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Technical Report

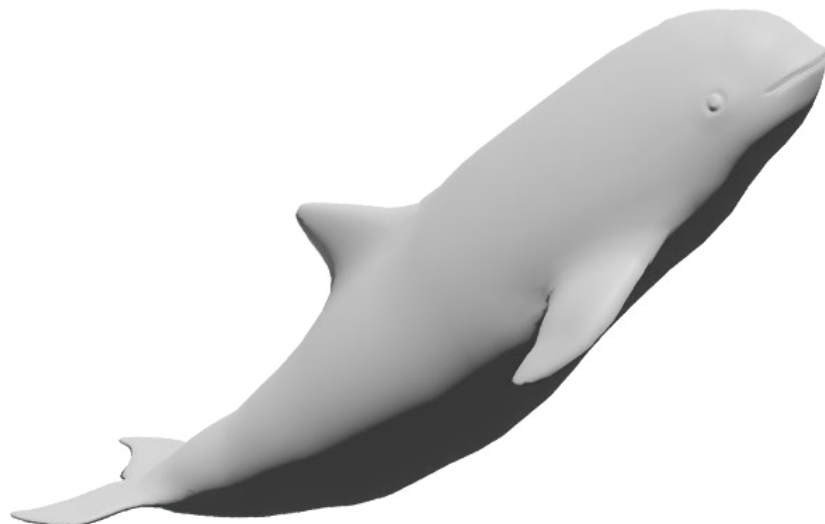


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Vanishing vaquita

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2021/2022



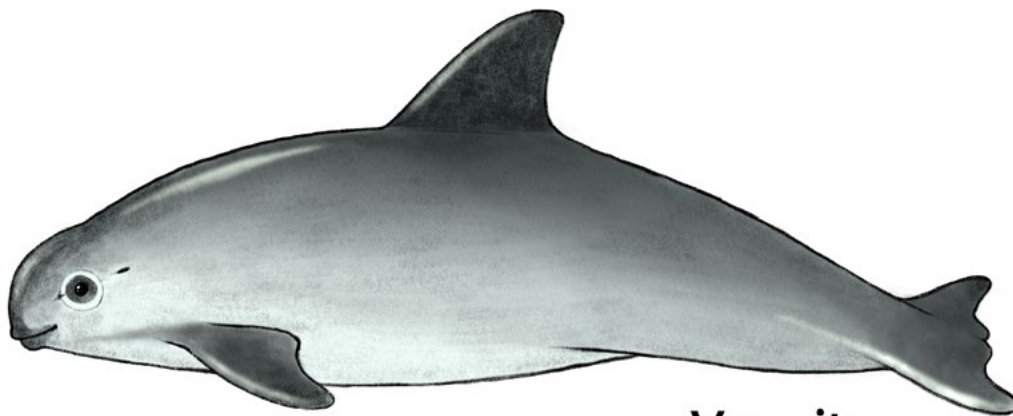
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Vaquita
(*Phocoena sinus*)

Illustration of a vaquita (Image credit: Caitlyn Eberle / UNU-EHS)

1. Introduction

The vaquita (*Phocoena sinus*), a species of porpoise only found in the northern end of the Gulf of California (Figure 1), is currently the world's most endangered marine mammal (Morin and others, 2021). Despite decades of international attention on its dwindling numbers, the latest surveys estimate that there are 10 or fewer individuals left (Rojas-Bracho and others, 2021). While many attempts from national and international actors have been made to halt the impending extinction of this critically endangered species, none has so far been able to reverse their decline (Sanjurjo-Rivera and others, 2021). Although the vaquita is not a target species for fishers, it is collateral damage of a long history of fisheries mismanagement and the poaching and illegal trade of an also endangered fish known as the *totoaba* (*Totoaba macdonaldi*) (Ben-Hasan and others, 2021; Crosta and others, 2018).

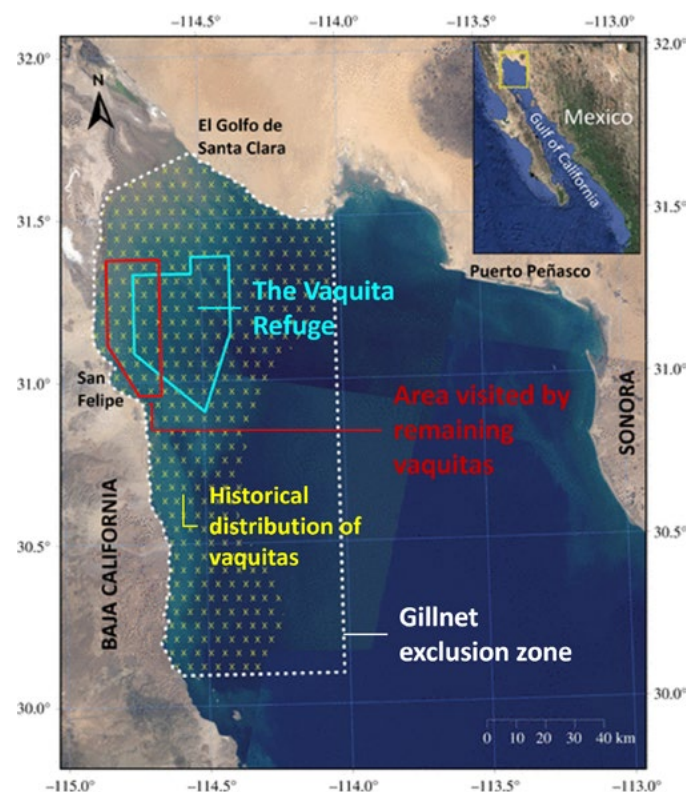


Figure 1: Distribution of vaquita population (adapted from Jaramillo-Legorreta and others, 2019)

