Survey report for Vaquita Research 2021

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Executive Summary

A survey took place between October 17 and November 3, 2021 to estimate the number of unique vaquitas (including the numbers of unique calves) seen in the Zero Tolerance Area (ZTA). The Government of Mexico agreed to strictly enforce a region-wide ban on fishing with gillnets within the ZTA where the remaining vaquita are concentrated. Most of the 2021 surveys were conducted in this area. Two ships (the R/V Narval with ship height of 7.7m and the M/V Sharpie with ship height of 8.1m) used experienced observers to find and track vaquitas with methods developed for the earlier effort to capture vaquitas in 2017 (Rojas-Bracho et al. 2019). There were only 5 full days when winds were low enough (Beaufort 2 or less) to sight and track vaquitas. Vaquitas were seen on 5 days. There were no photographs of sufficient quality to match within or between years. All individuals that could be seen well appeared in robust health. The method of expert elicitation will be used to estimate the number of unique vaquitas and calves seen within the ZTA and will be reported separately.

Many gillnets were observed being deployed within the ZTA (a rectangle of about 288 km^2 or roughly 12 by 24 km). The ability to survey the ZTA was hindered by the numbers of pangas and gillnets. As was the case for 2019, the extent of the hindrance of fishing on survey efforts was documented on a single day (Appendix 3). On that day 117 pangas were counted inside the ZTA and positions show the difficulty of navigating the area. The shrimp gillnets, which were documented in high use within the ZTA in the similar survey in 2019 and were presumably also used in 2020 and are documented here in 2021, are not those used for illegal totoaba fishing and thus represent an increase in the amount of illegal gillnet fishing. All gillnets have been shown to kill vaquitas (D'Agrosa et al. 2000).

Main Report

The decline in vaquita numbers has been well documented. The first survey to cover the full vaquita distribution used visual line-transect methods (Jaramillo-Legorreta et al. 1999). This report noted the difficulty in sighting this species because of small group size, inconspicuous surfacings and avoidance of the survey vessels. Imprecise abundance estimates raised concerns about timely detection of potential declines in abundance (Taylor and Gerrodette, 1997). Acoustic monitoring methods were developed to increase precision of estimating both abundance and trends in abundance (Jaramillo-Legorreta et al. 2017), and a combination of visual and acoustic methods were used to estimate vaquita abundance in 2008 (Gerrodette et al., 2011) and 2015 (Taylor et al., 2016). Acoustic monitoring indicated that the vaquita population continued to decline rapidly, about 50%/year, through 2018 (Jaramillo-Legorreta et al. 2019).

Recent developments, however, have made both acoustic monitoring and visual line-transect methods difficult. Fishermen have begun removing the acoustic devices (CPODs) used to record vaquita clicks. The data recorded on each device is lost, and it is expensive to replace the stolen CPODs. Unless the fishing ban is enforced and the theft of equipment is stopped, acoustic monitoring cannot collect data as it has in the past. Visual line-transect methods face a different problem. The number of vaquitas is now so low that the number of sightings are not sufficient to estimate the necessary parameters. If a line-transect survey were carried out utilizing the same ship as in past surveys (the R/V *David Starr Jordan/Ocean Starr*), an estimate of abundance would be possible with relatively few sightings, because the probability of detection is known for this ship. However, chartering this vessel and hiring experienced observers for the necessary time would be expensive, at least US$3,000,000 for a survey. Unless such funds were made available, the size of the 2021 vaquita population cannot be estimated using line-transect methods. Further, such large surveys have also been difficult if not impossible to conduct because of safety concerns resulting from the ongoing pandemic.

Faced with these difficulties, vaquita researchers turned to photographic identification, which requires high quality photographs to identify individual vaquitas. Photographic identification of vaquitas began in 2008 (Jefferson et al. 2009). Opportunistic photographic surveys resumed in 2017 during the VaquitaCPR project (Rojas-Bracho et al. 2019). In September 2018 a dedicated survey produced the first evidence that vaquitas could calve annually (Taylor et al. 2019) and showed that a minimum of 6 healthy animals remained in a small area near San Felipe, Mexico. This minimum abundance estimate was the number of animals seen simultaneously and was influential in the abundance estimate for that year (Jaramillo-Legorreta et al. 2019).

