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The Vanishing Vaquita: A Call for Definitive Action

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ABSTRACT

The world's smallest porpoise—the vaquita (*Phocoena sinus*)—is on the brink of extinction. Endemic to the upper Gulf of California, it has dwindled to fewer than 19 individuals in 2023. The primary source of mortality is drowning in gillnets set for totoaba (a giant croaker fish). Our review of the past 50 years of efforts to simultaneously attain conservation goals for the vaquita and economic and social goals for the fisheries concludes that they have consistently failed to meet the lowest expectations of any stakeholders. The time has therefore come to recognise that the only solution to this problem is to make an immediate and definitive decision: either preserve the vaquita or bolster sustainable fishing in the upper Gulf—and accept the associated social, economic, and political costs of either choice.

1 | The Backstory

The conservation of the vaquita (*Phocoena sinus*), a quasi-extinct small cetacean endemic to Mexico's upper Gulf of California, spans more than 50 years and intertwines biological, ecological, socio-economic, and even bioethical considerations. These factors and issues include the catching of totoaba (*Totoaba macdonaldi*, an endangered fish that is also endemic to the Gulf of California), the decline in numbers of vaquita and measures invoked to protect them, and the corresponding social, logistical, and financial costs of saving a species from extinction—all of which feed back into each other in complex ways.

A recent survey in 2023 estimated no more than 19 vaquitas remained alive (including 1–2 calves; Jaramillo-Legorreta et al. 2023). A follow-up survey in 2024 saw fewer vaquita than in 2023, which suggests the total population has continued to decline (Sea Shepherd 2024a). The vaquita thus appear to be genetically disadvantaged, highly sensitive to human interaction and disturbance, and trapped in an ecosystem where human activities and conservation are inseparable antagonistic forces.

The vaquita has been called the "panda of the sea" because of its eye markings (Sea Shepherd 2024b; Figure 1). It was first described in 1958 based solely on skeletons (Norris and McFarland 1958) and was later morphologically described from

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Etymology of Ghoti: George Bernard Shaw (1856–1950), polymath, playwright, Nobel prize winner, and the most prolific letter writer in history, was an advocate of English spelling reform. He was reportedly fond of pointing out its absurdities by proving that 'fish' could be spelt 'ghoti'. That is: 'gh' as in 'rough', 'o' as in 'women' and 'ti' as in palatial.

FIGURE 1 | A life-sized model of a rarely seen vaquita—*Phocoena sinus* (photo from www.savethewhales.org).

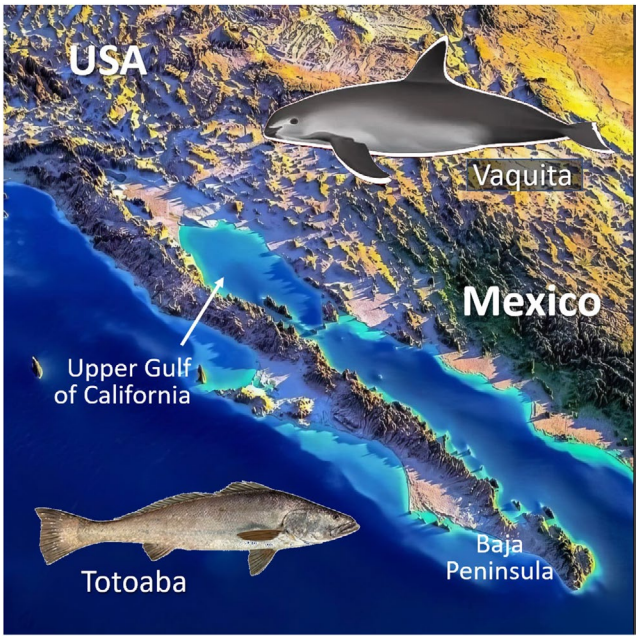

FIGURE 2 | Baja Mexico showing the upper Gulf of California home to the vaquita (*Phocoena sinus*) and totoaba (*Totoaba macdonaldi*).

individuals accidentally drowned in gillnets set to catch sharks and conduct totoaba surveys (Brownell et al. 1987). As few as 35 vaquita specimens incidentally caught and studied between 1985 and 1991 account for most of the rarely documented evidence of fishing mortality on the vaquita (Vidal 1995). When illegal fishing for totoaba was believed to have incidentally reduced the vaquita population to a few hundred individuals in the early 1990s, the vaquita was considered to be in imminent danger of extinction (Vidal 1993) and was listed in 1996 on the Red List by the International Union for the Conservation of Nature (IUCN) as "critically endangered".

