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ANALYSIS OF COHESION CALLS IN *ORCINUS ORCA*

(Linnaeus, 1758)

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Abstract

The killer whales emit emit vocal signals to maintain group cohesion. It is assumed discrete calls are used as cohesion calls, nevertheless has not been tested if any of them could be used for other reason. Combining different stereotyped discretes calls into specific sequences increases the probability to happen a call with response. The acoustic activity of five orcas (*Orcinus orca*) was monitored during five different nights and distributed in three pools, leaving one orca in pool A and the rest of the group between pools B and C. Out of 4311 classified vocalizations were obtained 632 call-response sequences between different pools. Therein, have appeared a few sequences more frequent than others and it seem to exist certain preference to use different call-response sequences depending on the animal. Distribution of total vocalizations is independent from distribution of vocalizations founded in the sequences. To conclude, it is likely there are differences in the use of the distinct discretes calls which are part of a dialect from a orcas group.

Key words: Bioacoustic, *Orcinus orca*, cohesion calls, dialect, sequences.

Resumen

Las orcas emiten señales vocales con fines de mantener el grupo cohesionado. Es supuesto que las llamadas discretas son utilizadas como llamadas de cohesión, sin embargo no se ha comprobado que algunas de ellas puedan utilizarse para otros motivos. Combinando las diferentes llamadas discretas estereotipadas para formar secuencias específicas, se incrementa la probabilidad de que se esté dando una llamada y su respuesta. La actividad acústica de cinco orcas (*Orcinus orca*) ha sido monitoreada durante cinco noches distintas y distribuidas en tres piscinas, quedando una orca en la piscina A y el resto del grupo entre las piscinas B y C. De un total de 4311 vocalizaciones clasificadas, se han obtenido 632 secuencias de llamada-respuesta entre las diferentes piscinas. En ellas, aparecen unas vocalizaciones más frecuentes que otras y parece existir cierta preferencia a usar distintas secuencias llamada-respuesta en función del animal. La distribución de las vocalizaciones totales es independiente de la distribución de vocalizaciones encontradas en las secuencias. Para concluir, es probable que haya diferencias en el uso de las distintas llamadas discretas que forman el dialecto de un grupo de orcas.

Palabras clave: Bioacústica, *Orcinus orca*, llamadas de cohesión, dialecto, secuencias.

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A mi madre y a mi padre, gracias a ellos mis sueños se están haciendo realidad.

1 Introduction

1.1 *Orcinus orca*

The Killer Whale, *Orcinus orca* (Table 1), is the largest member of the toothed whales belonging to the family Delphinidae and one of the most powerful predators in the oceans (they are in the upper levels of predation in the trophic chain). Delphinidae family is the most diverse of Cetacean order, including 17 genus and 36 species of dolphins, killer whales and pilot whales (Berta *et al.*, 2006).

Table 1. *Orcinus orca* scientific classification.

Domain	**Eukaryota**
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Cetacea
Suborder	Odontoceti
Family	Delphinidae
Genus	*Orcinus*
Specie	*O. orca*

Nowadays they are considered only a single cosmopolitan specie although different species have been suggested based on color patterns, diet, genetic and morphological differences and behavioral traits. It is clear the taxonomic revision may be warranted; it is likely that *Orcinus orca* is divided into a certain number of species or subspecies in the coming years (Reeves *et al*., 2004).

They are marine mammals, warm-blooded, air breathing and bear their calves alive. They appear to be most abundant in coastal waters and at higher latitudes, and relatively uncommon at tropical latitudes (Leatherwood and Dahlheim, 1978; Dahlheim and Heyning, 1999).

Individuals can be distinguished from each other by scars, pigmentation changes and the shape of the dorsal fin. This species are grouped in family pods, that always traveling together.

Regarding the associations that present this specie, the most studied orcas communities are from North Pacific, especially near British Columbia (Canada) and the coasts of Alaska and California. In these areas, several studies agree on the description of three orcas ecotypes, colloquially known such "Residents", "Transients" and "Offshores" (Bigg *et al.* 1987; Ford *et al.* 2000). The three ecotypes are genetically distinct (Stevens *et al.*, 1989; Hoelzel and Dover, 1991; Hoelzel *et al.*, 1998; Barrett-Lennard, 2000; Barrett-Lennard and Ellis, 2001) and easily distinguishable based on morphological (dorsal fin shape and saddle patch patterns) and behavioral features (diet, foraging, vocalizations, dialect, group size and social structure) (Ford *et al.* 1994; Ford and Ellis, 1999).

