FINAL REPORT

"Interaction between marine mammals with artisanal fisheries in the Puerto de La Libertad, El Salvador"

By Claudia Ascencio Elizondo

The interactions between marine mammals and artisanal fisheries is because the high diversity of both objective species, producing accidental bycatch, which produce a highest impact for the limited growth potential of the organisms. Such interactions can be divided into predatory and operational, which occurs in a competition of species to consume and the other in the physical harm because the engine of the boat or other objects that may cause damage to the body.

In Central America are several studies on the subject: Herrera-Miranda *et all* (2016) performs a special analysis of critical habitats for bottlenose dolphins and humpback whales in Golfo Dulce, Costa Rica; Dávila (2011) estimates the diversity and abundance of pelagic mammals in the Pacific of Guatemala; Guzmán *et all* (2015) with 6 years data base (2003-2009) of sightings, estimate the population size and migratory connectivity of humpback whales, as a result Panama change their vessel traffic and tourism of whales in Las Perlas; the opposite case, El Salvador doesn't have any record.

The present study will determine the interactions types that happens in costal water of the Departamento de La Libertad, as it is, know the species the used this zone, and, at last, analyze knowledge and perception that possess artisanal fishermen regarding marine mammals.

METHODOLOGY

The study covered coastal fisheries zone from Departamento de La Libertad, which is located between the coordinates 13°29'27.38'' N / 89°15'06.75'' W and 13°24'25.97'' N / 89°07'43.60'' W, from the northwest of El Salvador (Figure 1) and length of 51.3km from the Salvadorian coastal line.

Figure 1: Geographic position from Departamento de La Libertad, El Salvador. Red spot: Location of the viewpoint where it was made the land sightings.

Data collection was performed during the time of migration of Cetaceans, between months October 2015 and May 2016, through those months 56 trips were made. Of which 28 days were designated to take data from the vessel (boat), which was one day trip made from artisanal fisherman; and the other 28 days for land sightings, from 5:45am to 5:45pm. The survey was made on 10 trips with coordination with the fishermen.

Marine Mammal's Composition

The group of marine mammals sightings were studied to determine the composition, following the recommendation of Iñiguez and Gasparrou (2002), for land sightings methodology with data were collected: surface behavior and diving patterns, individual's number, state of life: adult or calf, geographic location, wing scale according Beauford chart, cloudiness, distance, course taken and photographic register (if it is possible).

For vessel sightings, data change lightly, it took previously mentioned adding distance from land, deep, temperature and turbidity.

Marine Mammal Interactions

The interaction worked in the study was operational, which was classified in: theft bait, hits the boat, break the fishing net, indifferent behavior and interaction with fisherman. For both methodologies it is observed the group of marine mammals to determinate the type it belongs.

Knowledge and Perception

For conducting surveys, establish communication with the presidents of cooperatives ACOPALLI DE RL and ACOOPALL DE RL, which they were very open to collaborate for the realization of it. The total of artisanal fishermen using the port of La Libertad are 160, associated and unassociated. Twenty-one fishermen participate in the survey, all of them associated, some of them were finishing the shift or were mending nets.

The survey was divided in 4 sections: respondent information: were age was known and since when they start fishing; economic activity: knowing if they performed artisanal or tourism fishing; whales and dolphins: specific knowledge of the species, areas and time were observed and behavior present; perception: if they have knowledge from tradition, if they think it affect their absence or presence in the marine ecosystem.

RESULTS

Marine Mammal Composition

The following graphic (Figure 2) resumes the total abundancy of species versus the individuals observed during all sampling and under both methodologies, where bottle noose (*Tursiops truncatus*) has 60% of representative in the area of La Libertad, followed be spotted dolphin (*Stenella attenuata*) with 33%; and with the least

amount of individuals is the humpback whale (*Megaptera novaeanglie*) and sea lion (*Zolapus wollebaeki*), both were observed only once in 8 months sampling.