Two short surveys focused on photographic identification were conducted in 2019 (see Report here). No within-year photographic matches were made that would allow an abundance estimate. In 2020 an Expert Elicitation (EE) effort was funded to better estimate the numbers of unique individual calves seen (only) and unique individual vaquitas seen (including adults, juveniles and potential calves) during the 2019 survey (Rojas-Bracho et al. 2019c).

The 2021 survey was planned to maximize the safety of all personnel to prevent COVID-19 infections. All personnel had to be fully vaccinated, isolate for 2 full days following travel, and have a negative PCR test before being allowed to begin the survey. Participants were also required to be masked and socially distance for 3 days following the PCR test to guard against potential infections not presenting symptoms in the early period following travel. Scientific personnel are given in Appendix 1.

Participants arrived in San Felipe on October 15, 2021. Assignment of observers to ships allowed the M/V Sharpie to maintain the same crew throughout the survey. M/V Sharpie scientific crew and equipment were transported to Bahia San Luis Gonzaga on the morning of October 16 and that ship began surveys on October 17. A few positive test results for R/V Narval crew, that later turned out to be false positives, delayed the start of surveys for that ship until October 21.

As in recent surveys, the location of acoustic detectors was used to guide visual ship transects (Appendix 2). Recent acoustic data suggest that vaquitas remain concentrated in the Zero Tolerance Area, which also should be conducive to vaquita survey efforts since the Government of Mexico agreed to strictly enforce a region-wide ban on fishing with gillnets in that area. Most of the 2021 surveys were conducted in this area. An acoustic survey from October 11 to 24 resulted in vaquita detections in several locations (see acoustics report in Appendix 3). These detections guided the search strategy in the early part of the survey, however, loss of 23 CPODs resulted in removal of all detectors by October 24 to prevent further loss. CPODs were deployed again during the neap tides when gillnetting within the ZTA was anticipated to be low, and additional acoustic detections guided search efforts in leg 2 (details in Appendix 3). These CPODs were removed on Oct 29.

Two ships (the R/V Narval with ship height of 7.7m and the M/V Sharpie with ship height of 8.1m) used experienced observers to find and track vaquitas with methods developed for the earlier attempt to capture vaquitas in 2017. In the first few days of the 2021 survey, only the Sharpie operated until COVID issues were resolved for the R/V Narval crew. The first sighting was made on October 18 when only the M/V Sharpie was surveying. Starting on October 21 the survey involved 2 full teams (each with 2 pairs of big eyes (25 power binoculars) and a tracking system) on each ship. Resulting tracklines are given in Figure 1. Vaquitas were seen on 5 days. Dates with hours of winds low enough to sight and track vaquitas (Beaufort 2 or less) were: 10/17 (5.1), 10/18 (0.2), 10/19 (0.5), 10/21 (1.3), 10/22 (7.4), 10/23 (0.5), 10/24 (3.6), 10/25 (4.7), 10/29 (3.3), 10/30 (4.6), 10/31 (5.2), 11/01 (8.5), 11/02 (11.0). Because of the large number of gillnets seen deployed in areas where vaquitas have been regularly detected both acoustically and visually, actual locations of the sightings are not shown to reduce chances of the areas used by these last individuals being specifically targeted by fishing activities.

