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Social and Economic Consequences of Conservation of Endangered Vaquita, *Phocoena sinus*, in Gulf of California, México

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Abstract

The conservation of ecosystems and marine species are a latent concern of the Mexican government. Since the creation of the Upper Gulf of California Biosphere Reserve in 1993, it has been a priority to protect endangered species and their habitats. The restricted habitat and strong catch by gill nets used in fishing activities has placed these species within the protected status and risk of extinction. After many years of biological and social studies, we can affirm that the intensive fishing activities using entangling nets during 8 months yearly have caused severe mortality on vulnerable species. Unfortunately, a considerable local market for fish and shrimp encourages fishing and there are no real economical alternatives for more than 4000 fishers. The Mexican people (government, fishers, and society) have to find a solution to the demise of endangered species, given the very limited possibilities of past actions of the authorities. Without a doubt, the effect of conservation schemes would be negative for society and its economy; the wrong decisions taken by the government and the impact of human activities could lead to the extinction of species.

Keywords: Conservation, endangered species, fisheries, socioeconomic analysis, Upper Gulf of California, Mexico.

Introduction

According to Jaramillo-Legorreta *et al*. (2007), 150 individuals of vaquita *Phocoena sinus* (Norris and McFarland, 1958) remain in the Upper Gulf of California. The authors raised a warning that

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the vaquita is the most endangered cetacean after the likely recent extinction of the baiji (*Lipotes vexillifer*) in China (Turvey *et al.*, 2007). They also declared not much time is available to find a solution to the bycatch problem, concluding that funds to establish a total fishing moratorium on all entangling nets is the only solution to reduce fishing related mortality to zero. This conclusion does not consider the social and economic costs to the fishers living within this Marine Protected Area. This oversight is a common issue addressed by Clausen and York (2008), concluding that social analyses must be included in overall conservation-research strategies. Under the local harsh climate along this coast, the most important economic activity is fishery although tourism is growing in importance. Transforming fishers into tourism service workers is still far away.

The rare vaquita, accidentally caught in all kinds of gillnets used in the Upper Gulf of California (D'Agrosa *et al.*, 2000) is endemic to this region and has the most restricted distribution of all marine mammals worldwide. This species is at risk of extinction because of its very small population size and reduced habitat (Jaramillo-Legorreta *et al.*, 2007).

The Mexican Federal Government has undertaken environmental and economic actions to protect the vaquita that started by declaring the Upper Gulf of California and the Colorado River Delta in the Mexican territory (Figure 1) a Biosphere Reserve (BR) in June 1993. The BR is supported with a management program designed to promote sustainable conservation activities to use and enjoy the biodiversity of the area (Rojas-Bracho *et al.*, 2006). The most recent measure to protect vaquita and its habitat was the declaration of a Vaquita Protection Area (refuge) in December 2005 to limit further fishing activities (DOF, 2005).

Economic action was taken in January 2008 when 65 fishery permits were withdrawn through a buyout program of the Mexican Ministry of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT) followed by the announcement of the Ministry of the Environment, Natural Resources and Fishing on 7 March 2008 of another 100 million Mexican pesos to continue the buyout program.

Material and methods

Management of the reserve and the refuge implies a series of actions to achieve protection of critical species and well-being of the communities within the reserve. From 2007 to 2010, a series of studies were conducted by the author through a grant by CONACYT (projects 48445;

172787) in the Upper Gulf of California to implement a scheme for compensation that would aid to reduce artisanal fishing with gillnets in the vaquita refuge, the buyout program mentioned above. A total of 2,554 official landing reports (CONAPESCA-SAGARPA, local offices), spanning from January 1996 to December 2010 were collected in the ports of San Felipe, El Golfo de Santa Clara, and Puerto Peñasco. Further information was gathered from a closed survey based on direct interviews of 146 artisanal fishers in those three ports. Questionnaires were designed to compute the direct cost structure of fishing operations, as well as fishing sites (see details of questionnaires in Rodríguez-Quiroz, 2008).

Artisanal catch by species was processed and spatially represented in a geographic information system (GIS) to identify fishing sites within the Refuge (Fig. 1) where the vaquita refuge area overlapped with the fishing sites using ArcView 3.2 and a 2002 Conical Lambert projection.