2. Impacts

2.1 Ecosystem damage and biodiversity loss

As both a predator and prey species, when in healthy numbers the position of the vaquita in the food web of the local area would be as an important food source for top predators while keeping populations of smaller species such as fish, squid, and crustaceans in check, thus promoting a healthy balance in the region’s interdependent food web (Riofrío-Lazo and others, 2013; Rodríguez-Pérez and others, 2021). However, due to unsustainable fishing activities over the few past decades, the population has declined, estimated at a 98 per cent reduction between 2011 and 2018 (Figure 2) (Jaramillo-Legorreta and others, 2019; Rojas-Bracho and others, 2021). By November 2021, the remaining vaquita population was estimated to be composed of the last few individuals, numbering around 10, or even less (Rojas-Bracho and others, 2021). Research recently concluded that there is enough genetic diversity in the small remaining population of vaquita to allow for recovery, but illegal fishing would need to end immediately (Robinson and others, 2022).

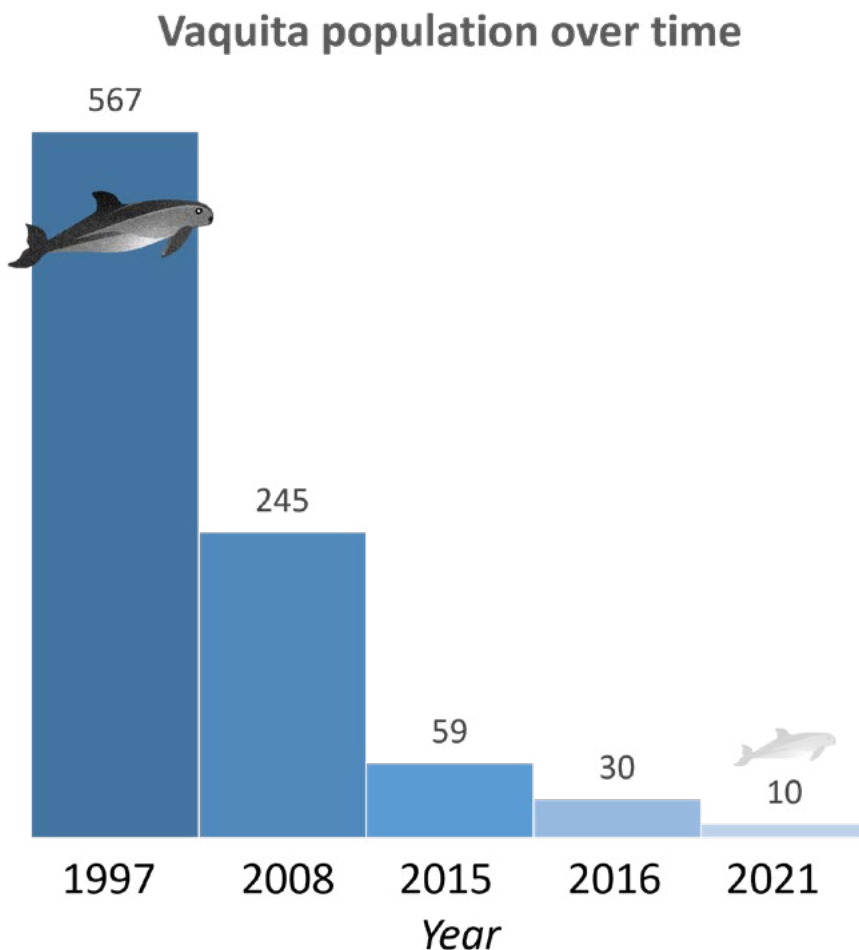


Figure 2: Vaquita population estimates over time (based on information from Crosta and others, 2018, and Rojas and Bracho, 2021)

2.2 Loss of livelihoods

The fight for the survival of the vaquita is also taking its toll on local fishing communities, as pressure mounts on the Mexican government to take action. The push for implementation of alternative fishing gear to aid in conservation efforts is predicted to put pressure on local fishers and their livelihoods, by reducing economic viability, potentially increasing certain environmental impacts and incentivizing increased illegal gillnet fishing (Aburto Oropeza and others, 2018). In government efforts to curb illegal and unsustainable fishing driving the extinction of the vaquita, local communities were at different times either paid not to fish, or threatened with criminal penalties, neither of which were policies that were sustainably maintained or resulted in notable success (Sanjurjo-Rivera and others, 2021). Research shows that there may be hope of transitioning to alternative livelihoods to mitigate this impact in fishing communities by structuring financial services with diverse, private and public funding sources, with women in artisanal fishing communities showing the highest likelihood of success (Avila-Forcada and others, 2020).

2.3 Loss of life

Criminal organizations driven by totoaba poaching have triggered territorial fights between cartels as well as violent clashes with conservationists and Mexican authorities, in which fishermen are caught in the middle (Felbab-Brown, 2020; Felbab-Brown, 2022; Crosta and others, 2018; Sanjurjo-Rivera and others, 2021). At least one person has died in these conflicts, with several others injured. In 2021, a collision between a local fishing boat and a vessel belonging to a marine conservation organization that was removing illegal nets in the Upper Gulf of California (UGC) resulted in the death of a fisherman, while in 2019 a fisherman was shot in San Felipe during a clash when navy vessels attempted to apprehend an alleged illegal fishing boat (Fry, 2021; BBC, 2021; Stevenson, 2019). The number of deaths related to the situation around the vaquita in the UGC is likely to be much higher, as the involvement of criminal organizations means that many deaths resulting from cartel clashes, extortion, reprisals and forced disappearances remain unreported and unrelated to vaquita conservation - even though they are linked (Crosta and others, 2018).

