FIRST SAMPLING PERIOD OF THE ACOUSTIC MONITORING SCHEME OF VAQUITA (*Phocoena sinus*) POPULATION TREND

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ABSTRACT

During 2010 work was done to implement an acoustic monitoring scheme to estimate vaquita population trend (SC/63/SM22). The design was aimed to be able to detect anticipated small annual changes in abundance (increments less than 4% or decrements of 5%) in a period of five years (requiring a sampling CV of 3%). The design includes 64 sampling sites inside Vaquita Refuge Area, where autonomous acoustic detectors (C-POD) are deployed during the lowest fishing intensity season of the year, previous to the shrimping season opening late September.

First sampling period occurred between June and September 2011, including the deployment of 48 moorings inside refuge and 13 in delimiting buoys. Ten of the moorings inside refuge were not located, although three detectors moored in these sites were returned by fishermen. Eleven of the detectors deployed in buoys got lost. The total sample includes 2,840 days and 1,655 acoustic encounters with vaquitas, resulting in an average encounter rate of 0.58 encounters / day / site and a CV of 0.0485, near to the goal of 3%. The distribution of the acoustic encounter rate is heterogeneous across the Refuge, with highest acoustic activity of vaquitas located towards the western and southern zones of the study area.

INTRODUCTION

In this paper we inform about the implementation and first sampling season of the "Acoustic Monitoring Scheme for the Vaquita", according to the designed operation plan (Jaramillo-Legorreta, 2011). Tasks done included the installation of the acoustic detectors in both, the buoys delimiting the Refuge for the Protection of the Vaquita, as in submerged moorings within this polygon. The Field Operations and Data Analysis teams were established and training workshops were carried out. The Workshop of field operations included an introductory session and explanatory notes, and one day at sea for the practice of deployment and retrieval of moorings and acoustic detectors.

According to the results and guidelines depicted in the document “Assessing Trends in Abundance for Vaquita using Acoustic Monitoring: Steering Committee Report on Pilot testing phase and recommendations for full deployment” (Rojas-Bracho *et al*., 2011), detectors were deployed during May, 2011, and retrieved during September, a period in which fishing operations are minimal, reducing the probability of losing deployed equipment. Due to bad weather conditions, deployment operation was delayed until early June. Only 6 detectors were deployed in buoys during mid-July and 7 more during late September. The activities to retrieve submerged moorings were carried out during September 5 to 20. Acoustic detectors moored to buoys will be working all year round, in accordance with the Report of the Steering Committee. However, here we report loss of many acoustic detectors due, presumably, to illegal fishing activities. A modified system to mooring detectors to buoys was essayed in a deploying of 12 detectors between January and April 2012. Again, most of the detectors were lost, evidently, by fishing operations. Steering Committee will meet again to try finding a solution.

In this work, we present the results of the first sampling period of a total of six that comprise the monitoring program, aimed to detect small changes in vaquita population in a period of five years. Analysis presented included the identification of vaquita signals in the raw data stored in the acoustic detectors, as well as quantification of the number of acoustic encounters and encounter rate on every sampled site. Finally, a comparison is made to previous data regarding accuracy and a rough estimate of recent population trend is depicted. All this analysis is presented only for data obtained from detectors deployed in submerged moorings, inside Protection Refuge (except one site), that represent about 93% of the total sample available.

FIELD OPERATIONS LOG

Deployed acoustic detectors

All the submerged moorings and acoustic detectors (48) were installed from June 2 to 9, in a total of four effective days of job. For each deployment, it was recorded the UTC date and time, the sampling site, the

number of detector installed, and the precise geographical coordinates of the sites where anchors were deployed (Table I, Figure 1).

A total of six acoustic detectors were deployed in buoys on July 20th (buoys A, B, D, I, G and 7; Table II, Figure 2). Due to poor weather conditions and other facts out of our control, 7 additional detectors were moored to buoys until September 28th and 29th (buoys 1, 2, 3, 5, F, 6 and 8; Table II, Figure 2). Previous to the start of operations, two of the total of 16 buoys that delimit the Vaquita Refuge got lost due to unknown reasons (buoys 4 and E, Figure 2), and in one was impossible to install the mooring structure as the current was too strong at the time it was tried to (Buoy C, Figure 2). Hence, a total of 13 detectors were deployed in buoys.

The moorings used for buoys were installed with a solid grip, because it was planned to keep sampling continuously in these sites during the five years duration of the monitoring scheme. In such a way, the design was made to exchange periodically the detectors, in the scale of useful life of the batteries (about three months). The mooring structure designed allows using a pole, with a hook in the tip, to retrieve detectors without any need to do underwater operations.