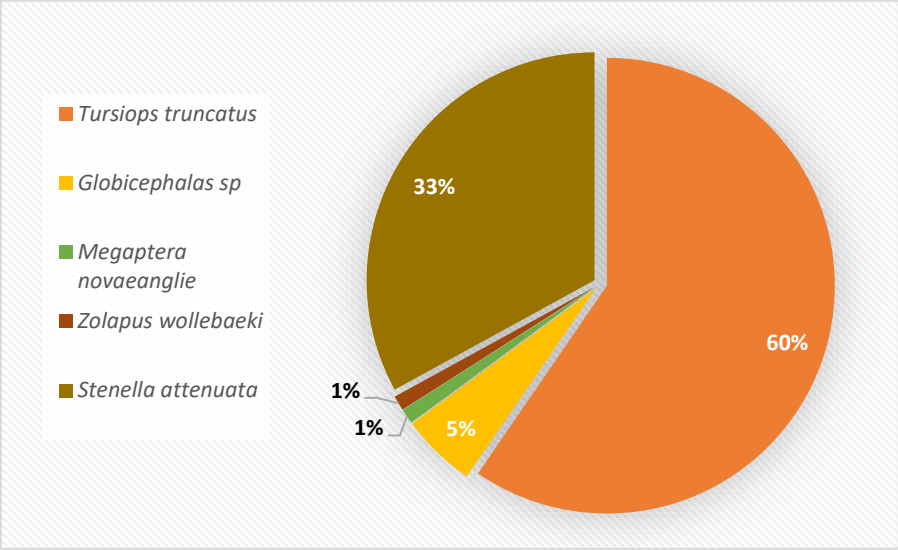

Figure 2: Abundance species throughout the sampling carried put.

The number of individuals for the species of bottlenose dolphin was higher in December, but the most diverse in April, as it is this month was recorded three of five species obtained.

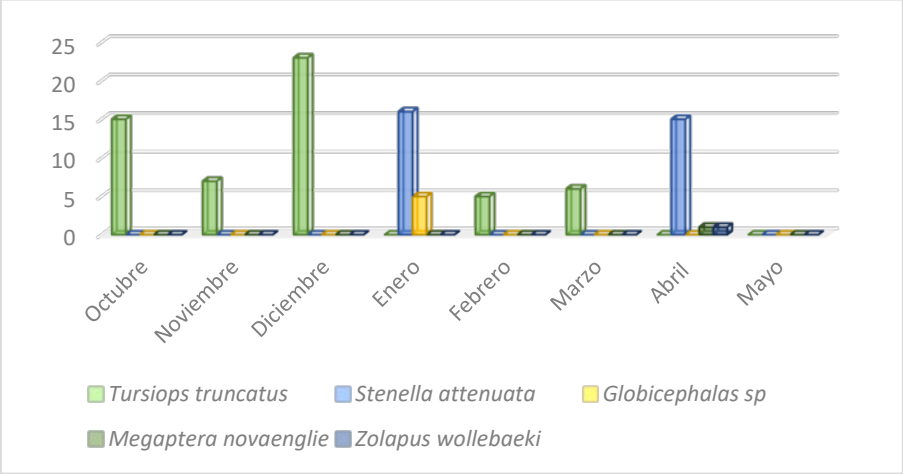

Figure 3: Abundance per occurrence for all months sampling.

Interactions between Marine Mammals and Fishermen

In 16 trips were sightings, which the interaction observed was indifferent conduct from the marine mammal to the artisanal fishermen.

Variables Occur During the Sightings

During the samples were taken physicochemical data for both methodologies, costal and boat, they were evaluated to find out which variables have the greatest weight when interaction occur.

Boat

The physicochemical variables taken during sightings from boat, generated two records (Table 1), it is noteworthy that in both were observed *Tursiops truncatus* and *Stenella attenuata* with 7:6 individuals respectively.