2.4 Food insecurity

Fisheries have a significant role in nutrition and food provisioning for coastal populations (Food and Agriculture Organization of the United Nations (FAO), 2020), and the UGC's fishery productivity (shrimps in particular) represents the basis of the diet of many local coastal communities (Lluch-Cota and others, 2007; Ardjosoediro and Bourns). However, overfishing has produced a rapid reduction in fish stocks, decreasing the volume of fish caught, and changing the types of species predominantly caught, as well as their size (Crosta and others, 2018; Lluch-Cota and others, 2007; Pomeroy and others, 2016; Sala and others, 2004). Consequently, marine ecosystems gradually become less able to produce food for local communities, compromising the latter's food security (Pomeroy and others, 2016).



*Fishermen prepare their nets at Campo Serena fishing camp, in the Gulf of California.
(Image credit: Guillermo Arias/AFP)*

3. Drivers

3.1 Illegal, unregulated and unreported (IUU) fishing

The vaquita is just one of 8,722 species worldwide listed as critically endangered or at “extremely high risk of extinction” (International Union for Conservation of Nature and Natural Resources (IUCN), 2021; Robinson and others, 2022), and the main driver of its disappearance is fishing nets. Endemic to the UGC, the vaquita is highly threatened by illegal fishing in Mexico, which ranges from 45 to 90 per cent of the national fishery production and is the cause of the rising mortality rate in marine ecosystems (Instituto Mexicano para la Competitividad (IMCO), 2013). As with many other cetaceans, gillnets are the main threat to the vaquita’s population (Sanjurjo-Rivera and others, 2021; Ardjosoediro and Bourns). Vaquita bycatch (other unwanted fish or marine creatures captured while fishing for a different species) occurs in almost all types of gillnets used in the UGC (Rojas-Bracho and others, 2006). The vaquita

is similar in size to a totoaba, meaning they often get entangled and suffocate in the gillnets used in illegal totoaba fishing (Crosta and others, 2018; Rojas-Bracho and Taylor, 2006; Würsig and others, 2021; Jaramillo-Legorreta and others, 2019; Navarro, 2018).



Vaquita entangled in a gillnet set for totoaba (Image credit: NOAA)

Since the price ranges from \$60,000 to \$85,000 per kg on the black market (Felbab-Brown, 2022), totoaba swim bladders (or “maws” in Chinese) are called the “cocaine of the sea” (Navarro, 2018) or “swimming gold” (Crosta and others, 2018). Thus, poaching captivated criminal organizations that find it a less risky and more lucrative way to make money compared to other illegal activities (Crosta and others, 2018). Mexican cartels and Chinese mafias have used their organizational structures, transport networks, and “influence” in official agencies to traffic totoaba swim bladders to China (Crosta and others, 2018). Half of the illegal totoaba supply chain is managed by Mexican cartels that control poaching and domestic smuggling of swim bladders, and the other half by Chinese mafias based in Mexico who place the totoaba maws on the black market in China (Crosta and others, 2018; Felbab-Brown, 2020). Indeed, criminal organizations are also taking over the shark, shrimp and corvina fisheries. By providing fishing gear and financing some of the poaching costs, organized crime is systematically indebting local fishers, who find no better options than illegal fishing in an attempt to quickly settle their debts with the cartels (Sanjurjo-Rivera and others, 2021).

3.2 Unsustainable fishing approaches

In Mexico, most commercial fisheries have been using unsustainable fishing gear (Crosta and others, 2018; Rojas-Bracho and others, 2006) to maximize their catch. For example, in the Gulf of California, the shrimp trawl fishery discards 75 per cent of the species considered as bycatch, with the vaquita as one of its victims (Pramod and others, 2014). Shrimp is Mexico's most important fishing commodity due to its large production volumes, high economic value, large share of exports, and capacity to generate jobs (Gillett). Around 20 per cent of Mexico's shrimp production comes from the Gulf of California, representing a significant source of livelihood for the local population (Ardjosoediro and Bourns; Gillett; Crosta and others, 2018).

Artisanal shrimp fishing along the coastline of Mexico uses gillnets from over 100,000 small boats called pangas (Felbab-Brown, 2020). A survey conducted by the Mexican Navy in 2006 showed that about 50 per cent of the pangas in the province of Sonora in the UGC were unregistered for shrimp fishing (Pramod and others, 2014), meaning they could fish shrimps illegally, for example, through gillnets ten times larger than allowed (CIRVA, 2019). Consequently, the increase in shrimp gillnetting likely contributed to the massive rise in incidental mortality of vaquitas, from 8 to 40 per cent per year between 2011 and 2016 (Crosta and others, 2018).