The totoaba, to which the fate of the vaquita is inextricably linked, is the largest known sciaenid—a croaker fish (Cisneros-Mata, Montemayor-López, and Román-Rodríguez 1995; Bahre, Bourillón, and Torre 2000), reaching up to 2 m in length and 100 kg in weight (Figure 2). In Mexico, totoaba have been heavily exploited because of the similarity of its maw (swim bladder) to that of the Chinese bahaba (*Bahaba taipingensis*), which is sold in Asia as a seafood delicacy and medicinal/cosmetic product (Sadovy and Cheung 2003).

Totoaba are illegally caught along both sides of the northern and central coasts of the Gulf of California—from San Felipe to Bahia de Los Ángeles on the west coast, and from the Gulf of Santa Clara to Guaymas on the east coast (Cisneros-Mata et al. 2020; Figure 2). The fleet, which numbered over 100 vessels in 2017, consists of fibreglass boats ranging from 24 to 33 ft in length. They are equipped with outboard engines that exceed the authorised horsepower that can be safely used and can accommodate four to five fishers per boat who set between three and five gillnets at a time (Cisneros-Mata et al. 2020; Aceves-Bueno et al. 2023).

While the exact level of totoaba catch remains uncertain, it is believed that each boat catches 6–20 fish per trip and that a minimum of 1.3 million kg of totoaba were harvested in the first half of 2017 (Cisneros-Mata et al. 2020). Failure to enforce environmental regulations has allowed fishing effort to grow and more derelict fishing gear to be abandoned (Aceves-Bueno et al. 2023), with Mexican authorities recovering about 1000 abandoned nets between 2015 and 2017 (Cisneros-Mata et al. 2020). Currently, this illicit fishery is controlled by organised crime (Aceves-Bueno et al. 2023).

The price for the totoaba began at US$5 per maw in 1910 (Bahre, Bourillón, and Torre 2000) and rose to US$8500 (ex-vessel) per kg of maw by 2020 (Ben-Hasan et al. 2021), with a retail price of up to US$80,000 per kg, depending on the maw quality (Boilevin, Crosta, and Hennige 2023). Prices increased as the illegal fishery reduced totoaba numbers (Ben-Hasan et al. 2021; Smith et al. 2023)—earning it the nickname "cocaine of the sea". This is not a metaphor—an entire illicit market chain has been established from Mexico to Asia, supported by criminal networks (Boilevin, Crosta, and Hennige 2023; Alvarado-Martínez and Ibáñez-Alonso 2021) that have claimed two innocent victims: legal fishers and the vaquita. The totoaba is listed as Vulnerable on the IUCN Red List, and is on the U.S. Endangered Species List.

The moratorium imposed on totoaba fishing in 1975 did not stop totoaba from being caught, but did hinder efforts to document and monitor vaquita deaths and fishing activities. Failure of this temporary ban to stop the vaquita from declining was seen as evidence that the fishery restrictions were not enforced rigorously enough to make a difference to the vaquita. In response, the Mexican federal government established the International Committee for Vaquita Recovery (known as CIRVA) in 1993 to study and plan for the conservation of the totoaba and vaquita. CIRVA advocated restricting gillnetting and trawling (which captures juvenile totoaba), as well as subsidising fishers that stopped fishing to ensure the survival of the vaquita.

The Mexican government also established the Alto Golfo de California and Delta del Rio Colorado Biosphere Reserve (RAG) in 1993 (Figure 3) and approved management plans for both species in 1995. The plan recognised that genetic degradation, pollution, and interruption of the Colorado River flow may have contributed to the decline of vaquita (Rojas-Bracho and Taylor 1999; Brusca et al. 2017). However, it identified

