15

Conservation of the Vaquita (*Phocoena sinus*) in the Northern Gulf of California, Mexico

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Phocoena sinus *was discovered as a new species in 1958 at a time when its populations were most surely already declining. Now, in only 17 years, it is on the border of extinction.*

—Bernardo Villa Ramírez, 1976

15.1. INTRODUCTION

15.1.1. The Vaquita: 50 Years from Discovery to Critically Endangered

Before the discovery of a bleached skull on a beach north of Punta San Felipe in Baja California, Mexico, on 18 March 1950, the vaquita was unknown to the scientific community. The following year, two additional skulls were found, and these three skeletal specimens formed the basis for naming a new species of porpoise, *Phocoena sinus* (Norris and McFarland 1958), commonly known as the *vaquita* ("little cow" in Spanish). The external appearance of the species was not described until the retrieval of 13 fresh specimens in the 1980s (Brownell et al. 1987) (figure 15.1). A detailed review of all known records confirmed that the distribution was restricted to the upper Gulf of California (Brownell 1986).

Coincident with this scientific description of the new species was the realization that individuals were incidentally taken in artisanal and commercial fisheries. Fishermen in the upper gulf were familiar with this species long before scientists were aware of its existence. While documented mortality of the vaquita in gillnet fisheries has been occurring since at least the 1950s (Norris and Prescott 1961), researchers noted that the vaquita has probably been incidentally caught since the 1930s (Brownell 1982; Vidal 1995). In the early years, most bycatch was in the gillnet fishery for totoaba (*Totoaba macdonaldi*), a large member of the croaker family (Scianidae) endemic to the northern Gulf of California (Brownell 1982; Flanagan and Hendrickson 1976).

While there was no systematic documentation of incidental mortality in the early years, scattered records noted that vaquitas were taken in the artisanal gillnet fishery for totoaba and shark and in the commercial trawl fishery for shrimp (Brownell 1982; Flanagan and Hendrickson 1976; Norris and Prescott 1961). Concern over the species' conservation status was expressed for many years (Brownell 1982, 1983; Barlow 1986; D'Agrosa et al. 2000; Perrin 1988; Robles et al. 1987; Vidal 1995). The species was reclassified by the International Union for Conservation of Nature (IUCN) Red List from Vulnerable (IUCN 1978) to Endangered and is currently listed as Critically

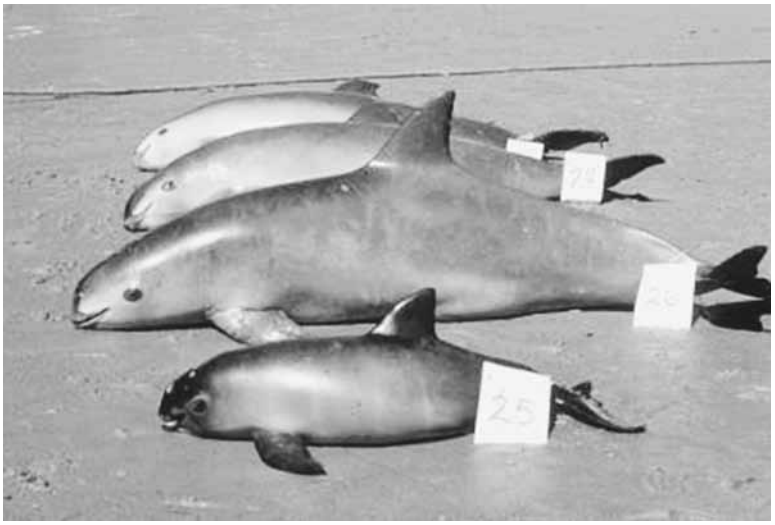

FIGURE 15.1 Four vaquita that were caught in gillnets in 1985. (Photo courtesy of Alejandro Robles)

FIGURE 15.2 Recent (October 2008) photograph of two vaquitas near the center of their distribution in the upper Gulf of California, Mexico. (Photo by T. A. Jefferson taken under permit DR/488/08 from the Comisión Nacional de Áreas Naturales Protegidas, SEMARNAT)

Endangered (IUCN 1996). The species has been listed on Appendix 1 (fully protected) of the Convention on International Trade in Endangered Species (CITES) since 1979. The species has been listed as endangered under the U.S. Endangered Species Act since 1985, and in 1994 the Mexican Standard NOM-059-ECOL listed the vaquita as in danger of extinction.