3.3 Lack of livelihoods

Many fishers in developing countries become involved in IUU fishing due to limited socioeconomic conditions and opportunities (Schmidt, 2005). There are often few better alternatives for well-paid jobs besides fishing in the region (Rodríguez Quiroz, 2019). Overfishing and declining fish stocks put incredible stress on local livelihoods, pushing as many as 80 per cent of fishers in the UGC to illegal fishing. It is understandable, considering that a single totoaba swim bladder caught in one night of work can be worth more than ten times a legal fisher's monthly salary (Crosta and others, 2018). Declining fish stocks push fishers to abandon traditional sustainable fishing methods, such as hook-and-line gear, for more destructive gear such as gillnets, which in some cases can double the size of the catch compared to sustainable methods (Crosta and others, 2018) (IMCO, 2013). Government buyout programs have seen a decline in fishing licences available to communities; however this does not affect unlicensed fishers and in fact gives them less competition for the dwindling fish stocks, putting pressure on the remaining licensed fishers (Ardjosoediro and Bourns).

3.4 Lack of regulation/enforcement

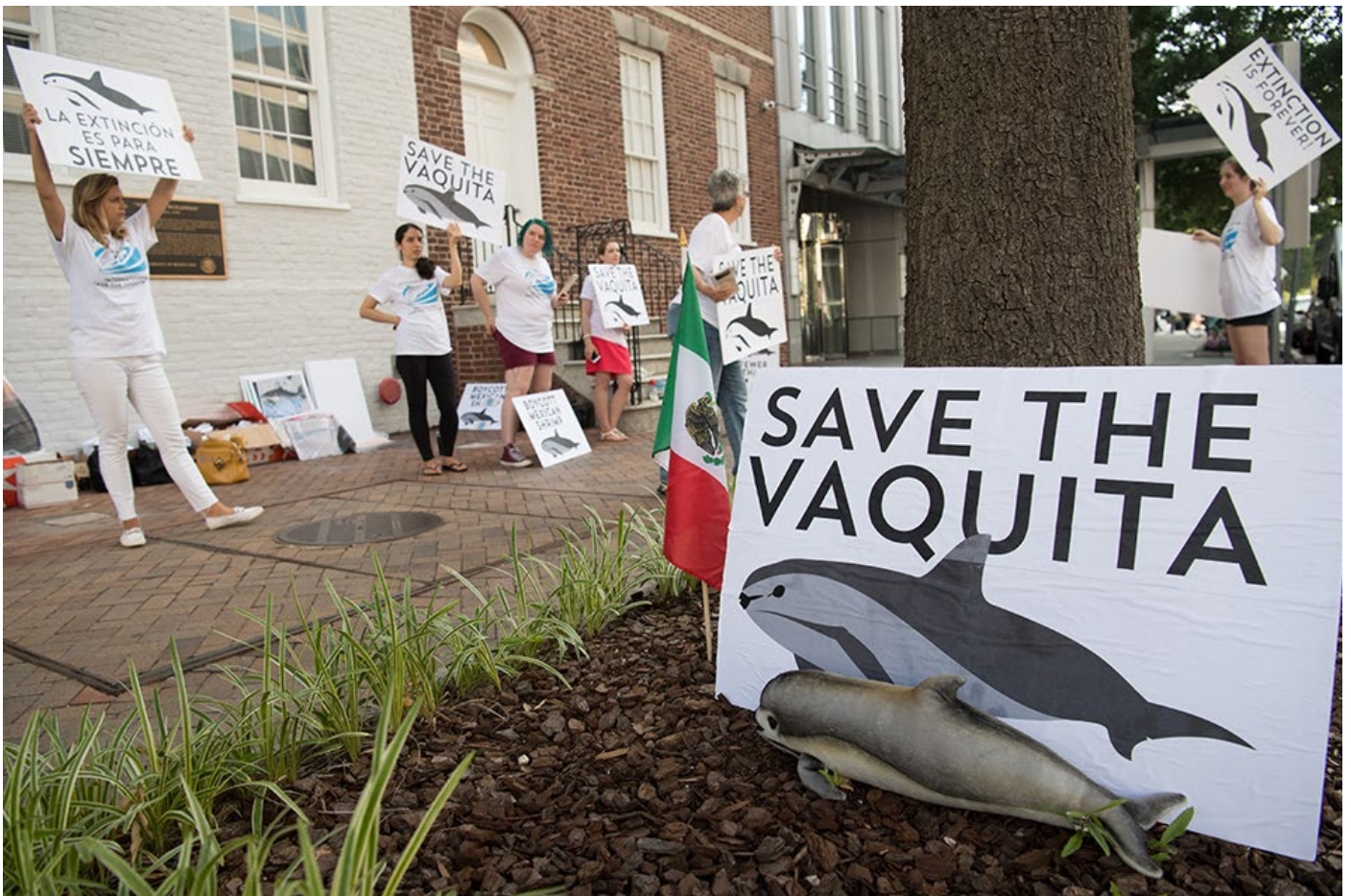
The vaquita was listed as “threatened with extinction” in 1976 by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and “critically endangered” by the IUCN in 1996. In addition, for more than 20 years, the scientific community and various conservation organizations have been working to protect the vaquita and advocate for banning gillnets as fishing gear (Crosta and others, 2018). Despite the Mexican government’s various efforts to protect the vaquita, poor enforcement of the law regarding gillnet use and illegal totoaba fishing has been a pattern in its failed implementation. Authorities continuously struggle to monitor and surveil fishing activities due to the size of Mexico’s coastline and the thousands of vessels along it (IMCO, 2013). For instance, despite the establishment of a “vaquita refuge” zone to reduce gillnetting and trawling within their habitat, illegal fishing increased between 2016 and 2019, reflected in sightings of unregistered vessels and illegal nets removed from the area (CIRVA, 2019). Furthermore, although the Mexican government has permanently banned gillnetting since 2017, none of the hundreds of illegal fishers arrested to date have been prosecuted on related charges, but rather released after paying a small fine that is insignificant in relation to the returns that the totoaba poaching generates. (Crosta and others, 2018; CIRVA, 2019).