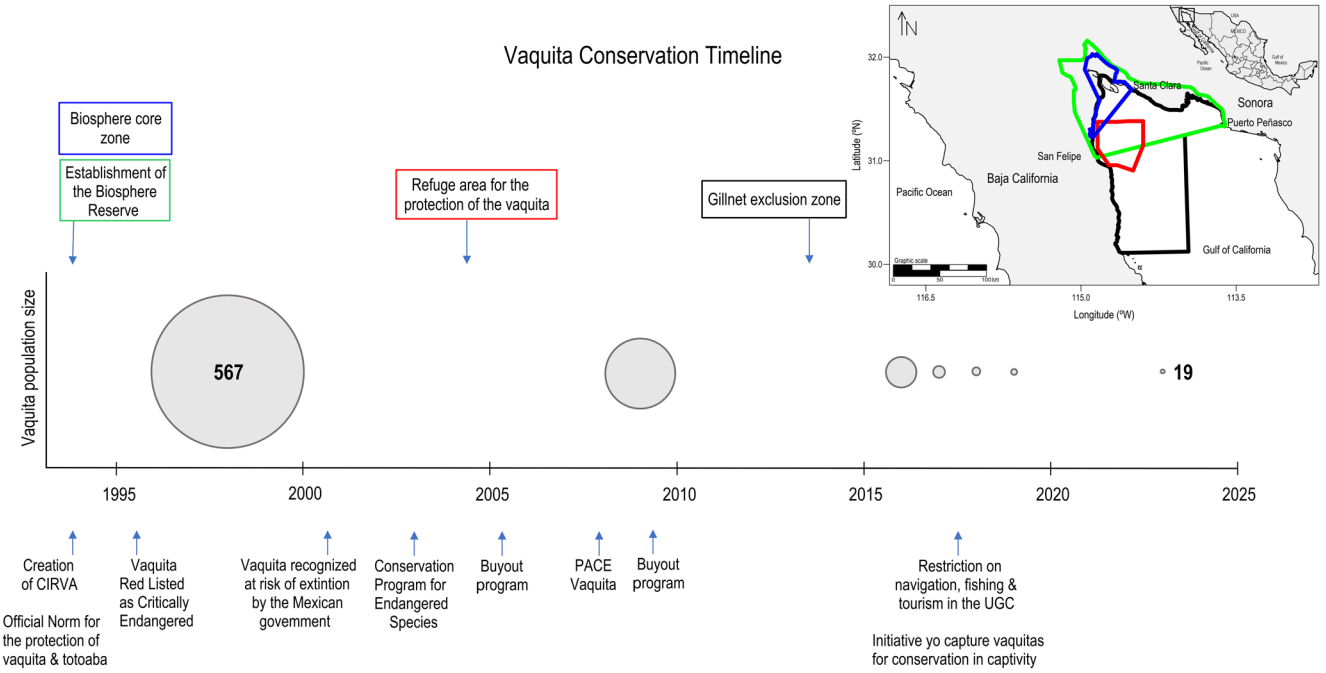

FIGURE 3 | Vaquita (*Phocoena sinus*) conservation timeline, showing relevant events related to the protection of the vaquita from 1993 to 2023, the main conservation areas in the upper Gulf of California (map in the upper right panel with colour codes in events along the timeline), and the estimated population numbers of vaquita through time (population size proportional to circle radius).

entanglement and drowning in gillnets targeting totoaba as the primary threat to the vaquita population towards the end of the 1990s, when the population was estimated to number no more than 600 individuals (Jaramillo-Legorreta, Rojas-Bracho, and Gerrodette 1999).

Mexico increased coastal ecosystem protection measures in 2002, with an emphasis on regions considered critical to the survival of endangered species, such as those of the upper Gulf of California (DOF 2002). Mexico also developed the PACE-Vaquita plan (Program of Action for the Conservation of the Marine Vaquita Species) in 2008 to do what CIRVA advocated 16 years earlier to protect the vaquita by paying fishers in the upper Gulf who voluntarily adopted environmentally friendly practices for the species, and who retired from particular fisheries either temporarily or permanently. The estimated number of vaquitas at the time the PACE-Vaquita plan was established was 245 (Rojas-Bracho and Reeves 2013)—a 50% population reduction over a decade (Figure 3).

In the early years of the PACE-Vaquita plan, fishers (mostly female) with skills to engage in economic occupations other than fishing (Avila-Forcada et al. 2020) gave up fishing in exchange for monetary compensation, while fishers who owned less profitable vessels opted to transition to vaquita-friendly fishing practices (Avila-Forcada et al. 2012). However, the PACE-Vaquita plan failed to yield its intended results. Regardless of how many fishers chose any of the alternatives, the vaquita population continued to decline to around 60 individuals in 2016 (Thomas et al. 2017).

Since 2017, navigation, nautical tourism and the setting of gillnets by artisanal vessels operating within the vaquita's range have been prohibited, as has commercialisation of totoaba from this fishery. Fishing concessionaires, licence holders, production units, captains, drivers, or operators of fishing vessels, technicians, fishermen, crew members, and other subjects who carry out these activities are subject to this law (DOF 2017, 2021). In 2021, the last 10 verified bycaught specimens of vaquita were documented (Jaramillo-Legorreta et al. 2019).

More recently (Figure 3), CIRVA proposed a last-resort action to capture at least 10 vaquita from the wild and place them in captivity (Rojas-Bracho, Gulland, et al. 2019). The goal was to preserve the species within a specially built pen before releasing the individuals into a fully protected and net-free habitat. A total of $5 million was raised for this purpose, with the Mexican government contributing a portion of the funds. Unfortunately, the mission was cut short. Of the two porpoises captured, a juvenile experienced extreme stress and had to be released, and an adult female died of a panic attack after being secured (Pennisi 2017). According to the 2023 survey, a minimum of 10–13 vaquita were alive, and likely fewer than 19 individuals were estimated in the upper Gulf (Jaramillo-Legorreta et al. 2019, 2023).

