

Kodiak Island red king crab larvae in the zoea stage, shortly after emerging from eggs at the Alutiiq Pride Shellfish Hatchery in Seward, part of the Alaska King Crab Research, Rehabilitation and Biology program.

Photo courtesy of Celeste Lenoux, Alaska Sea Grant

Trying to get **A Crab** in every pot

Can crab hatcheries save an industry?

By Doug Schneider

Inside the Alutiiq Pride Shellfish Hatchery on the south end of the fishing and tourism town of Seward, thousands of recently hatched red and blue king crab are starting to actually look like crab.

Just four weeks earlier, these king crab were embryos within eggs tucked neatly beneath their mothers' abdominal flap. The mothers — 20 red king crab from Bristol Bay, 20 red king crab from Southeast Alaska waters, and 19 blue king crab from the Bering Sea around St. Matthew Island — had been collected by local fishermen and the Alaska Department of Fish and Game, and delivered to the hatchery a few months earlier.

The newborn crab have so far grown through the major steps of larval development, collectively called the zoea stage. At the moment, they are well into the next stage, called glaucothoe, when they take on features common to all crab. They brandish tiny claws on their front legs. Large, beady black eyes sit atop their heads. In a few more weeks, these crab will have armored shells and be instantly recognized as Alaska's biggest crab.

"They start out small," says biologist Jim Swingle, a crab research biologist with Alaska Sea Grant. "It's amazing to see them develop."

For each of the past five years, Swingle and fellow Sea Grant biologist and UAF graduate student Ben Daly have carefully cared for and watched over the adult female king crab and the growth of their numerous offspring.

The efforts are part of a UAF partnership with fishermen and trade associations, coastal communities, and state and federal scientists to figure out how to hatch and raise large numbers of king crab from wild brood stock. The project will also teach scientists more about the ecology and biology of wild crab, and how hatchery crab might fare if they are released.

"Overall, the research is aimed at learning whether raising red and blue king crab in hatcheries is feasible as a means to help dwindling wild king crab stocks recover in places like Kodiak Island and the Pribilof Islands," says David Christie, director of Alaska Sea Grant.

King crab boom, then bust

For decades, Alaska crab fishermen from Southeast to the Bering Sea happily rode what seemed to be a tidal wave of king crab.

Take the waters around Kodiak Island, some 300 miles southwest of Anchorage. Beginning in the late 1950s, Alaska crabbers hauled in seemingly bottomless boatloads of red king crab. At the peak of the fishery in 1965, fishermen caught 94 million pounds of the colossal crustacean, valued then at \$12.2 million. At today's price paid to fishermen, the value would be \$500 million.

In Bristol Bay, fishermen in 1980 hauled in 130 million pounds of red king crab, worth \$115 million. (That's \$650 million for fishermen in today's dollars.)

They hunted blue king crab as well. At the peak in 1981, fishermen in the frigid Bering Sea around the Pribilof Islands and St. Matthew Island filled their boats with 14 million pounds of blue king crab.

But the boom was not to last. Following that gigantic Kodiak haul in 1965, red king crab catches there declined rapidly over the next decade. In 1983, after a few years of harvests in the 20-million-pound range, fisheries managers finally shut it down. The closure was a huge economic blow to the island's economy. And even though king crab fishing has been closed for more than 30 years, the stock has not recovered.



UAF photo by Ben Daly, Alaska Sea Grant.

About the size of a pea, red king crab in glaucothoe stage take on features common to all crab.

Around the Pribilof Islands, blue king crab have not fared well either. After years of erratic catches, the blue king crab fishery closed in 1999. Officially, the blues there are classified as overfished.

A similar fate befell red king crab in Southeast Alaska, where commercial fishing has been closed for the last five years.

About the only place in the United States where large numbers of red king crab can still be caught is in the eastern Bering Sea, near Bristol Bay, where some 50 – 70 boats, including the boats seen on the show *The Deadliest Catch*, still ply their trade. But even here, catches of around 15 million pounds each year are nowhere near what they used to be.