Though Mexico has laws and penalties in place to combat illegal fishing, their poor design lacks significant legal or economic consequences for illegal fishers (IMCO, 2013; CIRVA, 2019). For example, to have an economic impact to counteract IUU fishing, Organisation for Economic Co-operation and Development (OECD) suggested that the penalties associated with these activities should be 24 times greater than current fines (Schmidt, 2005). Additionally, representatives of competent authorities (e.g. the navy, the environmental police, the attorney general’s office) often fear illegal fishes because of their connection to criminal organizations and often end up compromising or, in the worst cases, engaging in corruption (Crosta and others, 2018; Brownell and others, 2019). In fact, the cartels often dictate the “law” surrounding the supply chain of totoaba swim bladders regarding how much can be fished, how much and when it should be processed, to whom it can be sold, the price of fish at the local level and even the payment method (Felbab-Brown, 2022). Although Chinese authorities have increased law enforcement and interception of illegally-trafficked wildlife products in recent years due to international pressure, the black market for marine products – such as totoaba swim bladders – continues to operate behind closed doors (Crosta and others, 2018; Felbab-Brown, 2022). Moreover, the Chinese government still lacks sustained interdiction operations to dismantle totoaba poaching networks and tackle smuggling routes and retailing (Felbab-Brown, 2022).

3.5 Insufficient communication/cooperation

Historically, Mexican authorities rejected intervention and support from international organizations such as the U.S. National Marine Fisheries Service, arguing that the vaquita is found in Mexican waters and therefore is a prerogative of the Mexican government (Rojas-Bracho and Taylor, 2006). Such narratives have changed in recent years as Mexico has accepted funding from the U.S. government for various conservation efforts oriented to saving the vaquita (CIRVA, 2012). However, rescuing the vaquita has evolved from an environmental concern to a social and security problem due to the involvement of organized crime, making cooperation across borders among law enforcement agencies an imperative (Crosta and others, 2018). While the Mexican government has done little to engage China in joint operations (e.g. intelligence exchanges), the Chinese government points to Mexico as the sole enforcer of environmental laws associated with illegal fishing occurring in its waters (Felbab-Brown, 2022).

Cooperation and coordination are also insufficient at the national level. Some state officials expressed that the CIRVA should be entirely based on Mexican science, claiming that, as an authorized advisory body for vaquita conservation, CIRVA and its members should be Mexican, and its scientific reports should come from Mexican scientific journals (Rojas-Bracho and others, 2006). Additionally, a lack of coordination between various authorities allowed the consolidation of illegal activities. The Federal Attorney of Environmental Protection (PROFEPA), the Mexican Environmental Police (SEDEMA), the National Commission of Natural Protected Areas (CONANP), and the Mexican Navy (SEMAR) are all involved in IUU fishing with different mandates: while some have the power to arrest, others have the weapons, and yet others have the boats necessary to carry out enforcement operations; therefore, none can effectively monitor illegal fishing completely without the assistance of others (Crosta and others, 2018).



Demonstrators with The Animal Welfare Institute hold a rally to save the vaquita, the world's smallest and most endangered porpoise, outside the Mexican Embassy in Washington, DC, on July 5, 2018. (Image credit: Saul Loeb/AFP)

4. Root causes

4.1 Global demand pressures

Global demand for fish is high and likely to grow as population and development increases, with nearly 4.3 billion people currently depending on fish stocks as a source of dietary protein, while supplies are dwindling due in large part to overfishing (FAO, 2020). In the case of the vaquita, the global demand plays out in a specific way, with specific demand originating in China for a specific part (swim bladder) of a specific fish (*Totoaba macdonaldi*). The sheer value of this product on the black markets is driving organized crime and the persistence of illegal fishing in the UGC (Crosta and others, 2018). The demand for dried swim bladder has increased in recent years, fetching a far higher price than other illicit seafood delicacies like shark fin, challenging the effectiveness of management interventions (Ben-Hasan and others, 2021). Although sought after as a luxury food product, it has had many other uses in Chinese culture from medicinal to contraceptive, but also as a lucrative investment (Sadovy de Mitcheson and others, 2019). This is not an isolated problem. The international illegal trade in wildlife and wildlife parts is estimated to be valued at up to \$20 billion annually, making it second only to the drug trade in terms of profitable illicit markets and an increasingly serious threat to environmental and social security worldwide (McMurray, 2008; Wilson-Wilde, 2010).

In this context, the role of “legitimate” international demand for seafood in the demise of the vaquita should also not be understated. A recent report showed that the U.S., a primary consumer of shrimp from Mexico, imported an estimated \$2.4 billion worth of seafood from IUU fishing in 2019, with over a quarter (25.1 per cent) coming from Mexico (Kearns and others, 2021). As mentioned above, unsustainable shrimp fisheries play a role in the approaching extinction of the vaquita, and although the U.S. imports account for around 80 per cent of shrimp caught in the UGC, there is little transnational cooperation to enhance sustainability or adherence to conservation regulations (Dunch, 2019). This does however illustrate the opportunities for leverage that U.S. consumers could potentially have to drive sustainable production, if certified market chains can be developed and made available to local communities (see section 6.1). And while the U.S. government implemented embargoes on UGC seafood in 2018 and sanctions on all Mexican-caught shrimpin 2021 in response to continued evidence of IUU fishing, the lost value of these fisheries (\$50 million and \$240 million respectively) will have wide-ranging social impacts, along with impacts to over 42,000 jobs (Felbab-Brown and Castillo López, 2021). If the Mexican government does not take steps to improve the illegal fishing situation to relieve these and any future sanctions, fishers could be pushed towards rather than away from more desperate measures. Nevertheless, the effects of international markets and political manoeuvres should also be taken into account (Kearns and others, 2021).