Recent studies suggest that the vaquita population was historically more abundant than previously thought (García-Dorado and Hedrick 2023). However, incidental drowning in gill nets used to catch totoaba has been reducing the vaquita population, at least since the early seventies—and has led to inbreeding depression and low genetic diversity that have significantly increased their risk of extinction (García-Dorado and Hedrick 2023). The critically low numbers of vaquita severely compromise their ability to survive, reproduce, and adapt to

environmental change. Although the species may not be irrevocably headed for extinction, its chances of survival are dim and worsen as the population continues to shrink (García-Dorado and Hedrick 2023).

2 | Why Have Conservation Measures Failed?

There is wide disagreement over why the vaquita conservation measures failed. For some, the implementation of the RAG and management plans for totoaba and vaquita in the 1990s did not result in any meaningful benefit to fishers because the various stated objectives were in inherent conflict and contained no means to measure compliance, and they failed to address actual socio-economic concerns (Vázquez-León and Fermán-Almada 2010; Cisneros-Montemayor and Vincent 2016). Similarly, the PACE-Vaquita plan formed in 2008 to compensate fishers had a number of shortcomings that included a discord between conservation and fishery objectives, confusion over alternative hypotheses to explain the reduced vaquita population, a lack of successful measures in official decrees, the need to integrate social and economic considerations into conservation plans, failure to inform fishers of the adverse effects of their activities, inefficiency in surveillance to deter illegal practices, and administrative government failures to implement proposed actions (Bobadilla et al. 2011; Rojas-Bracho and Reeves 2013; Grenon 2023).

The RAG plan was also criticised for not allowing other viable solutions to be implemented that might have been better aligned with the social and economic realities of the region's residents and the species itself (Rodríguez-Quiroz et al. 2019). Thus, the overall outcome of the vaquita conservation measures has been a dissatisfied, unwilling community of people with no incentives to comply (López-Torres et al. 2018; Manjarrez-Bringas et al. 2018) and no discernible benefit for the vaquita population trend.

Another point of contention that has kept the conservation and fishery stakeholders from making comprehensive plans has been the tendency from both sides to treat facts with differing degrees of certainty and uncertainty. This is particularly true when justifying actions simultaneously intended to save the vaquita from extinction while maintaining ecosystem services, and sustaining the long-term socio-economic development of the communities that depend on harvesting the marine resources of the Gulf of California. Unfortunately, the historical obfuscation of facts has left the vaquita little time to save itself.

While the perspectives we present on conservation measures to save the vaquita may differ from others (e.g., Aburto-Oropeza et al. 2018; Sanjurjo-Rivera et al. 2021), we contend that there are three critical facts that should be universally accepted.

First, the population size and rate of decline of vaquita have been rigorously studied, and statistical evidence leaves no room for claims questioning that the declines are too uncertain to be of concern (Gerrodette 2011). The search effort for vaquita has been extensive, and the time series of abundance estimates have been congruent. By 2023, there were fewer than 19 vaquita alive (Jaramillo-Legorreta et al. 2023).

Second, the available physical evidence indicates that fishing with gillnets may not be the only source of mortality, but is surely the main cause of the vaquita's population reduction (D'agrosa, Lennert-Cody, and Vidal 2003). An alternative explanation of the decline of vaquita is that all species inhabiting the upper Gulf of California ecosystem were negatively and profoundly affected by substantial reductions in freshwater flow that altered the estuary after the Colorado River was dammed (Manjarrez-Bringas et al. 2018). However, the bycatch hypothesis is supported by a broader and higher-quality body of evidence than any other competing explanation. Without minimising broader habitat impacts in the area, the hypothesis that environmental change has primarily affected the vaquita population lacks direct and even indirect supporting evidence (Rojas-Bracho, Brusca, et al. 2019).

The hypothesis that flow reduction of the Colorado River caused the collapse of the vaquita population is based on the premise that the food webs that vaquita depend upon were altered by reduced flows through the estuarian and marine waterways. However, there were no clinical signs that the vaquita were nutritionally stressed by the disappearance of estuarine prey, or that they shifted from an estuarine to a marine species-based diet, or that they experienced other sources of mortality related to these causes (e.g., increasing predation by strictly marine species). As such, the available data are not consistent with the reduced river flow hypothesis.

The third inescapable fact is that attempts to conserve the vaquita while sustaining commercial fishing have all led to dead ends. We believe this has occurred because the objectives of both intentions were mutually exclusive from the outset. Scenarios designed to benefit the vaquita population have been shown by ecosystem models to ultimately be the least beneficial for fishers, and vice versa (Morzaria-Luna et al. 2012), and none of the palliative fishery management measures evoked were ever enough to stop the vaquita from declining. What started as a simple goal to decrease fishing mortality evolved into an attempt to eliminate fishing entirely. Thus, the gradual tightening of control measures only increased tensions among stakeholders until those advocating to sustain fishing while conserving vaquita found themselves split into two irreconcilable factions.

