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Vaquita Face Extinction from Bycatch. Comment on Manjarrez-Bringas, N. et al., Lessons for Sustainable Development: Marine Mammal Conservation Policies and Its Social and Economic Effects.

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Comment

Vaquita face extinction from bycatch. Comment on Manjarrez-Bringas et al., Lessons for sustainable development: Marine mammal conservation policies and its social and economic effects. *Sustainability* 2018, 10, 2185.

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Abstract: We are among the scientists who have documented the environmental and ecological changes to the Upper Gulf of California following the reduction in the Colorado River's flow. We object to any suggestion that our research supports Manjarrez-Bringas et al.'s conclusion that the decline in the Colorado River's flow is the reason for the decline in the population of the endangered vaquita porpoise (*Phocoena sinus*). Manjarrez-Bringas et al.'s conclusions are incongruent with their own data, their logic is untenable, their analyses fail to consider current illegal fishing practices, and their recommendations are unjustified and misdirected. Vaquita face extinction because of bycatch, not because of the lack of river flow.

Keywords: Gulf of California, marine mammal, vaquita, *Phocoena sinus*, bycatch, fisheries policy

1. Introduction

Manjarrez-Bringas et al. [1] performed a valuable service in characterizing the Mexican fishing community of El Golfo de Santa Clara's (GSC) demographics, economic activities and attitudes and perceptions regarding conservation efforts. And they are correct to identify GSC as caught between the externally forced policies designed to reverse the decline in the population of the vaquita (*Phocoena sinus*) and the needs of its residents for a viable and sustainable economy. No easy solutions exist.

However, Manjarrez-Bringas et al. [1] (p. 11) assert – but do not cite – "Countless scientific studies have demonstrated the ecological damage that Mexico has faced due to the damming of freshwater." They conclude that the lack of Colorado River flow is the principal cause of the vaquita's decline. The 13 authors of this comment are among the scientists who have documented the environmental and ecological changes to the Upper Gulf of California (UGC) following the reduction in the river's flow. We object to any suggestion that our research supports Manjarrez-Bringas et al.'s [1] conclusion linking the decline in the Colorado River's flow to the dramatic decline in the population of vaquita. Given what is known about the biology of vaquita [2-7] and the documented environmental changes resulting from the lack of river flow [8-23], we conclude that vaquita face extinction because of bycatch, not the lack of river flow.

We are convinced by the research of the past 20 years, e.g., [2-7] that vaquita face extinction because they drown in gillnets. Manjarrez-Bringas et al. [1] fail to discuss the extensive evidence for the effects and extent of bycatch, their own data on the effects of fishing restrictions on GSC fishers are not adequate, their logic is faulty, and they present no direct evidence to support a causal link between Colorado River flow and the size of the vaquita population.

2. Fishing Restrictions and Productivity

Manjarrez-Bringas et al.'s [1] conclusions regarding the lack of desired effects of the increasingly restrictive fishing practices on the population of the vaquita are not supported by their own data. They note three increasingly restrictive limitations on fishing in the UGC: 1. The formation of a Biosphere Reserve in 1993; 2. The creation of a vaquita refuge in 2005; and 3. The buyout of fishing permits begun in 2007. The authors imply that because these restrictions did not reverse the decline in vaquita numbers, the species' decline must be the result of the reduction in the Colorado River's flow to the Gulf of California.

Fishing productivity in GSC does not appear to be affected by these fishing policies. Manjarrez-Bringas et al. [1] document that fishing production increased from 750 tons in 1987 to more than 4,000 tons in 2002 and that production totaled 21,823 tons in 2007. Either the imposition of geographic limits on fishing were not enforced or they had no effect on production. Indeed, accounting for the increase in GSC's population from 1987 (as interpolated from their Table 1) to 2002, and from 2002 to 2007, production per capita increased from 0.57 to 2.44 to 6.47 tons per person. However, the production figures they use are inconsistent. Their Table 5 lists a total nine-month production for 2007 of 2,182,300 tons – one hundred times greater than the figure reported in their previous paragraph, and that table reports only on the top four species. Regardless of this error, it appears that fishing productivity in GSC increased greatly from the formation of the Biosphere Reserve to the advent of the PACE-vaquita buyout program. No hardship to the community is evident in these numbers.

Johnson et al.'s [24] (p. 1) analysis of fishing effort in the Gulf of California indicated "…the current number of small-scale fishing boats in the Gulf is approximately double what is required to land theoretical maximum fish biomass." and that the communities of San Felipe and GSC are characterized by anomalously high fishing efforts, given their populations. Any real decrease in the fishery production at GSC not evident in Manjarrez-Bringas et al.'s [1] published numbers may be a consequence of over-fishing rather than any effective restrictions on fishing.

Manjarrez-Bringas et al. [1] fail to discuss the two-year ban (starting in 2015) on gillnet fishing in the gillnet exclusion zone [25] and the ban's indefinite extension in 2017 [26]. Even if enforcement was total, it would not be reasonable to expect the vaquita population to show a dramatic increase in such a limited time. As Taylor et al. [5] (p. 591) point out "If the vaquita population could grow at its maximum intrinsic rate, it would not reach 2008 levels (>250 vaquita) until 2050." Recovery will be slow and protracted.

Manjarrez-Bringas et al. [1] report that a total of 235 vessels (assuming that a permit applied to only a single vessel) were withdrawn from fishing activity through the PACE-vaquita buyout programs. They do not report, however, how many vessels retained their permits or how many un-permitted vessels continued to fish; nor do they cite any figures on changes in the number or duration of trips. An increase in the average number or duration of trips could result in an unchanged – or even increased – catch. The perceptions of the fishers notwithstanding, Manjarrez-Bringas et al. [1] provide no data to support the idea that the buyout program decreased fishing activity.