4.2 Inequality of development and livelihood opportunities

In the UGC, artisanal fishing has been the main economic activity for the local population, providing food and labour for over 50,000 (Morzaria-Luna and others, 2014). In the region, working for a large fishing company is one of the best jobs that a local can get to secure a monthly salary of \$500 – at best (Rodríguez Quiroz, 2019). But those opportunities are very limited, leaving artisanal fishing as the most common type of fishing with over 35,000 fishers living from it (Morzaria-Luna and others, 2014). However, socioeconomic disparities and limited options for making a living have pushed local fishers towards IUU fishing practices. On the one hand, artisanal fishers have restricted access to formal credit and savings and depend on informal or semi-formal trade credit from national and international brokers (Ardjosoediro and Bourns). On the other hand, there is a decided neglect of these communities by the government, which is reflected in limited and poor housing and transportation and basic infrastructure (e.g. roads) that prevent these communities from accessing other markets (Perez, 2002). A lack of opportunities is also rooted in combination with other social conditions such as poverty, lack of educational services and ethnic and gender inequality, which has resulted in the problem of overfishing (Pomeroy and others, 2016). For example, in the communities of Bahia de Los Angeles and Puerto Lobos, the limited economic conditions and lack of educational opportunities have stimulated local fishers to engage in IUU fishing of banned species such as turtles, sea cucumber and totoaba to balance income resulting from the declining fish stock (Morzaria-Luna and others, 2014). Additionally, given the arid and semi-arid environmental conditions of the region, communities of the UGC are unable to secure enough food through farming activities, highly depending on an erratic rainfall pattern that produces only three to four harvests every decade (Perez, 2002). The vulnerability of these highly fishery-dependent communities becomes more acute considering their low socioeconomic diversification and the fact that marine ecosystems in the UGC are prone to the effects of climate change (Morzaria-Luna and others, 2014). Artisanal fishers in the UGC do not have the flexibility, nor the capital, to look for alternative occupations (Morzaria-Luna and others, 2014). Therefore, they are trapped in a vicious cycle of inequality in which the fish stock is permanently overexploited and depleted, increasing fishing effort and driving fishers towards unsustainable practices to maintain their income levels (IMCO, 2013).

4.3 Undervaluing environmental costs

The declining population of the vaquita can be traced back to an unwillingness to participate in conservation measures due to their economic costs (Ortuño, 2020). In the late 1990s, as vaquita conservation recommendations were proposed, Mexican government officials first cast doubt on the vaquita's very existence, and then proceeded to push back on the scientific consensus that immediate action was necessary to reduce bycatch. Government officials and fishing interests were unwilling to make politically unpopular decisions, such as regulating fishing activities, in the absence of unequivocal proof of the vaquita's impending extinction. Even now it remains a challenge to make the case for the value of conservation: though the vaquita is endemic to the region with an important place in the local ecosystem and high value in terms of biodiversity, in human terms, it is economically worthless compared to species that can be sold for profit (Rojas-Bracho and others, 2006). Mexico has also refused aid for pro-environmental causes, claiming that these efforts are a form of "environmental imperialism," done only to undermine Mexico's fishing sector (Rojas-Bracho and others, 2006). Additionally, the current ruling government has effectively given up

enforcing the law against totoaba poachers (Felbab-Brown, 2022), making little effort to bridge human livelihood needs and long-term environmental stability. In 2022, the Mexican government reduced the budget allocated to CONAPESCA (the agency in charge of promoting fisheries and aquaculture development) by 3.4 per cent and limited the budget for BIENPESCA (the economic support program for fishers) leaving around 100,000 fishers out of the scheme (Humint, 2022). This reduces environmentally-sustainable livelihood opportunities for fishers, thereby increasing the likelihood of illegal and unsustainable fishing practices despite clear environmental consequences (Rojas-Bracho and others, 2006).



A rare photo of vaquitas (a mother and calf) in the wild. (Image credit: Paula Olson, NOAA)

4.4 Insufficient risk governance

A major cause behind the failure of effective conservation measures and regulations to curtail the illegal fishing activities pushing the vaquita to extinction lies in the inability of government to manage risks to ecosystems and local communities (Crosta and others, 2018; Brownell and others, 2019). Although regulations and protected areas have been introduced by the government over the past decade, it is common knowledge with the local people in the region that illegal fishing is continuing each day unabated, and most actions taken by the government are widely unpopular in the fishing communities they impact (Würsig and others, 2021; Aburto Oropeza and others, 2018). The uneven approach to managing this complex issue, ranging from complete absence to excessive military intervention, is in part related to political cycles that often deliberately take different approaches to previous administrations and discredit their policies, which in turn weakens the legitimacy of environmental institutions and the trust of local communities in authorities (Felbab-Brown, 2020; Cervantes, 2019). Powerful groups such as organized crime have taken advantage of this lack of effective authority in the region and embedded themselves in local communities and governments, further weakening the influence of the state (Aguirre-Ochoa and Gómez, 2021). Weak governance, characterized by corruption, poor enforcement, and lack of stakeholder participation, political will and capacity is a major cause of declining marine biodiversity worldwide (Pomeroy and others, 2016). In particular, the lack of political will to enforce environmental laws has been identified as a global trend that is exacerbating the range of environmental crises our planet now faces (United Nations Environment Programme (UNEP), 2019).