Retrieved and lost moorings and acoustic detectors

Operations to locate and retrieve submerged moorings and acoustic detection equipment were carried out between September 9 and 25. During the first two weeks 38 of the 48 moorings deployed were located and retrieved. Location times ranged from 15 to 90 minutes, with an average of 28 minutes. Once located, mooring recovery time averaged 20 minutes.

One of the 38 moorings recovered had no acoustic detector attached (site 32, Figure 3). A couple of detectors were delivered to the staff of the Biosphere Reserve Upper Gulf of California and Colorado River Delta previous to the start of retrieval period (sites 2 and 9, Figure 3), therefore, there was no search effort at these sites. Remaining time of the retrieval campaign was used to try locating the remainder eight moorings (sites 3, 8, 10, 17, 18, 33, 34, 45, Figure 3). At each site, search efforts were made on three separate occasions, using a minimum effort of 1.5 hours and a maximum of 3. None of the moorings were located. For two of the detectors recovered data got lost from data card due to resetting of operating system during sampling. The detector deployed in site 45, where one of the moorings was not located, was recently delivered by a fisherman to the Biosphere Reserve officials.

During December 15 and 16, 2011, efforts were done to retrieve and interchange detectors deployed in buoys. Following procedures designed during pilot tests, a pole with a hook in the tip was used to grasp the rope holding the detector. It was not possible to retrieve any of the detectors deployed. Even, the metallic frame composing the main body of the mooring structure was not located with the pole. On January 8, 2012, we get back to the sampling area with a submersible camera and diving equipment suited for cold water. It was found evidences of sabotage by observing cut ropes, detached snaps or complete loss of the whole structure.

Second deploying in buoys

During January 31 and February 1, 2012, a new deployment of detectors in buoys was done using a different method of mooring. On this occasion detectors were attached directly to the chain of the buoy, using a snap and shackle. Detectors were installed at a minimum depth of 7 and maximum of 12 meters below sea surface, trying to avoid any intentional theft actions. During this effort we completed the searching of detectors deployed on 2011.

Whole effort to retrieve detectors of 2011 deployment

In addition to buoys 4 and E, it was encountered that buoys C (the one where was not possible to deploy a detector) and D (where one detector was deployed on July) got lost. Hence, effort to look for detectors was done in the reminder 12 buoys. Only detectors deployed in buoys 2 and 8 were recovered (Figure 4).

On six of the buoys none of the elements of the moorings were found. On three buoys, all of some of the snaps and shackles that hold the metallic frame were found. On two buoys the mooring structure was detached from one of the two arms and, in one of the buoys, one detector was recovered (Buoy 2). In the reminder two buoys the mooring structure was intact, however, only one detector was recovered (Buoy 8). Detector deployed at Buoy A during July 2011 was delivered by a fisherman to authorities of the Biosphere Reserve.

Deployed detectors

On January 31, 2012, eight detectors were deployed in buoys G, 7, 8, A, 1, B, 2 and 3, in that chronological order. On February 1, other four detectors were deployed, chronologically, in buoys 5, F, 6 and I (Figure 4).

Retrieval of 2012 detectors

During April 28, 2012, efforts to recover detectors were done at seven of the 12 buoys where detectors were deployed (buoys I, 6, F, 5, 3, 2 and B; Figure 5). Only one detector was recovered at Buoy 5, however, it was entangled in a net. It was necessary to cut it for recovery of the equipment. On three of the buoys the snap and shackle were entangled in nets but the detectors were not there. On one of them shackles were so deeply entangled that was not possible to recover them. On other buoy was not any trace of the elements installed. In other one the same case occurred, but a rope was knotted to the chain, indicating the occurrence of human activity during the sampling period. The Buoy F got lost, being the fifth buoy that disappears and the second one with a detector deployed on it. Finally, the detector deployed at Buoy 8 was recovered by Environment Enforcement Agency (PROFEPA) floating in the area close to this buoy. It would be necessary to dive in this buoy to determine the potential causes. It will be done during the effort to recover the reminder 4 detectors.

Summary of moorings and detectors recovered and loss rate

Thirty eight of the 48 submerged moorings deployed inside Vaquita Refuge were recovered (21% loss rate). During the first deployment in buoys only 4 of 13 mooring structures installed were recovered (69% loss rate), although two of them with some elements lost. During the second deployment only one of seven detectors were found (86% loss rate), remaining four buoys to be searched for installed detectors. In both sampling periods at buoys loss rate was (75%) and overall, in submerged moorings and buoys, loss rate was 70%.