The conservation community saw little or no action from the fishery sector, whom they felt did not take responsibility for what they were doing to the vaquita (Rojas-Bracho and Reeves 2013). However, from the fishers' perspective, the conservation sector never made a convincing case for why it mattered to protect the vaquita when protection measures would directly impact them. Thus, the opposing forces played a zero-sum game that ended in a stalemate. The fishers have not been in favour of the restrictions imposed on them, given how rarely a vaquita is ever caught in a net. Indeed, with only a few vaquitas inhabiting an area spanning approximately 5 million hectares (~20,000 $mile^2$), the majority of fishers have never encountered a single specimen. The rarity of anyone encountering a vaquita likely contributes to the disconnect between conservation efforts and poor compliance.

Conservation efforts have been primarily premised on the need to preserve the vaquita and biodiversity, which has been of no

consequence to fishers engaged in legal fisheries (Rojas-Bracho and Reeves 2013). Fishers would likely be more motivated to adopt alternative fishing methods to stop vaquita from dying in their nets if consumer boycotts were to limit their ability to market their catches (Wang 2022; Grenon 2023) or if embargoes were placed on other fish products from the upper Gulf (Dunch 2019; Federal Register 2020; Wang 2022; Grenon 2023) under trade agreements between Mexico and China, Canada, and the United States. However, such measures would most likely only serve to unfairly penalise legal fishers without tangible conservation benefits to the vaquita if illegal fishing and black markets are not adequately controlled. In all likelihood, failure to address the demand for totoaba swim bladders and the unrestricted access to this valuable resource will lead to its complete loss, but not before the vaquita are long gone (Zambrano et al. 2023).

One needs to look no further than the objectives of the RAG Conservation and Management Program—ranging from sustainable use to genetic diversity, to species conservation and future development—to see the incompatibility of simultaneously allowing fishing while protecting vaquita. Unfortunately, the RAG program appears to have been little more than a wish list of good intentions with no concrete and formal indicators to objectively quantify fulfilling any of their multiple goals (Cisneros-Montemayor and Vincent 2016). In contrast, the conservation community has had the single emphatic objective of reducing fishing mortality to zero (Robinson et al. 2022), even if it comes at a great cost to fishers—and to exclude socio-economic issues that they consider to impede the effectiveness of vaquita conservation strategies (Rojas-Bracho and Reeves 2013). As for the fishers, adhering to increasingly stringent conservation measures and programs that transform their *modus vivendi* into a less desirable one only to save a charismatic species are not convincing alternatives—and none have contained any real economically sustainable incentives (Sanjurjo-Rivera et al. 2021).

3 | The Time to Choose Is Now

With fewer than 19 vaquita still alive, it is now beyond the point where the death of a single vaquita due to fishing is acceptable while still allowing the region's fishery activities to develop under its own volition. We believe that resolving the historical conflict between vaquita conservation and continued fishing in the upper Gulf requires choosing one of the two vocations in conflict: conservation or fishing. Whatever option is taken, the cost of making that excruciating but irrevocable decision must be assumed—and must be made quickly. There is no value in undertaking a retrospective assessment to understand how this dilemma could have been better resolved in the past.

If the decision is ultimately made to prioritise vaquita conservation, as has been recurrently proposed (Jefferson 2015), the greatest challenge will be to provide the regional fishers with the means that both parties (conservationists and fishers) agree are required to offset the immediate and long-term effects of the total fishery shutdown. This will necessitate objectively identifying the genuine stakeholders involved. Compensation should be proportionate to the profits from the activity and the degree of dependence on fishing, which would require a case-by-case examination. Similarly, since any kind of fishing would be prohibited (except subsistence and Indigenous fisheries), the banning of the activity would have to be ensured through a zero-tolerance law-enforcement policy and a strict and effective surveillance system, likely involving the Mexican military and civil society organisations (CSO). Furthermore, the government and CSO involved must also be able to bear the social and political costs of entirely eradicating gillnet fishing in the region.

The previous compensation project by the Mexican federal government and some CSO cost ~$74 million (Jaramillo-Legorreta et al. 2019). Gillnet and longline fishing operated by artisanal vessels in the upper Gulf was totally suspended from 2015 to 2017 (DOF 2017). Later, between 2019 and 2021, at least 7 vaquitas (perhaps 15) were observed alive, including some calves, which generated some optimism (Rojas-Bracho et al. 2022). However, 10 vaquita corpses were discovered entangled in illegal fishing nets in 2021, and the rate of population loss was estimated to be more than 34% per year (Jaramillo-Legorreta et al. 2019). This raises the question of whether the efforts to protect vaquita were ineffective and insufficient to counteract population declines, or whether the species is fundamentally beyond conservation efforts (i.e., unstoppable population decline), or a mix of the two.

