

Seventh Meeting of the Comité Internacional para la Recuperación de la Vaquita Caracol Museo de Ciencias y Acuario

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EXECUTIVE SUMMARY

The seventh meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA-7) was held in Ensenada, BC, Mexico, May 10-13, 2016. The meeting occurred at the midway point of the emergency two-year ban on gillnets throughout the entire range of the vaquita and six months after completion of the 2015 abundance survey.

EXTINCTION IS IMMINENT

CIRVA reviewed the 2015 population survey results, which showed that only about 60 vaquitas remained at the beginning of the emergency 2-year partial gillnet ban. CIRVA also heard reports from the Mexican Navy and the Sea Shepherd Conservation Society of extensive illegal gillnet activity and noted that at least three vaquitas are known to have died in fishing gear in March 2016. CIRVA therefore recommends that the Government of Mexico immediately implement and enforce a permanent ban on all gillnets throughout the entire range of the vaquita and seriously consider the closure of all fishing there if evidence of illegal activities continues. The choice is simple and stark: either gillnetting in the upper Gulf ends, or the vaquita becomes extinct within a very short time.

Results of the Acoustic Monitoring Program indicate that the vaquita population experienced an average annual decline of 34% (95% CI 21 to 48%) from 2011 to 2015, prior to the emergency gillnet ban which began in May 2015. It is certain (a 100% chance) that the population decreased during this time interval and almost certain (a 98% chance) that it decreased at an annual rate of more than 20%. Overall, the model results indicate that the population decreased by 80% (95% CI 62% - 93%) between 2011 and 2015. CIRVA recommends continuation of this work to allow annual estimation of population trend.

About 60 vaquitas remained at the beginning of the gillnet ban according to Expedición Internacional Vaquita Marina 2015, conducted from 28 September to 3 December 2015 and covering the entire known range of the vaquita. The estimated total abundance of vaquitas in 2015, based on the combined results of the visual line transect survey and static passive acoustic

monitoring, was 59 (95% CRI 22 – 145). Previous estimates of abundance were 567 (95% CI 177 - 1,073) in 1997 and 245 (95% CI 68-884) in 2008.

A PERMANENT GILLNET BAN IS REQUIRED

The gillnet ban appeared to be largely effective during October and November 2015, the typical shrimp season, with the waters virtually empty of pangas. However, in March 2016, during the curvina (*Cynoscion othonopterus*) season, three vaquitas were found dead from gillnet entanglement and extensive evidence of illegal fishing for totoaba (*Totoaba macdonaldi*) was obtained during the months from December-May, clearly demonstrating the inadequacy of the enforcement effort and that illegal fishing has continued to undermine the vaquita conservation effort (CIRVA emphasizes that there is no reason to believe any vaquitas died in the curvina fishery). CIRVA remains extremely concerned that illegal activities could be disguised by any form of fishing that involves pangas. This concern will remain as long as laws and enforcement are too weak to deter or prevent illegal fishing. CIRVA therefore recommends that the Government of Mexico immediately implement and enforce a permanent ban on all gillnets throughout the entire range of the vaquita and seriously consider the closure of all fishing there if evidence of illegal activities continues to come to light. At this juncture, the choice is simple and stark: either gillnetting in the Upper Gulf ends, or the vaquita becomes extinct within a very short time.

ENFORCEMENT MUST CONTINUE AND BE STRENGTHENED AND ILLEGAL TOTOABA GILLNETS REMOVED

The head of SEMARNAT, Secretary Rafael Pacchiano Alamán, emphasized to CIRVA-7 the need to strengthen protective measures for the vaquita. He encouraged local communities to assist with the detection of illegal fishing activity in the Upper Gulf. Federal authorities are working together in the Integrated Strategy for the Recovery of the Vaquita, set in place by the President of Mexico, to counter illegal fishing for totoaba and to combat illegal trafficking of totoaba products.

The Mexican Navy (SEMAR) and the Sea Shepherd Conservation Society reported on their joint monitoring efforts. In cooperation with the Navy and PROFEPA, Sea Shepherd gathered extensive evidence of totoaba poaching and, between January and May, retrieved 42 illegal gillnets and 16 illegal longlines. The team encountered nets that had been set for very long periods, as well as freshly set nets in recently patrolled areas. Even as the illegal totoaba fishery winds down in early summer 2016, abandoned nets pose an active risk to vaquitas throughout their range. CIRVA applauds the collaboration among the SEMAR, PROFEPA, and Sea Shepherd and recommends that such collaboration be continued and strengthened in the 2016-2017 season. CIRVA further recommends that efforts to remove gillnets from throughout the vaquita's range be intensified as a matter of utmost urgency.

USE AND DEVELOPMENT OF ALTERNATIVE FISHING GEAR MUST BE PURSUED WITH ATTENTION TO MARKETS

CIRVA reviewed the results and recommendations of a Workshop on Fishing Technologies for the Upper Gulf of California held in April 2016 in Mérida, México. CIRVA reiterates that there is no reason for the Government of Mexico to delay the issuance of commercial permits to fish

for shrimp with the “Selective net RS-INP-MX” trawl, which has received adequate testing. CIRVA stresses the need for continued investment of time and resources by all sectors in alternative fishing technology development. CIRVA believes that there must be an unequivocal, high-level commitment from the Mexican Government to ensure that lead agencies (INAPESCA, CONAPESCA, and SEMARNAT) are diligent in carrying out full implementation of the protocols described in the Mérida Workshop report. CIRVA noted that the burden on enforcement could increase considerably if many pangas are allowed access to the gillnet-free area. Therefore, a caveat to any recommendation concerning alternative gear development or testing is that it should be implemented as stated only if all experimental fishing operations are closely and effectively monitored.

CIRVA recommends that every effort be made to develop gillnet-free fisheries in the Upper Gulf and to strengthen linkages between the fishermen using alternative gears and the seafood supply chain – this is a critical step toward incentivizing the conversion to gillnet-free operations.

EX SITU CONSERVATION MUST BE CONSIDERED

Given the continued decline of the vaquita population, CIRVA considered the question of ex situ approaches to vaquita conservation. While recognizing the risks and complexities of such an approach, CIRVA concluded that fieldwork to determine the feasibility of ex situ conservation actions for the vaquita is warranted. However, CIRVA stresses that such ex situ work only makes sense if the gillnet ban is extended indefinitely and does not divert funding and efforts away from extension and enforcement of the gillnet ban, which remains the highest-priority conservation action for the vaquita. Any ex situ action will involve some risk to individual animals and the vaquita may not prove to be suitable for ex situ conservation actions. Fieldwork will proceed in a staged manner, with review by CIRVA at appropriate intervals and the option to cease work after each review. CIRVA agreed unanimously that capture of all remaining vaquitas is not a viable conservation strategy for vaquitas, which must, first and foremost, be protected in their wild habitat.

Finally, CIRVA recommends that: (1) a Presidential advisory body be formed to address vaquita conservation in a broader context, including the development of viable socio-economic alternatives for Upper Gulf communities; and (2) the Governments of Mexico and the United States co-host an Economic Summit to stimulate the development of alternative livelihoods, such as aquaculture, sport fishing, tourism, and wind and solar energy, in the Upper Gulf.

1. INTRODUCTION

The seventh meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA) was held at the Caracol Museo de Ciencias y Acuario, Ensenada, BC May 10-13, 2016. CIRVA members in attendance included: Lorenzo Rojas-Bracho (chair), Armando Jaramillo-Legorreta, Barbara Taylor, Jay Barlow, Tim Gerrodette, Peter Thomas, Andrew Read, Robert Brownell, Greg Donovan, Frances Gulland, Sarah Mesnick, and Randall Reeves. The committee’s work was supported by a number of invited experts who provided presentations and contributed to plenary discussions. Rojas-Bracho chaired the meeting and Read, Thomas, Donovan and Reeves acted as rapporteurs. Meeting participants are listed in Annex 1. The agenda is given as Annex 2.

2. VAQUITA TRENDS AND ABUNDANCE

2.1 Estimate of Vaquita Trends from 2011-2015

Armando Jaramillo summarized the origins of the Acoustic Monitoring Program, which began during the 2008 vaquita survey with a field test to evaluate the suitability of three types of autonomous acoustic detector (A-Tag, T-POD and C-POD) to detect vaquitas. The results of this test indicated that of these, the C-POD provided the best performance, detecting vaquita-like sounds at the greatest distance (approximately 200 m) and with the battery life necessary to obtain the data required to meet program objectives. C-PODs store temporal sequences of the ultrasonic clicks produced by vaquitas, which are subsequently processed and identified by signal-classifying software. In analysis, all initial identifications of click trains likely produced by vaquitas are visually inspected and validated by experienced observers.

The Acoustic Monitoring Program currently in place was designed at a workshop held in Ensenada, Mexico in 2009 (Rojas-Bracho et al. 2010). A review of models incorporating variances of acoustic detections and vaquita demography indicated that a sample size of 5,000 days per year would be required to achieve the precision needed to detect a population growth rate of 4% or a rate of decline of 5% over a five-year period. To meet this objective, a sampling grid of 48 monitoring sites was implemented in the Vaquita Refuge, where C-PODs are relatively secure from loss in fishing gear. Sampling occurred at the 48 sites between June and September, inclusive, each year from 2011 to 2015.

Equipment failures and the loss of some C-POD units in each year of the program, have led to an unequal number of monitoring days per year. In response, an Expert Panel was established to provide advice regarding the statistical analysis of this data set. The Panel concluded that clicks per day was the most appropriate metric to use in the analysis and recommended two modeling approaches: a geospatial model with spatial autocorrelation components, and a post-stratification mixture model. Both models were implemented in a Bayesian framework. Full details of the modeling approaches are described in Jaramillo-Legorreta *et al.* (in press).

The outputs of both models were similar and were averaged, with equal weight given to both approaches. The model-averaged estimates of annual rates of population change indicate that the vaquita population experienced an average annual decline of 34% (95% CI 21 to 48%) from 2011 to 2015. It is certain (a 100% chance) that the population decreased during this interval and almost certain (a 98% chance) that it decreased at an annual rate of more than 20%. Overall, the model results indicate that the population decreased by 80% (95% CI 62% - 93%) between 2011 and 2015.

There are several important assumptions in this analysis, including: (1) acoustic detections are proportional to abundance; (2) the acoustic behavior of vaquitas did not change over the monitoring period; and (3) the proportion of vaquitas present inside the refuge did not change over the monitoring period. Results from the 2015 combined visual and acoustic survey (described below, see Figure 2), which immediately followed the 2015 acoustic monitoring summer season, showed there was no major shift in vaquitas to areas outside the acoustic monitoring area, which is inside the Refuge, that would account for the large decline in acoustic detections inside the refuge.

2.2 Results of the 2015 Vaquita Survey

Barb Taylor presented the results of the 2015 vaquita survey, Expedición Internacional Vaquita Marina 2015, which was intended to document the abundance of the vaquita at the beginning of the gillnet ban and to support current and future management decisions. The primary objective of the survey was to obtain a robust estimate of vaquita abundance in 2015 using combined visual line transect survey and static passive acoustic monitoring methods.

The survey was conducted from 28 September to 3 December 2015, and covered the entire known range of the vaquita (Figure 1). The survey design was peer-reviewed by a panel of Mexican and international experts, and their comments were discussed in a teleconference chaired by Greg Donovan (IWC SC66b, in Preparation) and incorporated to improve the survey design. The combined visual and acoustic survey design involved use of several overlapping spatial strata. In waters between 20 and 50m deep, the same ship and visual line-transect survey methods were used as had been employed in the two previous vaquita surveys conducted in 1997 and 2008 (Jaramillo-Legorreta *et al.* 1999, Gerrodette *et al.* 2011); in fact, many of the same observers participated in all three surveys. Within the area of the visual survey, two depth strata were defined, with greater visual survey effort inside the core stratum (Figure 1). The area between 10 and 20m deep was defined as the shallow stratum, in which vaquitas were sampled acoustically using an array of C-PODs. To provide a comparative means of converting acoustic detections to abundance data, an array of acoustic detectors was also deployed in a portion of the core stratum designated as the “calibration area.” For abundance estimation, the visual survey data used were restricted to excellent sighting conditions, with Beaufort Sea States of 0-2 and a swell of less than 0.6 m. Full details of the survey design and analysis are presented in Taylor *et al.* (In Preparation).

Overall, vaquitas were observed less frequently than during previous surveys and no sightings were made outside the core stratum. In contrast, dolphins and baleen whales were seen throughout the survey area. Based on the observed distribution of sightings, it appears that the vaquita range has contracted since 2008.

In the hope of estimating $g(0)$, a measure of the proportion of vaquitas present on the trackline that are detected by observers, two independent sighting teams were deployed at different levels of the survey vessel. Unfortunately there were only two possible matches of sightings between the two independent teams, which was insufficient to allow estimation of $g(0)$. Instead, a mechanistic model, based on animal surfacing and observer scanning behavior, and fit to radial detection distances from all three surveys (1997, 2008, 2015), was used to estimate $g(0)$ under perfect observing conditions (Beaufort = 0, swell height = 0m). This approach indicated that a team of three observers, working in these conditions, would detect 97.5% of vaquitas on the trackline. The decrease in $g(0)$ under other less ideal conditions was estimated from encounter rate data using a method similar to that described by Barlow (2015). Observed group size was similar in 2015 to that in the two previous surveys.

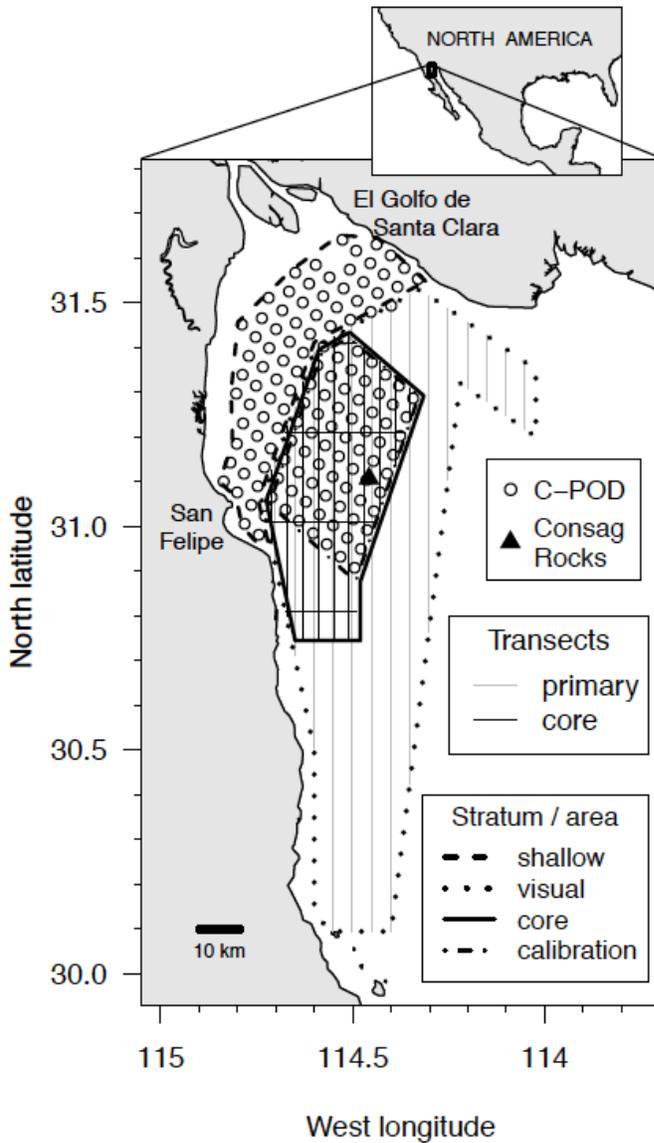


Figure 1. Design of the 2015 vaquita survey. Vaquitas were detected acoustically with C-PODs in the shallow stratum, and visually with a line-transect survey in the deeper visual stratum. Both visual and acoustic sampling were conducted in the calibration area.

Visual sightings and acoustic detections showed similar spatial patterns within the calibration stratum (Figure 2). Vaquitas were also detected acoustically in the shallow water areas near El Golfo de Santa Clara and San Felipe. The abundance of vaquitas in the shallow area was estimated to be 0.28 (SE = 0.02) times the abundance in the calibration area. There was no indication that these results were influenced by spatial variation in acoustic propagation conditions, the acoustic behavior of vaquitas, ambient noise, or C-POD performance.

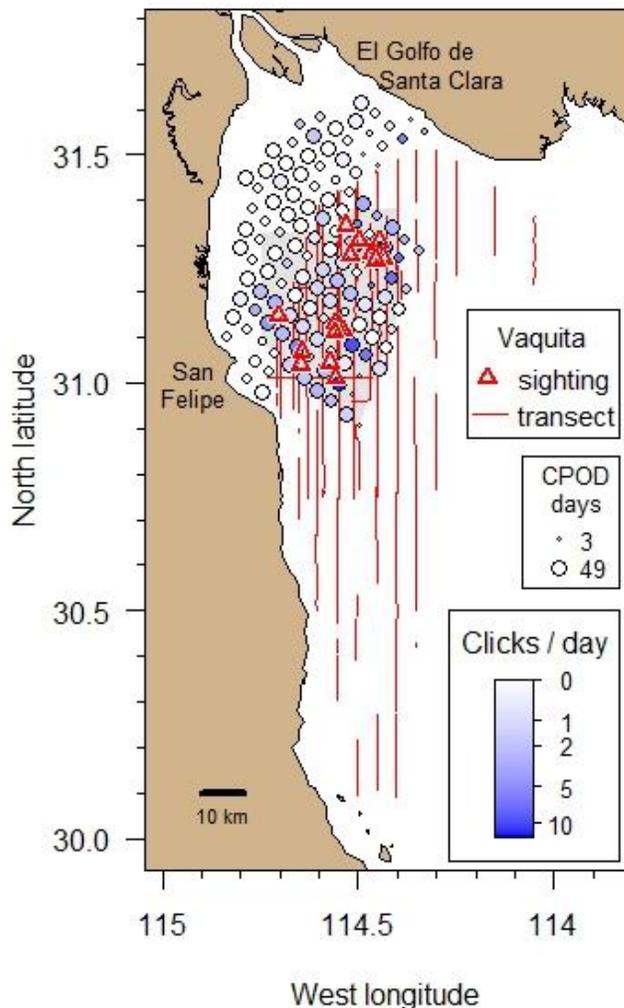


Figure 2. Visual line-transect survey effort (thin red lines) and vaquita sightings (triangles) in 2015 in conditions of Beaufort ≤ 2 and swell height $\leq 0.6\text{m}$. C-POD circle size indicates the number of days of acoustic effort used in the analysis at each location. Shading of the circles reflects the mean observed number of vaquita clicks per day. The gray polygon in the background is the Vaquita Refuge Area.

