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Genetic study of Alaska red king crabs suggests species is more diverse and resilient to climate change

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High-resolution data have important implications for management of red king crab fisheries by improving understanding of population structure and diversity

Recent genetic research on the Alaska red king crab (*Paralithodes camtschaticus*) supports the current practice of managing this species at a regional scale – it also strongly favors obtaining broodstock from the target population if stock enhancement is considered to circumvent genetic mismatch issues.

The **report** (<https://www.fisheries.noaa.gov/feature-story/genetic-diversity-alaska-red-king-crab-may-provide-resilience-climate-change>) – authored by Dr. Wes Larson, genetics program manager at the NOAA Alaska Fisheries Science Center – uncovers previously undiscovered diversity among different regions, suggesting this important crab species is more resilient to climate change and changing ocean conditions.

“We found that king crabs display high levels of genetic differentiation among areas across Alaska. We also found evidence for local adaptation, indicating that king crabs are adapted to their specific



New genetic research on the Alaska red king crab reveals previously undiscovered diversity among different regions, suggesting the species is more resilient to climate change and changing ocean conditions. Results have important implications for management of its fisheries by improving understanding of population structure and diversity. Photo of red king crab on the deck of a research vessel, by NOAA Fisheries / Erin Fedewaby.

environments,” Dr. Larson told the *Advocate*. “The portfolio of genetic diversity in king crab is important to preserve as it will potentially help them adapt to a changing world. Data from this study makes it easier to manage that portfolio of diversity to ensure the long-term viability of king crab.”

Maintaining genetic diversity within and among populations is fundamental to ensure species are resilient to challenging conditions. Without it, a disease or adverse environmental conditions – such as a prolonged change in ocean acidification – could lead to the species being driven to extinction. Fortunately, this new research has revealed more genetic diversity across Alaska’s red king crab populations than originally documented.



(<https://bspcertification.org/>).

Traditionally, information about commercially important species comes from fisheries-dependent data (collected on commercial fishing vessels) or independent surveys (from scientific research vessels). Genetics tools help to fill in the information gaps from traditional surveys, while whole genome sequencing builds on past methods by enhancing the ability to detect important differences between populations at finer scales.

Dr. Larson and a team of collaborators conducted a **study** (<https://doi.org/10.1111/eva.70049>) to generate whole genome sequencing data on red king crab in different locations across Alaska. The benefit of whole genome sequencing over previous methods is that it is a fuller picture of an organism's makeup. This holistic approach offers more robust analysis to separate similarities and differences between different locations.

The results of this study were revealing and informative. There was significant genetic structure within populations and genetic diversity between regions. In some cases, this diversity was determined between populations separated by only a few hundred kilometers. The updated method used provided more clarity of fine-scale genetic differences than previous methods, with the data indicating that there are six, possibly seven, genetically distinct populations of Alaska red king crab in the region.



Fisheries in Focus: How the mystery of the great eastern Bering Sea snow crab die-off was solved

A research team has uncovered the reason why billions of snow crabs died in the eastern Bering Sea in 2021, closing the fishery for the first time.



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Scientists attribute this genetic diversity to a combination of factors, including populations deriving from different glacial refugia. These are areas that remained ice-free during the Ice Age. And more recently, natural selection (genetic changes driven by adaptation) and genetic drift (genetic changes that are random) likely contributed to this diversity. The study results documented evidence of local adaptation in most populations.

This research has important implications for management of the red king crab fishery. It confirmed that fisheries are being managed effectively by regions in Alaska. Understanding population structure and these newly discovered genetic signals of local adaptation is also important for preventing overfishing on genetically unique populations. And it's critical to provide information on how local adaptations influence responses to different climatic conditions.

According to Dr. Larson "these data could be used to interpret why certain stocks may fare better or worse than others in a die-off but probably not to predict the die-offs."

Also, some populations may have the potential to fare better in future climate conditions that are likely as climate change progresses. Genetics can also reveal shifts in population distribution. Some shifts may already be underway in the Bering Sea as the North Pacific warms. And the research also provides important data that can be used to inform broodstock selection for red king crab enhancement programs.

“As fisheries managers consider various options for supporting red king crab fisheries in Alaska, our findings of population structure and local adaptation highlight the importance of managing stocks at a regional scale. This research fits into a broader pattern of recognizing more population structure than expected across many marine fisheries,” Dr. Carl A. St. John (Department of Natural Resources and the Environment, Cornell University, Ithaca, New York, USA) and corresponding author of the original publication on which the NOAA report is based, told the *Advocate*.

Read the full report. (<https://www.fisheries.noaa.gov/feature-story/genetic-diversity-alaska-red-king-crab-may-provide-resilience-climate-change>).

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