Authors like Bigg *et al*. (1987) and Ford *et al*. (1994) described the basic differences between Residents and Transients, which occur in sympatry but maintain social and reproductive isolation (Ford, 2009). Much less is known about the offshore form, which is rarely seen in inside waters, and presumably ranges in outer coastal or offshore waters (Ford *et al.* 1994; Ford and Ellis, 1999).

1.2 Sizes and morphology

The maximum body lengths are 9 m for males and 7.7 m for females. Males can reach 6,600 kg with 7.63 m, while the maximum weight for females is 4,700 kg and 6.58 m (Yamada *et al*., 2007). Calves at birth are about 2.4 m long and their weight is about 150 kg (Ivaldi, 2011).

The body temperature is about 36.4°C (Ivaldi, 2011). According to Gots and Ronald (2009), the brain of an adult orca weights about 6 kg.

They have a large mouth with the lower jaw slightly shorter than the upper. Both the jaws contain from 10 to 13 pairs of powerful, interlocking conical teeth. Usually they have a total of about 40-56 teeth, with a length of about 13 cm, and the number of the rings within them may indicate how old an individual is, only in case they are more than 30 years it becomes difficult to distinguish new rings. The teeth are used to grip and tear preys, but not to chew them (Gots and Ronald, 2009).

Cetaceans breathe through a blowhole reinforced by a muscle fin that provides protection to the cavity and is opened and closed according to the animal neccesities. It is located at the top of the head to facilitate the breathing process. Orcas also contain a melon which is placed on their prominent forehead and is useful to perform echolocation.

Killer whales are recognized by their distinctive black, white and grey coloration and a white eye patch, or spot, located just above and behind the eye. Just behind the dorsal fin there is a grey saddle patch. The whale's belly, lower jaw and the underside of the tail flukes are white. The rest of the body is black (Culik, 2011). In neonates, the normally white-pigmented areas on the body have an orange hue, and the saddle patch is indistinct or absent for the first year of life (Ford, 2009).

There is a clear sexual dimorphism in size (Figure 1), especially in the dorsal fin. It is upright and triangular in adult males, and it can reach two meters of height, and sometimes is bent due to the weight of the animal. In females and juveniles the dorsal fin is curved backward and can reach one meter of height, and normally it is not bent. The pectoral flippers are paddle-shaped. The caudal fin is used to propel, and while swimming they can reach a speed of 55 Km/h, this is the maximum speed that a marine mammal can reach (Gots and Ronald, 2009).

Figure 1. Differences between male and female. Note the size of the body and pectoral fins, and the dorsal fin shape. Ida Eriksson for Futurismo Azores, 2007.

1.3 Distribution

Orcas are a cosmopolitan cetacean that practically inhabit in all regions of marine environment: from oceans to regional seas, including some estuaries and bays (rarely in rivers), from poles to more equatorial regions (Figure 2). Generally they prefer deep water, but they are also found in shallow bays, being more numerous in coastal and cooler waters where the productivity is high (Jefferson *et al.*, 1993; Dahlheim and Heyning, 1999; Culik, 2011). Passadore *et al.* (2007) concluded that the presence of orcas changes depending on the surface water temperature.

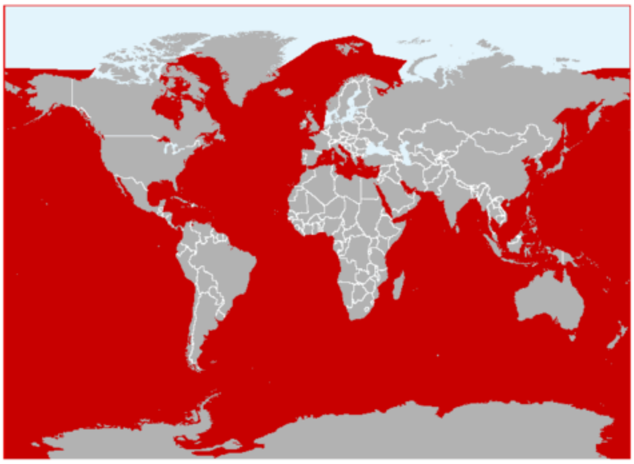


Figure 2. The map shows where the species may occur based on oceanography. The species has not been recorded for all the states within the hypothetical range as shown on the map. Map mod. by Taylor et al. 2008; © IUCN