Grassroots call spurs research

In the years following the collapse, fishermen called for a hatchery program to rebuild king crab stocks around Kodiak and the Pribilof Islands, in much the same way that hatcheries were used in Prince William Sound to restore salmon stocks following the 1964 Good Friday earthquake, which destroyed important salmon spawning habitat. In 1992, Kodiak residents convened a workshop on their island's crab crash and what might be done to help the stocks recover.

But no research effort came until the idea was brought up again in 2006 during conversations among Arni Thomson (Alaska Crab Coalition), Heather McCarty (Central Bering Sea Fishermen's Association) and Gale Vick (Gulf of Alaska Coastal Communities Coalition).

"We were all talking and I asked . . . about the possibilities of enhancing the wild king crab stocks. Arni arranged for us to meet with several scientists," says Vick. "From there, it picked up steam with the communities and other fishermen's groups. The beginnings were truly grassroots."

The group asked UAF's Alaska Sea Grant College Program to examine the hatchery idea. In 2006, Alaska Sea Grant hosted a workshop to discuss the status of red and blue king crab and the prospect for hatcheries to help rebuild the stocks.

Former Alaska Sea Grant Director Brian Allee recalls the mood of the people in the workshop.

"The consensus was that enough time had passed, that nature needed a little help," says Allee, who now works for the National Oceanic and Atmospheric Administration, helping rebuild salmon stocks in the Pacific Northwest. "The fishing industry wanted a research and development program to test the feasibility of hatcheries as a way to rebuild the crab stocks."

Taking cues from this meeting, Alaska Sea Grant pulled together university and federal biologists, fishermen, community leaders, and the Alutiiq Pride Shellfish Hatchery to form the Alaska King Crab Research, Rehabilitation and Biology — or AKCRRAB — program.

Slow start, then rapid progress on hatchery research

Hatchery research began in earnest in 2007, thanks to fishermen who gave scientists 36 adult female king crab whose abdominal flaps were stuffed with eggs.

"The exact number of eggs varies with the species and size of the female crab, but it is usually between 150,000 and 200,000 eggs for each red king crab, and fewer for the blues we have this year," says Alaska Sea Grant's Swingle.

Scientists monitored the expectant female crab, making sure water temperatures, salinity, flow rates and other factors in the hatchery's seawater tanks were just right.

Then, around the end of March and early April, the larvae began to wiggle free from their eggs. In all, some four million red and blue king crab larvae hatched that first year.

