

DETERRENCE MEASURES RESULT IN SUBSTANTIAL REDUCTION OF ILLEGAL GILLNETTING IN THE VAQUITA REFUGE'S ZERO TOLERANCE AREA IN EARLY SHRIMP SEASON 2022

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In 2022 there was a major new development in the Zero Tolerance Area (ZTA), the 225km² polygon inside Mexico's Vaquita Refuge in the Upper Gulf of California. The ZTA, which was delineated to [encompass](#) all recent vaquita acoustic detections, is subject to the strictest regulation since [September 2020](#) as a no-fishing and no-entry zone. However, to mitigate persistent violations of the ZTA by fishers using illegal gillnets, between [July 8](#) and September 30, the Mexican Navy installed a grid of 193 gillnet-deterrent structures on the seabed. They were lowered by crane into the water and placed in a grid [about 1.1 kilometers apart](#) over the summer (a time of low fishing activity). The structures are concrete blocks a meter square, with two 3.5 meter tall 1 ½ inch diameter iron rebar hooks protruding from the top, intended to entangle bottom-set gillnets as they drift with the tides.



Anti-trawl structures have been used by other countries to stop trawl nets from operating in protected areas (trawl nets are dragged along the seafloor), but this approach has never been tried against gillnets outside of shallow waters¹ (ZTA depths range from 10-30 m). Counts of fishing skiffs (pangas) in the ZTA from [Sea Shepherd Conservation Society \(SSCS\)](#) and scientific vaquita surveys were used to determine if there were any initial deterrent impacts (see [Sources and Methods](#) at report end for details).

Open season for shrimp, the most valuable commercial seafood type fished in the Upper Gulf, runs from the end of September to mid-March, with the bulk of the harvest occurring in early season in October and November (Sustainable Fisheries Partnership, pers. comm.). In recent years, this early period of shrimp season has been characterized by large concentrations of pangas using illegal gillnets in the ZTA. For example, the group of scientists participating in fall visual surveys for vaquitas [reported that](#), “substantial gillnetting was observed within the ZTA in both 2019 and 2021, and fishers did not attempt to disguise their illegal activity.” The highest ever recorded count of pangas in the ZTA in recent years was in early shrimp season: November 3 2021. After installation of the deterrent structures in fall 2022, the maximum number of pangas seen in a single count was markedly lower than in previous years (Table 1).

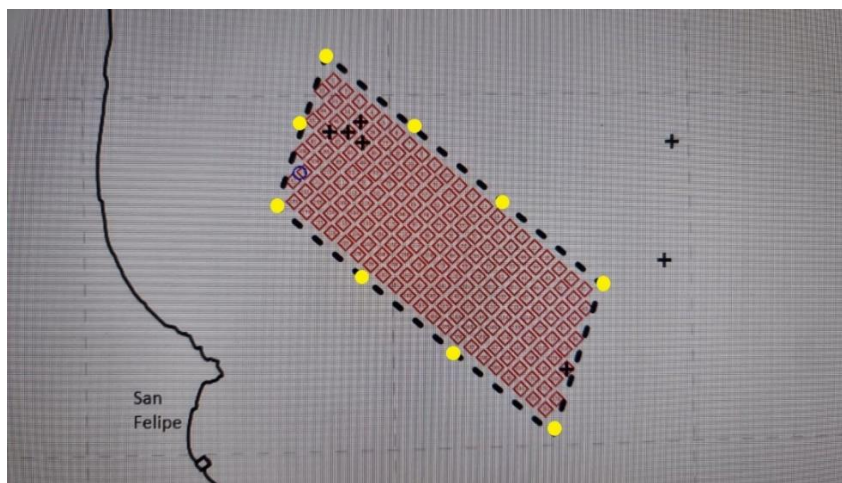
¹ Marine Conservation Cambodia (pers. comm.) has successfully used smaller structures to deter crab gillnetting in waters <10 meter deep.