The alternative scenario for shutting down fishing is to prioritise fishing over conservation in the upper Gulf, thereby leaving the vaquita to its fate. This scenario is closely aligned with the United Nations framework for promoting the human rights of small-scale fishers, fish workers, and Indigenous peoples (United Nations General Assembly 2024). However, supporting human rights in the upper Gulf comes with the devastating possibility that it will cause the vaquita to go extinct (assuming that the species would persist in the absence of fishing). No scientific forum has publicly admitted that the extinction of the vaquita is unavoidable, with studies choosing instead to use the word "hope" (for the species) with high frequency (e.g., Rojas-Bracho, Reeves, and Jaramillo-Legorreta 2006; Jaramillo-Legorreta et al. 2019; García-Dorado and Hedrick 2023; Robinson et al. 2022). No such comment has been published, possibly because it would be politically and even bioethically incorrect—but this is a real possibility, as awful and unthinkable as it may be. In contrast, the overarching conclusion of all demographic research on the vaquita is that the population decline has continued unabated over the past 30 years despite all efforts to stop it.

The second scenario to prioritise fishing over vaquita conservation would almost certainly result in a media tsunami, followed by a slew of negative socio-political and economic ramifications for Mexico. Some of these consequences have already been felt, despite the fact that the species has not yet been declared extinct. For example, in 2017, actor and environmental activist Leonardo DiCaprio urged Mexico's then-president to protect the vaquita—a message he also endorsed on social media. Furthermore, the government of the United States of America initiated legal action against the Government of Mexico in 2022 under the free-trade agreement (Wang 2022; Grenon 2023) and announced an embargo on imports of fish products captured with gillnets in the upper Gulf in 2018 (Dunch 2019), with an extension of that policy to nearly all fishery production from that region in 2020 (Federal Register 2020). There has been no

definitive estimate of the annual losses linked with the embargos (Dunch 2019), but they could be close to one billion dollars (México Ambiental 2022).

4 | Solution Implementation and Caveats

The legislative apparatus in Mexico possesses swift processes that have the potential to implement the suggested scenarios without adding complexity to the decision-making process through the involvement of the Houses of Representatives (Reglamento de la Cámara de Diputados 2023; Reglamento del Senado de la República 2023). One of these could be to directly request that the President of the Republic, who is in charge of the national executive branch, assign either conservation or fishing priority for the upper Gulf of California. The request could be made by the two disputing parties. In this instance, the Inter-Secretary Commission for the Sustainable Management of Seas and Coasts, which was established for this exact purpose, would receive the proposal from the executive. This commission then calls for an in-depth review and response to the request from the Ministries of the Environment and Natural Resources, Agriculture and Rural Development, the Navy, and Social Affairs, among others. As per their respective legal responsibilities and jurisdictions, the Ministries would procure the requisite data and technical-administrative staff to conduct an unbiased assessment of the two options, prioritising the public interest in the resolution to maximise the benefits for the Mexican society as a whole. This would lead to a detailed action plan that would be published in the Official Journal of the Federation by presidential order (DOF 2024).

Unfortunately, petitioning the President of the Republic may not be a timely or straightforward process. For instance, the petition might be considered non-urgent by the head of the executive branch, who may choose not to receive it or forward it to the House of Representatives—where it could take several years to resolve or possibly be placed in the "legislative freezer" (a repository for unresolved initiatives; Castañeda-Tenorio, Hernández-Salazar, and Tlahuel-Adrián 2015). This means that any petition that might be put forward must be persuasive and be presented in a well-balanced verbal and written manner. Other immediate obstacles to protecting the vaquita would include funding stakeholder identification, ensuring fishing communities have sufficient income in the medium and long terms, and establishing a robust monitoring and surveillance system throughout the upper Gulf. In contrast, obstacles to prioritising fishing operations would include numerous domestic challenges as well as external pressures because of Mexico's agreements with other nations that also have legitimate environmental concerns. This being the case, recent advancements in totoaba farming methods and the incipient recovery of totoaba's wild population (Valenzuela-Quiñonez et al. 2015; Rodríguez-García et al. 2020; González-Félix et al. 2021) point to some potential for alleviating tensions within the regional fisheries sector.