Meta-analysis of early surveys confirmed that the population numbered only a few hundreds of individuals (Barlow et al. 1997). Based on the most complete survey to date (in 1997), Jaramillo-Legoretta et al. (1999) estimated 567 individuals (coefficient of variation = 0.51, 95 percent log-normal confidence interval = 177–1073). Acoustic monitoring of vaquita echo-location clicks revealed that

the population had declined by 8.7 percent per year from 1997 to 2007 (Jaramillo-Legoretta 2007). Projecting the population forward from 1997 to 2007, Jaramillo-Legoretta et al. (2007) estimate that only approximately 150 vaquitas remain and conclude that, if no action is taken, vaquita are likely to decline within the next two years to a level where extinction may be inevitable.

The threats facing the vaquita have changed little since its discovery 50 years ago. With the recent extinction of the Yangtze River dolphin (*Lipotes vexillifer*) (Turvey et al. 2007), the vaquita (figure 15.2) is the world's most critically endangered cetacean species. The species will surely go extinct soon unless fishing practices are changed.

15.1.2. Northern Gulf of California: Habitat and Humanity

The northern Gulf of California not only is the only habitat of the vaquita but also is home to approximately 100,000 people who live around its margins. The northern gulf is a relatively shallow inland sea (figure 15.3) with a very high tidal range (~8 m). Tidal mixing brings nutrients to the surface waters, making the waters of the northern gulf some of the most productive of any ocean (Álvarez-Borrego and Lara-Lara 1991). The high productivity of the waters resulted in a great abundance of fisheries resources, some of which are now depleted by overfishing. The initial development of the three major settlements in this area (Puerto Peñasco, San Felipe, and El Golfo de Santa Clara) was intimately linked to the commercial fisheries that developed there.

Commercial fishing originally developed in the 1920 to exploit large populations of totoaba. Early fishing methods included handlines, spears, and dynamite. In many cases, only the swim bladder was harvested for sale to Chinese markets. By the 1940s, totoaba fishing was primarily by gillnets, and most of the catch was exported to the United States. Totoaba catches reached a maximum of 2,000 tons per year in the late 1930s and early 1940s (Cisneros-Mata et al. 1995), but the species continued to decline under heavy fishing pressure and is currently listed as endangered. A total ban on the fishing for totoaba did not occur until 1975 (Flanagan and Hendrickson 1976).

As the totoaba resources declined in the late 1940s, trawling for shrimp (*Penaeus* spp.) overtook gillnetting for totoaba in economic importance. Shrimp trawling was primarily carried out from

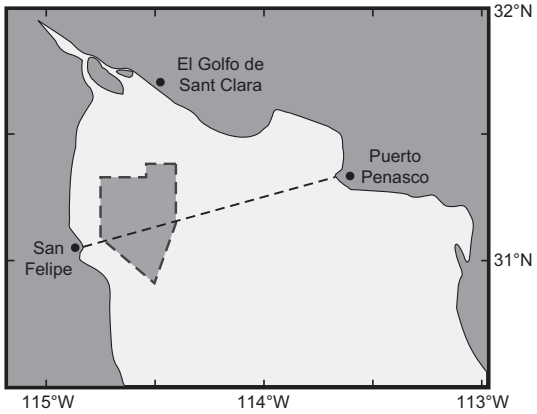

FIGURE 15.3 Map of the northern Gulf of California showing locations of the three fishing communities. Solid polygon indicates the Vaquita Refuge Zone and the dashed line between San Felipe and Puerto Peñasco is the aquatic boundary of the Biosphere Reserve

Puerto Peñasco because it was the only fishing village with a harbor deep enough for trawlers. Other gillnet fisheries developed for sharks, rays, curvina golfina (*Cynoscion othonopterus*), chano (*Micropoganias megalops*), and other species using small outboard-powered boats called *pangas*. Panga fishermen in San Felipe and Santa Clara discovered that they could compete with the shrimp trawlers by entangling shrimp in gillnets called *chinchorro de línea*. Gillnetting and trawling for shrimp are now the most important fisheries in the upper gulf.

