Setting the record straight on whether vaquitas may fail to recover due to habitat alteration

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Two recent papers propose that more funding should be devoted to research on the ecological aspects of vaquita habitat because species recovery may not be possible even if the gillnets that kill vaquitas are removed. Rodríguez-Pérez et al. (2024) and Arreguín-Sánchez et al. (2025) argue that changes in habitat in the Upper Gulf of California resulting from the damming of the Colorado River have sealed the fate of the vaquita.

Incidental mortality of vaquitas in gillnets as the cause of their decline towards extinction has been well documented (for a review see Rojas-Bracho & Reeves 2013, Gulland et al. 2020). Surveys of the full species' distribution pointed to a decline from around 600 in 1997 (Jaramillo-Legorreta et al. 1999) to around 60 in 2015 (Taylor et al. 2016). Estimates in more recent years (2017-2024) within the very small protected area called the Zero Tolerance Area are around 10 vaquitas (Thomas et al. 2017).

Rates of vaquita decline have changed during the period over which vaquita numbers have been monitored, i.e. since 1997. These changes occurred long after diversion of the Colorado River's flow began nearly a century ago (Reisner, 1986, Bureau of Reclamations https://www.usbr.gov/history/hoover.html). Changes in the rate of decline correspond to dramatic changes in the use of gillnets to target different fisheries. From 1997 to 2008 the rate of decline was around 8% when fishing was primarily for smaller finfish and shrimp (Gerrodette et al. 2011). This rate of decline was within the range predicted from models that used vaquita mortality rates estimated for gillnet fisheries (D'Agrosa et al. 2000) together with plausible vaquita rates of increase (Jaramillo-Legorreta et al. 2007). The large increase in totoaba poaching (from around 2010 to the present) was correlated with a greater than 99% probability that the annual decline was greater than 33% (Jaramillo-Legorreta et al. 2017, Taylor et al. 2016, Thomas et al. 2017). None of the changes in rate of decline of vaquitas were correlated with habitat changes resulting from Colorado River flow.

Necropsies of 60 vaquitas that died from net entanglement during the 1980s and 1990s did not reveal a single instance of emaciation, which would be expected if the lack of Colorado River flow had altered the habitat in such a way that it could no longer sustain vaquitas (Hohn et al., 1996; Vidal et al., 2025). At that time, there were still many hundreds of vaquitas. The 9 vaquita carcasses examined between 2016 and 2018 were in good nutritional status, with full stomachs, and the lesions on their bodies were consistent with fishery entanglement (Gulland et al. 2020). All vaquitas observed during surveys in 2017, 2018, 2019, 2021, 2022, 2023 and 2024 appeared to be healthy. The stomachs of ten vaquitas bycaught between 1986 and 1993 contained remains of 20 species of finfish, and cephalopodsindicating that they had fed

opportunistically on prey between 10-30 cm in length (Vidal et al, 2025; Findley and Nava, 1994; Perez et al, 1996)).

Rodríguez-Pérez et al. (2024) carried out carbon and oxygen stable isotope analyses of bone tissue collected from vaquitas during two time periods (1982-1988,1989-1993) to 1) explore potential changes in bone chemistry that could reflect changes in the Upper Gulf of California, and 2) evaluate potential changes in the trophic status of vaquitas. While oxygen and carbon stable isotopes could be informative concerning habitat structure and nutrient flow, the article fails to make a convincing argument that changes to the habitat actually occurred (see reasons below[1]). Moreover, regarding whether habitat changes are sufficient to cause vaquitas to be unable to recover, the primary indicator of diet intake is stable nitrogen, which was not analyzed.

All vaquita sighting surveys between 2018 and 2023 observed calves, often in unexpectedly high numbers. For example, an expert elicitation in 2019 concluded that roughly 11 different individuals, including about 3 calves, had been observed within the ZTA (Rojas-Bracho et al., 2022). Assuming that half of the 9 non-calf vaquitas were females, nearly every female accompanied by a calf, which is inconsistent with the hypothesis of nutritional stress. Drone video of a mother and calf in 2023 and a mother and yearling in 2024 gave the impression that all four individuals were very healthy.

The Upper Gulf of California remains a highly productive ecosystem that supports several fishing communities (Flessa et al., 2019; Brusca et al., 2017; Álvarez-Borrego, 2003). With only about 10 vaquitas remaining within the ZTA, it is implausible that these survivors are suffering from a lack of food. Throughout the period when vaquitas have been studied (from the mid-1980s to the present), no carcasses or living individuals have been observed to be emaciated. It is worth considering the number of vaquitas that could be expected in the next 50 years given plausible

[1] A major challenge with the paper is the small sample size. With only 13 individuals analyzed (7 specimens from 1982-1988, 6 specimens from 1989-1993), there simply are not enough individuals or replicability to have confidence in the findings. Moreover, there is only mention of individual isotope values in the results text and nowhere in the paper is the full 13-individual dataset shown. A second major challenge is that the authors cite the difference in stable carbon values between the two groups—a difference of only 1.7ppt—as the evidence of a shift in trophic status for the vaquita. However, from their own data they show that the stable carbon values vary by up to 3.0ppt in mature vs. immature individuals. Thus, because there is not an equal number of mature and immature animals in each time period, it is not possible to make an accurate comparison across time periods. For example, from 1982-1988 there were 4 mature, 1 immature, and 2 unknown-aged vaquitas; from 1989-1993 there were 1 mature, 3 immature and 2 unknown-aged vaquitas. Again, the authors reported major differences in isotope values between mature and immature vaquitas, thus based on the unequal lifestage distributions across time periods, one would expect to see significant differences across the two time periods. In other words, the difference between the two time periods does not necessarily have any relation to habitat changes, but instead may well be due to unequal sample sizes. The fact that 4 of the 13 individuals (31% of the sample) had no information on maturity status further weakens the ability to draw any conclusions of the kind made by the authors.

Lastly, the supposedly "significant" difference (1.7ppt) in the stable carbon values between the two time periods is not necessarily biologically significant, and not of great enough magnitude to support the idea proposed that a major shift in prey availability or type was to blame for the decreased vaquita counts. If changing prey availability were considered to be the limiting factor, an examination of prey compostion and abundance, not an analysis of vaquita bone stable isotope values, would be called for.

growth rates and assuming there are currently only 10 vaquitas alive in 2025. If vaquita numbers increased at 4%/year, a value often used as a default for porpoises and dolphins, there would be 74 vaquitas in 50 years. If vaquitas could increase at 8%/year (on the high end of what is possible for porpoises), there would be 546 in 50 years. Both of these values are well below the numbers of vaquitas that lived in the Upper Gulf in the 1990s.

Using the limited funds available for investment in vaquita protection to investigate habitat viability is clearly unwarranted given the complete lack of evidence that vaquitas are or ever have been nutritionally stressed (Rojas-Bracho and Taylor 1999, Rojas-Bracho et al. 2019). The focus, including use of all available funds, must remain on eliminating deaths of vaquitas in gillnets if Mexico's endemic mammal is to avoid extinction. As stressed many times, fishers must be incentivized and trained to use alternative gear to accomplish this goal.

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