The total abundance of vaquitas in 2015 was estimated as 59 (95% CRI 22 – 145), including 12 animals in the shallow water stratum. This indicates a continuation of the decline documented from 1997 to 2008, in which vaquita abundance was reduced from 567 animals (95% CI 177 - 1,073) (Jaramillo-Legorreta *et al.* 1999) to 245 animals (95% CI 68-884) (Gerrodette *et al.* 2011), at an average annual rate of 7.6%. The probability that fewer than 50 vaquitas now remain is 36% and the probability that fewer than 100 animals remain is 87% (Figure 3). Population trends are best reflected by changes in numbers within the core stratum, which was covered in all three

surveys. From 1997 to 2015, the abundance of vaquitas in the core stratum decreased by 92% (CRI 80% - 97%).

In 2014, CIRVA-5 reported a projection that abundance in mid-2014 was 97 using the 2008 abundance estimate and the trend estimated by the acoustic monitoring data available at that time (an estimated decline of 18.5%/year). The current estimate of around 60 vaquitas (based on the survey and not a projection) includes the period from summer 2014 to summer 2015, which was the year with the highest rate of decline and was just prior to the gillnet ban. Thus, the available data on both trends and abundance reflect on the catastrophic decline prior to the ban and do not contribute to understanding the effect of the ban. Only continued acoustic monitoring in the summers of 2016 and 2017 will cover periods during the gillnet ban.

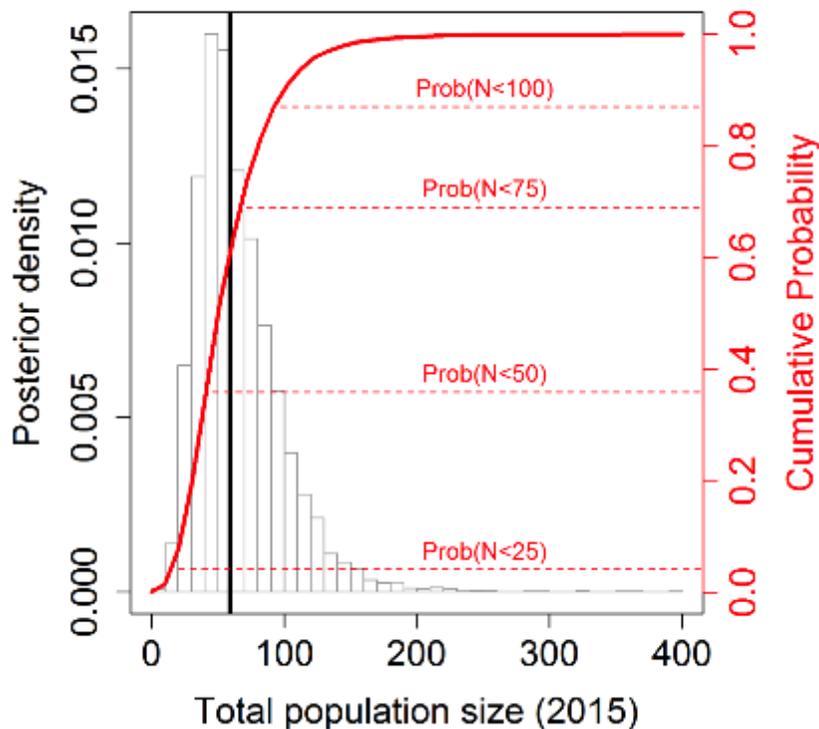


Figure 3. Bayesian posterior distribution for total vaquita abundance in 2015, with vertical dark line indicating posterior median of 59 animals. Cumulative probability distribution (red) indicates the probability that the population size is below any specific level.

Future vaquita abundance was projected using Monte-Carlo simulations under several scenarios, which will be described fully in Taylor et al. (In Preparation). In these deterministic simulations, uncertainty propagated forward included only the abundance estimate and the population growth rate, and did not include uncertainty in other factors, such as management actions and human behavior. Under the most optimistic scenario, in which the population is allowed to grow at its maximum rate of 3.8% (Gerrodette and Rojas-Bracho, 2011), the population will likely recover

to 2008 levels (> 250 vaquitas) in 2050, and to 1997 levels (> 600 vaquitas) in 2075. However, if following the current two-year gillnet ban the by-catch rate were to return to previous levels, the species has a nearly 5% chance by 2019 and a > 50% chance by 2022 of being reduced to 10 animals or fewer (Figure 4). The simple model used for this risk analysis does not account for risks that would likely accelerate the rate of decline, e.g. genetic issues, changes birth and death events, catastrophic events such as red tides. Thus, if the ban is lifted for even a year or two, the chance of extinction is very real. With at least three vaquitas killed in 2016 (see section 6.3) and totoaba gillnets known to be in the water, the vaquita population is still declining at some unknown rate.

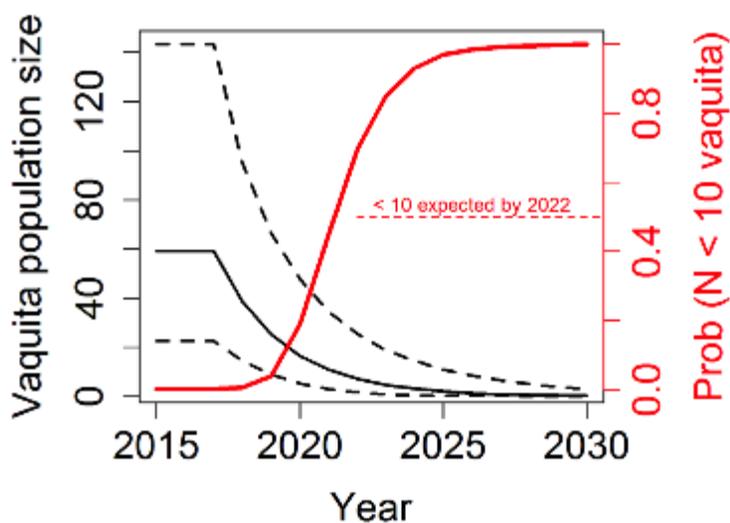


Figure 4. Future projection of the vaquita population, assuming no population change during the current gillnet ban (2015-2017), followed by a return to the 2011-2015 rate of decline. Solid black trend line is the posterior median; black dashed lines indicate 95% CRIs. The red curve depicts the cumulative probability that there are <10 individuals each year.

2.3 Future of the Acoustic Monitoring Program

Gustavo Cárdenas and Armando Jaramillo briefly outlined future plans for the Acoustic Monitoring Program. They proposed continuing to monitor the 48 current sites in June-September each year to provide updated estimates of the trend in population size.

CIRVA members expressed appreciation for the value of this program to the conservation of the vaquita. The approach is a relatively inexpensive means of obtaining data on population trends and has proven instrumental in assessing the state of the species and supporting the need for management action, such as the emergency gill net ban. There is simply no other cost-effective method of obtaining a continuous time series of population trends. In addition, the Program employs fishermen in the Upper Gulf to deploy and retrieve CPODs and, as such, helps to build support for vaquita conservation.

In addition to continuing ongoing monitoring efforts, Jaramillo described a proposal to deploy C-PODs year-round at the 11 sites, mostly in the southwestern portion of the Vaquita Refuge, which have accounted for 90% of past acoustic detections.

CIRVA members were strongly supportive of continuing this program and noted that the results of the 2015 survey validated inferences drawn from the past acoustic monitoring effort. Therefore, CIRVA **recommends** continuation of this work to allow annual estimation of population trend.

Taylor noted that the acoustic monitoring effort may actually need to be increased to maintain precision in trend estimates, because the population has declined so dramatically in absolute size. Thus, CIRVA **recommends** that the Steering Group advising the Acoustic Monitoring Program re-examine the sampling effort required, given the small current size of the population.

Finally, CIRVA **recommends** that adequate multi-year funding be secured to support the Acoustic Monitoring Program in the long term.

CIRVA is deeply concerned that the latest information from the visual and acoustic survey undertaken in 2015 confirms the extensive decline prior to the gillnet ban that was previously indicated by the acoustic monitoring data. The survey revealed a total abundance of about 60 animals for the species in 2015. In 2016, despite the increased efforts of the Government of Mexico and Sea Shepherd Conservation Society to eliminate gillnet mortality, three animals have been found dead, all likely as a result of entanglement in illegal gillnets, and the total mortality since the gillnet ban came into effect is unknown. **The species is racing toward extinction.** The recommendation that all gillnets **must be removed permanently** from the range of the vaquita, made previously by CIRVA and other bodies including the IWC, gains even greater urgency. Even under optimistic scenarios about reproductive and survival rates, a catch of only three animals per year will likely result in a continued decline.

3. ENFORCEMENT

The head of SEMARNAT, Secretary Rafael Pacchiano Alamán, attended the CIRVA meeting on 13 May and emphasized the need to strengthen protective measures for the vaquita. He lamented the discovery of three dead vaquitas and exhorted local communities to rise to this challenge and denounce any illegal activity that occurred in the Upper Gulf.

With respect to enforcement, Secretary Pacchiano said that Federal authorities are convinced that the *Integrated Strategy for the Recovery of the Vaquita* set in place by order of President Enrique Peña Nieto will contribute to the conservation of the species and prevent its extinction. Under the plan all agencies are working in a coordinated manner to counter the illegal fishing for totoaba in the area of the ban as well as to combat illegal trafficking of protected marine species and the presence of organized crime groups associated with these activities.

The Secretary indicated that surveillance operations have been intensified, especially at night, incorporating personnel of PROFEPA, SEMAR, the Federal Police, and CONAPESCA. This allowed a greater number of land and marine patrols during the fishing season for curvina (*Cynoscion othonopterus*), which took place in March and April.

3.1 Report from the Navy (SEMAR)

The Navy (SEMAR) reported that it has begun construction of a new base in San Felipe and stationed a permanent marine patrol and surveillance unit in the upper Gulf which includes a helicopter, Persuader and Maul marine patrol airplanes, six Defender rigid inflatable boats, two jet skis, four interceptors, three small boats, five pick-up trucks, and two Unimog vehicles. In April a system of unmanned aircraft (UAVs) was added to the effort. At the same time SEMAR has commissioned 106 personnel who are in permanent service providing social services in the region.

SEMAR reported the following results after the President's announcement of the Integrated Strategy through 12 May 2016: SEMAR has inspected 3,278 boats, 17,133 persons, 6,699 vehicles, 48 buildings, and 275 ships. It has deployed 1,244 personnel from the Navy, 289 from the Army, and 243 from other services. These personnel have seized or detained 122 small boats, 77 people, 20 vehicles, 79 totoaba specimens, 177 totoaba swim bladders, 600 gillnets or pieces of fishing gear, and four larger vessels. They have inspected more than 120 tons of fish products and more than 17 tons of equipment. They have assisted in the rescue of one humpback whale, four totoaba, and 11 sea turtles. All of the above was accomplished through surveillance at 223 launching areas (bajaderos) and fishing camps, 26 stores and fishing depots, and 298 marine zones as well as with the placement of 45 checkpoints and 91 aerial patrols.

3.2 Report from Sea Shepherd Conservation Society (SSCS)

Oona Layolle of SSCS presented a report on the activities conducted during "Operation Milagro", their campaign in the upper Gulf of California to protect the vaquita, and provided suggested actions to further protect vaquitas. She began by expressing thanks to the Mexican government, and for the opportunity to work in partnership with the Navy, PROFEPA, SEMARNAT and CONANP. She emphasized that the greatest threat to the vaquita is the continuing demand for totoaba swim bladders in China and expressed the view that this lucrative black market drives illegal activity and corruption in Mexico. In this context she suggested that international pressure be placed on China, in the form of a targeted embargo, to help curb this illegal trade.

The SSCS patrols involved two vessels, working in cooperation with the Navy and PROFEPA, and resulted in the gathering of extensive evidence of totoaba poaching. The SSCS used night-vision drones to film poachers hauling nets, and found fishing camps on remote beaches the north of San Felipe. Between November and May, the SSCS retrieved 42 illegal gillnets and 16 illegal longlines and recovered many live and dead marine mammals, sharks, totoaba and birds from these fishing gears. Importantly, SSCS encountered two of three dead vaquitas found in March 2016 (see Item 3.4 below).

Layolle presented a map of the locations where the SSCS encountered and retrieved illegal totoaba gillnets and longlines (Figure 5). These nets had no surface manifestations (floats or other markers). There was an alarming overlap between the distribution of these illegal totoaba nets with known vaquita habitat, including the refuge. The true distribution of illegal totoaba gillnet fishing is unknown, partly because of the limited ability, to date, of SSCS and the Navy to

detect and retrieve nets in deeper waters. Therefore, the map does not reflect a complete picture of the presence of illegal totoaba gillnets and the subsequent risk of entanglement throughout the Upper Gulf.

Layolle also reported that fishermen leave anchored totoaba gillnets in place for long periods, perhaps indefinitely. The Navy and SSCS encountered nets that had been set for very long periods, as well as freshly set nets in areas they had recently patrolled. It is very likely that, even as the illegal totoaba fishery winds down in the early summer season, illegal nets will remain throughout the range of the vaquita and pose an active risk to the remaining population. It also appears that the value of totoaba swim bladders is so high that the cost of abandoning a large gillnet is inconsequential to illegal fishermen and the organizations that support them. CIRVA therefore **recommends** that the effort to remove illegal gillnets be continued and intensified as a matter of the **utmost urgency**.

Layolle indicated that fishermen use legal activities, such as the exempted curvina fishery, as cover to gain access to totoaba fishing grounds. They operate under the guise of curvina fishing, sport fishing or “transiting” from one point to mask their illegal activities. The SSCS noted many pangas leaving at dusk or later, often with no running lights, and returning to port in the early hours of the morning, times when legal fishing is not allowed. They recommend that all pangas should be banned from the water after dark. The three dead vaquitas found in March 2016 were discovered during the curvina season (although it is important to make clear that there is no reason to believe they died from entanglement in the curvina fishery). Necropsies of these vaquitas determined that they had died in gillnets (see Item 3.4 below). Therefore, the SSCS urged cancellation of the curvina gillnet fishery as a necessary and critical measure to protect the vaquita because this fishery may provide cover for illegal fishing for totoaba. For new information on the curvina fishery, see Annex 8.

The SSCS also concluded that, despite the investment of the government of Mexico in the protection of the vaquita, corruption makes it possible for fisherman to poach totoabas at night. Furthermore, in Sea Shepherd’s view, the current laws for punishing poachers, smugglers and those found in possession of totoaba or other protected species are not strong enough with small penalties disproportional to the lucrative nature of the black market for the totoaba. Layolle also reported that the extensive photographic and video evidence they have collected could not be used for prosecution and suggested that measures should be taken to make it possible to admit such evidence into courts of law.

Layolle described the larger impact of illegal totoaba fishing on the biodiversity of the upper Gulf of California and noted that the name of the current Mexican Presidential program is the “estrategia integral para preservar el ecosistema marino del Alto Golfo de California” or “comprehensive strategy to preserve the marine ecosystem of the Upper Gulf of California.” In addition to illegal totoaba fishing within the Biosphere Reserve, Sea Shepherd witnessed many trawlers inside the vaquita refuge. In Sea Shepherd’s view fishing should be banned in the entire biosphere reserve, particularly within the nuclear zone, a measure that would allow species to recover and protect important spawning areas.

Finally, Layolle reported the SSCS view that allowing the gillnet ban to expire after two years would mean that all of the enormous financial investments and efforts in the protection of the vaquita have been in vain. In their view, the comprehensive strategy to preserve the marine ecosystem of the Upper Gulf of California as announced by the President of Mexico, including the gillnet ban that is its centerpiece, needs to be permanent. The full set of SSCS recommendations are in Annex 7.

CIRVA members thanked Layolle for her report and praised the efforts of Sea Shepherd in providing essential third-party monitoring of the vaquita refuge and the implementation of the gillnet ban in 2015 and 2016. CIRVA welcomed the important collaboration between the Mexican Navy, PROFEPA, and the Sea Shepherd vessels and **recommends** that this collaboration be continued and strengthened in the coming 2016-2017 season. CIRVA also **recommends** that the NGO community consider ways to reinforce such third-party monitoring efforts and contribute to the effort to locate and remove gillnets.