Table 1: Physico-chemical parameters under sampling boat sighting methodology.

Month	Temp. (°C)	Vis	Turbidity	C. Distance	Deep	#sp
November	0	2	3	9	34.5	1
January	32.5	3	5	2.23	8	1

Costal

Sightings from shore has a good amount of information, given the 50% of the samplings were observed marine mammals. To analyze which variables have more weight in the interaction of marine mammals and fishermen were estimated Principal Components Analysis (PCA)), where the first three components which have the 84.5% of the data were taken (Annex 1). When analyzing the picture of the weights of the variables was considered eliminating those who did not have the weight above 0.60. The variables that were considered for statistical found in Annex 2.

Once the variables that generated noise eliminated were reanalyzed in the statistical program PAST 3.0, resulting in the following table of variance (Table 2) where the first three components will be taken, generating a variance above 90% ; follow by the correlation matrix.

Table 2: Percentage of variance in the main components 1, 2 and 3

PC	Eigenvalue	% variance
1	4.33941	48.216
2	2.5988	28.876
3	1.70975	18.997

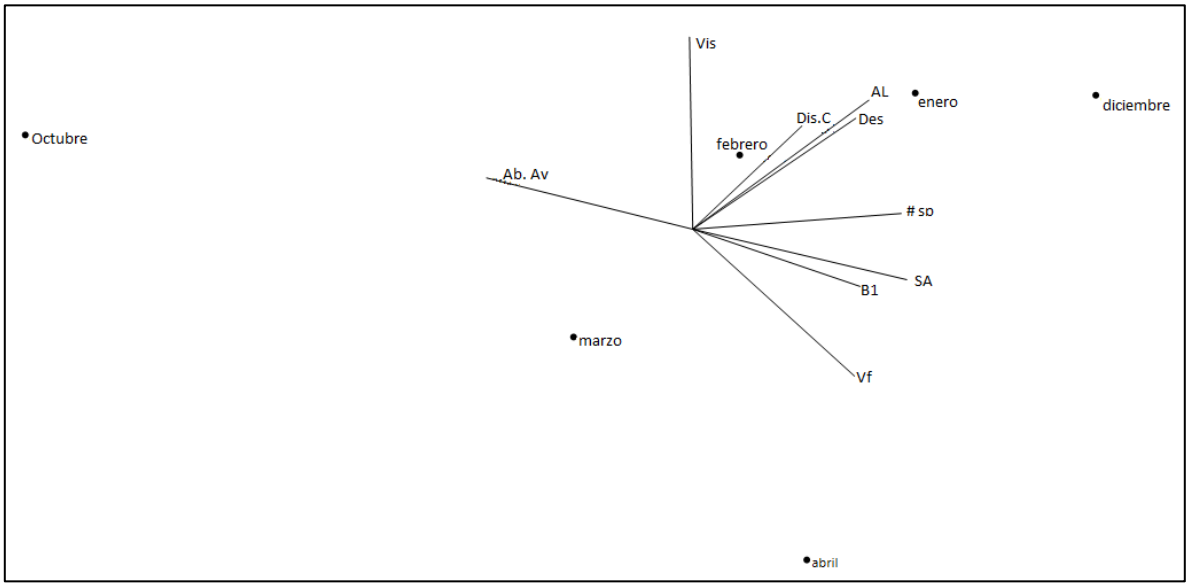

Figure 4: Correlation matrix of the variables that have the most weight in sightings from shore. Des: Clear. B1: Beauford scale 1. Dis. C: Distance from shore. VF: Strong wind. Vis: Visibility. Sal: Jump. Al: Feeding. #sp: number of species. Ab.av: Abundance of individuals.

October was the month that had the greatest number of individuals but in terms of variables, was the least met the weight thereof. January was the month that showed more feeding behavior bye marine mammals, as well had a clear sky and distance from shore was higher; if not for the months of March and April that the result was negative. Both visibility and distance from coast were strong for the month of February.

