Building new sea turtle populations in a biodiversity crisis

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The study assessed the role of assisted colonization in the establishment of new sea turtle populations and the fitness of the first generation of wild individuals. Credit: Alejandro Prat-Varela, Cayman Islands Department of Environment

Biodiversity loss has accelerated over the last decade, driven by the impact of global warming, alteration of habitats and the dispersal of

invasive exotic species due to human action. The reintroduction of captive-bred animals is one of the potential solutions to cope with this problem. A study led by the experts Marta Pascual and Carlos Carreras, members of the Laboratory of Evolutionary Genetics of the Faculty of Biology and the Biodiversity Research Institute of the University of Barcelona (IRBio), analyzed the impact of a green turtle reintroduction program that began 50 years ago in the Cayman Islands.

The results, published in the journal *Nature Communications*, confirm that the program was successful in establishing new green turtle populations in the Cayman Islands and that reintroduction from a captive population did not affect the fitness of the first generation of wild turtles. According to the authors, these conclusions "show that where climate change undermines species survival, assisted colonizations could possibly be used as a conservation measure. However, decision-making must include thorough cost-benefit analyses, risk assessments, and long term scientific monitoring."

The study, whose first author is Anna Barbanti, included the participation of the researcher Maria Turmo (UB-IRBio), and other experts from the University of Exeter and the Department of Environment of the Cayman Islands Government (United Kingdom).

An almost extinct species by mid-20th century

The green turtle (Chelonia mydas) is a globally-distributed migratory endangered species. In the Cayman Islands, the green turtle population was thought to be almost extinct by mid-20th century, mainly due to over-harvesting.

In 1968, a commercial green turtle farming operation—the Cayman Turtle Farm (CTF), now known as the Cayman Turtle Conservation and Education Centre—was established in Grand Cayman. This initiative

helped to increase the number of nesting females over the last twenty years, reaching a current population of between 100 and 150 adult breeding females.

Using the philopatric behavior of green turtles

This reintroduction was based on the release of captive bred turtles in Grand Cayman, often after captive rearing for one year in order to increase survival. This strategy makes use of the strong philopatric behavior of turtles: that is, the tendency to return to the beaches where they were born or released to lay their eggs.

The captive green turtle population of the CTF originated from adult and juvenile samples and from eggs collected from different populations in the Atlantic. "Therefore, the first breeding individuals of the farm have genetically diverse origins, which is seen in the study," notes Carlos Carreras. In this sense, Marta Pascual adds that it is "important to consider the genetic origins of the samples used for captive breeding in any species in order to avoid associated negative effects. Luckily, these negative phenomena were not seen in the first generations, but we cannot rule out the option of them appearing in upcoming generations."

Genetic analysis on turtles from two islands in the Cayman Islands

To assess the impact of the program, the researchers collected genetic samples and ecological data from the populations on two islands (Grand Cayman and Little Cayman) during three different stages of the assisted reintroduction process. With information obtained from breeding turtles, turtle nests, and genetic data from the farm, researchers could find the relationship of the turtles and the evolutionary processes that led to the formation of two new populations on both islands.

The results confirm that both populations are mainly the result of the captive bred program, since 79.4% of the turtles in Little Cayman and 90.3% of those in Grand Cayman were related to the adults the program released. However, they also detected that populations diverged quickly. "The random effects of the genetic drift led to the genetic differentiation of the populations, despite having originated with the same reintroduction program. Also, we did not detect any reintroduction-related adverse effect in the biological efficiency of the individuals in the new populations," note the researchers.

According to the authors, the philopatric behavior is expected to "increase this differentiation in the future by keeping the populations isolated across generations."

Replication of the program in other species

The results of the study shed light on the use of assisted colonization in turtles and the possibility for species with similar features —long-lived, migratory and philopatric—when the degradation of the habitat endangers their survival. However, the researchers recommend assessing other measures first. "We have to consider whether there are conservation options in situ, which are more economical and involve fewer risks, before considering an assisted introduction program," notes Carlos Carreras.

For sea turtles, important considerations for captive breeding include animal husbandry and welfare concerns, the potential for disease transfer through the release of animals from an intensive rearing facility into the wild, high costs, and apparently low rates of recruitment into wild nesting populations. The authors suggest that ex situ strategies should not replace, but aid in situ conservation, and the latter should be considered as a conservation management priority before resorting to complicated, costly and controversial ex situ conservation strategies.

"For any species, assisted colonization should go hand in hand with scientific monitoring, in the planning stages as well during implementation and long-term monitoring, in order to minimize any adverse effect in wild populations and to maximize the efficiency."

The authors highlight that these results were obtained with the first generation of wild offspring. Therefore, genetic analyses must be undertaken again in the future "since the harmful effects of inbreeding can appear in future generations," they conclude.

More information: Anna Barbanti et al, The architecture of assisted colonisation in sea turtles: building new populations in a biodiversity crisis, *Nature Communications* (2022). DOI: 10.1038/s41467-022-29232-5

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