3.3 CIRVA consideration of Enforcement

CIRVA was pleased to learn that gillnetting activity appeared to be nearly absent during the vaquita survey (October/November) when the shrimp gillnet fishery would have been underway in the past. However, the observations reported by SSCS in months after the vaquita survey ended (Annex 7) and the recovery in March 2016 of the carcasses of three vaquitas that had died in gillnets signal a decrease in the effectiveness of enforcement, including management of the curvina fishery, in the face of greatly increased illegal activity. This has undermined the vaquita conservation effort. The extent of illegal activities that took place during the one exception to the gillnet ban – where gillnets are deployed actively in a ‘rodeo-style’ fishery for curvina – shows that no exceptions to the gillnet ban can be allowed if there is to be any hope of saving the vaquita. In addition, the clear failure of the enforcement effort to stop illegal activities at night, when totoaba fishing has long been known to occur, means that a different approach is necessary. CIRVA **recommends** that no pangas be allowed on the water at night in the area of the gillnet ban and that the purchase or possession of gillnets on land or at sea be prohibited in all areas adjacent to the gillnet exclusion zone.

CIRVA further **recommends** that Mexico immediately and significantly increase the penalties for killing endangered species and engaging in illegal wildlife trade. The current penalties and enforcement effort have clearly been insufficient to deter or prevent large numbers of fishermen from conducting illegal activities, and this must change if the vaquita is going to be saved.

CIRVA remains **extremely concerned** that illegal activities could be disguised by any form of fishing that involves pangas. This concern will remain as long as laws and enforcement are too weak to deter or prevent illegal fishing. CIRVA therefore **recommends** that the Government of Mexico immediately implement and enforce a *permanent ban* on all gillnets throughout the entire range of the vaquita and seriously consider the closure of all fishing there if evidence of illegal activities continues to come to light. **At this juncture, the choice is simple and stark: either gillnetting in the Upper Gulf ends, or the vaquita becomes extinct within a very short time.**

3.4 Report on Necropsy Findings

Frances Gulland briefly reviewed findings from necropsies conducted on the three vaquita carcasses recovered in March 2016. The first carcass (PS1 – a 126 cm sub-adult male) was found floating March 4 2016 by SSCS. The second carcass (PS2 – a 127 cm sub-adult female) was found stranded 13 km north of San Felipe on March 13 2016. The last carcass (PS3 – a 140 cm adult male) was found floating March 24 by SSCS. The discovery locations of two of these carcasses are depicted in Figure 5. Despite moderate to advanced decomposition (Smithsonian Institution Codes 3-4), all three carcasses exhibited clear evidence of trauma consistent with entanglement in gillnets, including: linear skin abrasions and lacerations; skeletal muscle bruising; hemorrhage; and edema. The fore stomachs of the three animals contained recently ingested fish, reflecting feeding activity just prior to death. All three animals were in good body condition. Tests of intestinal contents were negative for saxitoxin, indicating that harmful algal blooms did not contribute to the deaths of these animals. Gulland noted that these findings were typical of porpoise bycatch and concluded that all three vaquitas had been entangled and killed in gillnets.

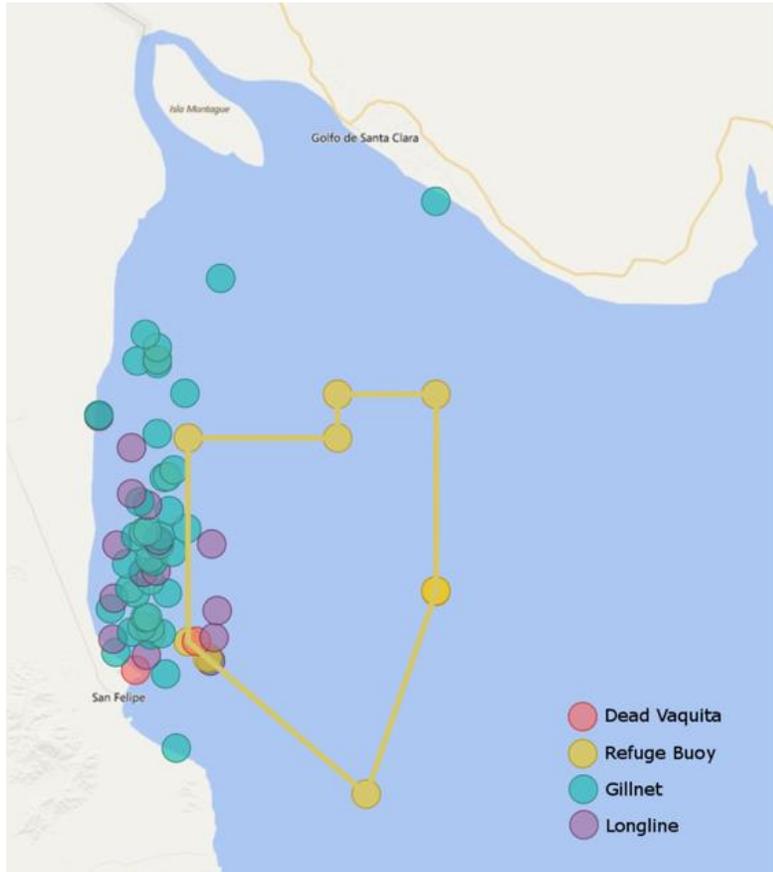


Figure 5. Locations of illegal totoaba gillnets and longlines recovered by the Sea Shepherd Conservation Society (SSCS) in 2015 and 2016. In addition, the location of the two vaquita carcasses recovered in March 2016 is indicated, as is the geographical boundary of the Vaquita Refuge. Figure courtesy of SSCS.

4. ALTERNATIVE FISHING GEAR

4.1 Summary and Recommendations from Workshop on Fishing Technologies for the Upper Gulf of California

Enrique Sanjurjo provided a summary of the report of the Workshop on Fishing Technologies for the Upper Gulf of California held in April 2016 in Mérida, México. He began by reiterating the recommendations in the CIRVA Express report related to alternative fishing gear (available in English at <http://www.iucn-csg.org/wp-content/uploads/2010/03/CIRVA-Express-Meeting-Report-2015-FINAL-14-01-16.pdf>; in Spanish at <http://www.iucn-csg.org/wp-content/uploads/2010/03/CIRVA-Express-Reporte-FINAL-2015-14-01-2016.pdf>). Those recommendations provided the basis for discussions at the workshop, which was organized by INAPESCA and WWF and co-sponsored by the U. S. Marine Mammal Commission, Packard Foundation, and Marisla Foundation. The Workshop took place during the Symposium on Technology Development and Sustainable Fisheries, organized by the International Council for

the Exploration of Seas (ICES) and United Nations Food and Agriculture Organization (FAO) as part of their annual meeting.

The main research topics addressed at the Workshop were: (a) improvements to the existing alternative artisanal shrimp trawl, (b) trawling options for finfish, (c) pots and or traps for finfish, and (d) hooks and lines. In addition, a number of potentially innovative fishing approaches were considered for small-scale proof-of-concept experiments. A summary of the conclusions and recommendations by the Workshop concerning those four topics was provided to CIRVA by Sanjurjo and Chris Glass (for more details, see Annex 6).

a) Economic evaluation and performance improvements to the shrimp trawl – INAPESCA has provided sufficient evidence that the selective RS-INP-MX trawl can be operated in a commercially effective manner. From 2009 – 2013 INAPESCA conducted six different trials of the net using pangas employed by artisanal fishermen in the region, with over 7,000 sets during the period. The trials clearly showed that, at least on the western side of the Upper Gulf, this net can effectively catch blue and brown shrimp when unobstructed by the presence of gillnets. Gillnets represent a physical obstacle for the correct operation of the selective net. One of the fishermen participating in the CIRVA meeting indicated that even with the gillnet ban in place from March through November 2015, when he was attempting to operate a small trawl for shrimp, he encountered physical interference from illegal totoaba gillnets.

The skill of the fishermen participating in the experiments is also crucial to the performance of the net. Experiments carried out in summer 2012, using skilled fishermen and in a period with no gillnets in the water, resulted in catches of 37.8 kg per trip on average. Fishing communities nonetheless remain skeptical about the economic performance of the small trawl because of concerns over engine maintenance and the gasoline consumption required to tow a net. The Workshop suggested working with a group of 20 to 30 skilled fishermen to test the economic performance, and consider all costs and benefits, of the trawl.

During discussion, CIRVA noted that evaluations of economic performance (costs and benefits) should consider not only comparisons between various artisanal fishing options (e.g. small trawls operated from pangas), but also the local (community-level) ecological and economic implications of industrial trawling in areas where gillnetting has been banned.

b) Trawl net for finfish – INAPESCA tested a trawl net for finfish on the R/V Unicap XVI in 2012 with good results. Subsequent INAPESCA work with fishermen in pangas has identified the following challenges to address: (1) few fishermen possess the skills to use a fish trawl effectively; (2) for administrative reasons, permits for testing the fish trawl have not been provided for the best season for finfish (April to August); (3) the presence of gillnets was a physical obstacle for operation and testing of the fish trawl (as with the shrimp trawl). The Workshop recommended (and CIRVA **agrees**) that future experiments should be conducted using only skilled or experienced fishermen (10 in San Felipe, 10 in El Golfo de Santa Clara), during the finfish season (April to August), with no gillnets in the water. Concern was expressed at the Workshop that the finfish net being used for experimentation was too large for the vessels operating it. Figures presented to the Workshop suggested that the net was being operated at

approximately 50% of its predicted opening and therefore was inefficient. The Workshop recommended construction and experimental tests of a scaled-down version of the net.

c) Pots for fish – INAPESCA has tested the use of pots in the upper Gulf with promising results. In 2012 INAPESCA tested rectangular pots for fish on the R/V Unicap XVI. These pots showed a high catch efficiency (3-8 kg of commercial catch/hour), good selectivity (bycatch ratios between 1:0 and 1:4), and zero vaquita by-catch. In 2015 INAPESCA tested these pots, onboard pangas with inconclusive results. Rectangular pots are effective, but only a small number can be deployed from pangas; for that reason, the Workshop recommended the use of other designs that allow more effort per panga: plastic pots, collapsible metal pots, polyethylene rectangular pots, and floating pots were suggested and potential designs were shared. The Workshop recommended testing the pots with 5 fishermen per village and 150 pots in the water (30 of each type), and to have a continuous analysis of the following data: catch per pot of commercial species (number and weight), soak time, position, time at which the pot was set, fuel consumption, bait used, and depth. It also recommended a simple bait experiment in the region before conducting the tests. Such an experiment can easily be carried out by placing underwater cameras with different baits placed in front of the cameras, which record the number of fish and the time they spend near the bait. This kind of technology is very promising for the Upper Gulf, specifically in the areas with rocky bottoms southward from San Felipe.

d) Hooks and lines – Hooks were demonstrated to be effective for fishing finfish in trials conducted from 2012 to 2014 in the Upper Gulf. The Mexican Government has banned longlines to protect the totoaba. Nevertheless, the Group recommended evaluation of strategies for using hooks and lines in different modalities (multi-lines and handheld hooks) to identify versions that meet certain criteria, such as no interactions with sharks, sea turtles, and totoaba. Based on experience, the Group specifically recommended evaluation of these fishing gears for baqueta, cabrilla, curvina, and sierra. The Group recommended carrying out these tests with five fishermen per town and in two different periods (April to May in both towns and October to November just in San Felipe).

e) Calendar – A calendar for actions to be taken with regard to the experimental protocols was provided by the Workshop (see Annex 6) and CIRVA **recommends** that it be adopted and implemented to the fullest extent possible. CIRVA **stressed** that although this schedule of activities may appear ambitious, it may fall well short of meeting the expectations of the fishing communities, while at the same time achieving the necessary level of protection to vaquitas.

4.2 CIRVA consideration of recommendations agreed upon by participants of the Workshop on Fishing Technologies

CIRVA reviewed the following recommendations by the International Expert Working Group (EWG) at the Merida Workshop, with caveats and additions as noted:

- (1) The EWG strongly recommended that the gillnet ban be made *permanent* and that gillnets no longer be used for any fishing activities, including curvina, in the Upper Gulf of California (UGC). The Group was firmly opposed to any future use of gillnets (even if modified) in the UGC.

- (2) To properly and fully execute the approved protocols, it is imperative that the areas in which the experimental fishing takes place be free from obstruction by other fishing activities. This has been a hindrance to effective approaches in the past.

CIRVA **recommends** that the concept of “free from obstruction” should be interpreted to mean free from interference by any form of fishing (or other) activity, including illegal totoaba gillnets and industrial trawling. In other words, free access to the resource is essential for experiments to be successful.

- (3) Solutions should take into account the vast experience of INAPESCA in the region. This experience should provide the background and basis for continuing research activities. The Group strongly supported the recommendation of CIRVA Express that the small trawl shrimp fishery be allowed to develop as intended under NOM-002-SAG/PESC-2013.

CIRVA **reiterates** that there is no longer any justification for the Government of Mexico to delay the issuance of commercial permits to fish for shrimp with the small trawl.

- (4) The “Selective net RS-INP-MX” shrimp trawl has received adequate testing, and a strong regulatory framework exists for its application. Therefore, the EWG recommended that such trawls be used on a commercial basis in the UGC.
- (5) Management and control of the experiments is crucial for success, thus the EWG strongly recommended that the experimental work be conducted with small, manageable groups of fishermen. The size for these groups (suggested in the Workshop) should vary from two fishermen per test in the case of the proof-of-concept efforts to up to 20-30 fishermen in the case of improvements to the selective net RS-INP-MX.
- (6) Selection of fishermen has been an ongoing problem. The EWG recommended that special attention be paid to the selection of fishermen under strict technical criteria and considering the performance of individuals in previous experiments. The criteria should include, for example, attendance at tests and courses, catch history, knowledge of the fishing systems, and ability shown during training courses.

CIRVA recognizes that this is a serious and difficult issue. These criteria, which will be set in a technical way that makes monitoring feasible, constitute guidance to INAPESCA, which retains authority over how the tests are conducted. The presenters (Glass and Sanjurjo) gave assurances that the EWG will participate in development of the criteria for participants in each project and will be “looking over the shoulder” of those who apply them. Some participants expressed unease with such assurances in the light of their experience in trying to obtain (in a timely manner) fishing permits for experimental and commercial fishing over the past several years.

CIRVA **emphasizes** the importance of ensuring that the selection process for participants in the trials is rigorous and transparent. It specifically **recommends** that the EWG is provided with sufficient information on the basis for decisions to allow it to evaluate such decisions.

- (7) The EWG recommended that the Mexican Government assure that INAPESCA has adequate and timely financial resources for the correct application of the agreed research protocols.

CIRVA sought clarification concerning how protocols would be approved, and by whom. Sanjurjo and Glass explained that they expect all research protocols to be subject to review and approval by the EWG before implementation by INAPESCA. The EWG's oversight role would include determining the kinds of data collected, how the quality of the data is to be assessed and assured, and how the data are to be analyzed.

- (8) The National Commission for Fisheries (CONAPESCA) must ensure timely issuance of all experimental permits.

CIRVA adds its own very strong **recommendation** that the Mexican government ensure the timely issuance of all experimental fishing permits, both for the trials themselves, and for the people undertaking the small-scale trials.

- (9) The EWG recommended that the Mexican government should continue its enhanced enforcement efforts in the region to guarantee the security of fishermen and observers participating in the tests, to eliminate the presence of gillnets during the tests, and to control illegal fishing activities that could undermine the tests.

- (10) The EWG should meet on a regular basis to analyze the development of the protocols, provide feedback, and make additional recommendations as necessary.

During discussion, Glass clarified that "regular" meant quarterly. He also indicated that thus far, EWG members have participated on a voluntary basis, with WWF-Mexico (Sanjurjo) functioning as the focal point for administration and coordination with INAPESCA. CIRVA noted the importance of keeping the EWG small enough to function efficiently and respond rapidly.

CIRVA took note of the *ad hoc* nature of the effort thus far and was pleased to learn of the cooperative and collaborative spirit shown by all participants in the Merida Workshop, including INAPESCA.

Given the immediacy and importance of the need for non-entangling alternative fishing gear in the Upper Gulf, CIRVA **stresses** the need for continued investment of time and resources (including financial) by the Government, the private sector, and non-government foundations and organizations in alternative fishing technology work. In this regard, CIRVA is especially concerned that there be an unequivocal, high-level commitment from the Mexican government to ensure that lead agencies (INAPESCA, CONAPESCA, and SEMARNAT) are diligent in facilitating full implementation of the protocols outlined in the report of the Merida Workshop.

CIRVA commended and thanked Sanjurjo and Glass, as well as all of the organizers, sponsors, and participants of the Merida Workshop, for their excellent work on this difficult but vital aspect of the overall vaquita conservation effort. CIRVA **recommends** that the International

Expert Working Group be provided with the financial, administrative, and logistical support needed to implement the Workshop recommendations.

4.3 Update from Noroeste Sustentable (NOS)

CIRVA also received an update from Christian Linan of NOS, who reported that the RS-INP-MEX shrimp trawl, developed and tested by INAPESCA in collaboration with WWF-Mexico and Pronatura is the only option currently available to eliminate incidental mortality of vaquitas when fishing for shrimp. As reflected in the Merida workshop report, NOS recommends continued experimentation with other models and prototypes for shrimp and other species. For its part, as one of the ongoing efforts on alternative gear design, NOS coordinated a series of workshops in recent years with a group of committed fishermen in El Golfo de Santa Clara to encourage creative thinking on gear design. The best 10 concepts, from 52 proposed, were selected for a second phase in which prototypes were developed by engineers from INAPESCA, CRIP-Guaymas, and Sara Skamsner (Foulweather Trawl, Newport, OR). Peggy Turk Boyer from CEDO noted via email that CEDO has also been promoting fishermen participation in the generation of alternative gear to test. As part of their impact assessment commitments, fishermen and CEDO organized a contest to obtain proposals from fishermen on alternative gear in the three communities of the Reserve. Ten proposals were received. CEDO and NOS collaborated to conduct a workshop with fishermen and gear experts (from INAPESCA, CRIP-Guaymas, and Sara Skamsner -Foulweather Trawl, Newport OR, who were brought in as judges for the contest) to improve on the designs that were generated from both CEDO and NOS initiatives. An award ceremony was held for improved designs that had been submitted to the contest (with monetary prizes), and the best overall designs (4) from both initiatives were included in a research permit request, with research protocols developed and submitted to INAPESCA and CONAPESCA by CEDO researcher and EAI coordinator, Dr. Sergio Perez Valencia. No permits have been issued to date. The Merida workshop included some of these for proof of concept studies alongside other larger trials during the proposed gear testing under the approved protocols.