Table 1. Highest numbers of pangas observed gillnetting in a single count during early shrimp season in the ZTA before and after installation of 193 gillnet-deterrent structures

Year	Before installation			After installation
	2019	2020	2021	2022
Highest number of pangas counted	87	>50	117	30
Date of count	Oct 17	Oct 28	Nov 3	Oct 26
Monitoring period	Sep 2-6 Oct 15-27	Oct 8-Dec 31	Oct 20-Dec 31	Sep 10-Dec 4
Total number of counts performed	1	49	>300	>350

Placement of the structures was publicized by the Mexican government on [July 8](#) and [October 7](#). The two large Mexican Navy ships installing the structures were new to the area and visible from land and sea; local fishers took photos of the ships and shared them amongst themselves. Additionally [Pesca ABC](#), a San Felipe NGO partner of Cetacean Action Treasury, made five posts on its Facebook page in September through October, providing the ZTA coordinates and offering [to assist fishers](#) to input them into their GPS. Over a dozen fishers came to their office for assistance, and overall the posts garnered nearly 18,000 views. On [November 16](#), Pesca ABC warned the community in its social media that they knew of fishers getting their nets stuck on the structures. On [January 11 2023](#), another San Felipe CAT partner organization ([MAREM](#)) asked fishers on Facebook to share coordinates of lost nets to aid in their removal. Although the only public comment on the post was “*Nobody wants to cooperate,*” (which is illustrative of local non-compliance with the [December 8 2021](#) requirement to report lost fishing gear within 24 hours), ultimately eight sets of coordinates were provided by fishers (Figure 1). All six reported locations in the ZTA coincided with coordinates of the deterrent structures. It is notable that all are near the outer boundaries, which suggests that fishers may have been trying to stay just outside the area (although boundaries were marked with [large yellow buoys](#) by the Navy [in March 2022](#)).

Figure 1. Locations of lost nets reported by fishers in early shrimp season 2022; all six inside the ZTA map onto coordinates of gillnet-deterrent structures



Dashed line – ZTA boundary (12 x 25 km). **Red squares** – location of 193 gillnet deterrent structures inside the ZTA. **Blue circle** – location of lost net reported on known date (November 7 2022, within first spring tide of that month, see Table 2). **Black X** – location of nets lost in early shrimp season reported in January 2023, but unknown date. **Black +** - location of lost nets in the Vaquita Refuge outside the ZTA. **Yellow circles** – ZTA boundary marker buoys

It is [well known locally](#) that gillnetters prefer to work in spring tides (strong tidal fluctuations associated with the full and new moons, with approximately two such tidal periods per month). Maximum daily panga count data for 2021 and 2022 was grouped and averaged for consecutive spring tides (days where the tides at time of panga counts cycled >350 cm). On such days few shellfish divers, who prefer the weak tidal flux of neap tides and whose gear poses no entanglement risk to vaquitas, would be expected to be included in ZTA panga counts – see [Sources and Methods](#) at end for details on how this was determined. Although panga counts were not available for all spring tide days due to occasional absence of SSCS ships from the area, comparing consecutive tides for the two years suggests a significant reduction in gillnetting in the ZTA in 2022 subsequent to the first major fishing effort in the second October spring tide,² suggesting many fishers with gillnets began to avoid the area.

Table 2. Reduction in average maximum daily count of pangas in the ZTA over consecutive bi-monthly spring tides suggest that fishers using shrimp gillnets began avoiding the area (Dates of observation, number of observation days, and average tidal flux at time of count in parentheses)

Spring tide	Sep – 2d	Oct – 1st	Oct – 2d	Nov – 1 st	Nov – 2d	Dec – 1 st
2021	n/a	n/a	27.6 pangas (20-24 [4 days]; 382 cm)	74.5 pangas (Oct 31-Nov 3 [4 days]; 454 cm)	42.5 pangas (16-20 [4 days]; 384 cm)	41.6 pangas (1-5 [5 days]; 481)
2022	0 pangas (28-30 [3 days]; 396 cm)	0.4 pangas (6-13 [5 days]; 465 cm)	21.3 pangas (21-27 [4 days]; 452 cm)	14.8 pangas (5-8 [4 days]; 500 cm)	11 pangas (26-28 [2 days]; 360 cm)	5.8 pangas (1- 4 [4 days]; 395 cm)
<i>Reduction</i>			33%	81%	74%	86%