In terms of acoustic detectors, considering the delivery of some of them from fishermen and environment authorities, 40 of them were recovered of the 48 installed in submerged moorings in the 2011 period (17% loss rate). In the case of buoys, three of 13 were recovered from the first sampling period in 2011 (77% loss rate) and two of eight during the 2012 sampling period (75% loss rate) considering that we need to look for remainder four still in water. Combined both periods, in buoys we lost 17 detectors (76% loss rate). Overall, combining submerged moorings and buoys, loss rate was 26%.

The deployment of submerged moorings only during the expected period of low fishing intensity, previous to the shrimp fishing season, resulted in a loss rate (21%) much better rate than that obtained during the pilot test of 60% (Rojas Bracho *et al*., 2011) but in the limit of 20% envisioned to obtain enough sampling (Rojas Bracho et al., 2010). It is, deploying the network of detectors during a period of expected low fishing intensity, resulted in a reliable strategy for minimizing loss of information. However, in the case of detectors deployed in buoys, an alternative method of mooring must be developed in order to be able to sample efficiently at these sites. It is important to sample at this sites all year long, as is right now the only way to depict distribution patterns in relationship with year seasons. Steering Committee will discuss this issue in an extraordinary meeting soon.

DATA ANALYSIS

Data available for analysis come from 40 detectors recovered from sites inside Vaquita Refuge during 2011 sampling season, and 5 detectors recovered from buoys after first sampling period in 2011 and second period during early 2012. However, as mentioned before, for two of the detectors recovered from submerged moorings (sites 12 and 24, figure 3) data got lost. Hence, the total sample comes from 43 detectors. In this work we present data analysis of 37 of the detectors deployed in submerged moorings inside Vaquita Refuge (figure 6, table III), as the other one was just recently recovered from a fisherman.

The set of 37 sampling sites includes 2,840 whole days of effort and 1,655 acoustic encounters with vaquitas, resulting in an average encounter rate of 0.58 encounters / day / site and a CV of 0.0485, near to the goal of 3%. Pooling all sites for days where al 37 detectors were operating (50 days), the acoustic encounter rate per day is 25.34 encounters (CV 0.0421). Per site, pooling the 50 days where all 37 detectors were operative, the average encounter rate was 34.24 encounters (CV 0.2943).

The CV calculated for average encounter per site reflects the high variability between sampling sites. The distribution of the acoustic encounter rate was, in fact, heterogeneous across the Refuge, with highest acoustic activity of vaquitas located towards the western and southern zones of the study area (figure 6).

FUTURE WORK

Next sampling season in submerged moorings, inside Vaquita Refuge, will start on late May. Detectors will be retrieved previous to the start of the shrimp season, expected to initiate after mid-September.

Steering Committee will meet to discuss about data already gathered and to find alternative mooring methods to deploy detectors in buoys. Once lost detectors get replaced they will be deployed under the alternative mooring method. An envisioned system will consist of a long rope (about 100 meters) attached

at one end to the weight holding buoys in place. At the other end an anchor with chain will be joined. At this end, the detector will be moored with a rope and a floating device. This design is similar to the one used for submerged buoys, hence detector could be retrieved by grasping the connecting long rope with a hook trawled behind a boat. No need for GPS marking will be needed, as the buoy will mark the position if the anchor is deployed inside refuge.

ACKNOWLEDGEMENTS

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CITED LITERATURE

Jaramillo-Legorreta, A.M., L. Rojas-Bracho, B. Taylor, J. Barlow and N. Tregenza. 2011. Implementation of an acoustic monitoring scheme for vaquita, design and pilot test phases and a review of the Recovery Plan. Working document SC/63/SM22 presented during the 63 Meeting of the Scientific Comity of the International Whaling Commission. Tromsø, Norway. May 27th – June 7th, 2011. 6 pp.