The variable abundance of sightings is correlated with the behavior of Jump and to a lesser degree wind measurement according to Beauford scale. December shows that many variables are present but none determines the sighting obtained.

Knowledge and Perception

Respondent information

Most fishermen of Puerto de La Libertad have an average between 30 and 40 years old. All are men, no women. Most are over 30 years of residence in the port. As members of the cooperative, they not have their own boat, so 13 of them used only for fishing and 6 for fishing and tourism. The time dedicated to the fishing day is mostly 6 days a week, with shifts of 48 hours. The average time of fishing is 30 years.

Economic activity

The 21 interview made artisanal fishing, which always keep fishing gear formwork and networks, often accompanied by some hook (26%). The fishing zones cover entire coast of La Libertad, it is noteworthy that 19 of them mentioned that fish all year. The farthest distance is arriving 30mn.

Tourism in La Libertad is performed throughout the year, even though it has not high demand; the distance navigated is not more than 10 mn.

Whales and dolphins

The results from this section are very enriching, since the 21 respondents replied that all the time they have seen whales and dolphins. Both frequently observed throughout the year, specifically from October to April in the entire coastal area of La Libertad. The fishing gear that fishermen are doing when seeing dolphins are networks and with whales longline.

The last sighting, November to January, it present more individuals, but for May to June, the presence of pups was evident. In June of the same year, activity was

increased, such as jumping, companying the boat, passing and floating. June 2016, register a high diversity species.

Regarding whale sightings, 2015 observation frequency was held overnight and evening, but these organisms are present at any time from November to January. According to fishermen, as many individuals is in the months from October to March and December 2015; despite this, the calves only observed from one to three individuals in February 2016. The behavior of the whales was varied, 2015 were observed that were passing through and doing jumps. The species most seen in 2015 was the sperm whale (*Physeter macrocephalus*), followed by the humpback (*Megaptera novaenglidae*), which can be found in the months of November to January.

Part of the marine mammal identification is to point out what was the first signal in the sighting which, on dolphins, was more frequent jumping and back-fin, just as was done for the whales the most frequented is the breath; the least is recorded for both groups is the presence of birds or other.

The answers to define calf were varied, where 33% relates it to a whale but 24% think it is a sperm whale and / or a large animal. However, all mention that differentiate it from a whale by its size. Calfs often find, mostly alone but also seen in groups.

Perception

The distance from the boat to the whale has been between 0.5m to 1m and the farthest up to 1 km. Although have been very close to these organizations, few said they had not touched a dolphin or whale. For the fishermen of La Libertad, dolphin meat has no use, so do not know the monetary value of it, therefore, it is not marketed.

Half of the respondents mentioned that they would pay the entrance to an aquarium to watch dolphins, the rest would not do as they prefer to see them in the sea. By observing dolphins near the fishing zones, fishermen have to think they can

break the network or is indicative that there is no fish. But when they see whales near their boats or nets, fishermen think it is better to stay away from, preventing any accident.

Dolphins, according to fishermen, tend to eat the bait or be feeding when they are fishing. In the fishing day, when an encounter with whales, respondents mentioned that these only go long, dodging the boat, and they never observed the whale steal bait.

Some fishermen believe that marine mammals help humans by rescuing castaways, others for maintenance of the ecosystem itself but do not know its function. Most do not know about the Wildlife Act which owns the country, despite this are aware that actions to protect these species are needed.

DISCUSSION AND RESULTS

Marine Mammal Composition

According to Hasbún et al (1993) the species listed as confirmed are *Stenella longirostris, S. attenuata*. Also Hoyt and Iniguez (2008) records the following species *Tursiops truncatus*, *S. attenuata*, *Physeter macrocephalus* and *Megaptera novaeangliae*. In this work reconfirms the presence of the species *S. attenuata, Megaptera novaengliae* and *Tursiops truncatus* and added to the species confirmed *Globiocephalas sp* (pilot whale), and *Zolaphus wollebaeki* (Galapagos sea lion), both seen from coast.