Linan also reported that the unstable socio-political environment in the Upper Gulf over the last few months has seriously affected the implementation of projects in this region. He indicated that a lack of law enforcement presence in the Upper Gulf has eroded local enthusiasm for the development of alternative fishing gear. In addition, the involvement of organized crime in the illegal totoaba fishery, and the collusion of some officials with these actions, has been a fundamental obstruction to progress.

4.4 Conclusions and Policy Recommendations on Alternative Fishing Gear

It was clear from the presentations and discussions at the CIRVA meeting that valuable opportunities to make the kind of rapid progress needed to make the transition to a self-sufficient, but gillnet-free, fishing economy in the northern Gulf have been lost. This is in spite of the many recommendations made by CIRVA over the years, the substantial investments by a wide variety of funding entities, and the valiant efforts by some fishermen and individual gear development specialists. A greater commitment is needed, and the issue needs to be addressed with a much greater sense of urgency. One obstacle to progress appears to be the fact that many fishermen are being compensated for not fishing during the two-year emergency gillnet ban and

they expect to be able to resume gillnet fishing after April 2017. CIRVA **re-emphasizes** that the gillnet ban in the Upper Gulf must be made *permanent*; without an extension of the ban, it seems unlikely that the requisite support for further work to develop alternative fishing technologies will be forthcoming.

In response to the Government of Mexico's announcement in January 2015 of a two-year ban starting in May 2015 on gillnetting in the Upper Gulf, CIRVA made a public statement (available at www.iucn-csg.org/wp-content/uploads/2015/01/CIRVA-comments-to-Government-of-Mexico-January-2015.pdf) in which it drew attention to the CIRVA-5 **recommendations**, which included that:

- The granting of permits for small-type shrimp trawls to trained fishermen and the investment in the production of small-type trawl gear and the training of fishermen to fish the new gear be expedited, and
- Efforts to introduce alternatives to gillnet fishing in the communities that will be affected by enforcement of the exclusion zone be increased.

It further noted: "Past, ongoing, and future investments by the Government of Mexico and others in vaquita conservation will only achieve their purpose if the northern Gulf is maintained as a gillnet-free area. The proposed two-year gillnet ban will only be successful if fishermen being compensated during this period are given the opportunity to develop alternative livelihoods, including the use of the recently developed small-trawls for shrimp as well as other fishing practices and gear that will allow porpoises to survive into the future. The proposed compensation scheme does not mention anything about development, testing, and implementation of alternative gear. The two-year period when fishermen are being compensated for not fishing with gillnets provides an excellent opportunity to train and equip them to use the already developed, legally mandated small-trawls for shrimp and to ensure that they apply their skills to develop and test traps or other gear for catching finfish. The fishermen could also be employed to construct or manufacture the needed alternative gear. Such activity and employment would be a constructive alternative to the proposed community enforcement role during this time of transition."

CIRVA stands by its previous advice and **recommends** that fishermen be provided with opportunities to pursue their livelihoods during the present two-year gillnet ban by either continuing to fish in ways that do not threaten vaquitas or by advancing their possibilities for doing so in the future.

CIRVA also **reiterates** its earlier advice that it will be important for the Government of Mexico to compile and analyze economic data and calculate compensation levels that will incentivize fishermen to adopt and use vaquita-safe gear.

CIRVA members noted media reports of compensated fishermen being prosecuted for illegally fishing for totoaba with gillnets during the ban. In the view of CIRVA, there should be no further compensation for any individual determined to have engaged in illegal fishing or other related illegal activities.

CIRVA noted that the burden on enforcement could increase considerably if many pangas are allowed access to the gillnet-free area. Therefore, a caveat to all recommendations concerning experimental fishing operations is that they should be implemented transparently, conducted in close communication with enforcement authorities, and closely and effectively monitored through a system developed in collaboration with the Navy. It is expected that the experimental protocols will provide assurance of such monitoring.

5. MARKETS AND ECONOMICS

Sarah Mesnick described a project to explore market-based approaches to vaquita conservation for the fishing communities in the Upper Gulf of California. The wild-caught shrimp fishery on the north-western (i.e. Pacific) coast of Mexico, and including the Gulf of California, is one of the most important fisheries in Mexico. It has the highest landed value, employs the greatest number of people, and has the largest number of vessels (Sustainable Fisheries Partnership 2016) in the nation. Annual landings are approximately 40,000 tons, of which more than two-thirds are imported into the U.S. market (Rojas Bracho et al. 2006, Ardjosoediro and Bourns 2010; Sustainable Fisheries Partnership 2016). A relatively small fraction of this fishery, approximately 700 tons of Pacific blue shrimp (*Litopenaeus stylirostris*) and brown (or “yellowleg”) shrimp (*L. californiensis*) caught by the panga fishermen in the Upper Gulf, demands the highest prices due to the preferred taste, large size, and high quality of these shrimp.

The communities of the Upper Gulf have made a livelihood from fishing with gillnets for the past several decades. They are currently receiving significant financial compensation for not fishing with gillnets and longlines, and CIRVA is well aware of the socio-economic issues faced by these communities as they consider alternative types of fishing gear. The identification of economically and ecologically viable vaquita-safe fishing gear, as well as potential alternative economic livelihoods for these communities other than live-capture fisheries, is critical to the long-term conservation of vaquitas.

The temporary gillnet ban and financial compensation program demonstrate the Government of Mexico’s “willingness to pay” for vaquita conservation, but the current approach cannot be sustained at present levels. There are opportunities to broaden engagement with the seafood supply chain as an important component of supporting the economic livelihoods of these communities. The seafood supply chain, the largely (until recently) open-access conditions in the shrimp fishery, and the minimal economic costs of fishing with gear that puts vaquitas at risk, have created incentives to fishermen to use such gear. Consumers, for their part, are largely unaware of the vaquita issue and are not required to bear any of the “bycatch costs” of consuming seafood, nor have buyers borne any of those costs in their business models. Faced with minimal cost of vaquita bycatch, absent conservation incentives from consumers and the supply chain, and lacking clear indications of whether the gillnet ban will become permanent, only a handful of fishermen have expressed a willingness to change their practices.

Linking conservation incentives to bycatch reduction is generally predicated upon the assumption that a significant market advantage (e.g. market access, a price premium) can be passed along directly to the fishermen so that the benefits of bycatch reduction outweigh the costs of conservation.

Since most of the shrimp caught in the region is imported into the United States, the current project focuses on providing a better understanding of the preferences of U.S. buyers, chefs, and consumers to determine if and how price premiums could play a role in incentivizing fishermen and to elicit information on “willingness to pay” for vaquita conservation throughout the supply chain.

One approach is to ensure a price premium for the shrimp or finfish harvested with alternative gear. Preliminary results based on an on-going study on consumer-facing prices in retail markets in Southern California are being used to estimate revealed consumer preferences through pricing, which is one way to gauge consumer willingness to pay. Using a stratified random sample of and repeated sampling through the year, these data are providing some of the first evidence that labels can result in higher prices – these include labeling products as “local” or “wild,” and using eco-labels such as Marine Stewardship Council certification and Monterey Bay Aquarium Seafood Watch ranking system. The data set also can be used to quantify the end- market prices for wild-caught shrimp with various attributes such as value-added processing or packaging, in addition to labeling.

Another approach being pursued is to characterize the value chain for conservation opportunities. Market research efforts to date have also focused on providing information on the “uniqueness” or otherwise exceptional qualities of a vaquita-friendly product along the supply chain, starting with specialty buyers in southern California who, as a matter of practice, source “sustainable” seafood. More traditional buyers from the region, and the food service providers they support, are increasingly using such information to draw consumer attention, and a price premium, to such products. Efforts to characterize the supply chain may reveal further opportunities to raise awareness, incentivize change, introduce new connections, and increase revenues at each juncture. For example, one option is to “shorten” the marketing chain such that the fishing sector receives a greater share of the final retail price and another is to identify value-added opportunities such as additional processing or new packaging to make the product more attractive to consumers.

Efforts to improve the prices paid to fishermen are an important part of determining potential net earnings from exploring alternative gear in the fisheries of the Upper Gulf of California. While it is likely that alternatives to gillnets will cause fishermen to incur higher production costs, these increased costs can be offset by increased gross revenues through targeted marketing and other value chain strategies, such that the net effect may be to allow a viable fishery supportive of Upper Gulf communities.

If fish products are not available from fishermen using alternative gear, there is no way to assure or evaluate the financial returns to local communities. CIRVA finds it regrettable that in the 2015-2016 shrimp season not a single shrimp caught with the RS-INP-MX trawl was sold. Valuable time has been lost; the two-year “window of opportunity” with compensated fishermen available to test and socialize the alternative fishing gear has now dwindled to just a single shrimp fishing season (beginning September 2016). Additionally, as stated above, current uncertainty over continuation of the two-year gillnet ban has led many fishermen to delay adopting alternative gear, and others, who are committed to making the transition, continue to face uncertainty as to whether they will be allowed to fish. CIRVA therefore **recommends** that

commercial use of the RS-INP-MX trawl be implemented immediately, with the caveat that there be a burden of proof that trawl fishing is not used as a camouflage for illegal gillnet activity.

Ramses Rodriguez (Pronatura Noroeste A.C.) informed CIRVA that fishermen in San Felipe working with WWF-Mexico and Pronatura have developed the vaquita-friendly eco-label to accommodate, and differentiate in the market, a product caught with alternative gear that does not entangle vaquitas. This label is meant to add value to the product and capitalize on the willingness of consumers to pay more in order to conserve vaquitas. Whether a product qualifies for the label is to be decided by a local regulatory council which is in the process of being legally constituted. This effort to develop a unique label was coupled with special dinners in Mexico and the San Diego area to call attention to this “vaquita-friendly” product. The team has also formed the commercial brand San Felipe Pescados y Mariscos and the non-profit Pesca Alternativa de Baja California (Pesca ABC) which provides both support for gear development and a voice for the fishermen. Unfortunately, there has been no opportunity to test the viability of this model, because fishermen are not yet allowed to sell shrimp captured with the RS-INP-MX trawls and, therefore, there is simply no shrimp to sell.

Finally, several partners in the efforts to conserve the vaquita have repeatedly called for an "Economic Summit" to explore alternative livelihoods for Upper Gulf communities, which could include expansion of nature-oriented tourism, recreational fishing tournaments, aquaculture, development of “green” energy (wind and solar), and other activities. The concept of convening an “economic summit” has been endorsed by the U.S. government, but no response has been received from CONAPESCA and time is running short. CIRVA recognizes that meeting the challenges of ensuring the long-term viability of Upper Gulf communities will require broadening of the conversation and embracing a full suite of economic instruments, including markets.

In discussion, Taylor noted that efforts to certify the sustainability of shrimp or finfish catches in the Upper Gulf are hampered by the absence of stock assessments for any commercial species – and Mesnick noted that this is an obstacle for rating under the Monterey Bay Aquarium and other seafood certification schemes.

CIRVA also noted that large shrimp trawlers from outside the Upper Gulf region are in competition with the artisanal fishermen of the Upper Gulf communities. Members discussed whether fishermen using small alternative trawl gear might be allowed to enter the fishery earlier in the season or otherwise gain some advantage over the large trawlers in gaining access to the highest-quality shrimp resources. The exceptional importance of the artisanal fishery should be reflected in eco-labeling schemes. CIRVA **recommends** that every effort is made during the coming year to support the development of permanent gillnet-free fisheries and to strengthen linkages between the fishermen using alternative gears and the seafood supply chain as a critical step in incentivizing the conversion of the fleet to gillnet-free operations. Again, these activities must be developed with tight collaboration with enforcement authorities so as not to allow any illegal activities. To implement this recommendation, the following needs to happen:

- (1) All available tools should be brought to bear to end illegal fishing;
- (2) Issuance of permits for legal non-gillnet fishing must be expedited; and

- (3) Testing of alternative gear must be supported and fishermen must be allowed to sell their products.
- (4) Existing traceability, chain of custody, and third-party audits should be adapted to seafood products originating from the Upper Gulf and all pangas should be equipped with digital tracking systems; and
- (5) Existing seafood round-tables should be used to increase direct dialog between producers and buyers.

More broadly:

- (1) CIRVA **recommends** that a small Presidential advisory body be created to address the broader context of vaquita conservation, including developing viable socio-economic alternatives that improve livelihoods and providing social services that improve human health and well-being. Ultimately, the vaquita will be saved by the people living in the communities that border the range of the species.
- (2) CIRVA **recommends** that the Governments of Mexico and the U.S. work together to host an Economic Summit to catalyze the development of viable alternative livelihoods, such as aquaculture, sport fishing, tourism, wind and solar energy, *etc.*, in addition to markets for fish caught with vaquita safe gear.

6. EVALUATION AND CONSIDERATION OF EX SITU CONSERVATION ACTIONS

CIRVA recognises that in such a critical situation, every possible conservation option must be considered, **recognising that none of the options negates the essential requirement to remove all gillnets, including those used for curvina, from the range of the species**, so that the habitat in the Upper Gulf can allow vaquitas to increase toward their former levels.

The issue of capturing vaquitas has been raised previously in various quarters and captive breeding programs (or other types of *ex situ* management such as rescue and later release, translocation, etc.) have been implemented for other taxa. In the present circumstances, it would be irresponsible of CIRVA not to evaluate *ex situ* options as potential conservation tools despite the difficulties highlighted in Curry *et al.* (2013) with respect to poorly known small cetacean species. No vaquitas have been live-captured and kept in captivity to date. Therefore, CIRVA **agreed** to develop the objectives for an *ex situ* conservation strategy within the next six months.

The conservation objectives of *ex situ* actions, *should they prove successful*, could provide extra time to allow *in situ* efforts to remove gillnets completely from the range of the vaquita. CIRVA members stressed that captivity is not a permanent solution to the conservation of the vaquita.

Annex 3 provides the report of an *ad hoc* group of experts (hereafter ‘the *ad hoc* group’) with experience in the live capture and/or keeping in captivity of harbor porpoises, finless porpoises and Dall’s porpoises. The group met in The Netherlands in 2015. Based on their experiences, the *ad hoc* group considered the *feasibility* of capturing wild vaquitas and keeping them for some period in captivity, along with captive breeding and release. The *ad hoc* group did not focus on the broader question of the desirability of an *ex situ* conservation strategy although it did address some of the pertinent issues.

In summary, the *ad hoc* group noted that at present, it is not possible to say whether it would be possible to capture vaquitas or keep them in captivity or semi-captivity for any length of time. Harbor porpoises have been captured successfully, maintained in captivity and bred. Finless porpoises have also been captured (as bycatch and intentionally for translocation) and maintained in captivity and in semi-natural reserves. Dall's porpoises have been captured but never maintained successfully. It is not possible to say at present whether the vaquita is likely to be a successful candidate for capture, maintenance and breeding but, given the success with the related harbor and finless porpoises, it is certainly worth investigating. Therefore, the *ad hoc* group had developed a staged approach to minimize risks to individuals and evaluate the prospects, beginning with exploration of the feasibility of capture, followed by housing, then release and breeding for release. The *ad hoc* group had stated that only when one stage is deemed feasible should the next stage be attempted and it had provided a number of recommendations for each stage. It also stressed that any *ex situ* efforts required a gill-net free refuge to release animals into, thus any *ex situ* efforts should not detract from gill net removal actions.

CIRVA commended the thorough nature of the report of the *ad hoc* group. Discussions of this report within CIRVA focused on: (a) what the objectives of an *ex situ* approach might be in the light of general guidance produced by IUCN (see Annex 4); (b) an examination of the strengths and weaknesses of such an approach in the case of the vaquita based upon the information provided in Annex 3 and the IUCN guidelines; and (c) an examination of the feasibility of the approach outlined in Annex 3.

In terms of the IUCN guidelines, it was agreed that the presently precarious state of the species (only about 60 individuals left; mortality in gillnets still occurring despite the ban and increased enforcement; no decision yet on making the 2-year ban permanent) warranted investigation of *ex situ* options, but a number of questions remain, *e.g.* determining how many animals would need to be captured and maintained, how long the program would be needed if it proved successful, and how to deal with a large number of practical details, including when to release animals and the size of a captive population that would be feasible to maintain.

During presentation of these conclusions to authorities, the question was raised whether all remaining vaquitas could be captured prior to the end of the emergency 2-year ban. CIRVA agreed unanimously that capture of all remaining vaquitas is not a viable conservation strategy for vaquitas, which must, first and foremost, be protected in their wild habitat.

Secretary Pacchiano and Governor Vega expressed strong interest in studying the possibility of *ex situ* capture, housing, care, and possibly breeding of vaquita. In such a program, some portion of the vaquita population would be captured from the wild and placed in a temporary facility. Secretary Pacchiano stressed that eliminating all gillnets will be very difficult as long as illegal totoaba fishing continues. CIRVA **recommends** taking first steps to evaluate the feasibility of such a program in Mexico. If conditions for holding in net pens in the region are determined to be adequate and methods can be developed for capture, the first attempts to capture a vaquita could take place in 2017. However, CIRVA strongly stressed that any such *ex situ* work only makes sense if the gillnet ban is extended indefinitely.