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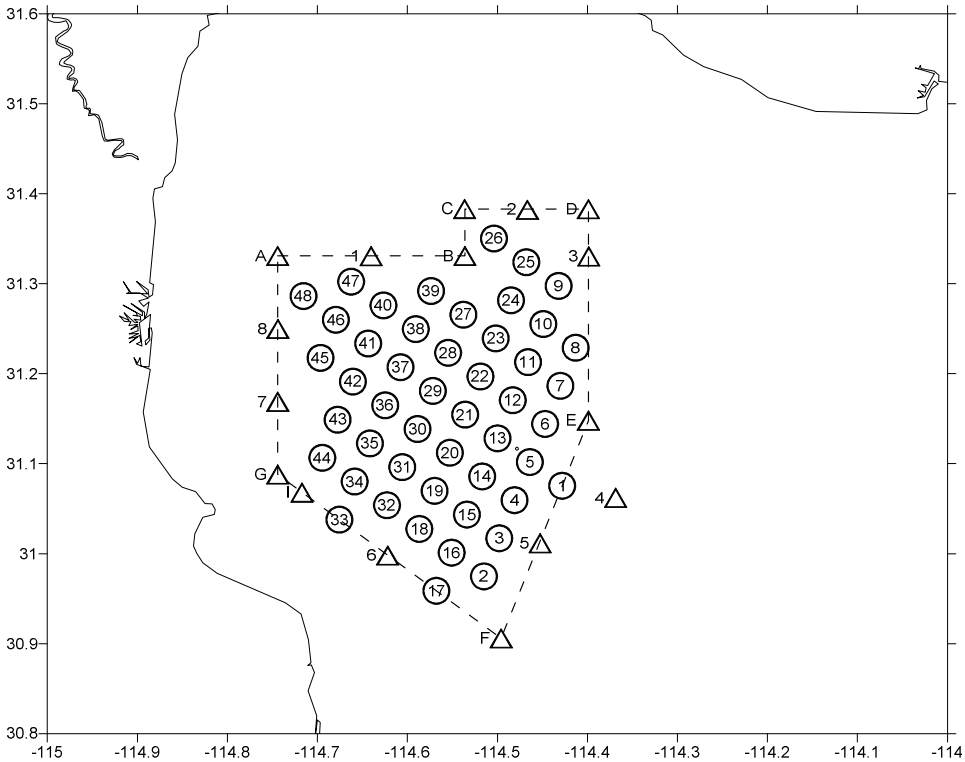

Figure 1. Sampling sites of the acoustic monitoring scheme, including sites inside Vaquita Refuge (broken line polygon) where submerged moorings are deployed (circles) and delimiting buoys (triangles) where detectors were deployed on the buoy chain.

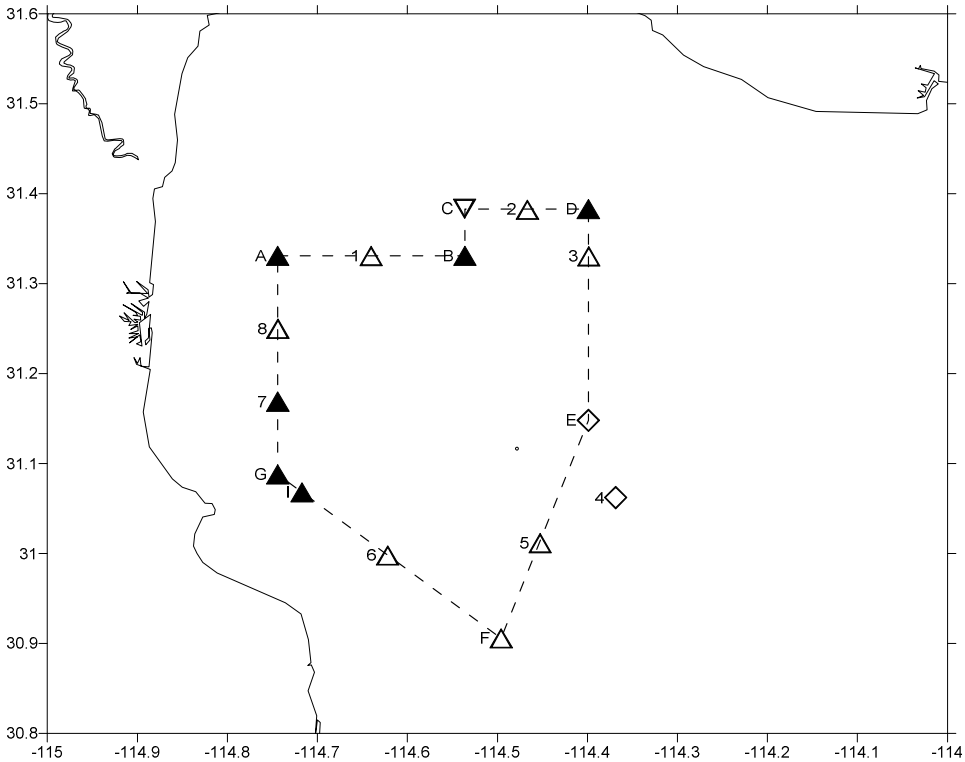

Figure 2. Position of buoys where detectors were deployed during the first sampling period between July and December 2011. Black triangles indicate the ones installed in July and white triangles the ones deployed on September. Diamonds indicate the buoys lost previous to the start of the sampling. The inverse white triangle shows the buoy where it was not possible to install a detector.