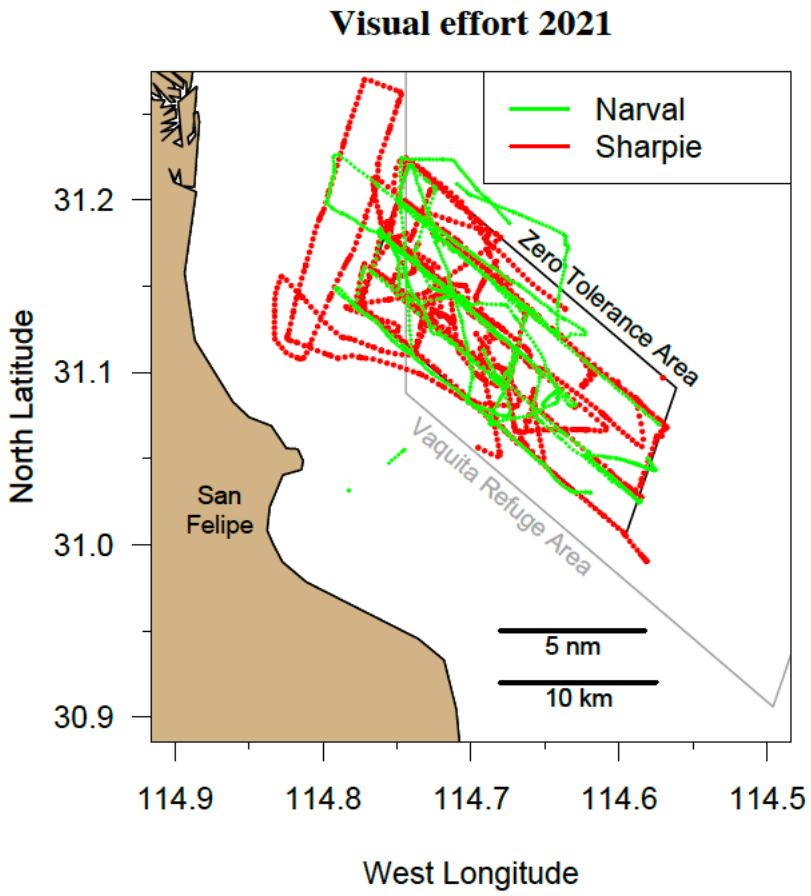

Figure 1. Track lines followed during the survey onboard M/V Sharpie (red lines) and R/V Narval (green lines). Vaquita Refuge is delineated with a gray line and the Zero Tolerance Area is delineated with a black line.

Radar images, counts of pangas and presence of Navy vessels were recorded 3 times each day on the M/V Sharpie. During a period when winds were too high for vaquita observation, a dedicated effort was made to document the amount of illegal gillnetting within the ZTA from the R/V Narval (see Appendix 4). No buoys were seen marking the corners of the ZTA though these had been deployed by the Museo de Ballena in 2019.

Raw data files (called DAS files) from the vaquita survey (on both ships) and the panga survey (from the R/V Narval) are available from Lorenzo Rojas-Bracho upon request and are also maintained at the Southwest Fisheries Science Center. Photographic identification was insufficient to use mark-recapture methods to estimate the numbers within the small area surveyed. An expert elicitation was conducted immediately following the survey reported here and is the subject of a second report. The elicitation will address the estimated number of unique calves seen and the estimated number of total vaquitas seen (including calves).

Discussion

Overall, the ability to find and track vaquitas remained good despite the lack of consistent acoustic surveys due to loss of equipment. The data and any conclusions are limited by the low number of sightings and the short time-frame of the survey only within the ZTA. Concentrating effort in the ZTA is logical given acoustic data indicated that the last vaquitas are most reliably found in this small area. However, the numbers in this report can only reflect the numbers in that area during this period and therefore may not account for the full number of vaquitas remaining. That said, recent acoustic evidence suggests that the numbers of vaquitas outside the ZTA are likely very low.

The poor success at obtaining photographs was due primarily to marginal wind conditions. Animals could be sighted but not tracked for the prolonged periods needed to obtain photographs of sufficient quality to identify individuals. Much more time would be needed to ensure obtaining a sufficient number of photographs for a mark-recapture estimate of abundance for the ZTA. In 2019, 3 weeks of effort resulted in only 4 days of weather conducive to sighting vaquitas. In 2021, 18 days of survey resulted in only 48 hours of weather conducive to sighting vaquitas (roughly 5 full days assuming 10 hours of effort per day). We should also stress here that the loss of acoustic devices reduced the chances of finding vaquitas since in many areas we had no near-real-time information to guide the vessels to where vaquitas were acoustically encountered. Moreover, the numerous instances where portions of the area within the ZTA could not be surveyed because of the high number of pangas present with gillnets out further hindered the survey.