There was considerable discussion regarding the strengths and weaknesses of an *ex situ* approach. These centered on:

- (a) the possibility that efforts may detract from the essential work to remove all existing gillnets from vaquita habitat immediately;
- (b) recognition that removing gillnets completely, while in principle simple, is in fact extremely complicated (e.g. the illegal totoaba fishery and market and organised crime) and may not occur in time to save the vaquita unless additional approaches and enhanced efforts are made with respect to enforcement of a permanent ban (see Item 6);
- (c) the fact that even phase I of the staged approach recommended by the *ad hoc* group might take a considerable period, and time is short, although experience from the most recent April cruise suggests that finding some animals may not be as difficult as originally envisaged by the *ad hoc* group;
- (d) the high cost and long-term nature of any *ex situ* option and the need to obtain Government of Mexico permits, even though there is no guarantee of success;
- (e) recognition that removing animals from such a small population could reduce the viability of the wild population with 15 or fewer adult females;
- (f) consideration that if the work does not start soon it may become too late, as it proved to be in the case of the baiji (*Lipotes vexillifer*) in China.

After considerable discussion and recognizing the complexity of the situation, CIRVA **concludes** that field work on determining the feasibility of *ex situ* conservation actions for the vaquita is warranted. However, CIRVA also **stresses** that:

- (1) this *ex situ* work only makes sense if the gillnet ban is extended indefinitely;
- (2) the work must not deflect funds and efforts from enforcing the gillnet ban, which remains the highest-priority conservation action for the vaquita;
- (3) it may turn out that the vaquita is not suitable for *ex situ* conservation actions;
- (4) this work will involve some risk to individuals;
- (5) the work must be designed and supervised by an international expert group [see Terms of Reference in Annex 5] that selects the field team, develops protocols, and reports to CIRVA, which in turn reports to SEMARNAT;
- (6) the work must follow a staged approach based upon that provided in Annex 3, with the option to cease work and allow review by CIRVA at appropriate intervals – the first stage is to investigate feasibility of capture and options for *ex situ* on site facilities at sea or on land;
- (7) as soon as possible, experts familiar with captive care of small cetaceans should visit the Upper Gulf to evaluate its unique conditions (especially extreme tides, currents and storms), to consider and test *inter alia* whether existing sites and facilities are suitable and sufficiently robust, in concert with efforts to determine the feasibility of capture, safe transport and maintenance of animals;
- (8) the Government of Mexico will need to issue any necessary permits in a timely fashion.

7. SUMMARY OF MAJOR RECOMMENDATIONS

7.1 Executive Summary

CIRVA therefore recommends that the Government of Mexico immediately implement and enforce a *permanent ban* on all gillnets throughout the entire range of the vaquita and seriously consider the closure of all fishing there if evidence of illegal activities continues to come to light.

CIRVA applauds the collaboration among SEMAR, PROFEPA, and Sea Shepherd and recommends that such collaboration be continued and strengthened in the 2016-2017 season.

CIRVA further recommends that efforts to remove gillnets from throughout the vaquita's range be intensified as a matter of utmost urgency.

CIRVA concluded that fieldwork to determine the feasibility of *ex situ* conservation actions for the vaquita is warranted.

CIRVA reiterates that there is no reason for the Government of Mexico to delay the issuance of commercial permits to fish for shrimp with the "Selective net RS-INP-MX" trawl, which has received adequate testing.

CIRVA recommends that every effort be made to develop gillnet-free fisheries in the Upper Gulf and to strengthen linkages between the fishermen using alternative gears and the seafood supply chain

7.2 Vaquita Population Trends and Abundance

CIRVA is deeply concerned that the latest information from the visual and acoustic survey undertaken in 2015 confirms the extensive decline prior to the gillnet ban that was previously indicated by the acoustic monitoring data. The survey revealed a total abundance of about 60 animals for the species in 2015. The recommendation that all gillnets **must be removed permanently** from the range of the vaquita, made previously by CIRVA and other bodies including the IWC, gains even greater urgency.

CIRVA **recommends** continuation of the acoustic monitoring program work to allow annual estimation of population trend.

CIRVA **recommends** that the Steering Group advising the Acoustic Monitoring Program re-examine the sampling effort required, given the small current size of the population.

CIRVA **recommends** that adequate multi-year funding be secured to support the Acoustic Monitoring Program in the long term.

7.3 Enforcement

CIRVA therefore **recommends** that the effort to remove illegal gillnets be continued and intensified as a matter of the **utmost urgency**.

CIRVA welcomed the important collaboration between the Mexican Navy, PROFEPA, and the Sea Shepherd vessels and **recommends** that this collaboration be continued and strengthened in the coming 2016-2017 season. CIRVA also **recommends** that the NGO community consider ways to reinforce such third-party monitoring efforts and contribute to the effort to locate and remove gillnets.

CIRVA **recommends** that no pangas be allowed on the water at night in the area of the gillnet ban and that the purchase or possession of gillnets on land or at sea be prohibited in all areas adjacent to the gillnet exclusion zone.

CIRVA further **recommends** that Mexico immediately and significantly increase the penalties for killing endangered species and engaging in illegal wildlife trade. The current penalties and enforcement effort have clearly been insufficient to deter or prevent large numbers of fishermen from conducting illegal activities, and this must change if the vaquita is going to be saved.

CIRVA remains **extremely concerned** that illegal activities could be disguised by any form of fishing that involves pangas. This concern will remain as long as laws and enforcement are too weak to deter or prevent illegal fishing. CIRVA therefore **recommends** that the Government of Mexico immediately implement and enforce a *permanent ban* on all gillnets throughout the entire range of the vaquita and seriously consider the closure of all fishing there if evidence of illegal activities continues to come to light. **At this juncture, the choice is simple and stark: either gillnetting in the Upper Gulf ends, or the vaquita becomes extinct within a very short time.**

CIRVA plans to meet again prior to the end of 2016 to consider the status of all items related to stopping the vaquita's rapid trajectory of moving towards extinction.

7.4 Alternative Fishing Gear

An implementation plan for actions to be taken with regard to the experimental [fishing gear test] protocols was provided by the Workshop (see Annex 6) and CIRVA **recommends** that it be adopted and implemented to the fullest extent possible.

CIRVA **recommends** that the concept of “free from obstruction” should be interpreted to mean free from interference by any form of fishing (or other) activity, including illegal totoaba gillnets and industrial trawling. In other words, free access to the resource is essential for experiments to be successful.

CIRVA **reiterates** that there is no longer any justification for the Government of Mexico to delay the issuance of commercial permits to fish for shrimp with the small trawl.

CIRVA adds its own very strong **recommendation** that the Mexican government ensure the timely issuance of all experimental fishing permits, both for the trials themselves, and for the people undertaking the small-scale trials.

CIRVA **recommends** that the International Expert Working Group formed at the Merida Workshop be provided with the financial, administrative, and logistical support needed to implement the Workshop recommendations

CIRVA **re-emphasizes** that the gillnet ban in the Upper Gulf must be made *permanent*; without an extension of the ban, it seems unlikely that the requisite support for further work to develop alternative fishing technologies will be forthcoming.

CIRVA stands by its previous advice and **recommends** that fishermen be provided with opportunities to pursue their livelihoods during the present two-year gillnet ban by either continuing to fish in ways that do not threaten vaquitas or by advancing their possibilities for doing so in the future.

CIRVA also **reiterates** its earlier advice that it will be important for the Government of Mexico to compile and analyze economic data and calculate compensation levels that will incentivize fishermen to adopt and use vaquita-safe gear.

CIRVA noted that the burden on enforcement could increase considerably if many pangas are allowed access to the gillnet-free area. Therefore, a caveat to the all recommendations concerning experimental fishing operations is that they should be implemented transparently, conducted in close communication with enforcement authorities, and closely and effectively monitored through a system developed in collaboration with the Navy. It is expected that the experimental protocols will provide assurance of such monitoring.

7.5 Markets and Economics

CIRVA [again] therefore **recommends** that commercial use of the RS-INP-MX trawl be implemented immediately.

CIRVA **recommends** that every effort is made during the coming year to support the development of permanent gillnet-free fisheries and to strengthen linkages between the fishermen using alternative gears and the seafood supply chain as a critical step in incentivizing the conversion of the fleet to gillnet-free operations.

CIRVA **recommends** that a small Presidential advisory body be created to address the broader context of vaquita conservation, including developing viable socio-economic alternatives that improve livelihoods and providing social services that improve human health and well-being. Ultimately, the vaquita will be saved by the people living in the communities that border the range of the species.

CIRVA **recommends** that the Governments of Mexico and the U.S. work together to host an Economic Summit to catalyze the development of viable alternative livelihoods, such as aquaculture, sport fishing, tourism, wind and solar energy, *etc.*, in addition to markets for fish caught with vaquita-safe gear.

Evaluation and Consideration of Ex Situ Conservation Actions

CIRVA recognises that in such a critical situation, every possible conservation option must be considered, but also **stresses**, once again, **that none of the options negates the requirement to remove all gillnets, including those used for curvina, from the range of vaquitas** to allow them to increase toward their former levels.

CIRVA **agreed** to develop the objectives for an *ex situ* conservation strategy within the next six months.

CIRVA **concludes** that field work on determining the feasibility of *ex situ* conservation actions for the vaquita is warranted. However, CIRVA also **stresses** that:

- (1) this *ex situ* work only makes sense if the gillnet ban is extended indefinitely;
- (2) the work must not deflect funds and efforts from enforcing the gillnet ban, which remains the highest-priority conservation action for the vaquita;
- (3) it may turn out that the vaquita is not suitable for *ex situ* conservation actions;
- (4) this work will involve some risk to individuals;
- (5) the work must be designed and supervised by an international expert group [see Terms of Reference in Annex 5] that selects the field team, develops protocols, and reports to CIRVA, which in turn reports to SEMARNAT;
- (6) the work must follow a staged approach based upon that provided in Annex 3, with the option to cease work and allow review by CIRVA at appropriate intervals – the first stage is to investigate feasibility of capture and options for *ex situ* on site facilities at sea or on land;
- (7) as soon as possible, experts familiar with captive care of small cetaceans should visit the Upper Gulf to evaluate its unique conditions (especially extreme tides, currents and storms), to consider and test *inter alia* whether existing sites and facilities are suitable and sufficiently robust, in concert with efforts to determine the feasibility of capture, safe transport and maintenance of animals;
- (8) the Government of Mexico will need to issue any necessary permits in a timely fashion.

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ANNEX 2: AGENDA CIRVA-7

AGENDA

CIRVA 7

**Caracol Museo de Ciencias y Acuario, Salón Estrella
Ensenada, BC**

May 10-13

Tuesday, May 10

10:30 – 17:00

1. *Welcome*
2. *Introduction of participants*
3. *Confirm chair and rapporteur(s)*
4. *Review and adopt the Agenda*
5. *Vaquita population abundance and trends*
 - Acoustic monitoring program
 - Review 2011-2015
 - Vaquita Survey 2015
 - Survey design
 - Visual results
 - Acoustic results
 - Full abundance estimate
 - The Acoustic Monitoring Program 2016 onwards
 - Discussion
 - Conclusions and recommendations
 - Rapporteurs to work on this section of CIRVA Report

Wednesday, May 11

9:00-13:00

6. *Evaluation and Consideration of Ex Situ Conservation Activities*
 - Report of the Harderwijk, Netherlands, Vaquita Conservation Workshop
 - IUCN Guidelines – Randy and Peter
 - Marine Mammal Foundation
 - Discussion
 - Next steps: conclusions and recommendations
 - Rapporteurs to work on this section of CIRVA Report

14:30-17:00

7. *Alternative Fishing Gear*
 - Merida-Fishing Technologies for the Upper Gulf of California Workshop Report
 - Where are we and where we should be going to implement policy
 - Next steps: conclusions and recommendations
8. *Review of item 5 for the CIRVA 7 Report*

Thursday, May 12

9:00-10:00

9. *Review of items 6 and 7 for the CIRVA 7 Report*

10:30-11:30

10. *Markets and economics*

- Discussion
- Recommendations
- Rapporteurs to work on the CIRVA Report over lunch

14:30-17:00

11. *Final review of items 5,6,7 and 10 for CIRVA 7 Report*

1930-2100

DINNER AT DECKMAN'S EN EL MOGOR

Friday, May 13

10:30-13:00

12. *Enforcement*

- SEMAR (Navy)
- Sea Shepherd
- Brief necropsy report of the three vaquitas
- Discussions and Recommendations

13. *Update to vaquita recovery plans*

14:30-1700

14. *Presentation to the Minister of CIRVA 7 recommendations*

List of documents

1. Report of the Harderwijk, Netherlands, Vaquita Conservation Workshop
2. IUCN Guidelines
3. Acoustic surveys show catastrophic decline in Mexico's vaquita porpoise, the world's most endangered marine mammal species (Acoustic monitoring program 2011-2015)
4. Supporting Information (SI) of the acoustic survey.
5. Merida-Fishing Technologies for the Upper Gulf of California Workshop Report –Not ready yet
6. Net loss: new abundance estimate reveals that Mexico's endemic porpoise faces imminent extinction due to illegal fishing (Vaquita 2015 Survey report) – Not ready yet
7. Sea Shepherd Report –Not available yet.
8. Update Recover plans – Not available yet.

ANNEX 3: FEASIBILITY OF *EX-SITU* CONSERVATION ACTIONS FOR VAQUITAS - REPORT OF THE *AD HOC* COMMITTEE FOR VAQUITA CONSERVATION, PROTECTION AND REPRODUCTION (VAQUITA CPR)

Workshop Report, Harderwijk, Netherlands, September 1 – 2, 2015

INTRODUCTION

A workshop to evaluate the feasibility of capturing, transporting, holding and breeding porpoises in captivity as tools for vaquita (*Phocoena sinus*) conservation was held in Harderwijk, Netherlands, September 1-2, 2015. The workshop was convened by The Marine Mammal Center and included experts in small cetacean (especially porpoise) capture, tagging, housing, veterinary care, release and reproduction (see Appendix 1 for list of participants). The group agreed to refer to itself as the *ad hoc* Committee for Vaquita Conservation, Protection and Reproduction (Vaquita CPR).

As mortality due to accidental drowning in gill nets is the primary cause of the vaquita population's decline, elimination of this threat is the most vital action to conserve this species. In April 2015 the President of Mexico announced a 2 year gillnet ban, accompanied by a strong commitment to enforcement and compensation to the fishing communities of the upper Gulf of California. However, previous measures to eliminate the use of gill nets within the vaquita's range have been hard to implement, there is uncertainty whether the gillnet ban will be made permanent and the vaquita population has continued to decline. With the current population at fewer than 100 animals, other emergency measures must be considered. The purpose of this workshop was to evaluate the feasibility of capturing vaquitas and maintaining and breeding them in captivity, based on knowledge and experience acquired from working with other porpoise species. The ultimate aim of any capture initiative would be to preserve the species for future release into fully protected (i.e. gillnet-free) wild habitat. Proximate aims could be protection until causes of mortality in the Gulf are mitigated, and establishment of a captive breeding program.

BACKGROUND

Ex-situ conservation strategies, such as temporary housing for protection, captive breeding for reintroduction and population augmentation, are considered useful tools to prevent extinction and help threatened species recover (Bowkett 2009, Martin *et al.* 2012, Ralls and Ballou 2013). Captive breeding with release into the wild of captive born individuals has not been used to date for marine mammal conservation, due at least in part to the generally limited success in maintaining and breeding some species of cetaceans in captivity, coupled with controversy over the potential utility of the action (Reeves and Gales 2006, Curry *et al.* 2013). Short-term *ex situ* methods, without captive propagation, have been applied on a small scale, however, and such methods could become of greater value to marine mammal conservation as knowledge and techniques are developed for such programs. The return of individuals temporarily removed from the wild is now common for several endangered marine mammal species. Human interventions to maintain reproductive potential of the wild population have led to increased survival of juvenile female Hawaiian monk seals (Gilmartin *et al.* 2011). Nearly a third of the wild Hawaiian monk seals alive today are living because of direct human interventions including disentanglement, translocation and nutritional support to animals held in temporary captivity

(NMFS 2014). In recent years, abandoned preweaned female Steller sea lions (*Eumatopias jubatus*) and California sea otter pups (*Enhydra lutris*) have been successfully rehabilitated and released, followed by their reproduction in the wild (Monterey Bay Aquarium & The Marine Mammal Center, unpublished data).

Recent reviews have emphasized the challenges of capture, maintenance, and captive reproduction of small, poorly known cetacean species such as the vaquita. While there is a body of knowledge and experience with more commonly held cetaceans such as *Tursiops*, *Delphinapterus*, and *Orcinus*, there has been less experience with others, including most porpoise species (Curry *et al.* 2013). Aware of the need for caution in considering or proposing any such measures as part of the conservation strategy for such species, this workshop reviewed the most recent information on porpoises.

Over the past decade, techniques have been developed for the capture, transport, rehabilitation and release of harbor porpoises (*Phocoena phocoena*). Success with the rehabilitation of porpoises caught in fishing nets or stranded has improved markedly (Kastelein *et al.* 1990, Yu *et al.*, 2009, van Elk pers. comm.). In addition, wild harbor porpoises are now routinely captured alive in Greenland and Europe for scientific research purposes (NAMMCO SC/20/HP/08).