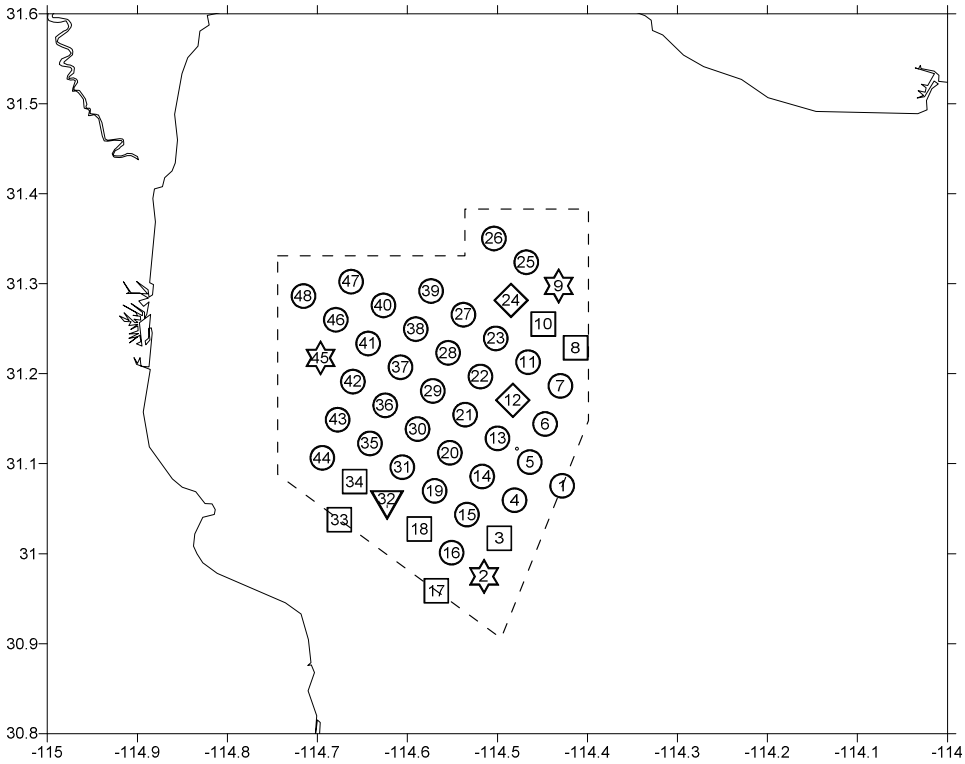

Figure 3. Fate of submerged moorings after 2011 sampling period. Circles show sites where moorings and detectors were successfully retrieved. Diamonds show sites where detectors were recovered but data got lost. The inverse triangle indicates the site of a mooring recovered without detector attached. Squares indicate sites where moorings get lost. The stars show positions where moorings get lost but detectors were delivered to authorities by fishermen.