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Appendix 1

Scientific personnel were as follows (legs in parentheses and funding source indicated by footnotes):
Overall project supervision: Lorenzo Rojas-Bracho (offsight), Barbara Taylor[1]
Project design and support: Andrea Bonilla (offsight), Annette Henry[1], Brooke Holt (offsight)
Chief Scientists: Armando Jaramillo-Legorreta[2] (1&2) and Barbara Taylor[1] (1) (*R/V Narval*), Sarah Mesnick[1] (1&2) (*Sharpie*)
Recorders: *M/V Sharpie* -- Sarah Mesnick[1] (1&2); *R/V Narval -- Dawn Breese[3] (1), Barbara Taylor[1] (1), Annette Henry[1] (2),* Eva Hidalgo[1] (2)
Observers: M/V Sharpie -- Ernesto Vázquez[3] (1&2), Sergio Martínez[3] (1&2), Felipe Triana[3] (1&2), Isidore Szczepaniak[3] (1&2), Chris Hoefer[3] (1); R/V Narval – Juan Carlos Salinas[3] (1&2), Marc Webber[3] (1&2), Jay Barlow[1] (1), Robert Pitman[1] (1), Allison Payne[3] (2)
Acoustics: Armando Jaramillo-Legorreta[2] (1&2), Gustavo Cardenas[2] (1)
Initial analysis: Tim Gerrodette[1] (offsight)

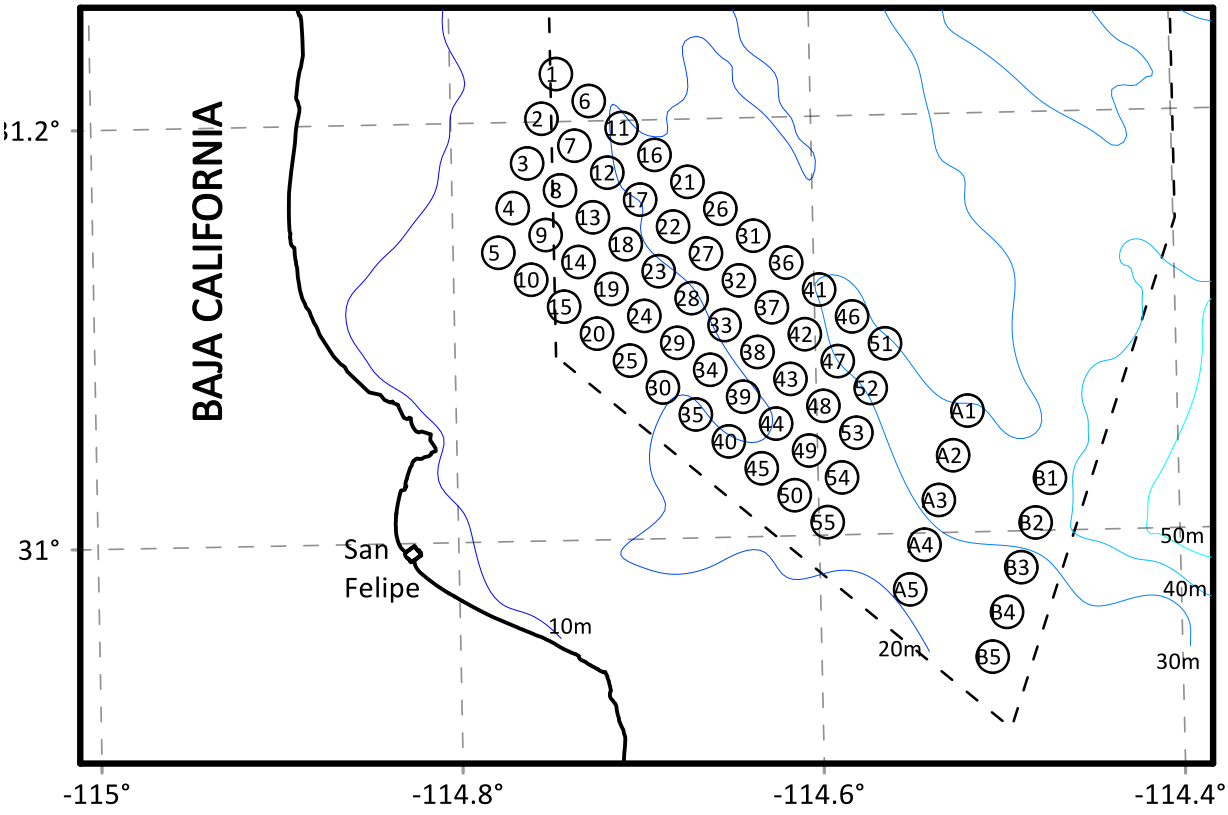
[1] Volunteer
[2] CONANP
[3] private funding

Appendix 2

Map and waypoint locations

The standard acoustic sampling sites listed below as waypoints to direct the ship for photographic identification efforts.