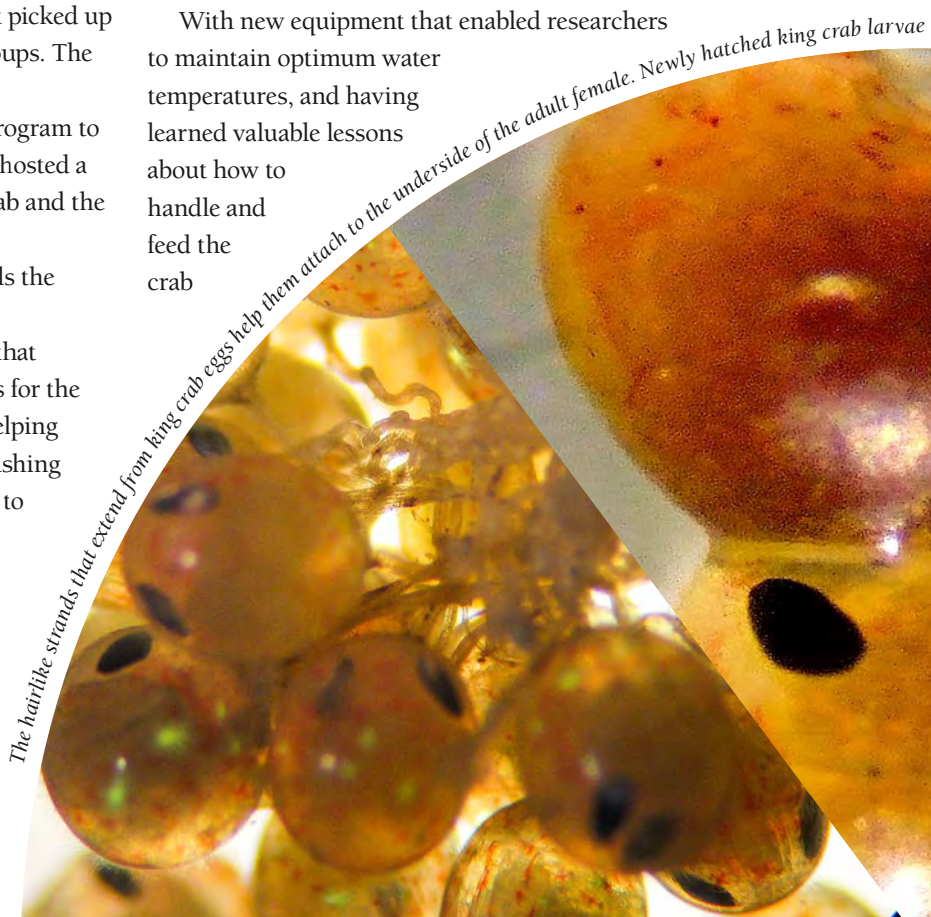
No one had tried this

"Getting the hatch completed was great, but at that time, we didn't know that much about how to take care of the larvae — what they ate, the exact combination of water temperature, light, food and other critical needs," recalls Allee. "We were learning as we went along."

The early problems resulted in the loss of nearly all the larvae that first year. Although a setback, no one had expected a flawless first year.

"No one had tried this before with Alaska crab," says Allee. "We learned a lot and we made adjustments."

With new equipment that enabled researchers to maintain optimum water temperatures, and having learned valuable lessons about how to handle and feed the crab



The hairlike strands that extend from king crab eggs help them attach to the underside of the adult female. Newly hatched king crab larvae

larvae, researchers made steady progress during the following years.

In 2008, 31 percent of larvae reached the glaucothoe stage. Of these, 10 percent survived to the first juvenile stage — the animal has fully formed legs, shell, mouth and internal organs, and has settled out of the water column to the bottom of the tank. Most importantly, the crab look like crab, albeit miniature ones.

“In 2009 and 2010, our methods allowed us to increase glaucothoe survival to 50 percent, and juvenile survival to 20 percent,” says grad student Daly. “In all, some 100,000 crab reached the juvenile stage in each of these years. We consider that to be reasonably good, but there is always room to improve.”

While Daly and Swingle continue to perfect techniques for hatching and raising red and blue king crab in the Seward

Association, the Aleutian Pribilof Islands Community Development Association and the Groundfish Forum, all based in Alaska, and Santa Monica Seafood, one of the largest West Coast seafood distribution companies.

Causes of the collapse

To understand what caused the collapse of red king crab, it's important to understand what caused the population explosion, says Gordon Kruse, professor of fisheries at the School of Fisheries and Ocean Sciences.

Kruse says that although no one knew it at the time, environmental events during the late 1950s set the stage for a crab population boom. Hundreds of feet below the surface of the North Pacific and the Bering Sea, millions of female red king crab were hatching billions of larvae. The ocean during this time was unusually cold — a good thing for crab — full of food and largely empty of predators.

“In almost every way, the Kodiak and Bering Sea ecosystems were a haven for king crab production during the 1950s,” says Kruse. He says that Alaska's red king crab bonanza couldn't have come at a more perfect time for fishermen.

“Just as fishermen were learning where to find red king crab, how to catch them and how to process them, they ran into the mother lode of red king crab,” Kruse says.

The fishermen proved fast learners, quickly reshaping their towns to catch, process and deliver millions of pounds of king crab to markets all over the world. For the next 20 years, the number of fishermen joining the frenzy increased, and for a time, so did the catch.

Signs of a collapse began to appear in the late 1960s, just a few years following the peak in 1965. At least one state biologist at the time warned of a crash, but few with the power to do something seemed to be listening. By 1983, with red king crab all but gone from waters around Kodiak Island, it was over.

In broad terms, says Kruse, the crash came from overfishing and a management system that simply didn't have a thorough understanding of the stocks or the variability of the ocean environment.

