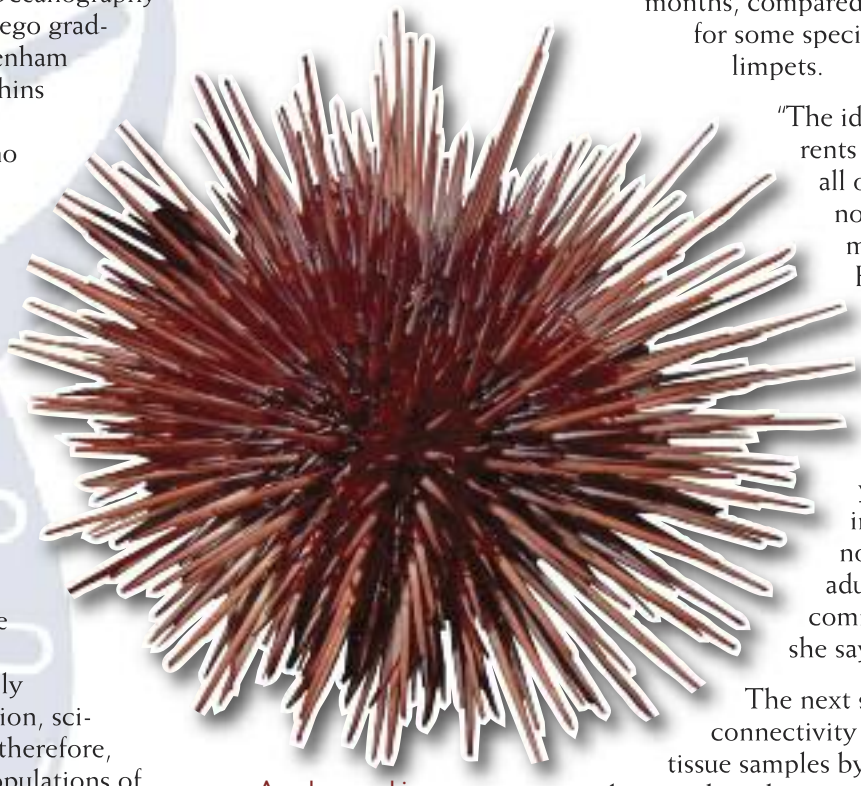
A Limit Detected in Dispersal of Urchin Larvae

SAN DIEGO – Despite their exceptionally long larval stage, red sea urchins appear genetically differentiated along the West Coast of North America.

It is the first time scientists have detected any population structure in the species.

Marine biology professor Ron Burton of Scripps Institution of Oceanography and former UC San Diego graduate student Celeste Benham analyzed 500 adult urchins from San Diego, Los Angeles and Mendocino counties across five microsatellite markers and compared the genetic patterns to an existing, similar dataset of 1,400 urchins from British Columbia.

The genetic signatures strongly suggest that California and British Columbia are not connected via larval dispersal because it takes only a few "migrants" to genetically homogenize a population, scientists say. There are, therefore, at least two distinct populations of the urchins, perhaps more.



A red sea urchin.
Wikipedia/Kirt L. Onthank

"The take-home message of this study is that if you use more markers and newer techniques you will find some population differentiation that before nobody found," Burton says, referring to past studies that used fewer genetic markers and detected no population genetics structure in the species across large swaths of its range.

"From my evolutionary perspective, our results are important because they imply that, even on long time scales, there is no mixing," he says. "This means there is at least the potential for populations to adapt to different ocean conditions and gradually diverge. This is the first step in the two populations potentially becoming different species."

The larval period of red sea urchins can exceed two months, compared with about a week, or less, for some species of abalones, chitons and limpets.

"The idea has been that ocean currents must be mixing urchin larvae all over the place," says Benham, now a research assistant at the marine mammal laboratory at Hubbs-SeaWorld Research Institute in San Diego. "But, there is more going on out there."

Genetic tests of "recruits" (urchins younger than 2 years old) from Point Loma in San Diego show they are not the offspring of nearby adults. "The next generation is coming from somewhere else," she says.

The next step in understanding larval connectivity is to begin binning DNA tissue samples by age, which roughly correlates with urchin size, Benham says.

WHY IS THIS KEY?

Adult urchins may reach the age of 100. Genetic analyses that don't take into account the span of ages in a set of DNA tissue samples could be averaging larval dispersal patterns over a century.

"We have been studying genetic differentiation at very low resolutions," Burton says.

California Sea Grant

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Wild Fish Test Negative for Virus Found at Hatchery

DAVIS – Wild white seabass have tested negative for a herpes virus that has lethally infected hatchery-born fish.

UC Davis fish health specialists Ronald Hedrick and Kristen Arkush say the absence of the virus in the 100 wild fish tested for the study warrants "conservative approaches to the release of virus-infected white seabass from hatchery-propagated programs."

HSWRI

White seabass.

The PCR-based technique for testing fish, developed by UC Davis scientist Tomofumi Kurobe, could be used to ensure fish slated for release in the wild are disease free.