ACOUSTIC SAMPLING SITES OF VAQUITA MONITORING PROGRAM



- Numbered circles are reference points corresponding with acoustic sampling sites inside the Zero Tolerance Area. Circles labeled A1-5 and B1-5 are additional points that will be used to extend navigation transects toward southeast when needed.
- Bathymetry lines are included, for depths 10, 20, 30, 40 and 50 meters.
- In the next page there is a table with geographic coordinates of all points in the map, in decimal and degrees/minutes formats.

Sites	Lon (dec)	Lat (dec)	Lon (deg-min)	Lat (deg-min)
1	-114.74090	31.22277	-114º 44.454"	31º 13.366"
2	-114.74939	31.20159	-114º 44.963"	31º 12.095"
3	-114.75788	31.18041	-114º 45.473"	31º 10.825"
4	-114.76637	31.15923	-114º 45.982"	31º 09.554"
5	-114.77486	31.13805	-114º 46.492"	31º 08.283"
6	-114.72294	31.20959	-114º 43.376"	31º 12.575"
7	-114.73143	31.18841	-114º 43.886"	31º 11.305"
8	-114.73992	31.16723	-114º 44.395"	31º 10.034"
9	-114.74841	31.14605	-114º 44.905"	31º 08.763"
10	-114.75690	31.12487	-114º 45.414"	31º 07.492"
11	-114.70498	31.19641	-114º 42.299"	31º 11.785"
12	-114.71347	31.17523	-114º 42.808"	31º 10.514"
13	-114.72196	31.15405	-114º 43.318"	31º 09.243"
14	-114.73045	31.13287	-114º 43.827"	31º 07.972"
15	-114.73894	31.11169	-114º 44.336"	31º 06.702"
16	-114.68702	31.18323	-114º 41.221"	31º 10.994"
17	-114.69551	31.16205	-114º 41.731"	31º 09.723"
18	-114.70400	31.14087	-114º 42.240"	31º 08.452"
19	-114.71249	31.11969	-114º 42.749"	31º 07.182"
20	-114.72098	31.09851	-114º 43.259"	31º 05.911"
21	-114.66906	31.17005	-114º 40.144"	31º 10.203"
22	-114.67755	31.14887	-114º 40.653"	31º 08.932"
23	-114.68604	31.12769	-114º 41.162"	31º 07.662"
24	-114.69453	31.10651	-114º 41.672"	31º 06.391"
25	-114.70302	31.08533	-114º 42.181"	31º 05.120"
26	-114.65110	31.15687	-114º 39.066"	31º 09.412"
27	-114.65959	31.13569	-114º 39.576"	31º 08.142"
28	-114.66808	31.11451	-114º 40.085"	31º 06.871"
29	-114.67657	31.09333	-114º 40.594"	31º 05.600"
30	-114.68506	31.07215	-114º 41.104"	31º 04.329"
31	-114.63314	31.14369	-114º 37.989"	31º 08.622"
32	-114.64163	31.12251	-114º 38.498"	31º 07.351"
33	-114.65012	31.10133	-114º 39.007"	31º 06.080"
34	-114.65861	31.08015	-114º 39.517"	31º 04.809"
35	-114.66710	31.05898	-114º 40.026"	31º 03.539"
36	-114.61518	31.13051	-114º 36.911"	31º 07.831"
37	-114.62367	31.10933	-114º 37.420"	31º 06.560"
38	-114.63216	31.08815	-114º 37.930"	31º 05.289"
39	-114.64065	31.06697	-114º 38.439"	31º 04.018"
40	-114.64914	31.04580	-114º 38.949"	31º 02.748"
41	-114.59723	31.11733	-114º 35.834"	31º 07.040"
42	-114.60572	31.09615	-114º 36.343"	31º 05.769"
43	-114.61420	31.07497	-114º 36.852"	31º 04.498"
44	-114.62269	31.05380	-114º 37.362"	31º 03.228"
45	-114.63118	31.03262	-114º 37.871"	31º 01.957"
46	-114.57927	31.10415	-114º 34.756"	31º 06.249"
47	-114.58776	31.08297	-114º 35.265"	31º 04.978"