“Huge numbers of crab led to too many boats taking part in the fishery,” says Kruse. “The resultant large harvests and king crab bycatch in other fisheries caused high mortality among undersize crab. The overfishing led to the rapid decline in the number of adult males and that led to long-term reproduction failure.”

If overfishing and inadequate management caused the collapse, what's keeping the stocks from recovering on their own? In a word, nature.

Kruse explains that around the mid-1970s, the North Pacific became warmer, triggering massive

before with Alaska crab.

hatchery, UAF scientists and graduate students in Seward and Juneau, and federal researchers in Kodiak and Newport, Ore., are studying the roles of habitat, water conditions, crab body size, prey density, and predator density and types on the survival of juvenile crab in the wild. There are lab experiments at the Hatfield Marine Science Center in Oregon and in the Kodiak fisheries lab run by NOAA, and small-scale field experiments near Juneau.

And while state and federal grants have paid for most of the research to date, there is growing interest from industry in supporting the program.

Donations come from organizations like the Bering Sea Fisheries Research Foundation, the Central Bering Sea Fishermen's



zooplankton blooms that helped halibut, cod, and pollock stocks skyrocket and move into new areas, particularly inshore areas used as nurseries for young king crab. On top of this, the warmer waters helped cod and other fish reproduce rapidly. Such ocean conditions continue to dominate the North Pacific and Bering Sea.

“We think it is likely that there is a whole suite of fish species that chomp down on young king crab and adult crab, and we think this may be what is keeping king crab stocks from recovering,” says Kruse. “Unfortunately, studies of predation on king crab in these shallow nursery areas are woefully lacking.”

But Kruse offered another possible explanation for the lack of recovery.

“It’s conceivable that with limited numbers of crab out there, they are experiencing reproduction problems,” says Kruse.

Put another way, male and female crab aren’t reproducing as much because they simply cannot find each other. Moreover, Kruse says the few remaining adult crab are farther out at sea, greatly reducing the chances that the few crab larvae produced will find their way into safer nursery areas near shore.

Should hatcheries be used to rebuild crab stocks?

AKCRRAB scientists stress that any program to seed Alaska waters with millions of juvenile king crab is still years away. “Hatchery scientists need to improve the production techniques to produce the very large numbers of crab that would be needed to enhance the low wild populations,” explains Christie, Alaska Sea Grant’s director.

He says continued research is needed to understand when, where and how best to release hatchery crab. Also underway is research into the genetics and distribution of wild crab stocks to ensure that any breeding program will not adversely affect the viability of wild stocks.

And while a large-scale hatchery program is not yet in the picture, scientists hope to begin small pilot programs to release some hatchery crab to see how they behave in the wild — assuming they survive.

Are hatcheries likely to be successful?

Like many Kodiak and Pribilof fishermen yearning for the good old days of big red and blue king crab harvests, Gordon Kruse thinks the hatchery research program is probably a good idea. But he is concerned that hatcheries might not be enough to jump-start king crab recovery.

High on the list of Kruse’s concerns is that ocean conditions today still largely favor halibut, flounder, cod and other fish that prey on crab. Such conditions are likely to continue, at least in the short term, according to James Overland, a leading oceanographer with NOAA’s Pacific Marine Environmental Lab, in Seattle.

“I would say do not look for big changes in the years to come, as compared to the changes we have seen the last few decades,” Overland says. “Global processes in the Gulf of Alaska will probably warm the region around 1.5 degrees by the year 2050, but you can also get that big a shift in any given year.”

If current ocean conditions persist, would an abundance of predators simply see the juvenile hatchery crab as a new source of easy food?

“If predation is the bottleneck, as our results thus far suggest, then a remedial hatchery program may have a difficult time rebuilding the stocks,” says Kruse. “However, if we are mistaking predation mortality for some reproductive failure, then if sufficient crab are seeded from hatcheries to help the wild stock reach some critical mass, maybe the crab will have a chance. It’s an open question.”



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To learn more about the Alaska King Crab Research, Rehabilitation and Biology program, please visit http://seagrant.uaf.edu/research/projects/initiatives/king_crab/general/.

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