The relative importance of fishing to the area has, however, declined considerably in the past two decades. Tourism has greatly surpassed fishing in economic importance in Puerto Peñasco and San Felipe. El Golfo de Santa Clara remains primarily a fishing village, but there is optimism that access by a new paved road may provide increased opportunities for tourism and associated development. Although there has been a shift from fishing to a tourism-based economy in the region, the Gulf of California remains the *raison d'être* for both.

Given that the economy of the region is so closely tied to the Gulf of California and given that the region is the only habitat of two endangered, endemic species (vaquita and totoaba), the health of this ecosystem is critical. Fortunately, primary production remains high and pollutant concentrations remain low, because of tidally driven upwelling that brings clean, nutrient rich deep water to the surface waters and the lack of river input of pollutants.

The principle human-caused perturbation to the northern gulf ecosystem has been overfishing and the reductions in flow from the Colorado River to near zero levels. Overfishing has driven long-lived species such as totoaba, sharks, and groupers to commercial extinction in the northern gulf ecosystem. Reduction in flow from the Colorado River has likely made conditions even worse for totoaba and for another estuarine-breeding fish, curvina golfina. However, the reduction of river input is not thought to have adversely affected the vaquita (Rojas-Bracho and Taylor 1999).

15.1.3. Fishery Bycatch

Although all marine mammals are susceptible to gillnet entanglement (Perrin et al. 1994), porpoises, including vaquita, are particularly vulnerable (Jefferson and Curry 1994). The first reports of incidental catch of vaquitas in totoaba nets came from Norris and Prescott (1961), and the problem of fisheries bycatch was acknowledged by every author writing about the species' status since that time. Vidal et al. (1994) documented 128 vaquitas caught in gillnet fisheries from March 1985 through February 1992, of which 65 percent were killed in gillnets set for totoaba. A minimum of 15 vaquitas died from early 1993 to early 1994 in nets set by fishermen from just one village, El Golfo de Santa Clara (D'Agrosa et al. 1995). These first minimum estimates of vaquita bycatch were presented to the small cetacean subcommittee of the International Whaling Commission in 1994, and that subcommittee expressed "extreme concern over the status of this species" and recommended that "immediate action be taken to eliminate incidental catches in all fisheries" (International Whaling Commission 1995).

The only effort-corrected study to estimate vaquita incidental catch was that of D'Agrosa et al. 2000). Their study used fisherman interviews and on-board observers to quantify the bycatch of vaquita per fishing trip in each of five types of gillnets from January 1993 to January 1994. They extrapolated their bycatch rate to the total estimated number of trips from El Golfo de Santa Clara to be 39 vaquitas/year (95 percent confidence interval = 14–93; D'Agrosa et al. 2000). When they extrapolated mortality rates to the estimated number of fishing trips from neighboring San Felipe, the estimate of total annual bycatch increased to 78–168 per year. D'Agrosa et al. (2000) concluded that these bycatch rates were unsustainable.

Although fishermen would no longer be willing to cooperate in such a voluntary study of vaquita bycatch, there is continued evidence of bycatch in fishing operations. From 1995 to 2004, 22 vaquita deaths were reported by fishermen and government field personnel, and 11 carcasses were recovered (Rojas-Bracho and Campoy 2004).

15.1.4. Other Risk Factors

Although fishery bycatch has been identified as the greatest risk factor for vaquita survival, other potential risk factors have been identified and reviewed. Rojas-Bracho and Taylor (1999) examined three risk factors (pollutants, loss of Colorado River input, and genetic inbreeding) and found that none would appreciably increase the risk of extinction and none would prevent the recovery of vaquita.