5 | A *Sui Generis* Path to Sustainability

While combining exploitation with conservation goals in management plans for coastal and oceanic areas has proven successful (United Nations Environment Programme, IUCN, and World Wide Fund For Nature 1991), there may be other ways of achieving environmental sustainability. For example, activities and preferred uses could be decreed for different areas within a region depending on their unique qualities, resources, or ecological values (Wilson, Carwardine, and Possingham 2009). Some areas may be better suited as conservation strongholds because they host unique and fragile biodiversity components, while others may be better considered fishing grounds because they are inhabited mostly by resilient and economically profitable species. Although the upper Gulf of California contains both types of species (vaquita, totoaba, finfish, shrimps, etc.), the strategy of simultaneously conserving the vaquita while fulfilling exploitation goals may not ultimately work for either side based on 40 years of trying without success. Defining a single use for this area may therefore be a new approach worth exploring.

5.1 | Prioritising Conservation

Examples of areas designated for conservation purposes can be found in different regions of the world. In Japan, as early as the 1970s, land and coastal areas such as Hokkaido, the Oi River, and Okinawa (+1000 km^2) were set aside for nature conservation, with little or no human intervention allowed (Ministry of the Environment 2017). The river dolphin (*Platanista gangetica*) in India and Pakistan, and the North Atlantic right whale (*Eubalaena glacialis*) in the Gulf of St. Lawrence, Canada, are examples where the status of an endangered species triggered the prioritisation of an area for conservation action (Braulik et al. 2015; Koubrak, VanderZwaag, and Worm 2021). In these cases, some fishing activities were closed, and some members of local fishing communities tried alternative fishing practices and gears to reduce incidental mortalities (Ali 2022). While long-term solutions have yet to be implemented, these examples show how fisheries can innovate when laws are enforced and livelihoods are threatened by failures to adapt to conservation needs.

In 2016, the Mexican federal government declared all (21) islands and (97) islets (+11,500 km^2) located along the lower western coast of the Baja Peninsula as areas whose primary purpose is the conservation of more than 50 imperilled species and marine ecosystems (DOF 2016). The actions have been largely viewed as successful. Unfortunately, attempts to force win-win outcomes on the complicated social–ecological upper Gulf system have failed by all accounts. As such, the best chance for achieving success in the upper Gulf now appears to depend on making a deliberate policy choice that prioritises a specific goal and openly acknowledges the trade-offs. To be clear, accepting trade-offs may be difficult, but history has shown that doing so is sometimes necessary to advance key objectives.

A pertinent example of a recent trade-off related to marine mammal conservation is the transition of the International Whaling Commission (IWC). While initially a body designed to promote sustainable whale harvest, it has been shifting through changes in membership to becoming a supporter of whale conservation worldwide. This shift includes endorsing international bans on whaling, which has been met with strong reservations and some member nations leaving the IWC (Wright, Simmonds, and Galletti-Vernazzani 2016). Despite these challenges, however,

the changing focused objectives of the IWC are undoubtedly contributing to the recovery of many whale populations worldwide (Magera et al. 2013; Tulloch et al. 2019).

5.2 | Prioritising Fisheries

An alternative to setting aside marine regions or redirecting institutional efforts for conservation purposes alone is to regard highly productive and dynamic oceanic areas as primarily utilitarian. These areas might not be officially designated as such by governments, but they are subject to comprehensive national and multinational governance frameworks to effectively address the sustainable management of living marine resources (Fanning et al. 2007).

There are two examples of internationally recognised scientific frameworks for defining areas that are naturally suited for fishing activities: Large Marine Ecosystems (LME; Sherman and Duda 1999) and Biological Action Centres (BAC; Lluch-Belda et al. 2000). The LME approach is a five-module framework for evaluating and monitoring areas that integrates socioeconomics, productivity, governance, pollution, and ecosystem health into strategic planning for their management and the design of corrective measures to ensure the sustainability of the services they provide (GEF LME: LEARN 2017). At a finer scale, BAC are relatively small areas, fixed in space and tied to coastal features, that have particularly high productivity and are usually associated with permanent or semi-permanent spawning grounds for abundant, small pelagic fishes. They can be considered hotspots for fisheries and good places to monitor the effects of environmental variability on fish abundance (Lluch-Belda et al. 2000) and are ideal units for spatially explicit fisheries management.

The Gulf of California has been assessed according to LME and BAC approaches (Lluch-Belda et al. 2000; Lluch-Cota et al. 2007; Arreguín-Sánchez et al. 2017). This has helped to identify the management and governance challenges that arise from the ecosystem's extreme diversity while also highlighting the region's significance as Mexico's primary fishing region. The two assessments provide strong, substantiated scientific and socioeconomic justifications to prioritise either fishing or vaquita conservation in the upper Gulf. The only thing that appears missing is the unambiguous choice of a single objective.