Sites	Lon (dec)	Lat (dec)	Lon (deg-min)	Lat (deg-min)
48	-114.59625	31.06180	-114º 35.775"	31º 03.708"
49	-114.60473	31.04062	-114º 36.284"	31º 02.437"
50	-114.61322	31.01944	-114º 36.793"	31º 01.166"
51	-114.56131	31.09097	-114º 33.678"	31º 05.458"
52	-114.56980	31.06979	-114º 34.188"	31º 04.188"
53	-114.57829	31.04862	-114º 34.697"	31º 02.917"
54	-114.58678	31.02744	-114º 35.207"	31º 01.646"
55	-114.59526	31.00626	-114º 35.716"	31º 00.375"
A1	-114.51641	31.05803	-114º 30.985"	31º 03.482"
A2	-114.52490	31.03685	-114º 31.494"	31º 02.211"
A3	-114.53339	31.01567	-114º 32.003"	31º 00.940"
A4	-114.54188	30.99449	-114º 32.513"	30º 59.669"
A5	-114.55037	30.97331	-114º 33.022"	30º 58.398"
B1	-114.47151	31.02508	-114º 28.291"	31º 01.505"
B2	-114.48000	31.00390	-114º 28.800"	31º 00.234"
B3	-114.48849	30.98272	-114º 29.309"	30º 58.963"
B4	-114.49698	30.96154	-114º 29.819"	30º 57.692"
B5	-114.50547	30.94036	-114º 30.328"	30º 56.422"

Appendix 3

Acoustics Report

Twenty-nine moorings to hold acoustic detectors (C-POD) were deployed in the ZTA, on Oct 11, covering the areas noted in Appendix 2. Replacement of acoustic detectors was attempted on Oct 14 and between 20-21. During this period 18 moorings were permanently lost, presumably to theft in areas where high shrimp fishing activity was observed. Twenty-five moorings were found and detectors replaced. To prevent further loss, we retrieved all moorings between Oct 22 and 24. Acoustic activity of vaquita was concentrated in the western portion of the ZTA. We deployed seven moorings in the ZTA between Oct 25 and 29 during the neap tides when fishing effort is much less and winds were also high making this period likely to be safe from further detector loss. All detectors were recovered. Again, vaquita acoustic activity was concentrated in the western portion and hence visual effort to locate vaquitas was concentrated in this area.

Appendix 4 Panga Quantification Survey

PANGAS AND VAQUITA IN THE ZERO TOLERANCE AREA (2021/11/03)

On the last day of the planned survey, winds were too high to effectively find and track vaquitas. This opportunity was used to quantify the amount of fishing effort to document the effects on our ability to conduct the vaquita effort. This effort is similar effort in 2019 that recorded 87 pangas in the ZTA (see appendix 3 in the Report). This panga quantification effort used the big eye binoculars (25 power) and computer software to provide data on the positions of pangas using the same methods used to determine the locations of vaquitas. The start time of this effort waited until pangas had set their nets and thus were likely to stay in place for several hours so that double counting could be avoided. The initial plan was to anchor the ship in two locations central in the ZTA and record the positions of pangas and Navy vessels. The first position in the south (Figure 1, small red arrows) had to be shifted when gillnets threatened to drift into the ship. Therefore, there are two slightly displaced positions from which both panga and any enforcement vessels were recorded in 360 degrees. The more northerly position (small arrows in line with ZTA position B) recorded pangas only ahead of the vessel to avoid double counting. Fishing activity was concentrated towards the central and western portion of the ZTA. In total 160 pangas were counted, 117 inside ZTA and 43 outside. Of the 84 points where pangas were counted, only 12 were outside ZTA and Vaquita Refuge. When panga densities were too high to efficiently record the positions of single pangas, positions were recorded for multiple pangas (this happened 34 times). There were 8 instances when more than 4 pangas were recorded as a single location including one instance of 11 pangas recorded as a single location. The effort took 2 hours and 14 minutes. No enforcement vessels were recorded in the area. Whenever possible photographs were taken of vessels to document the type of fishing activity.