15.2. POLITICAL, ECONOMIC, AND SOCIAL SOLUTIONS

15.2.1. Historical Governance: Much Talk and Little Action

From the first description of the species in 1958, more than 34 years passed before the first action directed toward vaquita conservation in 1992. Earlier, several management actions indirectly benefited vaquita and/or its environment (reviewed in Secretaría del Medio Ambiente, Recursos Naturales y Pesca [SEMARNAP] 1995). On 2 March 1992, the government created the Technical Committee for the Preservation of the Vaquita and the Totoaba. This group recommended provisions for protecting vaquita, including the creation of a reserve for the species. On 10 June 1993, the Biosphere Reserve of the Upper Gulf of California and Delta of the Colorado River was declared (Secretaría de Pesca 1994), and in 1995 the management plan for this reserve was published (SEMARNAP 1995). In 1994, the formal acknowledgment that the vaquita is a species in danger of extinction represented a fundamental change in the policy of the Mexican government toward vaquita. SEMARNAP listed the vaquita on its priority list of species subject to special protection and conservation (Conservación y Recuperación de Especies Prioritarias; Programa de Conservación de Vida Silvestre y Diversificación Productiva en el Sector Rural, 1996–2000; Dirección General de Vida Silvestre, Instituto Nacional

de Ecología, 1997). In 1997 the Mexican Government, through its National Institute of Fisheries, created the International Committee for the Recovery of Vaquita (Comite Internacional para la Recuperacion de la Vaquita [CIRVA]) with scientists from Europe, North America, and Mexico. The goal of this team was to draft a recovery program based on the best available scientific information. In its first meeting the recovery team concluded, after reviewing and analyzing potential risk factors, that incidental mortality in gillnets represented the greatest immediate threat to the survival of the species (Rojas-Bracho and Jaramillo-Legoretta 2002).

Later, in its second meeting CIRVA recommended the following:

- The bycatch of vaquitas must be reduced to zero as soon as possible.
- The southern boundary of the Biosphere Reserve should be expanded to include all known habitat of the vaquita.
- Effective enforcement and development of effective enforcement techniques to regulate fisheries activities should be implemented as soon as possible.
- Research should start immediately to develop alternative gear types and fishing techniques to replace gillnets and development of socioeconomic alternatives for fishermen.

On 29 December 2005 the "Program for the Protection of the Vaquita" was published in the *Diario Oficial de la Federación*, the *Mexican Federal Register*. The main components of the program were the declaration of a Vaquita Refuge Zone and the transfer of $1 million to the state governments of Baja California and Sonora to implement actions within the Vaquita Refuge Zone. However, the measures failed due to a lack of specific terms of reference regarding a compensation scheme (see Rojas-Bracho et al. 2006). In 2007, the president of Mexico announced the Conservation Program for Endangered Species (Programa de Conservación de Especies en Riesgo), which will initiate specific Species Conservation Action Programs (Programas de Acción para la Conservación de Especies) for a list of selected species, including vaquita within the top five.

Despite all these well-intentioned government declarations, little was done in practice to protect the vaquita until 2008 (see section 15.2.4). After the Biosphere Reserve's management plan was published, no decisive actions were taken to regulate fisheries bycatch within the reserve areas where vaquitas are most commonly found. Furthermore, about 40 percent of vaquitas occur outside the boundaries of the Biosphere Reserve. The Program for the Protection of the Vaquita established the Vaquita Refuge Zone in 2005 that included most of the vaquita habitat, but fishing in that zone continued through 2007 with little change. In fact, the number of pangas fishing with gillnets roughly doubled after CIRVA recommended that the number of pangas be capped and that vaquita bycatch should be reduced to zero as soon as possible. The implementation of a real vaquita refuge failed because of a lack of enforcement and a lack of an adequate compensation plan or economic alternatives for the artisanal fishermen who depend on that area for their livelihoods.

15.2.2. A Way Forward

Clearly, management has been ineffective at controlling vaquita mortality in gillnets. The vaquita will surely go extinct if nothing changes. For change to occur, we must understand the impediments to change and correct them. Some of these impediments are as follows:

(1) There has been a history of denial and delay in dealing with the problem of vaquita bycatch. The prospect of losing a porpoise species did not seem real or immediate. No species of cetacean had previously gone extinct in historic time. The problem was left to future administrations or future generations.
(2) Fishing is viewed more as a right than a privilege in the region. Until recently in Mexico, access to fisheries has not been limited. Although a system of permits was established for gillnet fisheries, there was little enforcement of permit regulations in the northern gulf. There is a history of civil unrest in the region when attempts were made to implement fisheries regulations.
(3) There is little in the way of economic alternatives for fishermen. Although tourism and associated development are booming in Puerto Peñasco and, to a lesser extent, San Felipe, most fishermen do not have the training, education, or inclination to move into alternative careers. El Golfo de Santa Clara remains a fishing village with few other economic opportunities even if the barriers of training, education, and inclination were eliminated.