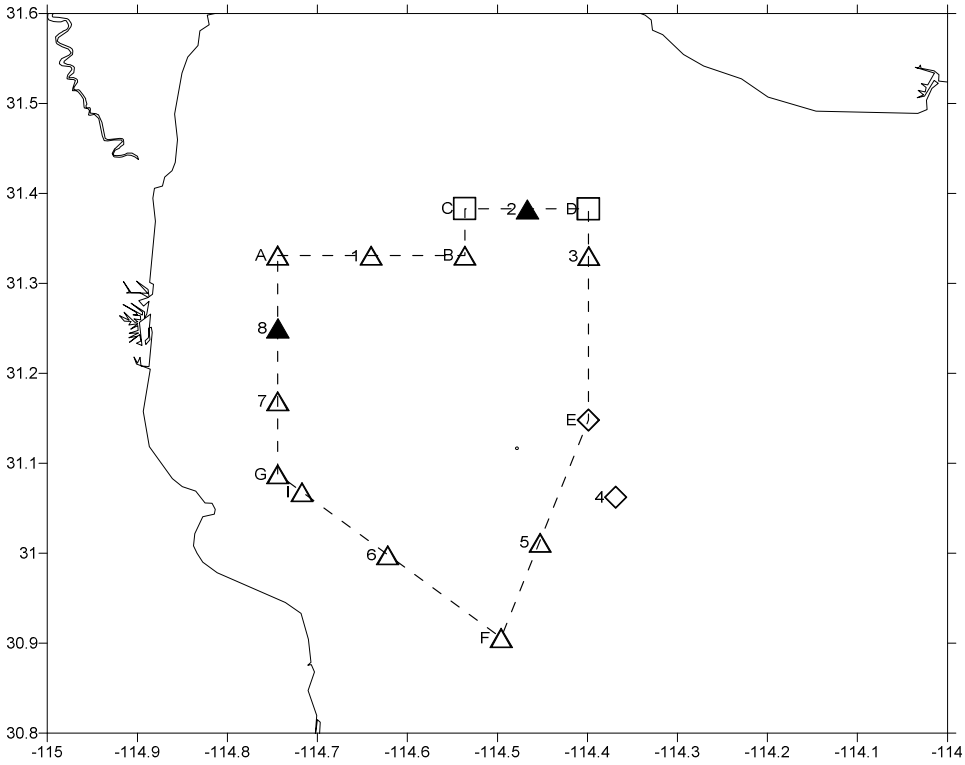

Figure 4. Fate of moorings deployed on buoys after first sampling period during 2011. Diamonds indicate buoys lost previous to sampling and squares the ones lost during the sampling. A detector was lost in Buoy D. White triangles indicate buoys where moorings or detectors get lost. Black triangles indicate the only sites where detectors got recovered.

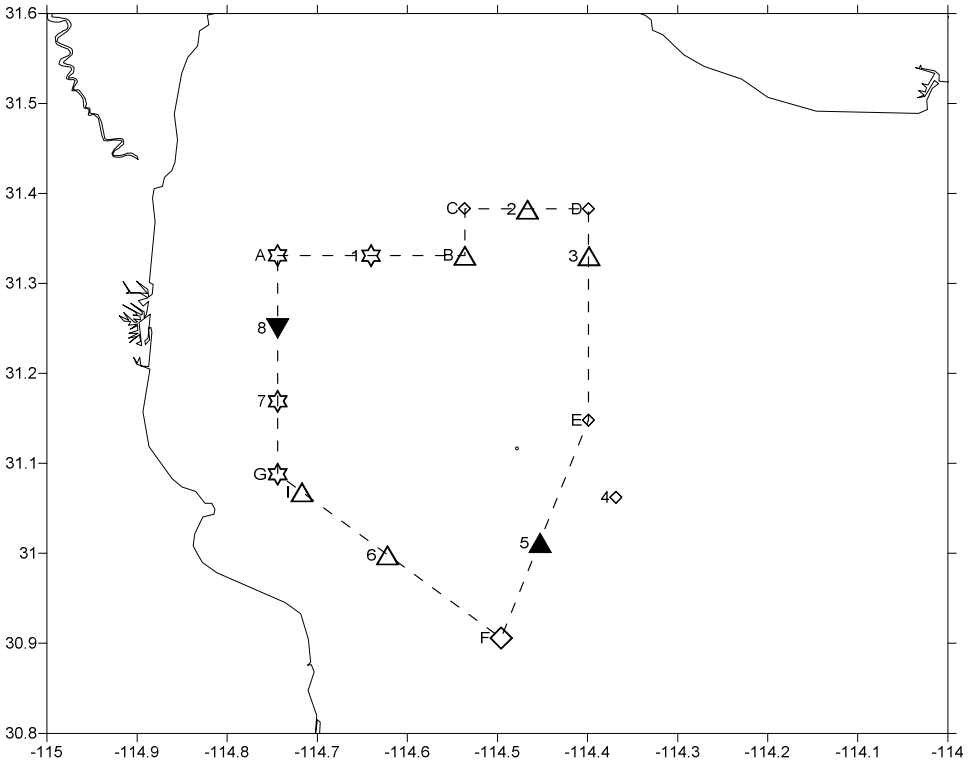

Figure 5. Fate of moorings deployed on buoys after second sampling period during 2012. Small diamonds indicate buoys lost previous to sampling. Detectors were deployed in the reminder 12 buoys. One detector was recovered at Buoy 5 and the one deployed in Buoy 8 was recovered floating near this site. Detectors got lost at buoys marked with white triangles and Buoy F got lost. Still is pendant the searching of detectors in buoys marked with stars.