Active deterrent actions by the Mexican Navy facilitated through [SSCS cooperation](#) increased significantly in the 2022 early shrimp season compared to the previous year (Table 3). SSCS ships assist compliance monitoring by sending situation reports (SITREPs) of gillnetting in the ZTA; Navy actions are described in [SSCS daily Scientist reports](#). The Navy was generally responsive to SSCS SITREPs during the spring tides of 2022, and was observed to “drive pangas out of the ZTA” on multiple occasions, with several instances where gillnets were seized or fishers directed to remove them. In contrast, although Navy patrol boats were present during the 2021 fall vaquita survey (first two spring tides in Table 3), [no interaction with pangas](#) was observed (in ten days at sea). Subsequently Sea Shepherd [ship logs](#) did not note any Navy activity or interdictions in the ZTA (although this could be an omission as observations of enforcement were not standardized for inclusion in SSCS reporting until [January 2022](#)).

Table 3. SSCS observations of approximate number of pangas engaged with by Navy patrol speedboats in and around the ZTA during early shrimp season spring tide periods

<i>See Table 2 for spring tide dates monitored</i>	Oct – 2d spring tide	Nov – 1 st spring tide	Nov – 2d spring tide	Dec – 1 st spring tide
2021	0	0	0	0
2022	18	24	6	25

² Due to Hurricane Kay striking San Felipe September 8 2022, causing damage to houses on shore and washing large quantities of potential net-snagging debris in the sea, shrimp season got off to a late start, with little activity in the ZTA witnessed by SSCS in during the first two spring tides of shrimp season. During these first two tides local fishers said their catches were very low, which may also have contributed to low fishing effort until late October.

In past years, gillnetting effort for shrimp has been observed to shift outside the ZTA in mid to late shrimp season as shrimp move to deeper water, so a decline of such activity within the ZTA over time would be expected and is indicated for both 2021 and 2022 in Table 2. Fewer pangas in the ZTA in 2022 compared to 2021 is unlikely to be the result of fewer pangas fishing for shrimp (lower fishing effort), although this cannot be verified as SSCS did not begin to record panga counts systematically outside the ZTA until late December 2021. Anecdotally 2022 was considered a comparatively poor season in terms of harvest volume, but shrimp is the most sought after and lucrative category of commercial seafood in the Upper Gulf, and fishing effort for shrimp has [increased since 2019](#). [In early shrimp season of 2013](#), the average daily number of fishing trips out of San Felipe was 56.6, with frequent observations of over 100 panga fishing trips. During 15 days of monitoring between November 6 and December 6 2022 at San Felipe embarkation points, MAREM community catch monitors recorded an average of 119 pangas returning to San Felipe after shrimp fishing trips, ranging from 16 on November 28 to 247 on November 8 (pers. comm). Table 4 shows substantial shrimp fishing effort in 2022 by adding average daily maximum panga counts inside and outside the ZTA.

Table 4. Total average early shrimp season 2022 fishing effort based on maximum average daily panga counts in spring tides inside and outside of ZTA

<i>See Table 2 for spring tide dates monitored</i>	Oct – 2d spring tide	Nov – 1st spring tide	Nov – 2d spring tide	Dec – 1st spring tide
ZTA (from Table 2)	21.3	14.8	11	5.8
Vaquita Refuge outside the ZTA	46.5	135	58.5	78.5
Total average fishing effort	67.8	149.3	69.6	84.3
<i>Percent of effort inside ZTA</i>	<i>31%</i>	<i>10%</i>	<i>16%</i>	<i>7%</i>