To save the vaquita, steps need to be taken immediately to eliminate fisheries bycatch. The perception that cetacean extinction is not a real threat is gone, now that the Chinese river dolphin has been declared "probably extinct" (Turvey et al. 2007). The perception that the problem of vaquita bycatch can be delayed has been vanquished by additional research that shows the population to be only approximately 150 individuals and still declining. The government of Mexico must now take the politically unpopular steps of banning the use of gillnets throughout the range of vaquita and of enforcing that ban. For a generation of fishermen who have, for the most part, not been regulated, this action will be perceived as taking away their right to a livelihood. In the short term, economic compensation will be required to compensate fishermen for their loss of income. In the longer term, alternative methods of fishing must be developed that do not result in vaquita bycatch, fishermen must be provided alternative means of making a living, or both.

15.2.3. Economic Valuation of the Fisheries

The government of Mexico has already undertaken a critical first step in planning for the economic compensation that will be necessary in order to implement a gillnet ban. Economists at the National Institute of Ecology (INE) have undertaken a study to determine the value of the gillnet fisheries in the upper Gulf of California. Information for the economic analyses presented here was largely gathered from trusted anonymous sources within the fishing industry and the government. Much of the gillnet fishing is conducted illegally (without permits) and is therefore not included in the official records.

The number of pangas fishing with gillnets was estimated as the sum of legally permitted and illegal boats. The number of legal boats is not known precisely because some permits cover an unspecified number of vessels. In 2007, the fisheries agency in Mexico (CONAPESCA) began a process of individualizing the multiboat permits so that each permit covered only one vessel. The numbers of legal vessels reported in table 15.1 are the estimated numbers of individual permits plus the estimated number of pangas covered by multiboat permits. These estimates are most accurate for San Felipe and Santa Clara, where the individualization process is nearly complete. Estimates of legal vessels in Puerto Peñasco (table 15.1) are less precise because the individualization process has just begun there. Estimates of the number of illegal pangas (table 15.1) come from local Secretaría del Medio Ambiente, Recursos Naturales (SEMARNAT) officials and nongovernmental organizations that work with the fishermen and are only rough estimates. With these caveats, we estimate the total number of pangas fishing with gillnets in the northern gulf is approximately 1,073.

The total catch of shrimp is known relatively precisely because virtually all landings are handled by a few firms (private or cooperatives) and the international distribution is handled largely by one company. By far, the largest and most profitable catch is of the premium-sized blue shrimp (*Penaeus stylirastris*). The catch of blue shrimp by panga fishers is approximately 722 metric tons per year, with a beach landing price of approximately US$14/kg. The total gross income from shrimp for all panga fishers is approximately US$10.1 million per year (table 15.2).

The gillnet fishery for finfish is an important source of income for fishermen, especially in the months when the shrimp fishery is closed. Six major finfish species are caught (chano, curvina golfina, manta, sierra, shark, and guitarra), with an aggregated catch of 5,583 metric tons (table 15.3). The gross income from finfish is approximately US$5.7 million.

TABLE 15.1 Estimated number of small skiffs (pangas) fishing with gillnets in each of the three communities in the upper Gulf of California

	San Felipe, Baja California	Santa Clara, Sonora	Puerto Peñasco, Sonora	Total
Number of pangas legally fishing with gillnets (with permits) for shrimp and finfish in 2007	321	243	69	633
Number of pangas illegally fishing with gillnets for shrimp and finfish (circa mid-2000s)	170	200	70	440
Total	491	443	139	1,073

TABLE 15.2 Estimates of fisheries landings for shrimp and their economic value in three communities of the northern Gulf of California