Whales watchings have occurred from the surf zone to the open ocean, approximately until 800 km from the coastline. Nevertheless, it has also been seen large concentrations of orcas beyond the continental shelf. The distribution also varies depending on whether they are Residents, Transients or Offshores.

For example, in the northwest Pacific communities, Residents cover large depths along the migration route of tuna and Transients are looking for pinnipeds in confined waters (Dahlheim and Heyning, 1999; Culik, 2011).

In the IUCN Red List (Taylor *et al.*, 2013) it is estimated an abundance of sampled areas around 50,000 whales around the world. However, it is likely that the total abundance is higher because the available data are far from being completed, especially in high latitudes of the Northern Hemisphere, areas of the South Pacific, South Atlantic and Indian Ocean. In the IUCN Red List are categorized as DD (Data Deficient). This classification is justified by the potential taxonomic reclassification of orcas, in anticipation that some specie or subspecie may have few effectives.

Ford (2009) in his study observed how orcas move in one direction at a steady, fast pace, with no evidence of foraging. Groups normally travel on a current line, with synchronized dives and surfacing. Taylor *et al.* (2013) identified movements of some groups of orcas which cover distances from Alaska to central California, more than 2000 km.

1.4 Biology and behavior

Patterns of association among Residents indicated that both males and females maintain a link and continue travelling with their mothers for life (Bigg *et al.*, 1990; Matkin *et al.*, 1999a). Mothers and their descendants are a basic unit of social organization and form so-called matrilineal groups, usually include 2-3 (occasionally 4) generations. These matrilineal groups always travel together as a cohesive unit and are recognized as a fundamental social unit of Residents populations (Bigg *et al.*,1990;. Ford and Ellis, 2002). These groups are recognized as pods (Bigg, 1982), and each whale is named individually based on the pod which it belongs. The pods acquire letters from A to Z, and each individual in each pod is assigned a number. Example: A2, A5, B12, C7...

Culik (2011) classifies social organization in communities, pods, subpods and matrilineal groups: a community is composed of individuals that share a common range and are associated with one another; a pod is a group of individuals within a community that travel together the majority of time; a subpod is a group of individuals that temporarily fragments from its pod to travel separately; and a matrilineal group consists of individuals within a subpod that travel in very close proximity.

Most of orcas pods contain from 1 to 55 individuals, noting that Residents pods tend to be larger than those of Transients (Jefferson *et al.*, 1993). Baird and Dill (1996) summarize that typical size of Transients groups is consequence of maximizing energy intake hypothesis (energy intake varies with the group size; groups with three whales have an energy intake rate higher per individual).

1.5 Reproduction

In terms of reproduction, Jefferson *et al.* (1993) observed that in Pacific Northwest communities, calving occurs in non-summer months, from October to March. Similarly in the Northeast Atlantic, it occurs from late autumn to mid-winter.

Gestation lasts between 15 to 18 months and it is first observed in wild females at 12-14 years old. Intervals between calves average 5 years, and the reproductive life span is around 25 years long (Ford, 2009). Females which more than 40-years-old have a prolonged period of reproductive senescence (COSEWIC, 2008).

Based on data obtained of a killer whales study in British Columbia over 30 years through photographic identification, it is dated a lifespan of 80 years for females and about 40-50 years for males (COSEWIC, 2008).

1.6 Feed

Orcas are generalist predators on the global scale (Ford, 2009). It is known that they feed a wide variety of prey, including other marine mammals species (except river dolphins and manatees), seabirds, sea turtles, many species of fish (including sharks and rays) and cephalopods (Dahlheim and Heyning, 1999; Ford and Ellis, 1999; Ford, 2002).