In Denmark, studies on stress in harbor porpoises accidentally entrapped alive in pound nets and then removed, sampled, tagged and followed post-release showed indicators of stress (respiratory and heart rates, blood cortisol levels) that varied markedly among 42 individuals, but no deaths of the animals handled were reported (Eskesen *et al.* 2009). In the Netherlands harbor porpoises caught accidentally in pound or gill nets or stranded alive are rehabilitated at the Harderwijk aquarium, with survival varying among years and age classes but reaching 80% in recent years (van Elk pers. comm.). In Japan, several aquaria (e.g., Toba aquarium, Shimonoseki Marine Science Museum) currently hold finless porpoises (*Neophocaena asiaeorientalis sunameri*) that were caught accidentally in fishing nets and removed by fishermen and subsequently taken into captivity, and a stranded finless porpoise (*N. a. asiaeorientalis*) was rehabilitated and successfully released from Beijing Aquarium in China (Yu *et al.* 2009). Yangtze River finless porpoises have been successfully translocated (captured and transported) in China to semi-natural oxbow lake protected areas, and others have bred in captivity (Wang Ding *et al.* 2005). Survival of cetaceans after -stranding on beaches is generally low due to stress and associated cardiac lesions, but two adult beach-stranded harbor porpoises were released off the west coast of North America following rehabilitation. Satellite tracking indicated they survived at least 6 months post-release (Zagzebski *et al.* 2006; Vancouver Aquarium <http://www.vanaqua.org/act/research/cetaceans/porpoise-research>). Rehabilitation of very young, unweaned porpoises remains challenging due to difficulty in providing adequate nutrition and the stress from handling for feeding (van Elk pers. com). There is one record of a live-stranded neonate vaquita two decades ago which died quickly with no serious attempt at rehabilitation (in Curry *et al.* 2013).

Methods for porpoise capture, transport, housing, veterinary care and reproduction

1. Capture

A variety of capture methods have been developed for small cetaceans (Asper 1975, Loughlin *et al.* 2010). Capture methods used to date specifically for porpoises were reviewed and described for the workshop by Heide-Jørgensen, Teilmann, and Hanson. Harbor porpoises in Greenland, Denmark and the United States (U.S.) have been caught successfully in light surface salmon gill nets (that allow porpoises to surface once entangled) tended by small boats. In Greenland, 35 porpoises were caught in 2012-2014 to apply satellite-linked tags, with no deaths associated with capture and handling (Heide-Jørgensen pers. comm.). The technique is dependent upon (1) observing porpoises (either from air or small boat) in flat calm seas, (2) the animal(s) responding by moving away from a herding boat into a net deployed in their path by a second boat, and (3) the ability to remove the entangled porpoise(s) from the net rapidly and lift it into a small boat within 5 minutes of capture. About 30 % of animals observed near the capture nets are not caught after attempts at herding them. Consistent sighting of the porpoises is essential to enable herding, and if more than 3-4 surfacings are missed, the attempt may not be successful. The monofilament net typically used has an un-stretched mesh size of about 15 cms, is about 100 meters long and 4 meters deep, and has been used in water 200-300 meters deep. Once caught, stress to the animal is minimized by keeping it moist and minimizing sound; the porpoise is monitored by assessing heart and breathing rates. Use of D-tags attached by suction cups has shown that caught harbor porpoises resume feeding within 5 hours after capture and release. Passive approaches that rely on the animals swimming into nets (up to 1 km long) without being herded have not been as effective in Denmark (although four porpoises were caught this way). In the U.S. animals were caught passively (without being herded) in 600 ft (182m) “drift gillnets” in open-water areas of high porpoise density off Washington State.

Pound nets and herring weir trap systems have been used to entrap harbour porpoises, but are hard to work around in tidal areas, must be robust to withstand tide, remain vertical, and require a lot of construction. Seine nets have been used but are considered risky for porpoises, in one study approx. 5% drowned (Read, pers. comm.).

Abel reviewed capture techniques used for finless porpoises in Asia, including a large-scale purse-seine operation performed successfully by Japanese fishermen in the Inland Sea of Japan. After aerial spotting of animals, a group of porpoises was encircled by a large, small-mesh purse-seine. This was drawn in to act as a wall surrounding the porpoises which were then manually captured by divers. This technique requires extensive organization, collaboration of fishermen, and the ability to detect animals from the air. Driving with sound and using seine nets to capture finless porpoises has been successful in the Yangtze River.

The use of hoop nets and tail grabs to catch some dolphins and porpoises was described by Hanson and Abel, but as these exploit bow-riding behavior which is not often seen in harbor porpoises or vaquitas, they were not considered suitable capture techniques for them.

Species differ in how they react to capture. For example, Dall’s porpoises are more sensitive than harbor porpoises to stress and must be maintained in the water on slings during tagging (Hanson pers. comm.; also see Ridgway 1966). This makes it especially important, when initiating work with a new species, to carefully assess reactions during all stages of capture and handling and

build in contingencies for immediate release and/or medical care from the moment of contact with the animals onward.

Recommendations for potential vaquita capture

- a. The *ad hoc* committee recommends use of the light salmon gillnet technique to capture vaquitas, using 2 or more rigid-hulled boats with 150 horsepower and a team experienced in capturing harbor porpoises in this manner.
- b. As flat calm seas are needed, teams should allow an adequate time window in the field for any capture attempt (several weeks to a few months may be required).
- c. The utility of aerial spotting of vaquitas should be assessed to enhance the ability to locate and approach them for capture.
- d. The possibility of using trained bottlenose dolphins to locate vaquitas should be explored.
- e. The utility of towed hydrophone arrays to detect vaquita in real time should be investigated (e.g. Seiche, with PAMguard software which has porpoise detector built in as used for detection of Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in Hong Kong waters).
- f. Disposition of animals caught in any pilot effort should be determined in a precautionary step-wise manner reflecting experience acquired and may include: immediate release after minimal handling; short-term handling on the boat with biomedical sampling and placement of either a non-invasive (suction cup tags) or a pin-affixed long term satellite tag, or both; placement in temporary holding facilities for assessment of reaction to captive holding.
- g. Tag placement will allow assessment of the effects of capture and handling on movements and feeding and may provide click frequency measurements for calibration of C-POD data.
- h. It is also recommended that if all goes well with the capture and handling in the field (i.e. the animal appears relatively unstressed), a satellite tag be attached with a single small pin to monitor movements and facilitate future population assessment and capture efforts. The single-pin trailing tag configuration covers less fin surface than other satellite-linked tags used on other porpoises, a factor that may be important relative to vaquita thermoregulation in the comparatively warm waters of the Upper Gulf of California (Wells)

2. Transport

Transport of stranded harbor porpoises to and from the Harderwijk aquarium was reviewed and described for the workshop by van Elk. Porpoises have been transported for up to 15 hours, using cars, enclosed or open trucks, boats, airplanes (below 1,600 m), and helicopters (below 800 m). Transport is performed by placing the animal in a stretcher with slits for flippers, and suspending the stretcher in a transport box lined with moist foam. A soft sheet is placed over the animal's fin to protect from sun and drying. Porpoises do not tend to overheat, but must be protected from sun, air and drying. Of 96 sick or injured stranded animals transported, six died during transport. All of these had underlying medical problems, especially pneumonia. Abel reported on transport of Commerson's dolphins using similar techniques for up to 24 hours without any mortality.

Recommendations for potential transport of vaquitas

- a. Vaquitas should be transported in a soft stretcher with slits for flippers, and with the stretcher resting on foam if in a small boat. In a larger boat or truck, the stretcher should be suspended in a frame or box lined with wet foam. Water should be available at all times to moisten the animals, and noise should be minimized to reduce stress.
- b. Transport distance should be minimized, so holding pens and pools should be close to the vaquita refuge, no farther from the capture site than about 5 hours' transport time by boat or truck.
- c. Veterinary support should be available with drugs for emergency administration if needed through all stages of capture and transport.



3. Housing

Due to species differences in adaptability to different housing options, several types of pools and pens were reviewed. Types of short and long term housing used for bottlenose dolphins were described by Smith. These included commercially available, soft sided “splash” pools on rigid frames (e.g. 15 feet x 30 feet and 5 feet deep) and floating net pens, see figures below.



Benefits of using net pens include: pens can be prefabricated and assembled on site; expertise exists for safe use of net pens with small cetaceans; acoustically rich, natural bay/ocean environment; local fish often swim into pens, providing natural hunting opportunities; net pen growth can serve to filter and clean water. Challenges of using net pens include: time to access animal in an emergency; and algal build up on sides requires routine cleaning; care must be taken to ensure nets do not billow at low tide, which can present an entanglement risk. 1 inch stretch (or similar small mesh) is likely suitable for porpoises, which would mitigate entanglement risk. Additionally, for rapidly obtaining access to animals, boat hooks could be used to lift the floor of the net pen and/or a stranding net can be used to safely strand or scoop animals. For planned medical procedures, a medical platform can be fitted within a net pen that can be raised by hydraulic lifts.

Benefits of using splash pools include: rapid access to animals; multiple options for water sterilization and filtration; easy visualization of animals; environmental control (warming or cooling the water and/or air). Challenges of splash pools include: equipment operation and maintenance for environmental control and filtration system; adjustment of animals to pool's acoustic environment; pool maintenance (cleaning, scrubbing) may cause stress to animals, as seen in harbor porpoise. To mitigate acoustic and maintenance-related stress, splash pools could be placed on noise-reducing pads, and additional pools could be available to rotate animals while pool cleaning is performed.

Bunskoek reviewed use of the concrete pool at Harderwijk, this requires filtration to maintain water quality and people in the pool when stranded) are first placed in concrete pool to reduce risk of hitting walls.

Due to species differences in adaptability to different housing options, several types of pools and pens were reviewed. Smith described types of short- and long-term housing used for bottlenose dolphins. These include purpose-built soft-sided popup pools, commercially available above-ground pools on rigid frames (15 x 30 feet and 5 feet deep), and floating net pens. All of these, including net pens, can be prefabricated, easily transported to remote locations, and assembled on site.

Van Elk described in ground concrete pools used in Harderwijk and net pens used for porpoises in Denmark, and Abel described net pens used for other small cetaceans in Asia and Mexico and noted that the use of net pens with natural bottoms is good for allowing natural foraging on and in the sand or mud. One-inch stretched mesh netting is probably suitable for porpoises, however salmon farming net-pen technologies should be reviewed for application with vaquita.

Challenges of using net pens include: time it takes to gain access to the animal in an emergency (a medical platform can be fitted within the net pen that can be raised by hydraulic lifts); algal build-up on sides, which can be ingested by the animals, requires cleaning and use of high-pressure air/water to clean that can stress animals; the bottom floats above the seabed, but at low tide the bottom can rest on the seabed and the sides can billow, creating risk of entangling the animal(s).

Bunskoek reviewed use of the concrete rehabilitation and long-term maintenance pools at Harderwijk. Filtration is required to maintain water quality. People are in the water when stranded animals (that usually can't float when first admitted) are initially placed into the concrete pool in order to reduce risks of the porpoises hitting the walls or having difficulty surfacing to breathe. The larger outdoor facility includes a shallow area for conducting medical treatment and gates to allow management of animal groupings. Bunskoek noted that harbor porpoises are more sensitive to loud and sudden noises than bottlenose dolphins and this requires that trainers familiar with other species be alert to these differences when caring for or working with porpoises.

Recommendations for potential housing of vaquitas

- a. As species adaptability to enclosures varies and how vaquitas will respond to enclosures is completely unknown, the safest type of enclosure should be used initially. This should be close to the refuge, soft-sided, quiet and insulated from the immediate environment to mitigate unnecessary sound. One cetacean rehabilitation facility in Florida (Mote Marine Lab) accomplished this by constructing such a pool from an earthen berm covered by a plastic liner. The gently sloping sides and the earthen berm insulate the pool from external sounds and eliminate reverberations in the pool.
- b. Both an above-ground pool for intensive medical care and a net pen with minimal constraining walls should be available for initial temporary housing.
- c. At the time of initial capture and housing and onward, contingency plans and arrangements should be in place for release at any time if animals become stressed or do not adapt to a provisioned diet.
- d. Fish from local fishermen and frozen high-quality fish should be available for feeding.
- e. Personnel experienced in caring for porpoises (or other marine mammals considered sensitive to adaptation) should be on site to care for the vaquitas.
- f. If animals adapt to temporary housing, further pools for housing larger numbers and developing soft-release strategies should be built.
- g. Sites for net pens or beach pens with natural bottoms should be developed.

4. Veterinary care

Van Elk and Bunskoek reviewed veterinary care of stranded porpoises at Harderwijk Dolfinarium. Over the last ten years, despite the fact that these are animals that have been found on beaches or are otherwise sick or compromised, 53/95 stranded survived (about 57%) and 39 rehabilitated animals were released. Neonates stranded at under 4 weeks of age do not survive. There is no long-term tracking of released animals in Holland, although plans are underway to do so. Several porpoises have also been rehabilitated and released in the U.S. post-stranding (Rowles pers. comm.). Common problems in captive animals include ingestion of foreign bodies when under human care, pneumonia, and fungal and parasitic infections. Neonates possibly acquire nematodes congenitally or in milk and infections can flare up in all age classes when animals are stressed. Baseline blood values are important for assessing change and early signs of disease and should be taken regularly. Facilities for care should include equipment for imaging and endoscopy. Morphometrics, appetite and swimming activity are important indicators of health.

Requirements for veterinary care of vaquitas

- a. Given the unique nature of porpoise veterinary care, which is distinct from that for dolphins, at least one on-site veterinarian with experience in porpoise medicine should be available at all times. Trainers/handlers should be similarly experienced.
- b. Baseline hematology and serum chemistry values should be developed immediately so as to have normal ranges with which to detect changes in early stages of illness through regular blood sampling.
- c. Perform entrance health exam as soon as feasible, to include physical exam with routine small cetacean diagnostics.
- d. Appetite and activity need to be monitored carefully to detect changes in health status.

Given the prevalence of nematodes, de-worming should be undertaken on capture, with care following the Harderwijk protocol, and enclosures must be maintained free of foreign bodies that could be ingested.

5. Reproduction

Van Elk and Bunschoek reviewed reproduction of harbor porpoises in the Harderwijk Dolfinarium, and at the Fjord & Belt facility in Denmark. Mating behavior is regularly observed in captive porpoises. Males are extremely sexually active, often requiring separation of the sexes. All females that have been observed pregnant at Harderwijk calved successfully (4 of 6 lived to adulthood). Females admitted to rehabilitation at approximately two months old have reproduced successfully. Calves start to feed on solids at 3 months of age but may suckle for up to 2 years given the opportunity. One calf that did not begin to suckle within the typical time period was held onto the mother to successfully encourage feeding, and given milk collected from the dam. Artificial milk formula has not been used successfully to rear calves, so stranded neonates under one month old die, usually due to poor digestion. There has been little or no work on reproductive technologies for harbor porpoises, but techniques for storage of sperm from at least five species of cetacean are well developed, so opportunities to store semen from vaquitas should be used to preserve genetic material.

Recommendations for potentially enabling vaquita reproduction ex situ

- a. Undertake proof of concept studies involving capture, transport, and temporary holding to ensure long-term captive survival (as above).
- b. Identify or develop facilities and a long-term funding plan to hold animals for up to 50 years in collaboration with the Mexican dolphin display community.
- c. Have experienced husbandry staff and at least one veterinarian with experience in porpoise medicine on site for birthing and calf rearing periods.
- d. Determine the minimum number of animals needed for a viable ex situ population (see Ralls and Ballou 2013)
- e. House males and females together in a large pool or net pen, with pens for temporary separation of sexes, age classes, etc.
- f. Undertake research on captive reproductive technologies that might allow widening of the reproductive population beyond those held in captivity. In support of this, collect semen from fresh dead animals if opportunities arise

6. Release

As noted at the outset a captive breeding and release program for vaquita would be the first of its kind for cetaceans. The track record of release of cetaceans after stranding was recently reviewed by Wells *et al.* (2013). General findings indicate that animals survive better when released near others of the same species, and after minimal transport. Few cetaceans have been released after more than 6 months in captivity, and those that have been were released using gradual, “soft release” strategies (Gales & Waples 1993, Wells *et al.* 1998). Released animals in the U.S. are currently tracked with minimally invasive satellite tags that are attached with a single pin

through the dorsal fin, so that loss of the pin results in tag loss and minimal damage to the animal.

Recommendations for potential vaquita release

- a. Based on experience with harbor porpoises, in the case of short-term captive holding of vaquitas, or of rehabilitation of stranded and/or injured animals, release is a potentially viable option.
- b. Any discussion of captive care and any decision on eventual re-release of vaquitas into their natural range in the upper Gulf of California must be predicated on the absence of gill nets in the species range in order to prevent the deaths of animals released.
- c. Long-term development of captive care, reproduction and eventual release strategies should include consideration of soft release from large conditioning net pens, beach pens or lagoons, in the vicinity of the vaquita range.
- d. Released animals should be appropriately tagged to allow tracking and determination of their fate.

Decision framework

The removal of gill nets from the vaquita's range is essential to the species' conservation. However, as actions to prevent mortality in gill nets have been slow to develop, those that have been taken are of uncertain durability, and the vaquita population has continued to decline, emergency supplementary actions to conserve the species may be needed. Use of any *ex situ* tool must not hinder or slow down actions to ensure that suitable (i.e. gillnet-free) habitat for the species persists and the primary threat to the wild population is removed. The potential for controversy must not, however, delay the initiation of *ex situ* conservation actions until a point has been reached when such actions are no longer of value because the population has declined beyond any hope of recovery (Ridgway *et al.* 1989, Turvey 2008, Martin *et al.* 2012). The decision to pursue *ex situ* actions to conserve vaquitas should thus be made carefully, by evaluating the risks to the species, relative to leaving the entire population in-situ, of pursuing, a series of actions aimed at protecting them in captivity and breeding animals for release to supplement the wild population or re-populate the range.