	San Felipe, Baja California	Santa Clara, Sonora	Puerto Peñasco, Sonora
Total shrimp landings per season-year (metric tons)	342	280	100
Average shrimp landings per season per panga (metric tons)	0.70	0.63	0.76
Regional total gross income per season from shrimp captured by all pangas (million US$)	4.7	4.0	1.4
Average shrimp gross income per season per panga (thousand US$)	9.6	8.9	10.3
Labor costs per season per panga (thousand US$)	2.3	2.1	2.5
Other expenditures per season per panga (thousand US$)	4.6	4.6	4.6
Net income per panga per season, (thousand US$)	2.7	2.2	3.2
Total value of profits obtained by the legal fishing activity per season (thousands US$)	873	534	201
Estimated total profits obtained by pangas illegally fishing shrimp per season (early 2000s) (thousand US$)	462	439	227
Sum of net profits from legal and illegal shrimp fishing per season in the area (thousand US$)	1,335	973	428

The net income from fisheries is estimated as the gross income minus the operational costs. We consider the fixed costs (gasoline, nets, ice, depreciation, etc.) and labor separately and estimate these as annual costs for each panga. The gross income per panga is estimated as the gross income for the fishery in each community divided by the total number of pangas (legal and illegal) fishing there. For the shrimp fishery, we estimate the fixed costs to be US$4,600 per year per panga for all areas and estimate the labor costs as the wages that would be paid to two fishers (US$1.50/kg shrimp caught) if they were hired from the community (although, in fact, the fishers are often the permit holder and a family member). For the finfish fishery, we estimate fixed costs to be 72 percent of the gross income (higher than for the shrimp fishery) and the labor costs to be 12 percent of the beach-landing value of the catch (equal to the shrimp fishery). The annual profits per panga in the shrimp fishery range from US$2,200 to $3,200 in the three communities (table 15.2), and the annual profits per panga in the finfish fishery range from US$226 to $1,935 (table 15.3). Although all of these values are sensitive to uncertainties in estimates of the number of pangas and of the operational costs, they provide a good first approximation for estimating the opportunity cost of not fishing.

Our estimates of the value of a permit are based on the assumption that the labor market works smoothly in the region, and that a family that provided all its labor for the panga could easily find work outside the fishery at the same implicit wage. If the fishers use family labor to work the pangas, then their opportunity cost would increase by an amount equal to any difference between the wage the fishers could obtain in other economic activity and their implicit fishers' wage. While local labor markets are thin in Santa Clara and San Felipe, the regional and U.S. labor market provide more opportunities. In that case, the cost of job search and migration costs should be included. We have little information on the set of skills the fishers' families have and thus could not produce an estimate of this difference. Our estimates use the net profits as the lower bound for the fishers' opportunity cost of handing back the permit, while the upper bound would include the labor costs.

The opportunity cost of not fishing for a year can be used directly to estimate the cost of a "rent-out" to temporarily reduce fishing effort and vaquita bycatch. Permit holders should be willing to accept a payment of this amount to forgo fishing for one year. The cost of a permanent "buyout" of a permit would be equal to the expected net profits in perpetuity given the discounted value of future catches. If catches were constant and the discount rate was 10 percent per annum, the value of a permit would be approximately 11 times the annual net profits. For shrimp permits, this would be US$29,700, $24,200, and $35,200 for San Felipe, Santa Clara, and Puerto Peñasco, respectively (table 15.2). The

TABLE 15.3 Estimates of fisheries landings for finfish and their economic value in three communities of the northern Gulf of California

	San Felipe, Baja California	Santa Clara, Sonora	Puerto Peñasco, Sonora
Total finfish landings per year (metric tons)	1,469	3,946	168
Average finfish landings per year per panga (metric tons)	2.8	7.0	0.6
Regional total Gross Income per year from finfish captured by all pangas (million US$)	1.6	3.9	0.2
Average finfish gross income per year per panga (thousand US$)	3.0	6.9	0.8
Estimated labor costs per season per panga (thousand US$)	0.7	1.7	0.2
Other estimated expenditures per season per panga (thousand US$)	1.5	3.3	0.4
Net income per panga per season (US$)	857	1,935	226
Total value of profits obtained by the legal fishing activity per season (thousand US$)	297	702	52
Estimated total profits obtained by pangas illegally fishing finfish per season (early 2000s) (thousand US$)	146	387	16
Sum of net profits from legal and illegal finfish fishing per sason in the area (thousand US$)	442	1,089	68

value of a finfish permit varies more widely from US$2,400 in Peñasco to $21,300 in Santa Clara.