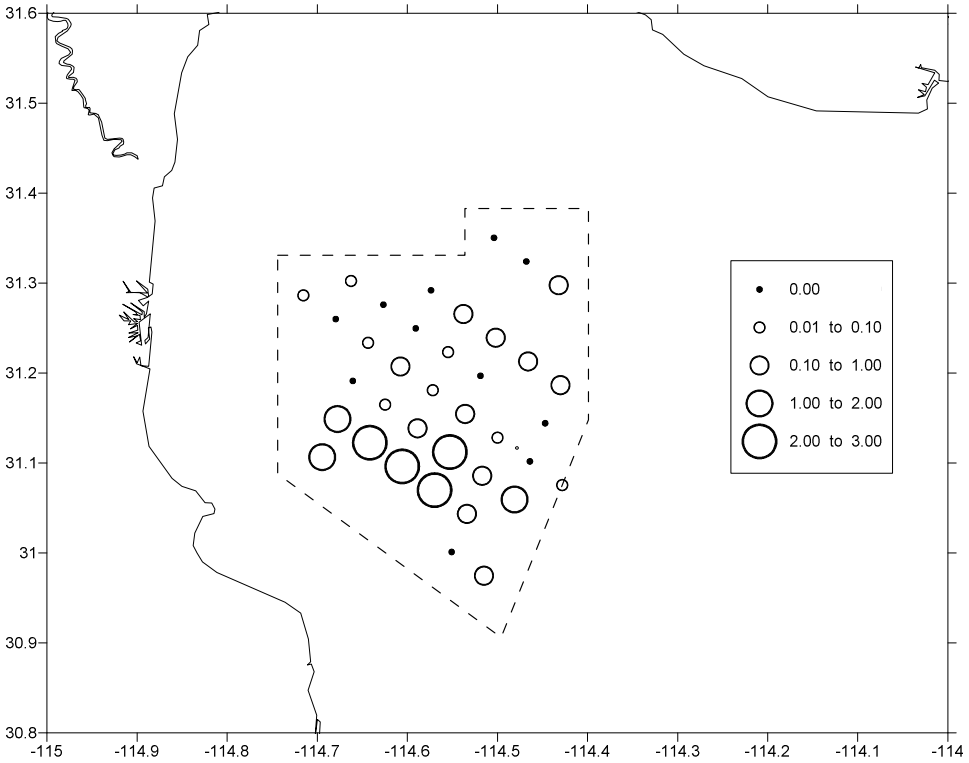

Figure 6. Distribution of acoustic encounter rate for 37 sampling sites with submerged moorings inside Vaquita Refuge, during the period between June and September 2011.

Table I. List of the submerged moorings and detectors (C-POD) deployed during the first sampling period of the Vaquita Acoustic Monitoring Scheme, including date and time of deployment as well as the GPS position (North latitude and West longitude) of both mooring anchors. Last two columns show whole days of data gathered per detector and number of acoustic encounters of vaquitas identified.