Barraza et al (2014) refers to the seasonality of a group of bottlenose dolphins for the Golfo de Fonseca, and also could observe for the area of the Departamento de La Libertad, but to have clearer if this behavior presents it has to be done a study on seasonality of these species.

Fernandez et al (2011) refers that a factor that contributes on sightings of *Stenella attenuata* is the environmental conditions, specifically during dry months. Guevara and Gallo (2015) for the Golfo de California, says that *Tursiops truncatus* had fewer sightings in the summer season. According to this study it matches with both authors, since register a higher number of *S. attenuata* in January and April, months that for El Salvador are listed as a dry season. For *T. truncatus*, it differs from the above by Guevara and Gallo since this species was presented with a greater number of sightings from October to December (summer months).

The only record that was obtained from *M. novaeangliae* was at a distance of 20 m from the coast, so it matches the data provided by Ruano (2008), mentioned that it can be found on shallower depth -100 m- for the Guatemalan Pacific.

Interaction between Marine Mammals and Fishermen

Operational interactions are all those who engage in physical harm to the marine mammal, whether the group of whales, dolphins and pinnipeds (Jefferson et al 1992, Gallo 2003, Plagányi & Butterworth 2009). Gallo (2003) refers to the death of 9 whales and calves due to gill shark fishing with seines and longlines. Based on the results obtained, for artisanal coastal fishermen of Puerto de La Libertad (up to 30mn from shore), does not occur operational interaction, since all individuals had an indifferent behavior in the presence of the fisherman, so, although this was fishing, marine mammals passed him by without getting to contact fishermen and / or their networks.

Palacios (2007) reports that as many sighted groups found in feeding behavior, also mentions that *S. attenuata* is associated with the abundance of their prey so it tends to be found in deep water. The study in question agrees with Palacios, since the behavior that had the most weight was the feeding, specifically for January where it had a bigger presence.

According to Fernandez et al (2011) humpback whales increases the probability of observation by decreasing swell during the summer and, consistent with the results obtained this year the scale of Beauford was scale of 2: presence of small waves without foam.

Knowledge and Perception

Given the experiences in their working time, fishermen know that marine mammals can be observed along the entire coast of La Libertad. CPPS (2010) reports that the most commonly gill on dolphins is caused by fishing nets, which coincides with the work because the dolphins are sighted more frequently when they used networks and, whales with longlines.

May-Collado (2009) presents in her study that the abundance of dolphins begins to increase at the end of the rainy season and reaches a high level in the dry season. As Palacios (2007) refers that for two species of dolphin there is no specific time of observation; Ruano (2008) agrees with Palacios. Under these aspects, knowledge of fishermen is equal to what is found in the literature, as mentioned for summer season (October to March) it can be observed more individuals and there is no specific time for such sightings.

Ruano (2008) via survey to the fishermen in Guatemala refers to the confusion that arise when identifying species of dolphins or whales, and even in different stages and different sexes. El Salvador is no special case, since there is a complication with the term calf, for fishermen refers to a whale (species not known) or a large animal, despites they distinguished by their body size.

Manzanilla (1998) mentions the Mexican coast occupy dolphin meat to catch sharks. El Puerto de La Libertad is not a place where dolphin meat is marketed, so the fishermen have no need to catch them for this purpose and therefore do not know how much it could cost.

Because the presence of dolphins can cause damage to their fishing gear, they try to avoid them, as well as the presence of whales, for fear that toppling at the sight of this organisms, they try to go on the opposite direction.

According to fishermen, marine mammals help human beings when they have been shipwrecked, bringing them close to the shore; and they say they are part of the ecosystem and therefore the ocean itself needs these organisms. Although without knowing the Wildlife Act of El Salvador, they believe convenient to create actions to conserve marine mammal species.