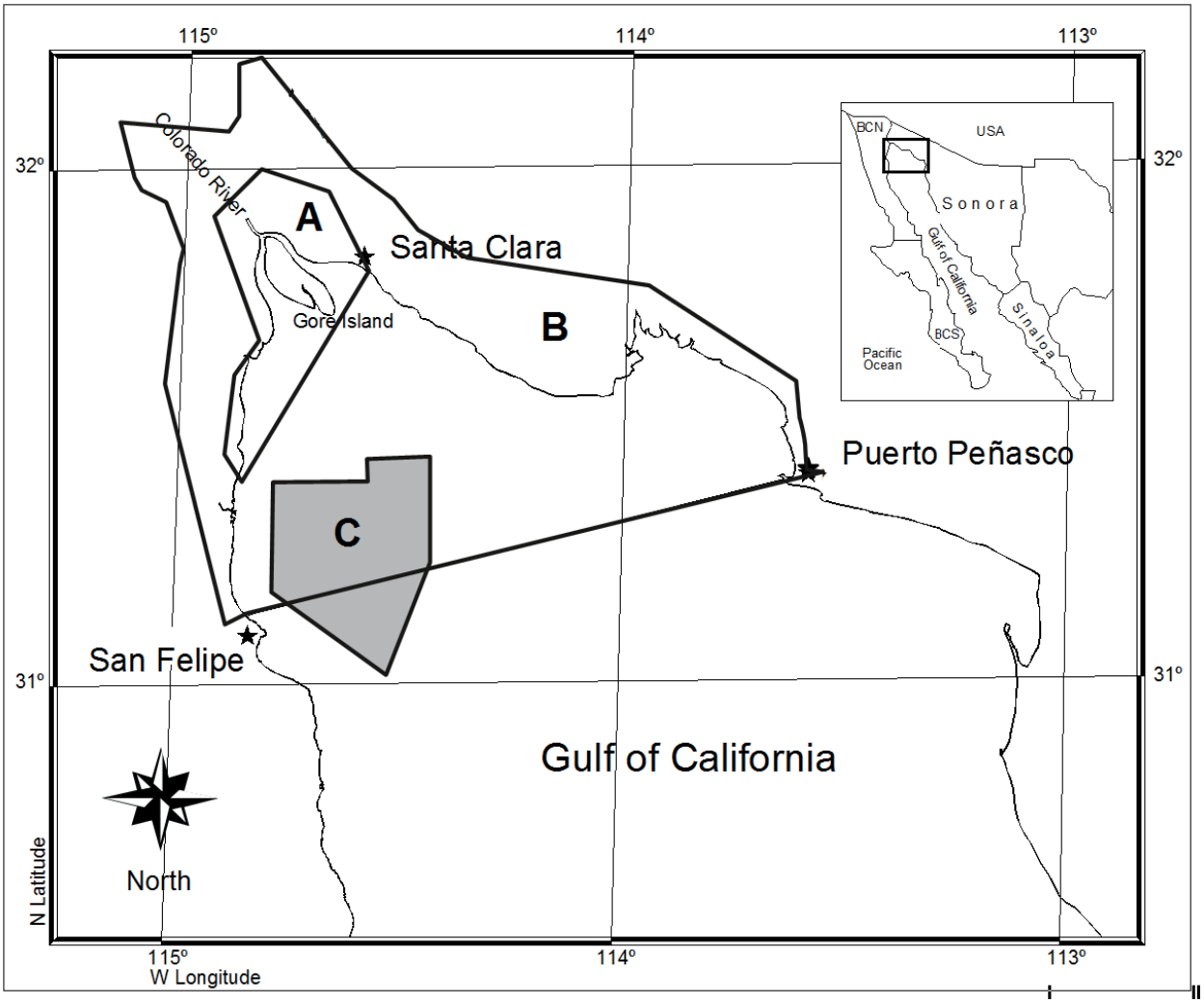

Figure 1. Location of the Biosphere Reserve of the Upper Gulf of California and Colorado Delta River and the Vaquita Protection Area. (A) Core zone, (B) Buffer zone, (C) Vaquita Protection Area.

Results and discussion

In the study, we interviewed ~10% of the fishers in the three fishing communities in this area. The most important results of these studies came from their responses where 60% in San Felipe and 40% in Santa Clara stated they would not stop fishing because it was the only activity they have felt comfortable doing and have done for years (Table I). It was the main explanation why only 65 permits were withdrawn in the buyout program where more than 2000 small boat fishers make their living (Table II).

Table I. Response of fishers in the Upper Gulf of California to the question: "If the most important fishery to you was closed, what would you ask of the government?"

Option if fisheries close	Puerto Peñasco	Golfo de Santa Clara	San Felipe
Economic compensation	7	27	7
Permit for another fishery	39	33	29
Payment of cost of permit	4	15	2
Nothing	11	7	10
Continue fishing anyway	21	8	27
Other	18	2	4
Employment creation	-	7	8
No answer	-	2	13

Our survey data and the GIS analysis showed that 62% of the captures of the six major fisheries were conducted within the Vaquita Refuge and the Biosphere Reserve. Artisanal catch in the Refuge varied depending on the species; 84% of shrimp capture, 83% of bigeye croaker, 80% of Spanish mackerel, 71% of Gulf corvina, and 53% of sharks and rays were captured in both marine protected areas (Reserve and Vaquita Refuge; Fig. 2). Seventy-seven percent of the surface of both marine protected areas was used for fishing by the three communities in the Upper Gulf of California.