Going forward, it is concerning that pangas could potentially concentrate with gillnets around the ZTA in an edge effect, and continue to pose a risk to vaquitas which [are largely but not solely](#) restricted to the ZTA. Beginning on February 6 2023, SSCS is now conducting panga accounts in a one nautical mile buffer zone around the ZTA (SSCS pers. comm), and hopefully the Mexican Navy will be as responsive to SITREPs of illegal gillnetting around the ZTA as inside it. Time-bound international compliance processes in 2023 under [CITES](#) and the [USMCA](#) will further increase the pressure on Mexico to enforce its gillnet ban more effectively in the Upper Gulf of California. Although civil society organizations including SSCS, Museo de la Ballena and Pesca ABC are willing to contribute to the solution, it is also concerning that a program to frequently inspect and clean the deterrent structures of entrapped net material, which could pose a vaquita entanglement risk, has not yet been finalized and instituted, despite this being [a requirement of the Navy’s environmental impact permit](#). There will be continued urgency to prevent fishers with other types of gillnets from entering the ZTA as the fishing seasons changes in spring from shrimp to commercial finfish and illegal totoaba poaching. Some types of finfish and totoaba gillnetting are not bottom-set as shrimp gillnets are, and these types of illegal gillnetting may not be deterred by the seabed concrete structures, so that security for the [Critically Endangered vaquita population](#) will depend on increased voluntary compliance by the fishing community and enforcement actions by authorities.

Sources and Methods

Use of maximum daily panga counts: SSCS reported that illegal fishing in the ZTA [decreased at least 72%](#) in fall 2022 compared to fall 2021, based on average number of pangas counted per hour per day from the end of October to the beginning of December. However, it was not until January 2022 that SSCS began counting pangas on an hourly basis. The average number of counts per day in early shrimp season 2021 was 5, compared to 12 for 2022. Since shrimp fishers are rarely active for more than a few hours, to avoid the possibility that 2022 averages were biased lower by incorporating more hours of low activity, this analysis used the maximum number of pangas seen in a single count (a parameter [also measured by SSCS in 2021-2022](#)).

“Highest ever recorded number of pangas in the ZTA (November 3 2021):” based on sources for Table 1 below

Sources and methods for Table 1:

2019 – [Rojas-Bracho et al. 2019. Survey report for Vaquita Photographic Identification Research 2019](#). Although only one day of the survey was dedicated to “document the amount of illegal gillnetting in the ZTA” by counting pangas (methods detailed in Appendix 3 of the report), the authors note that “Pangas with gillnets deployed were seen within the Zero Tolerance Area (ZTA) on every day that we searched for vaquitas” (10 days total).

2020-2022 - Scientists working aboard SSCS ships have been counting pangas in the ZTA and adjacent portions of the Vaquita Protection Refuge since October 2020, although hourly counts were not systematically conducted until late December 2021. The panga detection methods have been consistent throughout: using radar scope imagery as well as visual confirmation of fishing activity using binoculars and an aerial drone. However, presentation of the results has changed year to year. Since the ZTA is a no-entry zone, any pangas without permission are in violation, but transiting pangas were not counted separately until [January 23 2023](#), so it is unclear whether earlier counts included pangas in motion which were unlikely to be fishing at the spot where counted. In addition, shellfish divers were not counted separately until fall 2022, although their presence was sometimes recorded in observational notes.

2020 – [Maps of monthly panga locations provided to IUCN Cetacean Specialist Group by SSCS](#). Daily maximum was set at >50 based on a pers. comm. from SSCS: maximum count of “50+ shrimp fishing pangas in the ZTA on the 28th of October.” The number of patrol days was used as the number of total counts from October 8 – December 31, although the actual number of daily counts were higher than one (SSCS pers. comm.).

2021 – Spreadsheet of daily maximum panga counts used to compile the [Pangas and Military Presence](#) report for the 2021 vaquita survey (October 20 – November 2); Annex 3 of the [2021 Vaquita Survey](#) (November 3 panga count), and online SSCS ship logs of the vessels [JPD](#) (November 16 2021 – May 26 2022) and [Sharpie](#) (November 18 2021 – May 18 2022). The total number of counts was compiled from the reports and by summing the total number of counts from the two ship logs from October 20 – December 31.