Proposed actions using the precautionary approach

If the decision to pursue an *ex situ* option for vaquita conservation is made, a series of actions are proposed, each being contingent and dependent upon success of the previous one – see Figure 1 below. This takes a precautionary approach to vaquita capture and housing that is intended to minimize the risk to individual animals and avoid unnecessary or premature financial expenditure. The series of actions involves (1) locating vaquitas, (2) capturing vaquitas, (3) providing short-term housing for vaquitas, (4) providing long-term housing and enabling the vaquitas to breed, and (5) releasing animals (wild-caught and captive bred) once their natural environment is adequately protected from the danger posed by gill nets, i.e. their survival *in situ* can be assured (see Table 1).

This decision tree does not include the element of regulatory and policy approval for such a program to proceed. This subject was outside the expertise of the participants of this workshop. Required steps and appropriate authorities need to be identified.

As vaquitas are rare and infrequently observed, the most challenging action is likely to be capture of animals. Hence, investment in the development of holding facilities will likely be contingent upon demonstrating the feasibility of finding and catching vaquitas safely. As capture is likely to be difficult, the first capture efforts should aim to catch and tag an animal, with subsequent efforts proceeding to short-term holding with small holding facilities available as close to the capture site as possible. Tagging will enable assessment of the response to capture and possibly identify vaquita hotspots for further captures. If this is successful, and approvals for captive approaches are in place, then further housing pens and pools should be constructed immediately close to the vaquita refuge, so that additional animals can be caught, transported and housed. As vaquitas have never before been held in captivity, the response of vaquitas in pools of different designs, their appetite for different prey types, their health status and overall stress must be monitored carefully by experienced staff and adjustments to accommodations, diet and group size made accordingly. If a healthy animal does not adapt to captivity, it should be released as soon as possible at the site of its capture or in proximity to con-specifics within the vaquita range and fitted with a satellite tag to monitor survival and movements.¹ If animal(s) are healthy and stable after one month of captivity, further capture efforts should be considered and plans for construction of permanent pens for breeding and pre-release housing should proceed as soon as possible.

¹ NMFS release guidelines provide the most complete guidance on such releases

Figure 1. Simple flow diagram of proposed actions in developing and implementing a program of captive care, breeding, and release.

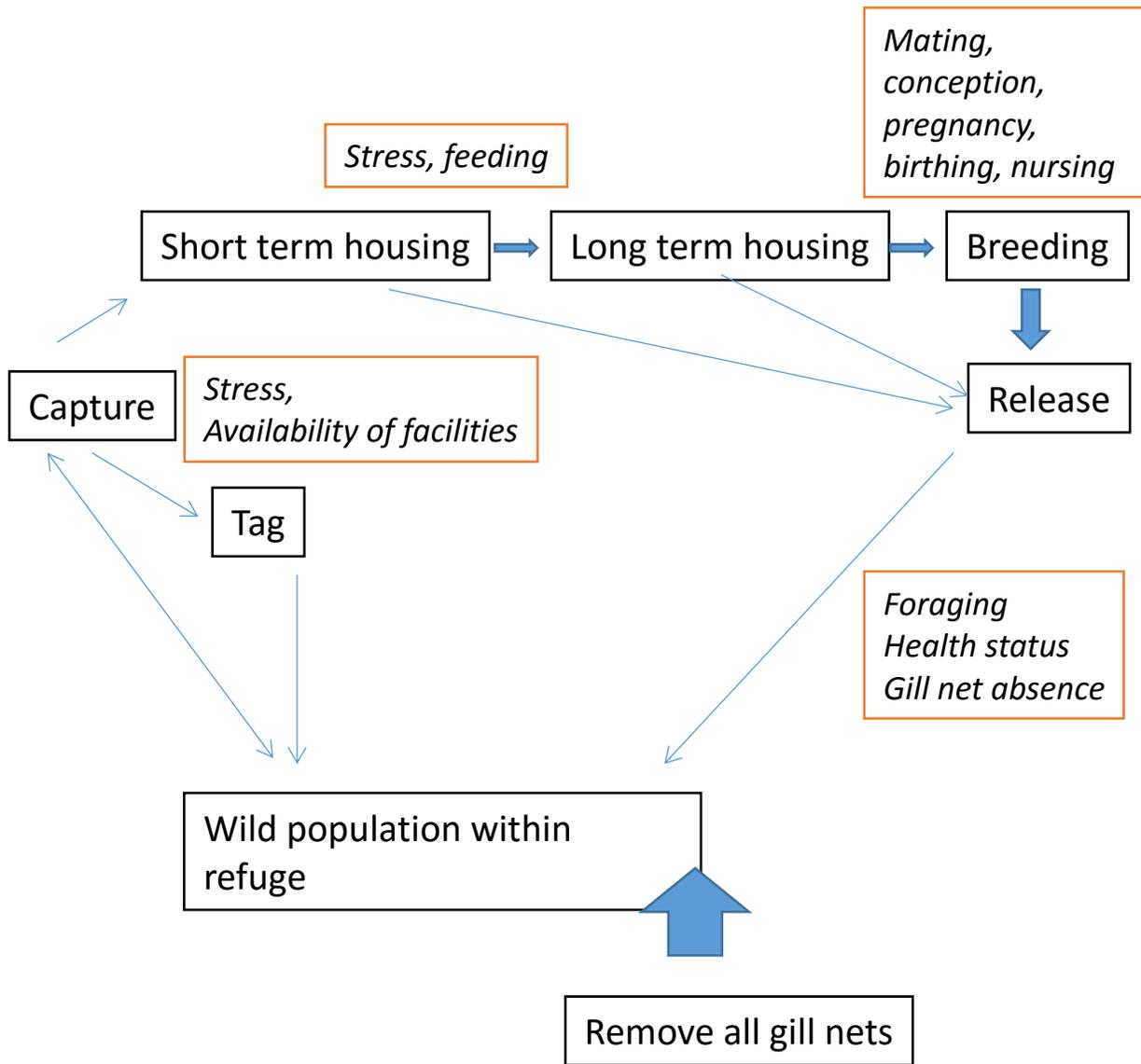


Table 1. Proposed sequence of actions for *ex situ* vaquita conservation²

Activity	Unknowns	Actions to address unknowns	Potential partners
Locate vaquitas	Detectability by spotter aircraft	Fly refuge during boat-based survey	SWFSC Eddy Kisfaludy LightHawk
	Detectability by small boat-based trained porpoise catchers	Trial with experienced crew	Heide-Jørgensen, Tielmann,
	Detection by trained <i>Tursiops</i>	Train <i>Tursiops</i> to detect <i>Phocoena</i>	U.S. Navy & NMMF
	Towed hydrophone array	Consult Barlow and Taylor	SWFSC
Capture	Approachability with small boats and response of vaquitas to herding	Trial with experienced crew	Heide-Jørgensen, Tielmann, Hanson, Wells, NMMF
	Response of vaquitas to light capture net presence	Trial with experienced crew	
	Response of vaquitas to handling	Trial with experienced crew, tag	
Temporary housing	Response of vaquitas to pen type	Provide popup and net pens	TMMC, NMMF,
	Group size for optimal housing	Have minimum of two pools available	Mexican dolphin display community,
	Husbandry requirements, Appetite	Provide variety of prey	Hardewijk Dolfinarium,
	Medical issues	Experienced veterinarian	AMMPA
Permanent housing and breeding	Ideal groupings	Observation by experienced staff	NMMF, Mexican dolphin community,
	Likelihood of mating, successful gestation, birthing	Observation by experienced staff	Harderwijk Dolfinarium,
	Calf behavior in enclosed area	Observation by experienced staff	AMMPA, AZA
Release	Adaptability of vaquitas to long-term captivity	Soft release of wild-caught animals	Wells, Gales, Read

² This does not include the series of regulatory steps and approvals that would be required to implement the activities discussed in this report.

	Ability of captive-born vaquitas to survive in wild	Soft release with mother or wild-caught animals	
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ANNEX 4: ANALYSIS OF VAQUITA *EX SITU* OPTIONS IN CONTEXT OF IUCN GUIDELINES

(Prepared by Peter Thomas, Randall Reeves and Frances Gulland in March 2016 as a background document for CIRVA-7)

Introduction

Given the very small number of vaquitas and the ongoing threats they face, the option of *ex situ* conservation must be openly evaluated. If the vaquita goes extinct, the question will be asked: Was *ex situ* conservation considered as an option and, if not, why not? We need to be ready to answer that question either affirmatively or otherwise convincingly.

The *IUCN Species Survival Commission Guidelines on the Use of Ex situ Management for Species Conservation* (IUCN Guidelines) provide a framework for deciding whether to explore *ex situ* approaches for conserving endangered species. Given what is known about vaquitas and the threats they face, it is relatively straightforward to identify needed information and thus begin to inform decisions.

The IUCN guidelines outline a five-step process which we use below as a way to begin discussion of whether and how to proceed. The September 2015 “Report of the *ad hoc* Committee for Vaquita Conservation, Protection and Reproduction on Feasibility of *ex situ* Conservation Actions for Vaquitas” (Feasibility Report) is available as a convenient and timely supplementary resource.

STEP 1. Compile a status review of the species, including a threat analysis.

There is no single, up-to-date, published status review for the vaquita although periodic reports of the International Committee for the Recovery of the Vaquita (CIRVA) have updated the information in the Red List documentation for listing the species as Critically Endangered in 2008. The following is a brief synopsis.

Status: The vaquita, an endemic porpoise with a small range in the northern Gulf of California, Mexico, is believed to have been declining since before it was described in 1958 and now numbers fewer than 60 individuals. The demographic composition and genetic viability of the species population is unknown. Its ecosystem is highly productive and carcasses examined to date appeared healthy.

Threats: Incidental mortality in gillnets (bycatch) has been a major factor affecting the vaquita population since at least the early 1940s. Although the commercial fishery for totoaba was

banned by the Mexican government in 1975, vaquitas have continued to die at an unsustainable rate in gillnets and other fishing gear. No effective conservation measures were implemented until 2005 and the measures introduced at that time proved far from adequate to stop the decline. The July 2014 meeting of CIRVA (CIRVA-5) concluded that at-sea gillnet enforcement efforts had failed, and that illegal fishing, especially the resurgent totoaba fishery, had increased. In response to the recommendations of CIRVA-5, in April 2015 the President of Mexico announced new measures to protect vaquitas. These included expansion of the protected area for vaquitas to encompass their entire range, a two-year ban on gillnets throughout this area, concerted enforcement, support for alternative fishing methods, and compensation to the fishing communities affected by the gillnet ban. However, the delay in implementing protective measures and the continuation of intensive gillnet fishing for many months after release of the CIRVA-5 report almost certainly had a severe impact on the vaquita population.

The gillnet ban is intended to remain in place for one more year, there is a significant enforcement presence in the northern Gulf, and independent observers are present. However, recent law enforcement actions against totoaba fishermen and detections of totoaba nets in the closed area indicate that enforcement is not fully effective. Independent observers continue to find totoaba gillnets deployed surreptitiously within the closed area, and two dead vaquitas were found there in March 2016. Importantly, it is uncertain whether the ban will continue beyond April 2017, especially given that the current Mexican administration will leave office in December 2018.

STEP 2. Define the role(s) that *ex situ* management will play in the overall conservation of the species.

A number of possible roles of *ex situ* management for vaquita conservation have been identified that are in-line with the IUCN Guidelines. The ultimate aim of any *ex situ* initiative would be to preserve the species for future release into fully protected (i.e. gillnet-free) wild habitat. Proximate aims could be temporary protection in a semi-natural environment (e.g. sea-pen, enclosed lagoon) until the risk of mortality in the Gulf has been eliminated (or at least greatly reduced), establishment of a self-sustaining captive population, or a combination of these. Given the precarious status of the population, it is possible that any *ex situ* effort would end up consisting of long-term maintenance of a population *ex situ* after extinction in the wild, with preparations being made for reintroduction or assisted colonization if, when, and where feasible. There has also been some consideration of the value of maintaining vaquitas in captivity for the purposes of education, awareness-raising, and scientific research.

STEP 3. Determine the characteristics and dimensions of the *ex situ* population needed to fulfill the identified conservation role(s).

Biological factors to be addressed when designing a possible *ex situ* program

- Number of founders to obtain genetic or demographic goals: Given the small number of vaquitas potentially available as founders, setting such goals may not be a realistic option. In this emergency situation, the most important consideration is whether two or more reproductively capable individuals can be maintained *ex situ* with the possibility of breeding.
- Number of individuals to be maintained: Again, in this emergency situation the number of founders is bound to be small and the number ‘to be maintained’ can only be expressed as ‘as many as possible’.
- Whether propagation required: While a program might be initiated with the goal of simply rescuing individuals from dire, unmanaged threats in the wild, any *ex situ* program would by necessity investigate the feasibility of captive propagation, and, if feasible, pursue it.
- Length of program: It is anticipated that the length of a program for captive propagation of porpoises for eventual release into the wild could be on the order of at least several decades.
- Risk of artificial selection during period of program: This is not considered a risk as long as genetic evaluation is conducted to ensure that breeding between closely related individuals does not occur.
- Whether the *ex situ* phase is to be followed by release: The goal of any such program would be eventual release of animals back into a gillnet-free environment. Experience with harbour porpoises indicates that it should be possible to release rehabilitated vaquitas or return captured vaquitas to the wild. Release of captive-born animals into the wild is a subject of great uncertainty.
- The type of environment required to maintain individuals in suitable conditions: The topic of both temporary and longer-term holding facilities for porpoises is addressed in detail in the Feasibility Report.

Practical considerations

The Feasibility Report considers the practical aspects and feasibility of capturing vaquitas and maintaining and breeding them in captivity, based largely on experience with capturing harbour, Dall’s, and finless porpoises and the more general experience of transporting, maintaining, and breeding small odontocetes. Some of the relevant conclusions highlighted in the Feasibility Report include:

- Geographic location of *ex situ* efforts: Ideally, initial efforts would be conducted in small field facilities adjacent to the vaquita’s range. With proof of concept, long-term efforts should be based in established marine mammal care facilities within Mexico.
- Welfare issues: A precautionary stepwise approach to investigation of the feasibility of locating, capturing, maintaining, and eventually breeding vaquitas would ensure that the program adheres to the highest standards in all respects, minimizing risk to the wild population.
- Legal and regulatory requirements for removing individuals from the wild and transporting or maintaining them: These have yet to be specifically determined. The Feasibility Report recommends that the animals be kept in Mexico but does not attempt to address “the element

of regulatory and policy approval for such a program to proceed” as this subject was outside the expertise of workshop participants. Required steps and appropriate authorities still need to be identified.

STEP 4. Define the resources and expertise needed for the *ex situ* management program to meet its role(s) and appraise the feasibility and risks.

The IUCN Guidelines state, “it is ... critical to evaluate the resources needed, the feasibility of successfully managing such a programme, the likelihood of success at all steps of the programme, including where relevant any subsequent return to the wild, and the risks, including risks to the species in the wild and to other conservation activities.”

The Feasibility Report lays out a framework for assessing the response of vaquitas to each step of an *ex situ* program, and a process for determining such a program’s practicality and eventual viability. The approach is intended to minimize the risk to individual animals and avoid unnecessary or premature financial expenditure. The series of actions includes (1) locating vaquitas, (2) capturing vaquitas, (3) providing short-term housing for vaquitas, (4) providing long-term housing and enabling the vaquitas to breed, and (5) releasing animals (wild-caught and captive-bred) once their natural environment is adequately protected from the danger posed by gillnets, i.e. their survival *in situ* can be assured. The report lays out the specific requirements in terms of expertise, equipment, and facilities for location and capture, transport, temporary and permanent housing, veterinary care, potential reproduction, and release of vaquitas.

Among the factors identified in the IUCN Guidelines as needing to be determined to assess feasibility and risk is “the likely impact on the remaining wild population and its habitat of establishing, or not establishing, an *ex situ* population.” At their current low numbers it is very difficult to make this determination for vaquitas. At larger numbers, quantitative approaches to estimating feasibility and risk could be of value, but in the present circumstances decision-making necessarily will depend on expert opinion and qualitative evaluations. Any calculation must be made without the benefit of good information on the demography of the wild population or the feasibility and viability of capture, maintenance, and *ex situ* reproduction.

The Guidelines go on to note that “special consideration may be given to situations in which all remaining wild individuals may need to be removed due to a very high probability of extinction in the wild that cannot be mitigated in time.” As discussed below, one choice that managers may soon face is between leaving the small remnant vaquita population to die out in the wild and attempting to capture the remaining individuals in the hope of maintaining the potential, however remote, for species survival, propagation, and eventual reintroduction.

The probability of obtaining the required resources: Given public concern, and the great interest of individuals and institutions in finding means to conserve the vaquita, there is a high level of potential support for any well-considered program, whether *in situ* or *ex situ*. The monetary

resources required to implement each element or the totality of an *ex situ* program have not been assessed, but given the stepwise approach laid out in the Feasibility Report, a funding strategy can be developed to generate resources for each step, with the success or failure of that step dictating what is required for the next.

Available expertise: While no one has direct experience or specific expertise in capture, husbandry and captive care of vaquitas, there is considerable experience with and expertise on caring for other porpoises and for small cetaceans more generally. It is clear that the qualified professional community is ready and willing to engage fully in meeting the challenges of saving the vaquita.

Critical governmental and non-governmental partner institutions and probability of successful collaboration: The agency or agencies of the Mexican government that have the authority to initiate and administer such a program have yet to be identified. It is likely that private or public institutions in Mexico, the United States, the Netherlands, and other countries would be very strong supporters and long-term partners in the effort.