Another economic issue has been the fishers' income. Shrimp is the most economically important fishery followed by Gulf corvina. These two resources provide employment from September to April. Income for ~71% of the fishers ranges from 1500 to 3000 Mexican pesos per week (~US$150–300) during the fishing season, and 87% mentioned they receive <1000 Mexican pesos per week (~US$100) in other activities when the shrimp and Gulf corvina season end (Fig. 3).

In April 2008, Ani Youatt of the Natural Resource Defense Council, a non-governmental organization from the United States, declared the intention of establishing an embargo on Mexican shrimp to force protection of the vaquita. Stopping shrimp fishing is almost impossible because the Mexican market for shrimp is very important. In 2006, Mexico produced 100,000 MT of shrimp and imported 20,000 MT for local consumption. The irony is simple. Mexican shrimp for export to the United States is caught by industrial fishing trawlers. The shrimp caught by small-scale shrimp fishers using entangling nets is almost entirely for consumers in the domestic market. Thus, the shrimp embargo would affect a different target than the one where vaquita live.

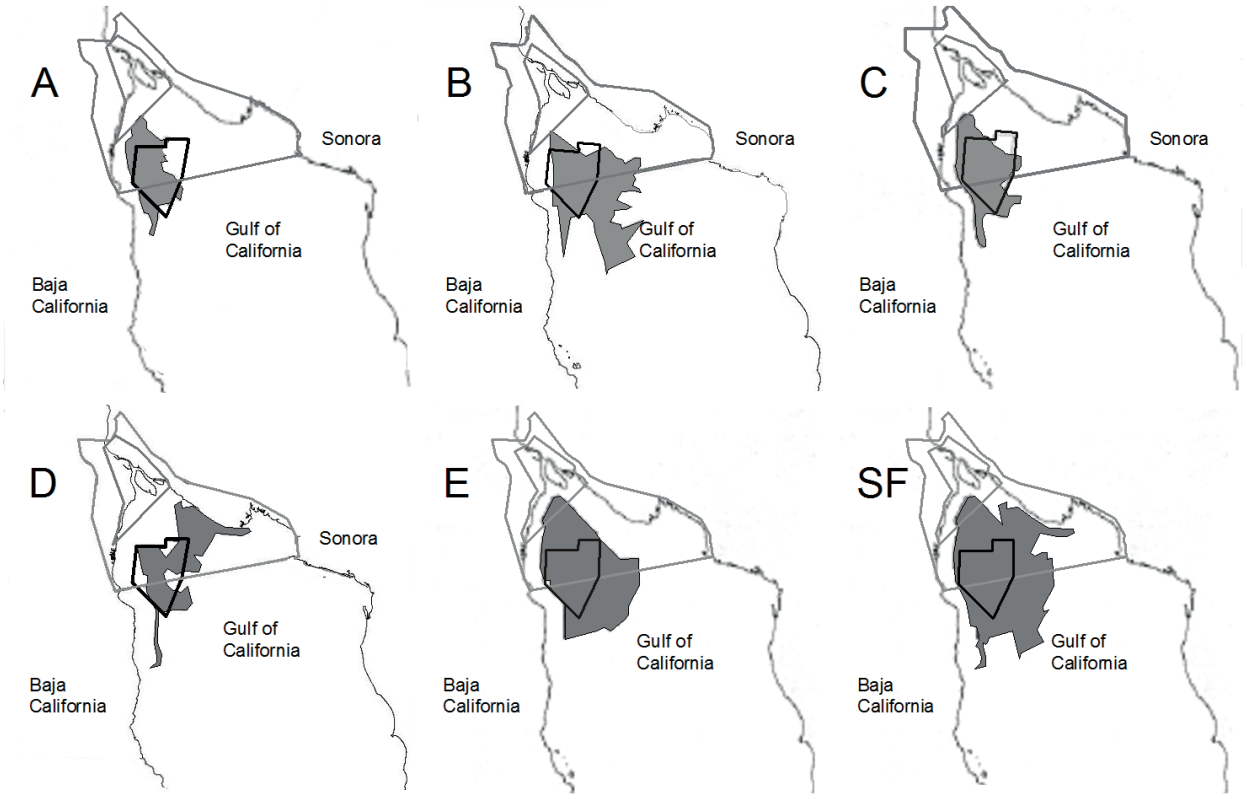

Figure 2. San Felipe fishers capture area by species in the Upper Gulf of California. (A) bigeye croacker, (B) sharks and rays, (C) shrimp, (D) Spanish mackerel, (E) Gulf corvina, (SF) Combined fisheries

Another very important fishery is Gulf corvina, except in 1993–1994 when chano was more important than Gulf corvina (D'Agrosa *et al.*, 2000). Since 1996, Gulf corvina catch has been over 2000 T per year. About 98% of interviewed fishers participated in the Gulf corvina fishery. Discouraging Gulf corvina fishing is another sensitive issue because it is almost entirely consumed

in local markets, such as Mexico City and Guadalajara. Besides, the open Gulf corvina season is coupled with the peak fish-consuming season in Mexico (40 days before Easter Sunday).