5. Big picture

The continuing practice of illegal wildlife trafficking around the world not only threatens species like the vaquita, but also whole ecosystems as species disappear from webs, threatening the food security of billions of people relying on wild caught animal proteins and feeding criminal networks that undermine the rule of law. IUU fishing alone causes losses valued between \$10 billion and \$23.5 billion annually (Agnew and others, 2009) and poses a significant risk to over 85 per cent of global fish stocks (Freitas, 2015). Including other forms of wildlife trafficking and illegal logging, this figure could be as high as \$216 billion, not only contributing to the global biodiversity crisis but also creating enabling conditions for the spread of invasive species, disease transmission, criminal networks and impacts on economies, non-target species and ecosystem services (Cardoso and others, 2021). A common problem to solve in this complicated global issue is the pitting of conservationists against local communities and their livelihoods, as is playing out in the tragic case of the vaquita, a problem that continues to create barriers to sustainable solutions for saving species from extinction (Redpath and others, 2013).

6. Solutions

6.1 Innovate

One way to remove the gillnets driving the vaquita to extinction is by replacing them with different technologies that lower the risk of non-target species being ensnared. Sustainable fishing gear is designed to reduce bycatch by being more efficient with the area being fished and deterring or obstructing non-target species. In the case of the vaquita, some gear types suggested to replace gillnets include light, selective towed nets (known as light trawls) and pots, which lure target species into traps specific to their morphology (FAO, 2019; CIRVA, 2012). Light trawls, like the RS-INP prototype, better suit artisanal fishing operations while reducing bycatch, fuel demands and damage to benthic ecosystems compared to larger standard trawls (Figure 3), and were recommended as a viable option to replace shrimp drift gillnets (Rojas-Bracho and Reeves, 2013).

Efforts to further ground-truth the efficacy of these and other sustainable techniques have been slow and underresourced however, with fragmented studies providing various results depending on time of the study and which fishers were involved. Despite evidence that viable alternatives to gillnets exist (Herrera and others, 2017), other studies point to data showing that they will result in economic trade-offs for fishers, costing over \$8 million annually to mitigate (Oakley Smith and Lopez-Sagastegui, 2017) or would need to be implemented at a much larger scale than at present (Königson and others, 2019). Scaling up commercial use of sustainable technologies is a key part of saving the vaquita from extinction; however, buy-in from fishing communities is essential, and concerns around jeopardizing livelihoods must be addressed (Brownell and others, 2019). Incentives for sustainable fishing techniques, such as certifications for sustainable, “vaquita-safe” sources, could offer access to certain market channels and deliver market premiums, encouraging fishers to serve as stewards of the region rather than being seen as drivers of ecological damage. Developing market linkages and consumer demand is required to help such ideas to further push for the uptake of sustainable fishing gear (Ardjosoediro and Bourns).

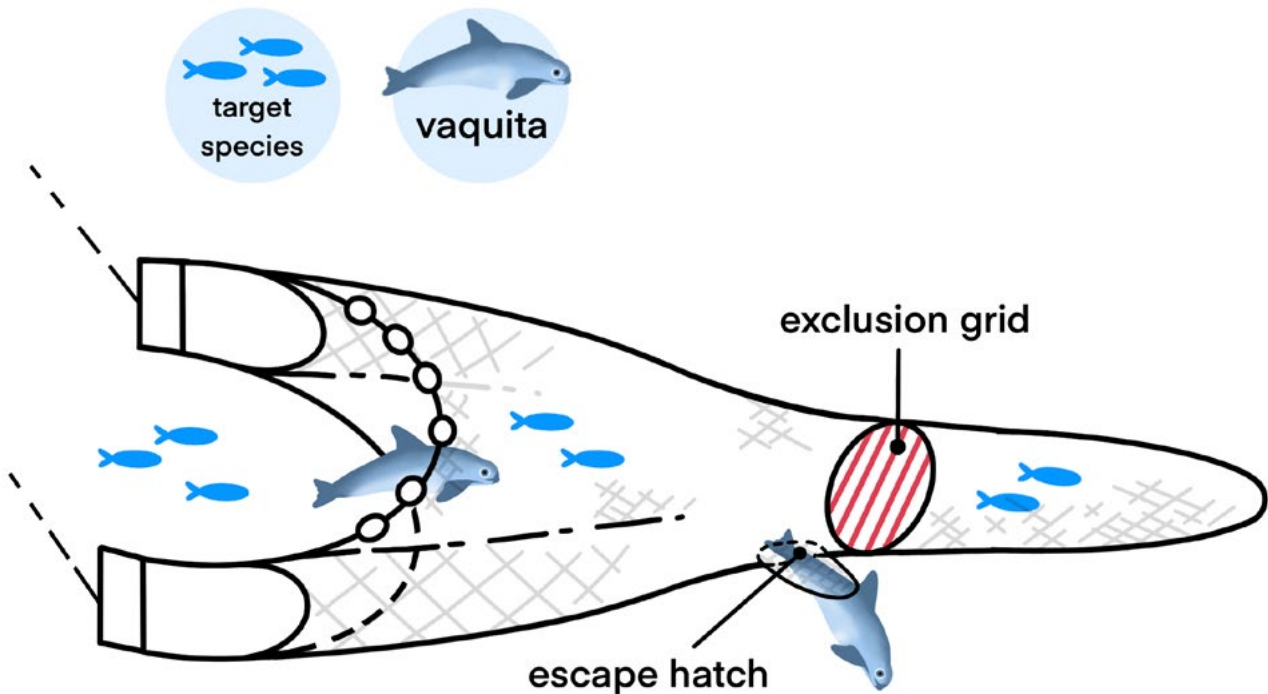


Figure 3: Light trawl concept including an exclusion grid to minimize bycatch (own figure)