Details of fishing activity were recorded three times daily on survey days aboard the M/V Sharpie and were submitted to the Government of Mexico. Onboard R/V Narval counts of pangas were made at some sites using handheld binoculars (7 power) during the survey, but focus was on vaquita and hence panga counts were not systematic.

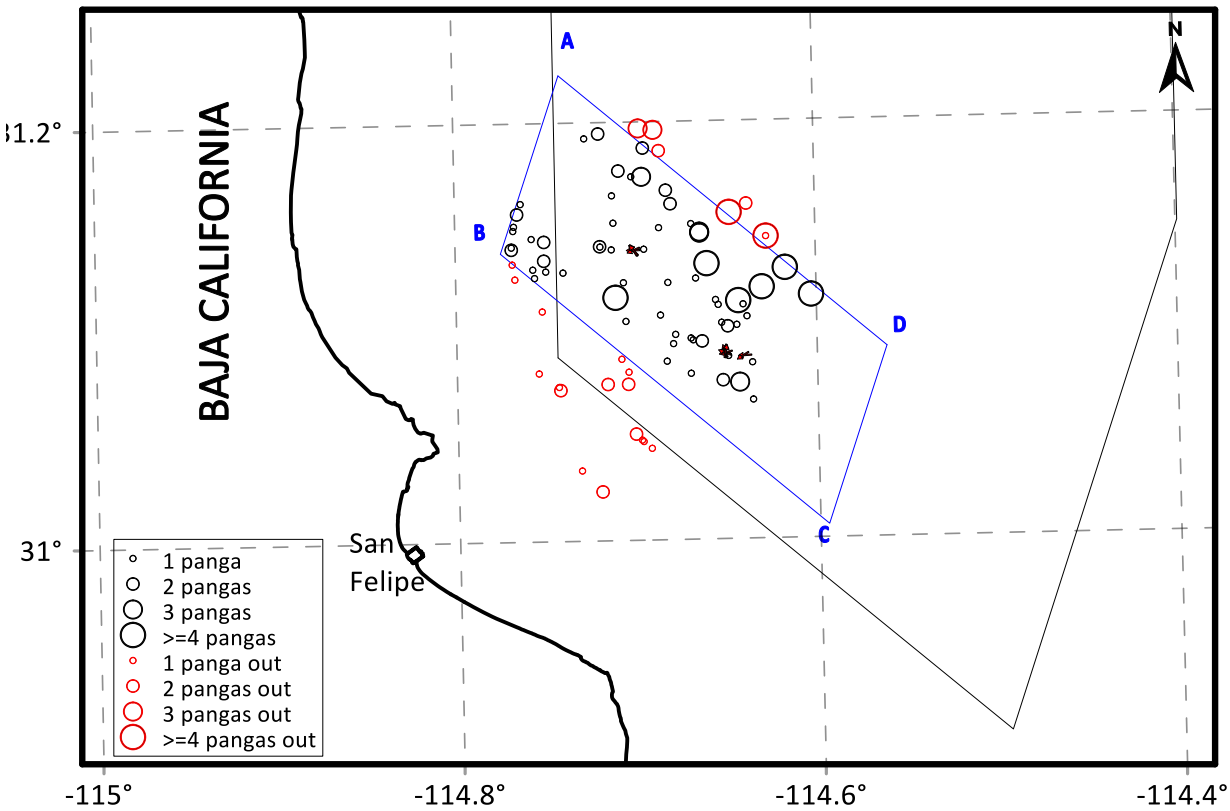


Figure 1. Panga count from within Zero Tolerance Area (blue polygon, vertices with letters). Red arrows represent the position and direction of bow of vessel at the times of counting. The boat was anchored. In the southeastern anchored location, panga locations were recorded 360 degrees around the anchored vessel (the R/V Narval). At the northwestern anchored location, locations were recorded 180 degrees in front of the boat. Black circles denote the position of the counted pangas observed inside ZTA. Red circles denote pangas observed outside the ZTA.