3. Illegal Fishing and Vaquita Bycatch

Manjarrez-Bringas et al. [1] do not mention the increase in the illegal gillnet fishing of totoaba (*Totoaba macdonaldi*) in the UGC. The gillnets trap and drown vaquita. Dried totoaba swim bladders are prized in the Chinese market and, according to media reports [27, 28] fetch prices that are, gram-for-gram, similar to those of cocaine. Prices for totoaba swim bladders are a powerful economic incentive for illegal gillnet fishing in the UGC. Illegal gillnet fishing in the UGC is a major cause of vaquita mortality [4, 29, 30]. Tragically, both totoaba and vaquita are endangered species.

All the available evidence suggests that both legal and illegal fishing activity have increased, despite the increasing restrictions. An increase in fishing activity since 1987 likely increased the inadvertent capture and mortality of vaquita.

The failure of fishing policies to reverse the decline of vaquita numbers is not evidence that the policies are misdirected. Well-designed policies have no effect if local communities are not willing to adopt them or enforcement is ineffective [31].

4. Effects of Decreasing River Flow

Manjarrez-Bringas et al. [1] blame the decline of vaquita numbers on the lack of freshwater flow from the Colorado River. Indeed, since the completion of Glen Canyon Dam in 1963, little river water has reached the UGC, except during high flow periods in the 1980s and 1990s. But correlation is not evidence of causation and Manjarrez-Bringas et al. [1] provide no evidence linking the decline in river flow to the decline of vaquita.

The UGC has been affected by the lack of Colorado River flow. Studies based on biogeography, genetics, stable isotopes, fisheries biology, sclerochronology and analyses of the shelly faunas show that the Colorado River was a significant influence on the UGC. These studies document the river's effects on salinity [8-10], ecosystem services [11], benthic productivity and relative abundance [12-14], growth rates in mollusks [15] and fish [16], distribution of species [17-20] and trophic relationships [21, 22].

We note again that our research does not support Manjarrez-Bringas et al.'s [1] conclusion linking the decline in the Colorado River's flow to the decline in the vaquita population. There is no evidence to indicate that restoring the flow of the river to the UGC would restore the vaquita population. There is ample evidence [2-7] to identify bycatch as the imminent threat to the vaquita's survival.

Manjarrez-Bringas et al. [1] (p. 12) claim that vaquita has "always been an estuary species...", but do not provide any evidence for this statement. Manjarrez-Bringas et al. [1] (p. 12) also state that "Between 20 to 25 PSU (Practical Salinity Unit) are suitable for life adapted to estuary environments."

First, we note that estuaries are typically defined as "…bodies of water usually found where rivers meet the sea." [32] – no precise range of salinities defines an estuary. Estuaries are highly variable environments – salinity varies from season to season and from year to year.

Second, Manjarrez-Bringas et al. [1] do not offer any evidence for their supposed range of vaquita-preferred salinity values for when the Colorado River still flowed to the UGC. The lowest salinity observed during a 1993 release of approximately 700 m^3/sec of river water was 32.0 PSU southwest of Isla Montague, close to the river's mouth [33]. Modeling, based on estimated pre-dam flows of 2,000 m^3/sec [34] yielded values less than Manjarrez-Bringas et al.'s [1] arbitrary upper limit of 25 PSU only up to 30 km from the river's mouth. Proxy estimates of salinity in the era before upstream dams [10] document salinities lower than 25 PSU only in the vicinity of Isla Montague, at the river's mouth. The estimated zones of significantly reduced salinity under pre-dam conditions do not overlap the area of highest observed sightings of vaquitas – the refuge zone (Figure 1 in [1]).

5. Hypothesis Testing

There is no inconsistency in maintaining that the vaquita is suffering from bycatch **and** that the Upper Gulf's environment has been affected by the decline in the flow of the river [35]. Nature does not present itself as a carefully controlled experiment where only one variable is changing.

Nor is it scientifically valid to treat the alleged failure of one hypothesis (bycatch) as evidence in favor of an alternative hypothesis (reduced river flow) for the decline of the vaquita. Scientific hypotheses must stand or fall on the evidence accrued to test their own individual merits. Manjarrez-Bringas et al. 's [1] own evidence does not disprove the bycatch hypothesis, nor do they provide any evidence in favor of the reduced river flow hypothesis. By any measure, they fail to support their own conclusions and recommendations.

6. Misdirected Recommendations

Their recommendations, even if implemented, are not likely to result in the recovery of vaquita. Indeed, one of their recommendations - to "capture [vaquita] and place in exceptional shelter facilities of at least 10 specimens of this species…" is misleading. Manjarrez-Bringas et al.[1] submitted their manuscript more than six months (May 19, 2018) **after** the vaquita capture effort was halted on November 3, 2017. Capture efforts were called off because of the death of a female vaquita and the release of a juvenile stressed by its capture [36]. This species of porpoise does not tolerate captivity. Deliberately suggesting a captivity program after the failure of an extensive and well-supported one is irresponsible.

7. Act Now

The hypothesis that is best supported by the data continues to be that the decline in the vaquita population is caused by their drowning in gillnets [2-7]. An enforced ban on gillnet fishing is essential to vaquita's survival. Alternative fishing gear and alternative economic opportunities are essential to the communities of the UGC.

Action to prevent vaquita extinction needs to happen quickly and must rely on the best scientific evidence. Bycatch is the problem. To direct efforts toward the unrealistic goal of captivity and the unsubstantiated cause of decreased river flow is irresponsible. Manjarrez-Bringas et al. [1] are "merchants of doubt" [37], creating the appearance of uncertainty where none exists. Uncertainty causes delay; delay will cause extinction.

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