6.2 Work together

The adversarial nature of the relationship, and resulting lack of collaboration, between government and fishery groups has resulted in patterns of non-compliance with fishing restrictions that have continued to frustrate conservation attempts to save the vaquita from extinction (Aburto Oropeza and others, 2018). Improving the governance of fisheries to factor in social well-being through the direct involvement of fishing communities is thus perhaps the most essential element for the successful conservation of many threatened marine species, including the vaquita (Brownell and others, 2019). Community participation and empowerment in regulatory design have been linked to higher levels of buy-in and compliance, by building accountability and legitimacy while reducing the potential for political backlash (Sanjurjo-Rivera and others, 2021). To improve adherence to conservation regulations, fishers should be involved with early participation in their development by fishery committees and councils at state and federal levels. For instance, by working together with fishers to develop community surveillance programs in the waters of the Gulf of California, with options for exclusive use rights and collaborative monitoring of resources together with authorities, transparency and therefore trust could be improved on both sides (IMCO, 2013). In other parts of Mexico, such as the Yucatan, self-organized fishing communities have managed to join forces with authorities to tackle the issue of poaching in the Sian Ka'an Biosphere (Felbab-Brown, 2020). In the Gulf of California however, alternative livelihoods such as ecotourism have not taken off, alternative fishing gear are not viewed favourably by fishers and the influence of organized crime continues to motivate illegal fishing. Promoting wider participation and the voices of organized fishing communities in fisheries management and environmental protection is crucial for overcoming these roadblocks (Felbab-Brown, 2020).

6.3 Consume sustainably

Another useful element of a solutions package for saving the vaquita from extinction could come in the practice of aquaculture, or farming of the target fish at the centre of this problem: the totoaba. Also a threatened species, the high price for totoaba swim bladders on the black market continues to motivate illegal fishing activity that is also killing the few remaining vaquita (Sanjurjo-Rivera and others, 2021). In an effort to save the totoaba from extinction, aquaculture initiatives have been trialled to farm the species both for sale and for restocking the wild population. Growing the aquaculture industry in the Gulf of California could help species such as the totoaba and other commercially-viable species, as well as the marine ecosystem as a whole, to bounce back from historical overfishing, while providing options for alternative livelihoods in local communities where fishers often have little option to diversify (Aburto Oropeza and others, 2018). Luckily, the totoaba has proven to be a suitable fish for aquaculture – as it is fast growing, and able to be reared such that farmed fish are comparable in size and market quality to wild-caught equivalents (Juarez and others, 2016; González-Félix and others, 2021). If stocks can be replenished, this could have an effect on the black market for swim bladders, lowering their value and, in turn, the incentive for illegal fishing by helping supply exceed demand, with positive flow-on effects for reduced vaquita deaths in illegal gillnets. A Greenpeace investigation of the totoaba trade revealed that in 2013 prices in some places in China dropped by as much as 70 per cent due to an influx of supply after a surge in Chinese immigration to the fishing area of San Felipe in the Gulf of California (Greenpeace East Asia, 2015).

Recently, the CITES ban on international trade in totoaba, initially implemented to protect the species from rampant over-fishing, was lifted for the first time in almost 50 years in an effort to support the development of the aquaculture industry (Center for Biological Diversity, 2022). Some conservation groups oppose this move, concerned that permitting totoaba exports will only strengthen the international market and further support illegal trade, and there is little faith in the ability of authorities to effectively police it in light of a history of failures regulating the wild-caught trade (Rodríguez, 2022). As with approaches for implementing sustainable fishing gear in wild fisheries, the implementation of aquaculture solutions will require participatory approaches to secure buy-in from local communities and authorities alike, while ensuring that issues of equitable access, environmental sustainability and adherence to regulations are addressed.

6.4 Conclusion

The solutions mentioned in this report are only a selection of possible solutions for addressing the long-running challenge of saving the most endangered marine mammal in the world, the vaquita, from becoming only the second known marine mammal driven to extinction in history. Finding a way to implement such solutions in an integrated, coordinated way is critical not only for the vaquita but also for many other species on Earth facing the same imminent fate. Other possible solutions may be necessary for different contexts, such as tracing illegally traded products, stronger prosecution of criminals, raising awareness among key consumer groups and multilateral partnerships to build the capacity of local authorities and community organizations. The solutions outlined above exemplify a shift in our collective mindset to address the root causes of, reduce the impact of and increase resilience to the practices leading to the extinction of species in a holistic way. Therefore, they are intended to work together as a package, taking advantage of the different co-benefits and synergies of the collected solutions to address multiple challenges while minimizing trade-offs. The solution package approach also represents the idea that none of these solutions is sufficient if they are implemented in isolation; only through this integrated, multifaceted approach can the problem truly be addressed and the needs of both humans and nature to coexist be met.

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