Generally, Resident individuals prey mostly on fish, Transient ones prefer marine mammals and Offshores orcas seem to feed on both types of prey but they are more specialize in sharks. Some subpopulations are specialized in certain preys in particular (Bigg *et al.,* 1990). Local subpopulations reflect specialization regarding food preferences.

<u>Hunting techniques</u>

In general, orcas are known to utilize cooperative techniques to hunt fish and attacking large preys (Dahlheim and Heyning, 1999). They have a wide variety of foraging tactics, such as intentional beaching to have access to seals on land. In this case, it is a cooperation of at least 2 whales, one is on the surface near to the coast and the other one swims underwater in the opposite direction to the coast. Therefore, pups which found near water can hardly escape. However, even it may seem easy, authors like Gots and Ronald (2009) estimated that in the case of sea lions, orcas hunt one every three attempts.

Another case is when they attack baleen whales or sperm whales, they do it in groups of 10-20 orcas (Ford, 2009), usually attacking hatchlings or juveniles, rarely adults. In 1979, Tarpy recorded a group of 30 orcas in synchronism attacking a young blue whale average 18 metres. They tored flesh and fat, piece by piece for about 5 hours until stopped, being mortally wounded.

They also eat herrings using the known technique called 'carousel feeding' in the Fjords of Norway. Hundreds of orcas surround a shoal of herring and lead it to the surface. Individually they take turns to hit them quickly with their caudal fin and leave them dead or stunned until they can feed them (Knudtson, 1996). Miller *et al*. (2006) studied this tactic in Iceland. In this case, they do a call during 3 seconds (680 Hz) that ends just a second before they hitting herrings with their tail and leave their prey stunned. Ocasionally, they take advantage of herrings and mackerels fishing operations. They are often found near the fishing vessels to capture the fish that is escape when retrieving the purse seine nets (Similae, 2005). In southern Brazil and many other parts of the world, orcas have learned to hunt fish hooked on long-lines (Culik, 2011). For instance, captures of Patagonian cod (*Dissostichus eleginoides*) decreased more than 50% when orcas appear (Kock *et al.,* 2006). In the tuna case, they chase the medium-sized ones (<1.5 meters) for 30 min at high speed until they leave tired. For larger tunas they need to use cooperative hunting techniques or take advantage of fish caught by different fishing gears as long lines or traps (Guinet *et al.*, 2007).

There are even films of *Orcinus orca* attacking to other ocean predator as: the great white shark. It has only been seen twice, once in October 1997 and another in late 2009 (Culik, 2011). In 2009, Dr. Ingrid Visser describes a couple of strategies to attack sharks. One technique is to create strong streams of water with their body to prevent the shark escapes. Then, it swims disoriented to the surface and the orca takes to beat him violently from below, throwing out the shark from water and leaving it completely stunned. Another technique is to surround and attack repeatedly the shark taking turns until it is disoriented so they can eat it.

1.7 Threats

Historically the main threats were:

- Commercial hunting,
- Live capture for aquarium display, particularly of the Southern Resident stock (some live capture still occurs in Russia),
- And culling due to depredation of fisheries.

Nevertheless, threats have now increased, mainly due to:

- Contaminants. Killer whales are on the top of predators at the trophic web, and for that reason they are the most vulnerable for bioaccumulation of heavy metals and Persistent Organic Pollutants (POPs), which are characterized by their presence in the whole planet, accumulation in fat tissue (blubber) and slow biodegradation.
- Depletion of prey due to overfishing and habitat degradation (climate change).
- Ship collisions.
- Oil spills. Spills affect them directly and indirectly causing mortality of its preys.
- Noise disturbance from industrial and military activities. It could disrupt hunting or rest activities and alter their social communication or echolocation signals.
- Interactions with fishing gear.
- Whale-watching can be a threat if not conducted responsibly.
- Directed catch of killer whales still occurs, though these levels are presumed low.

1.8 Type of sound

Many researchers have described that killer whales communicate using a limited number of stereotyped vocalizations, referred to as dialects. The structure of these dialects is different between populations and also differs between family groups within the same population (Luke *et al*., 2010).

Nowadays there are three types of sounds emitted by orcas, which are clicks, calls and whistles.

