

Anthropogenic Impacts on Rocky Intertidal Mollusks in Southern California: Compiling Historical Baseline and Quantifying the Extent of the Problem

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Summary: Loving the Coast to Death

Do you ever wonder what the seashore looked like a century ago? Many would be shocked at the changes accompanying the exponential population growth along the coast. Gone are the 20-pound lobsters, 500-pound black sea bass, rocks carpeted in abalones and octopi hiding in tide pools. Biology professor Kaustuv Roy at UC San Diego compares the cumulative consequences of human activity—trampling, shell collecting, poaching and pollution—akin to the proverbial death of a thousand blows.

Project: Why Size Declines in Intertidal Gastropods?

With California Sea Grant support, Roy is studying processes controlling the spatial and temporal distributions of biological diversity in Southern California’s rocky intertidal habitats. By identifying the role that people play in altering these habitats, scientists can create tools to protect what is close to being lost. In previous research, Roy and colleagues showed that the average body size of marine snails and limpets along Southern California has declined significantly over the past century and that humans appear to be the culprit.

“We showed that since 1869, human exploitation has led to a striking decrease in the sizes of many marine invertebrate species,” said Roy, who was the primary author of the report, “Anthropogenic impacts and historical decline in body size of rocky intertidal gastropods in southern California,” published in *Ecology Letters*. “The effects are

pervasive and not restricted to species that are commonly exploited for food. We also showed in the study that it is possible to mitigate for these effects if current laws are enforced, but that such enforcement is largely lacking in the Southern California region.”

For this work, scientists compared museum collections of shells dating back to 1869 with field samples of four species of gastropods along 120 miles of coast between Los Angeles and San Diego. These species vary in their body sizes, life habits and tendency to be harvested by humans.

Of the four species, the owl limpet, *Lottia gigantea*, has long been collected for eating. The Gilded turban snail, *Tegula aureotincta*, is

—continued on reverse



Photos Bonnie J. Becker, Cabrillo National Monument, National Park Service



“In this country, we have a wilderness ethic, but that does not seem to apply to intertidal habitats,” said UCSD biology professor Kaustuv Roy, who has California Sea Grant funding to study the effects of human activity on tide pools and other rocky intertidal habitats. “When you go to a state park or a national park you stay on the trail. When you go to the coast, you are free to go anywhere. We need a wilderness ethic to protect intertidal habitats, too.”

“We cite [Roy’s] study quite a bit,” said marine biologist Bonnie Becker at the National Park Service’s Cabrillo National Monument in San Diego. “The study gave us clear documentation that our efforts to protect the tide pools from illegal harvests is paying off... Without the research, our hands are tied. We can create management policies, but if we don’t study the effects of what we are doing, we can’t possibly protect the species we are charged with protecting. It is hugely important to study the specific effects of our management policies.”



Photo: Joe Heath

also harvested. The other two species studied, the volcano keyhole limpet, *Fissurella volcan*, and *Acanthinucella spirata*, a small predatory snail, are not commonly exploited for food.

When people collect intertidal species, they tend to remove larger individuals, Roy said. This reduces the average body size of remaining populations since only smaller individuals are left to reproduce and pass their genes to the next generation. In the case of the owl limpet, removing larger individuals also results in a gender imbalance. All owl limpets are born male and turn into females later in life. The researchers originally hypothesized that if harvesting were the only factor acting on populations, size declines would be observed in owl limpets and to a lesser extent in Gilded turban snails, but not in the other two species.

Size declines, however, were found in all four species. From the specimens in the museums collected during the 1800s to the living gastropods, which were collected and measured at 14 separate field sites along the coast, the researchers showed that the average body sizes of all four gastropods declined significantly over time.

"The declines in the species supposedly not targeted were a surprise," Roy said. "Nobody expected it."

As significantly, declines in size were not observed in specimens collected from the National Park Service's Cabrillo National Monument on Point Loma in San Diego, the site of a 120-acre protected tide-pool area adjacent to the mouth of the San Diego Harbor—where a team of volunteers and park staff strictly enforces no-take rules.

Findings: Enforcement of Conservation Laws Crucial

The absence of size declines in the one truly protected area in Southern California has led Roy to conclude that human activity—not natural variation in oceanic or atmospheric conditions—is the root cause of degradation along the coast.

"If you want to find big gastropods, go to Cabrillo," Roy said. "Don't waste your time at another place, at least not in Southern California." The lesson, he said, is that marine reserves serve to protect intertidal life only when conservation laws are strictly enforced. "Without enforcement, reserves are not worth calling reserves."

With a two-year grant from Cali-

fornia Sea Grant that began in 2005, Roy is expanding the historical database on the sizes and distribution of intertidal mollusks in the region. A more comprehensive database will allow him to study the causes and ecological implications of human activity in intertidal habitats in greater depth. The big questions we want to ask are: 'How do we use the coast?' and 'What are the ecological effects of such use?'" he said.

Better historical baselines paired with exhaustive field surveys will also allow scientists to estimate rates and patterns of local species declines. In most cases, human activities have not yet pushed rocky-shore organisms to extinction. "The pattern is that many species are just getting smaller and smaller over time," he said. "We want to know the biological consequences of size declines. Because changes in size impact many aspects of a species' life history, the long-term viability of populations in the face of such strong selective pressure remains an open question."

Trainee

Benjamin Pister

Publication

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