				Danforth anchor		River Anchor			
Date	**Time**	**Site**	**C-POD**	**Latitude**	**Longitude**	**Latitude**	**Longitude**	**Effort (days)**	**Acoustic encounters**
07/06/2011	15:20	1	1316	31.07553	114.42825	31.07505	114.42687	80	4
07/06/2011	15:53	2	998	30.97455	114.51521	30.97377	114.51140	52	21
07/06/2011	15:38	3	1317	31.01715	114.49832	31.01658	114.49682		
09/06/2011	12:33	4	991	31.05962	114.48081	31.05984	114.47984	100	199
05/06/2011	09:51	5	1304	31.10157	114.46339	31.10032	114.46209	94	0
05/06/2011	09:37	6	1302	31.14423	114.44673	31.14390	114.44494	89	0
05/06/2011	09:23	7	1300	31.18638	114.43041	31.18609	114.42853	87	32
05/06/2011	09:09	8	1305	31.22870	114.41275	31.22813	114.41106		
05/06/2011	08:47	9	1301	31.29769	114.43178	31.29771	114.42975	75	14
05/06/2011	08:16	10	1303	31.25541	114.44891	31.25546	114.44694		
05/06/2011	08:37	11	1306	31.21282	114.46590	31.21307	114.46417	94	10
05/06/2011	08:20	12	1307	31.17043	114.48284	31.17046	114.48106		
07/06/2011	12:49	13	1315	31.12966	114.49985	31.12949	114.49802	69	1
05/06/2011	07:55	14	1308	31.08570	114.51675	31.08510	114.51498	71	62
05/06/2011	07:38	15	1309	31.04342	114.53376	31.04354	114.53213	70	53
05/06/2011	07:20	16	1313	31.00102	114.55074	31.00100	114.54902	80	0
05/06/2011	06:56	17	1310	30.95861	114.56784	30.95858	114.56612		
07/06/2011	11:01	18	1318	31.02754	114.58672	31.02768	114.58535		
07/06/2011	11:19	19	1319	31.06975	114.56976	31.06972	114.56798	94	206
07/06/2011	11:36	20	1320	31.11213	114.55286	31.11218	114.55116	73	146
07/06/2011	11:52	21	1331	31.15451	114.53579	31.15478	114.53408	69	34
07/06/2011	12:07	22	1332	31.19692	114.51884	31.19720	114.51702	80	0
07/06/2011	12:26	23	1333	31.23921	114.50183	31.23929	114.50015	76	19
07/06/2011	11:46	24	1312	31.28169	114.48492	31.28217	114.48293		
07/06/2011	12:00	25	1314	31.32410	114.46816	31.32405	114.46635	61	0
02/06/2011	15:48	26	995	31.35026	114.50367	31.35024	114.50272	68	0
02/06/2011	15:30	27	1006	31.26575	114.53744	31.26581	114.53616	76	26
02/06/2011	15:19	28	1009	31.22344	114.55468	31.22369	114.55350	92	4
02/06/2011	15:07	29	1336	31.18105	114.57167	31.18133	114.57013	73	5
02/06/2011	14:36	30	1337	31.13863	114.58864	31.13876	114.58734	91	29
02/06/2011	14:05	31	1334	31.09620	114.60542	31.09677	114.60385	96	257
09/06/2011	08:34	32	1503	31.05606	114.62691	31.05730	114.62499		
09/06/2011	08:20	33	1340	31.03792	114.67521	31.03845	114.67346		
09/06/2011	08:57	34	1299	31.08022	114.65871	31.08136	114.65691		
09/06/2011	09:22	35	1502	31.12264	114.64200	31.12356	114.63976	101	222
09/06/2011	09:36	36	1350	31.16511	114.62448	31.16550	114.62251	57	3
09/06/2011	09:52	37	1342	31.20732	114.60769	31.20711	114.60564	56	11
09/06/2011	10:09	38	1341	31.24971	114.59044	31.25016	114.58844	72	0
09/06/2011	10:31	39	992	31.29201	114.57364	31.29133	114.57191	70	0
09/06/2011	09:07	40	1348	31.27603	114.62666	31.27743	114.62569	92	0
09/06/2011	08:56	41	1349	31.23365	114.64361	31.23491	114.64237	62	4
09/06/2011	08:44	42	1343	31.19132	114.66058	31.19277	114.65964	55	0
09/06/2011	08:32	43	1506	31.14892	114.67755	31.14950	114.67649	95	157
09/06/2011	08:19	44	1504	31.10655	114.69444	31.10695	114.69342	95	132
09/06/2011	10:01	45	1345	31.28638	114.71542	31.28794	114.71426		
09/06/2011	09:21	46	1346	31.30372	114.66139	31.25999	114.67947	57	0
09/06/2011	09:19	47	1347	31.30231	114.66253	31.30372	114.66139	66	1
09/06/2011	09:46	48	1344	31.25999	114.67947	31.26170	114.67858	52	3

Table II. List of the detectors (C-POD) deployed in buoys during the first and second sampling periods of the Vaquita Acoustic Monitoring Scheme, including buoy name, GPS position (North latitude and West longitude), date of deployment, number of C-POD deployed and fate of the detectors. A total of four buoys get lost. Still remain to look for detectors in four buoys.

			First sampling period			Second sampling period		
Buoy	**Latitude**	**Longitude**	**Date**	**C-POD**	**Result**	**Date**	**C-POD**	**Result**
A	31.33109	114.74412	20/07/2011	1405	POD lost	31/01/2012	1510	Pendant
B	31.33100	114.53600	20/07/2011	1411	POD lost	31/01/2012	1512	POD lost
C	31.38326	114.53621	No used		Buoy lost	Buoy lost		
D	31.38300	114.39900	20/07/2011	1415	Buoy lost	Buoy lost		
E			Buoy lost			Buoy lost		
F	30.90592	114.49579	28/09/2011	1497	POD lost	01/02/2012	1313	Buoy lost
G	31.08800	114.74400	20/07/2011	1400	POD lost	31/01/2012	1502	Pendant
I	31.06800	114.71700	20/07/2011	1495	POD lost	01/02/2012	1304	POD lost
1	31.33084	114.64031	29/09/2011	1501	POD lost	31/01/2012	1306	Pendant
2	31.38226	114.46663	29/09/2011	1498	Recovered	31/01/2012	1334	POD lost
3	31.33049	114.39839	29/09/2011	1496	POD lost	31/01/2012	1300	POD lost
4			Buoy lost			Buoy lost		
5	31.01172	114.45251	28/09/2011	1500	POD lost	01/02/2012	994	Recovered
6	30.99795	114.62196	28/09/2011	1499	POD lost	01/02/2012	1348	POD lost
7	31.16900	114.74400	20/07/2011	1402	POD lost	31/01/2012	1508	Pendant
8	31.25002	114.74393	29/09/2011	1511	Delivered	31/01/2012	1513	Delivered