- **Whistles** are tonal signals (Figure 3) with little or no harmonic content that tend to be most common in social contexts and are thought to play a role in short-range communication (Ford 1989; Thomsen *et al.* 2002). The most common frequency range is between 17 and 48 kHz, but it has been recorded frequencies up to 192 kHz in some case, with the fundamental frequency at 48 kHz (Samarra *et al.*, 2010). The duration of whistles ranges from 50 ms to 10–12 s (Luke *et al.*, 2010).

- **Clicks** are short pulses of sound, usually produced in serie. They are used in echolocation for orientation and prey detection (Figure 4). They have a frequency range between 20-180 kHz (Barret-Lennard *et al.,* 1996; Simon *et al.,* 2007). The duration of clicks ranges from 0.1 to 25 ms (Luke *et al.,* 2010).

- **Calls** are the most common vocalization of killer whales and are thought to function in group recognition and coordination of behaviour (Ford 1989,1991; Miller *et al.* 2004). Ford (1989) grouped pulsed calls into three categories: discrete, variable and aberrant. <u>Discrete calls</u> are highly stereotyped and can easily be assigned to different call types according to their structural properties. <u>Variable calls</u> are not stereotyped and cannot be divided into clearly defined call types. Finally, <u>aberrant calls</u> are structurally based on a discrete call type, but show some degree of modification. As with whistles, killer whales tend to produce aberrant calls most frequently during social interactions (Ford 1989, 1991). The frequency ranges of calls are between 1 and 6 kHz (Ford, 1989) and their duration ranges between 0.5 and 1.5 s (Luke *et al.*, 2010).

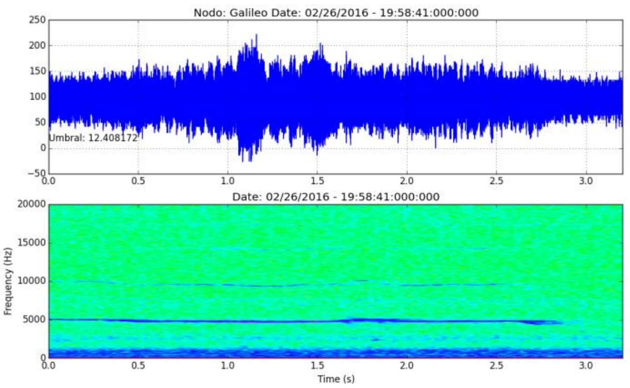


Figure 3. Output image of Classifier program. February at 19:58h. The graph above is the amplitude of the wave and below the spectrogram, in which appears a whistle.

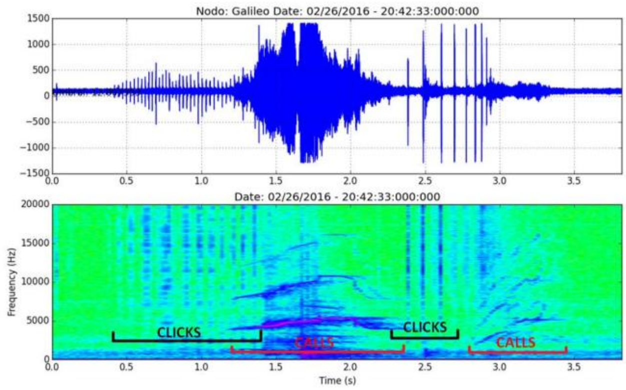


Figure 4. Output image of Classifier program. February at 20:42h. Two graphs are observed, above the wave amplitude and below, the spectrogram with Clicks and Calls issued in just 3 seconds.

1.9 Objectives

All the cetaceans in the planet need, or it would be advantageous for them, to have a mechanism to maintain the cohesive group. This mechanism could be two ways: (i) recognize the space envirnoment in which the last interaction occurred either or, (ii) it is the possibility of a recognition system based on the signals given by an individual, which other can recognize in it. Like many other signals, the signals of recognition provide information about the location of an individual, as well as his identity. Both are important for maintaining the cohesion of the group (Janik and Slater, 1998).

In killer whales, Kenneth (1984) reported that discrete calls have an even greater potential function as effective cues for coordinating group activities and maintaining pod cohesion. According with Ford (1989) discrete calls probably function as intragroup contact signals to maintain pod cohesion and coordinate activities. Therefore, in the current work cohesion signals in discrete calls are going to be encompassed, and will consider all those sequences of vocalizations (call-response) that occur between an individual separated in a pool and the rest of the group.