2022 – A spreadsheet for this report was compiled containing the highest single hourly daytime counts of “shrimp” or “net-fishing” pangas plus “unknown” or “likely net-fishing pangas” (but not including “divers”) taken from daily Scientist reports on SSCS [Illegal Fishing Report Vaquita Refuge webpage](#) and cross-checked with the SSCS graphic [Maximum amount of Illegal Net Fishing Vessels at the Same Time in the ZTA Each Day](#). The total number of counts was compiled by summing counts listed in each SSCS daily Scientist report from September 28 – December 4, although the monitoring period began earlier when the SSCS ship arrived in the area on September 10, shortly after Hurricane Kay (SSCS pers. comm.).

Sources for Figure 1:

Coordinates of the gillnet deterrent structures included as Annex 1 to the Mexican Navy’s [May 19 2022 application](#) for an environmental impact permit [were obtained](#) via a freedom of information request under Mexico’s national Transparency law, but not published. Coordinates of lost nets were shared anonymously by local fishers with Cetacean Action Treasury partner organizations.

Table 2 and shellfish divers:

Although “fishing activity of any kind” was [prohibited](#) within the ZTA in September 2020, some shellfish divers have nonetheless been [issued permits](#) to work within it, a seeming legal contradiction. SSCS only began to count diving pangas separately in fall 2022. It is possible that prior counts could be elevated by the inclusion of some diving pangas, which could lead to an overestimate of gillnet reduction. The [2020](#) report never mentions divers. The 2021 panga counts [reportedly excluded shellfish divers](#), but examination of the underlying data calls this into question. From October 20 to November 2 (spreadsheet of counts made during the 2021 vaquita survey), clusters of divers were noted only two days (October 30 and 31, during times when the tidal flux was <350 cm), and these pangas were apparently included in the total count. For the subsequent period, divers were only noted in the [JPD](#) ship log beginning in April 2022 (and were also presumably included in the total counts), and divers were never distinguished in the [Sharpie](#) ship log notes.

Although the decision to go out fishing is based on a variety of factors (personal, economic, weather), anecdotally it is generally understood within the fishing community that clam divers prefer to work in neap tides, when currents are weak, and that gillnetters prefer spring tides when currents are strong. This was validated by analyzing the 2022 SSCS data, so that the Table 2 comparison of 2021 and 2022 data focuses on spring tide dates when diver presence would likely be minimal. The tidal flux (difference between high and low tide in cm) was obtained for the time of each maximum daily count in 2022 from [CICESE tide charts](#) and included in the 2022 spreadsheet. Table 5 shows that few divers were present when the tidal flux was >350 cm, and therefore maximum daily panga counts for 2021 dates where the tidal flux was >350 cm are unlikely to be elevated by inclusion of diving pangas.

Table 5. Difference in amount of net fishing and diving fishing activity in the ZTA based on tidal flux at time of count in early shrimp season 2022

Tidal flux at time of maximum panga count	Average maximum panga count			Number of counts
	Confirmed and potential gillnet		Shellfish divers	
	In ZTA	Vaquita Refuge		
>350 cm	9.0	57.9	1.5	20
<350 cm	1.9	13.3	17.2	9

Sources for Table 3 and number of pangas engaged by Mexican Navy in the ZTA:

2021: [Pangas and Military Presence](#) report for the 2021 vaquita survey (October 20 – November 2); Annex 3 of the [2021 Vaquita Survey](#) (November 3 panga count), and online SSCS ship logs of the vessels [JPD](#) (November 16 2021 – May 26 2022) and [Sharpie](#) (November 18 2021 – May 18 2022).

2022: Number of pangas engaged estimated from text of SSCS daily Scientist Reports, based on pangas noted in the ZTA at time of Navy arrival in response to a SITREP and description of Navy Interceptor patrol boat interactions with pangas.

Sources for Table 4: same as for Table 2