The degree of compatibility of the ecological, demographic, behavioural, or other characteristics of the species with the type of *ex situ* management proposed: This would be evaluated through the stepwise program outlined in the Feasibility Report.

Requirements to ensure the welfare of any living individuals *ex situ*: As mentioned earlier, any program needs to adhere to domestic and international standards for welfare, and include the highest standards of handling and care to reduce the risks of stress or suffering.

Legal and regulatory requirements for the project: Again as already mentioned, the applicable legal and regulatory requirements for such a program in Mexico need to be identified and any proposal would have to meet those requirements. All necessary permits would need to be secured and inspections carried out.

STEP 5. Make a decision that is informed (i.e. uses the information gathered above) and transparent (i.e. demonstrates how and why the decision was taken).

*The decision to include *ex situ* management in the conservation strategy for a species should be determined by weighing the potential conservation benefit to the species against the likelihood of success and overall costs and risks of not only the proposed *ex situ* programme, but also alternative conservation actions or inaction.*

To date there has been no attempt to systematically evaluate the pros and cons of an *ex situ* program for vaquitas. The fundamental question of what might trigger such an approach has been avoided as population estimates have plummeted from over 400, to 200, to around 100, to under 50.

There is no conceptual guidance on when would be the right time to consider or initiate an *ex situ* effort. At present, there is no integrated conservation strategy for vaquitas against which to evaluate *in situ* efforts, or to consider *ex situ* options. Current vaquita conservation measures have been established by the Mexican government based on recommendations of CIRVA and the Presidential Commission on the Conservation of the Vaquita. In terms of future work, CIRVA is an international advisory body with no decision-making role, and the status of the Presidential Commission is uncertain. Decisions on all aspects of vaquita conservation, including *ex situ* approaches, require a transparent, inclusive process led by the responsible Mexican authorities and the experts on cetacean science and conservation.

Decision-making is always influenced by public opinion and public perception. In general, public opinion appears to be strongly in favour of exploring all means to save the vaquita. It is common for citizens to ask why no vaquitas are being maintained in captivity. At this point, the answers given to this question often fail to acknowledge the gains made recently in capture, care, captive breeding, and release of harbour porpoises as well as the grim reality that time has nearly run out to save the vaquita in the wild: For example, “Keeping these animals in captivity would be challenging; the lack of previous experience capturing and holding vaquitas makes the risk of failure (i.e. unintended loss of animals) too high.” Or, “There are too few left and any removals from the wild would simply add to the species’ endangerment and make extinction more likely.” It is also commonly assumed that if an *ex situ* program were announced, this would undermine efforts to protect the northern Gulf ecosystem and lead authorities to abandon measures to improve fishery management. Therefore, as stated in the Feasibility Report, the ultimate aim of any *ex situ* initiative must be explicitly stated to be the release of vaquitas back into their natural wild habitat as soon as full protection from incidental mortality can be assured.

The IUCN Guidelines call for evaluation of the relative importance (weight) of potential conservation benefit *vs.* likelihood of success. Costs and risks will vary for each species and situation, according to factors such as, but not limited to:

- The severity of threats and/or risk of extinction of the wild population;
- The significance of the species (ecological, cultural, sociological, economic or evolutionary distinctness, value of the species in leveraging large scale habitat conservation, etc.); and
- Legal and political mandates.

As a simple first such analysis for the vaquita:

- The severity of the threats and extreme, immediate risk of extinction dictate that all conservation avenues must be thoroughly explored.
- Visual and acoustic surveys confirm that the total species population is below 50 individuals. The demographic structure and reproductive potential of the remaining population are completely unknown.

- The risk of gillnet entanglement, while likely ameliorated to some degree for the time-being, remains due to the inexorable economic incentive to fish illegally for totoaba. Therefore conditions in the wild remain dangerous for vaquitas.
- While the President of Mexico has stated his personal commitment to the survival of the vaquita and while the species is given special protection under Mexican law, it is uncertain how effective that protection is at present and how long the current level of compliance and enforcement can be maintained. There is a real possibility that the present gillnet ban will be compromised or even lifted after April 2017.
- A plan has been developed to explore the feasibility of *ex situ* approaches, based on the input of international experts on porpoise and dolphin capture, rehabilitation, husbandry, and breeding. This plan could be initiated in a stepwise manner with minimal cost.

Conclusion

The fundamental question of what would trigger an *ex situ* approach for vaquita conservation remains unanswered. In retrospect, it is easy to say that if we could again be in the situation of having several hundred vaquitas alive in the wild, we would almost certainly put in motion a plan to seriously explore *ex situ* options.

However, now that fewer than 50 animals are left, the decision to attempt the capture and removal of any animals, even if only as a feasibility exercise, is much more difficult.

- Removing reproductive individuals (regardless of how well they survive in captivity or semi-captivity) means reducing the viability of the wild population.
- There is valid concern that animals will be frightened, injured, or even die in the process of capture, transport, or maintenance in captivity.
- On the other hand, all animals in the wild are at high risk of gillnet entanglement and death. It is not known, and in fact may be impossible to know, if it is more dangerous to be a vaquita in the wild or a vaquita in captivity.
- If animals can be maintained in captivity, they will have the potential to 1) survive even if, or as, wild animals continue to die in fishing gear (whether legal or illegal), 2) be released at a later time, 3) contribute to captive reproduction, and 4) otherwise contribute to the well-established goals of *ex situ* conservation approaches.
- Initiation of a careful, stepwise *ex situ* conservation program designed to test the methods and viability of each element before proceeding to the next, and that emphasizes precaution for the health of the animals at every step and stage, may be worth the inevitable losses to the wild population represented by captures.

Finally, it is important to consider the situation if there were only, say, ten animals left. In such a situation, in the absence of any experience with *ex situ* conservation efforts, it would be difficult

to accept the unknown risk of bringing the last individuals into captivity, and this would likely mean the remaining animals are left in the wild. If, however, there were a body of experience indicating that an *ex situ* effort posed an acceptable level of risk in a situation of last resort, it might be deemed appropriate to attempt to bring those last individuals into captivity, in the hope that their habitat would someday be improved and the captive population would enable re-establishment of the species in the wild. At this point we do not have the experience to know if the risks of *ex situ* approaches are too great to contemplate such a last-ditch intervention, but there is still the possibility of learning more about those risks.

As recognized in the proposed stepwise plan, capture, *ex situ* maintenance, and captive breeding of small cetaceans is a difficult and long-term endeavor with no guarantee of success. There is no precedent for such a plan being used successfully in the conservation of small cetaceans. Captive-born individuals have not been released and shown to have adapted to life in the wild. However, harbour porpoises (reasonably close relatives of vaquitas) now survive well and breed readily in captivity. Rehabilitated harbour porpoises have been returned to the wild and wild-caught porpoises have been tagged, released, and tracked for long periods, with little evidence of compromised health, condition, or survival. Some encouragement can be found in viewing the harbour porpoise (but not the Dall's porpoise) as a model for the vaquita in terms of ability to capture, care for, and breed in captivity.

DRAFT Recommendations

1. CIRVA concludes that at the present level of vaquita abundance, *ex situ* conservation approaches need to be seriously considered – any measures taken towards implementing such an approach would have to be undertaken with the goal of returning animals to a healthy gillnet-free natural habitat.
2. CIRVA thanks the *ad hoc* Committee for Vaquita Conservation, Protection and Reproduction (Vaquita CPR) for producing the Feasibility Report and concludes that it provides a solid roadmap for exploring the practicalities of *ex situ* conservation for vaquitas in a stepwise manner.
3. CIRVA therefore **recommends** that appropriate authorities of the Mexican government be briefed as soon as possible (no later than June 30, 2016) on the Feasibility Report by members of the International Vaquita CPR.
4. CIRVA further **recommends** that appropriate authorities of the Mexican government, after being advised by the International Vaquita CPR, move ahead to evaluate *ex situ* options including:
 - Outlining permitting requirements for finding, capture, handling, and captive maintenance (within one month).
 - Developing efficient methods for locating vaquitas in the wild.

- Using methods identified in the Feasibility Report, secure funding and implement a dedicated field program to explore the feasibility of locating and capturing vaquitas. If capture and handling are achieved and judged both feasible and safe for the animals, affix satellite tags to one or more animals to track movements (within 7 months).

CIRVA will meet in September 2016 to evaluate progress on these three elements and to modify or add to these recommendations as appropriate.

ANNEX 5: TERMS OF REFERENCE FOR STEERING GROUP ON EX-SITU CONSERVATION

Terms of Reference for Steering Group on Ex-Situ Conservation

CIRVA recommends the establishment of a Steering Group to consider the topics listed below. The Steering Group should convene as soon as is practicable and report back to CIRVA as soon as possible. The Steering Group should:

1. Develop a field protocol and program to evaluate and test the feasibility of locating and capturing vaquitas, and propose a field team with the required skills and expertise;
2. As soon as practicable, evaluate and test the feasibility of establishing and maintaining short-term holding facilities for vaquitas in the Upper Gulf of California;
3. Assess requirements for funding, permits and logistics for actions 1 and 2 above; and
4. Draft a decision tree to evaluate this work and guide possible future ex-situ conservation actions.

The SG should be convened by a member of CIRVA (Gulland) and include expertise in the following fields:

1. Capture and handling of wild dolphins and/or porpoises (e.g. Wells);
2. Veterinary care and husbandry of porpoises (e.g. Van Elk);
3. Establishment of temporary holding facilities (e.g. Smith);
4. Local environmental conditions, logistics and permits (e.g. Jaramillo).

ANNEX 6: SUMMARY OF FINDINGS OF MERIDA ALTERNATIVE GEAR WORKSHOP

Following is a summary of findings by the Workshop, in addition to those described and discussed in the main body of this report:

Table 6-1 – Summary of research protocols recommended by Mérida Workshop

Gear	Technical specifications	Effort	Recommendations
Shrimp trawl	Selective Net RS-INP-MX with specifications in the Mexican Norm NOM-002	20 to 30 skiffs for all UGC	Not only evaluate performance but also gather economic information and allow small variations to the design of the net. Only skilled fishermen
Finfish trawl	Original design with modifications in the bag, size of the net and doors. Construct a scaled down version to achieve more appropriate net spread.	10 skiffs per town	Include sweeps to improve performance in muddy bottoms. Get data on height and spread with sensors. Only skilled fishermen
Pots for fish	5 types of pots (many different kinds are available) considering the original design, plus other 4 designs that allow fishers to carry more pots per fishing journey	5 skiffs per town	To conduct a bait experiment before making the tests of pots. Only skilled fishermen
Hooks and lines	Trawling multi-line hooks/handheld hooks 0.06-0.8 triple hooks (sierra) [longlines are banned, so only these kinds permissible]	5 skiffs per town	Daylight fishing Spring tides and neap tides 1 st quarter of the moon. Only skilled fishermen

Proof of concept studies – In addition to the research described above, the experts discussed proof of concept studies for promising ideas that are not ready for formal tests. They ranked new ideas and **recommended** moving forward with four of them: (1) comparison of catch efficiency using diesel-powered vessel(s) vs. traditional outboard motors; (2) mini-seine net; (3) modifications to the small trawl; and (4) stow nets.

Onboard observers and electronic monitoring – The Workshop discussed data collection protocols necessary to achieve quality results from proposed experiments. Experiments with onboard observers, if applied correctly, could give more accurate information than alternate systems, but, if not selected or coordinated properly, the reports of the observers might be biased. The use of onboard observers would likely increase the costs of the experiments so other options such as electronic monitoring and the use of dockside recorders/observers should be considered in some cases to reduce the costs of the experiments. INAPESCA should consider different monitoring systems and choose the most reliable, accurate and cost-effective for each case.

Participation of other organizations – The correct application of the experimental protocols will require different and diverse skills in addition to technical capacity. INAPESCA has the technical capacity for implementing the research protocols; however, the experience of Civil Society Organizations in the management of field projects would contribute to better management of the experiments. Pronatura-Noroeste should support INAPESCA in the management of onboard observers. The Intercultural Center for the Study of Deserts and Oceans (CEDO) should help with the electronic monitoring and dock observers. Noroeste Sustentable (NOS) could help with the socialization of the tests. Pesca Alternativa de Baja California (Pesca ABC) could participate directly in the different tests. WWF should play an important role to help facilitate the participation of the group of experts during the experiments.

Scope of the protocol – INAPESCA will define and refine the research protocol(s) on the basis of the recommendations of the expert group. This will include tests with experimental gear, improvement of developing gear types, and evaluation of the economic performance of the selective net RS-INP-MX. The application of the norm NOM-002 that mandates the use of the selective net for catching shrimp in the Upper Gulf should be the responsibility of CONAPESCA and is independent of this protocol.

ANNEX 7: SEA SHEPHERD CONSERVATION SOCIETY

CIRVA 7 presentation summary

- **Problem 1:** Continuing demand for totoaba swim bladders in China needs to stop.

Suggestion:

1. A targeted embargo against Chinese markets by the US and Mexico combined.

- **Problem 2:** Fishermen use corvina fishing, sport fishing, or “transiting” as an excuse to be out at night and mask their illegal activities under the cover of legitimate licenses.

Suggestions:

1. No pangas should be allowed to navigate after sunset and until sunrise.
2. All pangas should be required to launch only from a few specific ramps, which are tightly controlled by the authorities.
3. For any panga wishing to launch or returning, soldiers should perform a thorough search of the panga for illegal gear and check for appropriate licenses. Specially trained dogs should also be used.
4. Implementation of a simple digital tracking system, RFID chips, to log panga activity, assigned to each panga and attached in a secure, permanent manner.

- **Problem 3:** Corruption makes it possible for illegal fisherman to go through all the surveillance and still poach.

Suggestions:

1. Internal investigations.
2. Officials in key positions should be paid sufficiently so that bribes are not an issue.

- **Problem 4:** The current laws for punishing poachers are not strong enough.

Suggestion:

1. Criminal penalties must be used and include imprisonment just as for other illegal substances such as drugs. Financial penalties must be greatly increased to match the lucrative nature of the black market for totoaba swim bladders.

- **Problem 5:** Video evidence collected is useful only for operations and not for prosecutions. Criminal acts have to be witnessed first-hand by an appointed authority; this makes it extremely difficult to apprehend and convict any poachers.

Suggestion:

1. It must be made easier to admit evidence of criminal misconduct into court.

- **Problem 6:** Some types of fishing vessels have encountered problems with totoaba nets fouling their gear. There was a system for reporting this to PROFEPA and handing over illegal nets with immunity but it has been discontinued. Now fishing vessels reportedly dump any entangled nets in shallow, rocky waters.

Suggestion:

1. Reinstate the system whereby other types of fishing boats can hand over illegal totoaba nets without risk of punishment.

- **Problem 7:** The corvina season provided the greatest cover for poachers to continue their activities as it coincides with the totoaba season.

Suggestion:

1. Cancellation of corvina fishing.

- **Problem 8:** Nets inside the Northern Gulf of California Biosphere Reserve, are killing all the biodiversity of the area.

Suggestion:

1. If the Biosphere Reserve is to remain a place of abundant life and biodiversity, fishing of any kind should not be allowed.

- **Problem 9:** The gillnet ban expires too soon to give the vaquita a chance to recover.

Suggestion:

1. The ban needs to be in place long enough for the vaquita to have time to reproduce and reach healthy numbers. We strongly recommend a permanent gillnet ban on commercial fishing and on the use of gillnets and longlines from small boats operating in the Northern Gulf of California.

ANNEX 8: THE CORVINA FISHERY IN THE UPPER GULF OF CALIFORNIA: ARE WE REPEATING HISTORY?

Octavio Aburto-Oropeza

Gulf of California Marine Program at Scripps Institution of Oceanography

Gulf corvina, *Cynoscion othonopterus*, are a vital component of commercial fisheries in the Upper Gulf of California, but the lack of a holistic and long-term vision for the conservation and exploitation of this natural resource has thus far prevented sustainable fishery management. The commercial fishery for Gulf corvina is economically significant, especially for the town of El Golfo de Santa Clara in Sonora, and has direct conservation impact regionally because it takes place inside the Upper Gulf of California and Colorado River Delta Biosphere Reserve. The fishery primarily targets the species' spring spawning aggregations; small boats use gillnets with a mesh size of 5 $\frac{3}{4}$ inches and lengths of up to 293 m to harvest fish as they move to the Colorado River delta to spawn. Management guidelines for the corvina fishery are controversial, mainly because of the lack of good enforcement. Other conservation and management actions that have been put in place in the region have made the fishing dynamics even more chaotic for fishers and local authorities during the season. These actions include a total catch quota for corvina and the two-year gillnet ban implemented to protect the vaquita marina, which in turn have facilitated the growth of a complex black market network for totoaba swim bladders (fish maw).

The price of corvina meat has not varied much in the last eight years (average MX\$13.3, Std. Dev. 2.5), however the price of a kilogram of corvina bladder has increased 1,273% in the same period of time. Our estimates suggest that on top of the MX\$202,700,000 generated by the corvina meat fishery each year, the corvina bladder market is generating an additional MX\$100,000,000 for the local economies during the fishing season. The problem is, just as happens with other threatened/endangered species, when a "byproduct" (in this case swim bladders) is more valuable than the product as a whole (fish meat), the incentive to waste increases. In the case of Gulf corvina, it is resulting in more overfishing. Our results once again illustrate that extreme and isolated conservation and management actions, which do not account for the livelihoods of the local extractive sectors, are unlikely to solve problems over long-term scales. The best-case scenario is always one in which the extractive and conservation sectors involved collaborate towards a commonly shared goal, something which is often easier said than done. Without this in the Upper Gulf of California, polarization between the conservation and fishing sectors will increase and local livelihoods in the region will continue to worsen.