However, in order to ascribe a specific function to vocal sequences, at least two prerequisites have to be fulfilled: (1) the signals within the sequence have to follow a specific and nonrandom pattern, and (2) the behavioral context in which the sequence takes place has to be identified (sensus Riesch *et al*., 2008).

For this we have a group of orcas in a controlled environment, which have been studying their dialect for eleven years, and therefore the vocalizations can be classified in different categories thanks to the dialect LP (Appendix 1).

The hypothesis of the study is that orcas use one or more vocalizations of calls from their dialect in order to keep the group united.

In this way, the objectives are the followings:

- To observe and identify if there have some call vocalization more often used between the separated orca and the rest of the group.
- To characterize the preferred call-response sequences.
- To determine whether the use of cohesion calls is homogeneous or, on the contrary, the different individuals use them differently.

2 Material and methods

2.1 Location of study

The study is made at Loro Park, particularly in Orca Ocean facilities where several specimens of target specie are found in captivity. This place was chosen because it has:

- The specie in question in a controlled environment, which facilitates the recording of sounds and the possibility of separating the animals to perform the experiments.
- Facilities with all the necessary electrical equipment to record, store, process and analyze data later on a computer.

Loro Park, founded by Wolfgang Kiessling, opened his doors for first time in 1972 with 13,000 m^2 and 150 species of parrots. Currently it has an area of 135,000 m^2 and a great diversity of species. This park is located in the north of Tenerife island (Spain) in the municipality of Puerto de la Cruz, whose coordinates are 28 ° 41'23 ''N, 16 ° 57'0 '' O.

The work is carried out thanks to the collaboration of Loro Park Foundation, an international non-profit institution designed for conservation, research, education and species rescue in nature. It is registered in the Ministry of Education and Science of the Government of Spain since 1994. This foundation conduct several research and conservation projects both inside and outside the park. This particular study is within the research of dialect and vocalizations of *Orcinus orca*, as a prototype for future works of association the behavior to the dialect.

2.2 Orcas in Orca Ocean

Orca Ocean was inaugurated in 2006 with the arrival of four orcas (Keto, Tekoa, Kohana and Skyla) originating from Seaworld Orlando (Florida) and San Antonio (Texas). The four orcas borned in captivity; they are the second generation of orcas borned in a controlled environment (Table 2).

In October the 12 th, 2010 borned Adán, son of Kohana and presumably Keto, but there are no DNA tests to confirm this. In November the 29th Morgan arrived after spending 17 months in a dolphinarium in Netherlands, country where in 2010 was found stranded on the coast. However, because of Morgan is hearing impaired, can not use the same dialect as the rest of orcas and therefore has not been included in this study.

Table 2. Dates of births, sexs, parents and blood. Lenghts and weights are from 22/02/2016.

Name	Keto	Tekoa	Kohana	Skyla	Adán	Morgan
Date of birth	17 June, 1995	8 November, 2000	3 May, 2002	2 February, 2004	12 October, 2010	Unknown
Sex	Male	Male	Female	Female	Male	Female
Lenght	6'02 m	5'71 m	5'25 m	5'39 m	4'22 m	5'13 m
Weight	3667'29 Kg	2467'54 Kg	2136'41 Kg	1979'92 Kg	1075'01 Kg	2036'62 Kg
Mother	Kalina	Taima	Takara	Kalina	Kohana	Unknown
Father	Kotar (Iceland)	Tilikum (Iceland)	Tilikum (Iceland)	Tilikum (Iceland)	Keto or Tekoa	Unknown
Blood	75% Iceland; 25% Resident south of Canada	75% Iceland; 25% Transient Canada	100% Iceland	75% Iceland, 25% Resident south of Canada	Unknown	Unknown

Normally in this specie, as in many others, dominant members are females. The dominant orca in this group is Kohana. They are fed herrings, capelins and sprats. The amount of food varies depending on the weight of the orca and its activity, taking between 320 and 560 kg distributed in 8 meals per individual and per day.

Orca Ocean structure consists of 4 pools:

-Pool M: is the Medical one, 7,1x12,4 m large and 4'2 m deep. The floor of this pool can be raised to bring the animal out of the water. In this way can be assured the necessary medical care and other routine controls (for example take the measures of the body of the animal).