CONCLUSIONS

It reconfirms the presence of the species *Stenella attenuata, Megaptera novaengliae* and *Tursiops truncatus* and is confirmed the species *Globiocephalas sp* (pilot whale), and *Zolaphus wollebaeki* (Galapagos Sea Lion), both seen from coast.

S. attenuata species and *T. truncatus* can be seen in the dry season, in the months from October to March.

The coast of the Departmento de La Libertad, does not occur operational type of interaction, since in all sightings could be observed behavior of indifference to the presence of the fisherman, without contact with fishermen and / or networks.

Feeding behavior by dolphins is conduct that had greater weight and presence throughout the sampling.

Knowledge of sighting and observation time is equal to that found in literature, however many respondents had problems to identify the species observed, because the confused them or have a different name.

According to previous experience or knowledge generation, fishermen are afraid when they are approached by a marine mammal, since these could ruin the team or capsize the boat. But the perception of conservation is very marked fishermen, although it is noteworthy that they do not know why describe it.

The methodologies used for sightings were very effective because they provide the data necessary for analysis.

RECOMENDATIONS

* Perform the same work at national level to identify areas where such interaction occurs, so it could be created a program to avoid competition for prey among fisherman / marine mammals, therefor avoiding accidental bycatch of these species, in turn help their conservation.
* Create a sustainable tourism program in marine mammal watching, as an alternative for the fisherman when it is a low fishing season
* Strengthening education in marine conservation, as attitudes toward it are nothing beneficial to the ecosystem
* If the work is done again, should be good to add more time to the sampling for any weather that could make difficult data taking or could canceled the trip.

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ANNEX

Annex 1: Principal components to be taken into account in the analysis of the influential variables in the interaction

PC	Eigenvalue	% variance
1	**8.45676**	**36.769**
2	**7.03546**	**30.589**
3	**3.94137**	**17.136**
4	2.51382	10.93
5	1.05259	4.5765

Annex 2: Variables to take into account for the second principal component analysis

	PC 1	PC 2	PC 3	PC 4	PC 5
Des	0.28282	0.17143	0.11588	0.084044	-0.20934
Mnub	-0.2644	0.21396	0.10905	0.12332	0.03939
Pnub	-0.19781	0.16667	-0.1395	-0.082791	0.60064
B1	0.01578	0.32886	0.21932	0.10611	-0.13483
B2	0.27443	0.1423	-0.16273	0.027333	0.32966
Dis.C	0.19361	0.016258	-0.4131	0.056905	0.019325
DE	0.20917	0.21755	-0.076068	0.33009	0.01778
DO	-0.10455	0.19521	0.28618	-0.35415	0.036148
Vd	0.25417	0.19166	0.19585	0.10415	0.12621
Vf	-0.15287	0.32148	-0.11979	0.018551	-0.13021
Vis.	0.2794	-0.09341	0.042403	0.080647	0.4922
LA	0.20837	0.19136	0.2787	-0.10673	0.19597
OT	0.14118	0.024029	-0.17573	0.52053	-0.15267
SA	0.027577	0.28407	-0.29463	-0.094585	-0.24111
SO	-0.2644	0.21396	0.10905	0.12332	0.03939
AL	0.29428	0.14531	-0.12779	-0.14733	0.012262
DE	-0.2076	0.083936	0.1685	0.43088	0.083607
ME	-0.2644	0.21396	0.10905	0.12332	0.03939
SO	0.21281	0.17002	0.24292	-0.25581	-0.12541
#sp	0.13693	0.33134	0.10446	0.09851	0.039632
Ab.Av.	-0.014919	-0.2806	0.30353	0.16581	0.10651
PI	0.26202	-0.10256	0.27854	-0.054515	-0.17478
PA	0.10332	-0.26191	0.25355	0.26243	-0.024219