Table II. Authorized artisanal scale fishing vessels (pangas) by group of species in the three fishing ports in the Upper Gulf of California

Species	Puerto Peñasco	El Golfo de Santa Clara	San Felipe
Clams	39	12	15
Jumbo squid	4		
Shrimp	56	232	318
Snails	42		1
Fishes (*)	175	412	295
Swimming crab	229	39	11
Mullet	8	76	10
Octopus	40		2
Sharks	69	26	10
Total	662	797	662

Source: Government offices in the communities of the Upper Gulf of California.*Gulf corvina, bigeye croacker, Spanish mackerel, rays.

In previous studies dealing with vaquita conservation issues (D'Agrosa *et al.*, 2000; Jaramillo-Legorreta *et al.*, 2007), the steps taken to protect the vaquita have been described. However, we need to admit that it is another case of failure in conservation planning, as addressed by Redford and Taber (2000) and later rethought by Knight (2006). What was the real failure in vaquita conservation in the Upper Gulf of California? As mentioned above, the social and economic aspects of fisheries were never considered. Even D'Agrosa *et al.* (2000) and Jaramillo-Legorreta *et al.* (2007) mentioned the need to develop an economically feasible alternative source of income, but these measures have not been explored. Even now, after years of the buyout program, no one expected the low success of the program (only 65 permits withdrawn). Another example of the failure of the buyout program is the experience of fishers who go into tourism activity. With the money they got from selling their permit, they built resort cabins, but few clients have been using these cabins (pers. observation, 22 April 2008, meeting in Santa Clara, Sonora between Mexican authorities and fishers who sold their fishing permits).

Conclusions

In summary, 8 months of very intensive fishing activities using entangling nets incidentally kill vaquita. No real economic alternatives have been explored for more than 4000 fishers (2 men per

boat, 2000 boats). Furthermore, there is a considerable national market for fish and shrimp. The authorities have to find a solution to the demise of the remaining vaquitas, a very slim possibility given the past actions of the authorities. Two suggestions for reducing the economic impact on vaquita conservation could be: (a) Switched fishing gears should be subsidized in conjunction with a high product value (an ecological overprice) for using such nets in order to persuade fishermen to change; (b) Job alternatives should be supported by financial fishing insurance to prevent a massive return of fishermen to the activity in cases where the buy-out program fails in the short term. Many observers believe that the vaquita will be the second cetacean species driven to extinction by humans.

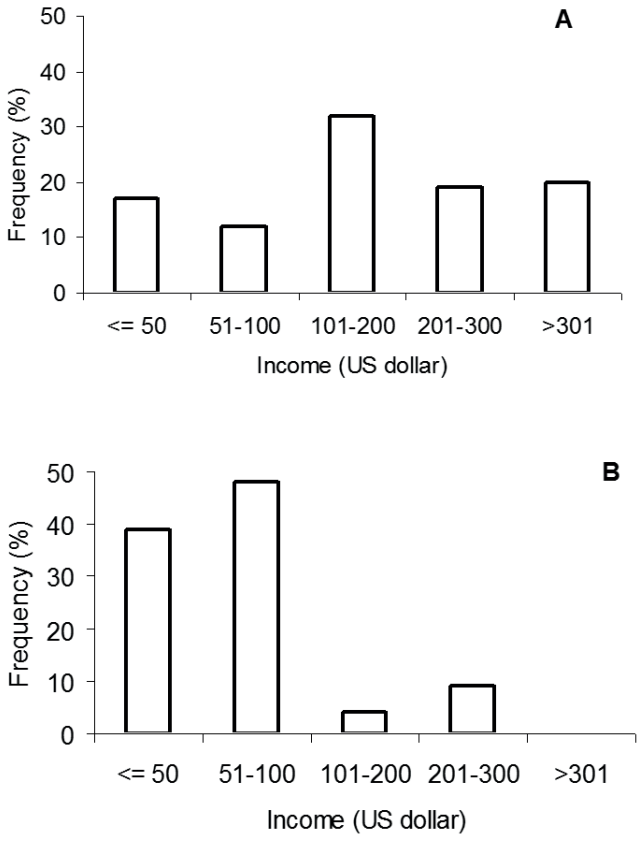

Figure 3. Weekly income of fishers in the Upper Gulf of California. (A) In fisheries duties, (B) In activities different to fisheries.

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