Although these preliminary estimates of economic value are useful for decision making at early stages of designing a buyout program, the estimates can be improved through the use of a contingent valuation study or through a revealed preference approach, observing results of the informal sales/rents of permits among fishers or observing the larger scale responses once the first stages of the buyout program begin.

15.2.4. The Vaquita Recovery Plan

In 2007, the Mexican Federal Government began implementing a plan to save the vaquita (Programa de Acción para la Conservación de Especies 2008). That plan includes four key components:

1. Both the federal fisheries and environmental enforcement agencies (CONAPESCA and PROFEPA) have committed additional resources for the enforcement of current regulations to eliminate fishing without a permit. Reducing the number of illegal fishers and closing access to the fishery are the most cost-effective conservation measures to protect vaquita. However, this will be difficult to implement for political and logistical reasons. Illegal fishing has been historically tolerated in Mexico, particularly by poor, artisanal fishers using small boats. Political opposition is likely if poor families are economically hurt by this enforcement. Also, enforcing regulations on dispersed, small-scale fishing operations requires many enforcement officers and is expensive. In both 2007 and 2008, US$1 million was appropriated for increased fisheries enforcement in the northern gulf.
2. The National Institute of Fisheries (INAPESCA) is instituting a program to test new fishing methods that can be used from pangas without a risk of catching vaquitas. Trials with *suripera* nets were begun in 2007. These nets have been used successfully to catch shrimp in narrow canals along the Pacific coast of Sinaloa. They typically have very low bycatch rates and, because of their small exposed surface, would be extremely unlikely to catch vaquitas.
3. SEMARNAT is instituting a voluntary program to compensate fishermen who choose to give up their gillnet permits. This compensation would take the form of a buyout for fishers who are willing to stop fishing or a "switch-out" for fishermen who are willing to switch to alternative, vaquita-safe fishing methods.

Several options were considered for setting the price for permit buyouts (Curtis and Squires 2007): bilateral bargain between the government and fishing associations, an inverse auction where fishers would submit sealed bids with the price they would be willing to accept and the lowest prices would be accepted, and a government-set, fixed-price offer to buy. SEMARNAT chose the offer-to-buy approach, with offers slightly higher than the combined value of permits for shrimp and finfish for a total buyout (US$50,000) and less for a switch-out (US$27,300). In 2008, US$17 million was appropriated for permit buyouts and switch-outs, which retired the gillnet permits for approximately one-third of the legal fishers.

4. All gillnet and trawl fishing would be banned in the Vaquita refuge. Rigorous enforcement of this ban by PROFEPA began at the start of the shrimp season in September 2008.

Currently, the government of Mexico is investing unprecedented resources to eliminate gillnetting and protect the vaquitas in the upper Gulf of California. The core area where vaquitas are most abundant is being protected. Despite this, illegal fishing continues, and two-thirds of the legal fishing effort continues within areas where vaquita are known to occur. A similar level of effort and resources will be needed in future years to ensure that the plan is fully implemented. The social and economic problems associated with the ban on illegal fishing still need to be addressed. Although the work is not finished, a way forward has been found.

15.3. CONCLUSIONS

The vaquita can be saved. The primary risk factor (fishery bycatch) has been identified, and secondary risk factors should not prevent recovery if bycatch can be eliminated. However, CIRVA has determined that the population is so low now that only a complete elimination of bycatch is likely to provide a reasonable level of assurance that the population will recover. This will require the complete elimination of entangling nets within the range of the species. The government of Mexico is currently implementing a plan to accomplish this with a combination of fishing permit buyouts, conversions to alternative fishing methods, and at-sea enforcement. Mexico is looking to partner with other countries and with nongovernmental conservation groups to accomplish this daunting task. If they are successful, this will be the first time that any country will have eliminated bycatch to bring a species back from the brink of extinction while dealing with the social and economic well-being of their fishermen. If they fail, the whole world will feel the loss.

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