Worldwide lessons from marine protected area management have similarly shown that areas that are specifically managed to benefit fishing livelihoods—even when managed with less ambitious long-term sustainability goals—tend to be more successful than those that rely on the assumption (often untested) that fishing benefits will naturally accompany ecological conservation efforts (Grip and Blomqvist 2020). This appears to be particularly the case where fishers have historically faced marginalisation and significant barriers to accessing resources and equitable benefits (Finkbeiner et al. 2017). In such contexts, arguments for accepting further short-term impacts in exchange for possible long-term benefits often lack credibility. Of course, it is fundamentally important that any such policies explicitly ensure that it is indeed local fishers and communities that will benefit from priority access to fishing resources.

6 | Lessons Learned

There is little or no value in arguing over whether the vaquita would have recovered or maintained the trend of population decline in an unaltered, fishing-free habitat, or at what rates these processes could have occurred. Arguing that conservation measures may have reduced vaquita fishing mortality, but that the residual incidental mortality is still driving the species to extinction, does not align with the current scientific understanding of vaquita mortalities. Similarly, arguing that the extinction of the vaquita is unavoidable and that fishing regulations only slow the process down are little more than smokescreens to avoid seeing what is happening. These all appear to be part of the Gordian knot that has confounded all efforts to conserve the vaquita and maintain fisheries. In our opinion, the only way to untangle this inescapable, complex problem is to unambiguously define a single goal to either save the vaquita or support productive fishing activities in the upper Gulf of California. Failing to achieve competing goals not only incurs financial opportunity costs compared to more effective and targeted strategies, but also erodes the trust of all stakeholders.

While each case of human conflicts with marine mammals is different, and the vaquita's circumstance is unparalleled due to its strong ties to the illegal totoaba fishery, the plight of the vaquita should serve as a cautionary tale for other endangered marine mammals, such as the Rice's whale in the Gulf of Mexico. With fewer than 100 individuals remaining (similar to the vaquita's population size in 2015), Rice's whale faces threats from ship strikes and habitat alteration by oil spills, oil exploitation, and noise pollution (Rosel et al. 2021). Conservation measures have been proposed to mitigate these threats (NOAA 2020), but without immediate action, Rice's whale could face a similar fate as the vaquita. However, unlike the vaquita, there is a better chance for carefully regulated anthropogenic activities to co-occur with the long-term persistence of the Rice's whale.

In contrast to the vaquita and Rice's whale, the baiji (*Lipotes vexillifer*), a dolphin endemic to the Yangtze River, China, went extinct due to failure to address recognised threats over two decades. These unchecked threats included incidental mortality from unselective fishing gear, range fragmentation, pollution, and boat strikes (Turvey et al. 2007). Collectively, the baiji faced a far more extensive and complicated array of threats compared to the vaquita, which are mainly threatened by gillnets. While this suggests there is a simple solution to saving the vaquita, it belies the fact that decisions to invoke simple solutions are no easier to enact than all-encompassing ones.

Several recurring themes connect the loss of the baiji dolphin, the near disappearance of the vaquita, and the precarious state of Rice's whale. Central to their vulnerabilities has been their restricted geographic ranges, which made them highly susceptible to localised human pressures. Additionally, economic interests—such as commercial fishing, maritime shipping, and resource extraction—have always overshadowed and undermined conservation initiatives to save them. Finally, the protective measures needed to stop them from declining have been consistently ineffective and implemented too late to make a difference. Collectively, the commonalities among these species and their fates underscore why actions needed to prevent

the loss of vulnerable marine species must be immediate, profound, and decisive.

An important lesson to take away from the plights of endangered and extinct marine mammals is the importance of making timely decisions and bearing the social and economic costs that come with them. This lesson rings true in other conflicts that extend beyond that of the vaquita, such as adaptation to climate change. The Intergovernmental Panel on Climate Change warns that reactive and marginal adaptations that face the least resistance to fossil-fuel-based development models are not enough to keep the planet from reaching undesirable tipping points. Thus, the window of opportunity to limit the risks of climate change is quickly closing, and there is hardly enough time to implement deeper, proactive, and transformative adaptation measures, despite the accompanying short-term costs (IPCC 2022). The local communities that disproportionately bear the costs of environmental impacts and subsequent adaptations must not be further marginalised or villainised because of their continued direct reliance on natural resources. On the contrary, they should be recognised and supported as those most deeply concerned with the state of habitats and species, but who also have the most limited alternative economic options.

Similarly, for the vaquita, there is little time remaining to invoke truly disruptive measures and employ the arsenal of technical-scientific and political talent needed to deal with the reactions they will provoke. Society must not miss its last chance to create a future in the upper Gulf of California that, while imperfect, has the potential to be sustainable. Invoking disruptive measures means there will be winners and losers, but persisting in making the same past decisions and expecting to get different outcomes means that all will ultimately end up as losers.

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Data Availability Statement

The authors have nothing to report.

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