- Pool C and Pool B are respectively 20'5x36'5 m and 30'5x44'8 m large, and have the same deep of 8'1m.

-Pool A is the largest one and is where the show is made. Has a deep of 12 m and is large 24'5x50'5 m.

2.3 Hydrophones and File System Data Base (FSDB)

Bioacoustics is a scientific discipline that investigates the production and reception of sounds emitted by animals. Generally, the analysis procedures are performed manually (recording, detection and classification), and due to the high number of recordings it becomes a task that consumes a lot of time, so automation is necessary. Automation requires prototyping and development of bioacoustics devices more simples, which have to be tested under controlled conditions before they can be integrated and used in real conditions (e.g in the open sea). To this end, in collaboration with the University of La Laguna (ULL), Philipp Lüke, Fernando Rosa, Jose Carlos Sanluis and Javier Almunia created in 2012 an experimental framework in the facilities of Loro Park (Figure 5).

In this context, they have developed OrcaNet, a net of smart hydrophones (ITC-6050C International Transducer Corporation, Santa Barbara, CA) distributed among the three pools and connected to a computer (sample rate 200 kHz, frequency response 20–75000 Hz, resolution 16 bits).

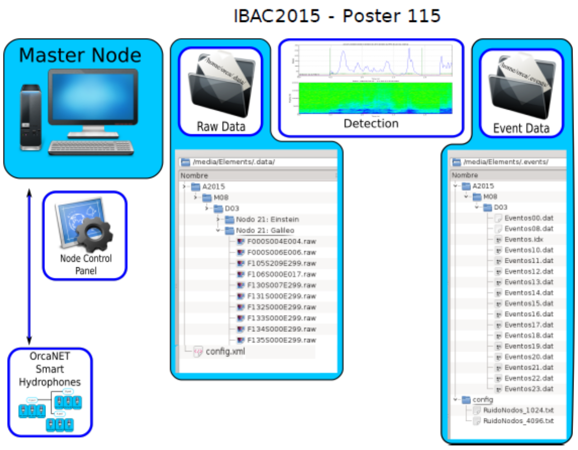


Figure 5. Master node is the receptor of all packages of raw data and it is the manager of all processing. Rosa, F. et al., 2015.

The sounds of the hydrophones are digitized in nodes connected directly to them and individually sent to the Master Node, which are stored in the FSDB (File System Data Base) into digital packets of 512 samples continuously and in real time. ULL team developed an automatic detector of acoustic events that can reduce the large amount of data produced. An event contains sound information produced by an orca. Once detected, the events are stored in the FSDB and ordered according to the dimensional distance at noise at the moment of the animal acoustic emission. (Rosa *et al*., 2015).

That is, the better signal-noise relation (if the signal is very strong and little noise, there is a good signal-noise relation) is, the greater dimensional distance between the event and the noise will be. The system arranges depending on signal quality, in order from lowest to highest distance.

Given that only events are stored in database, storage demand was reduced about 7% compared to the space required to store the entire recording. This allowed the storage of all the sound events produced in about one month on a standard computer harddisk (Luke *et al*., 2010).

Below it is presented a general synopsis of an automatic bioacoustic pattern classification device designed by Luke *et al.* 2011. This summary is organized into layers:

- The first layer consists in the necessary hardware to acquire bioacoustic signals, in this case a set of hydrophones and an acquisition card.
- The second one consist on the necessary software or hardware for signal detection. The objective of this layer is to distinguish between signal and noise. So, only signal intervals are available to the upper layer. For this purpose, several algorithms have been developed and compared to see which was the better result.
- The next layer is followed by the classification and analysis layer. In the future, the classification will be automatic, but is still under development. The mission of the layer is to classify the vocalizations of the orcas using certain criteria and obtain statistical information about the occurrence of vocalizations.
- Finally, it can appear a fourth layer which extracts temporal patterns of vocalizations and generates temporal vocal behavior rules. Another aspect to develop in this layer is the localization of sound sources providing the position of specimens that vocalize.

In the future, the system will be completed with automatic event classification modules. For this purpose, features have to be extracted automatically from the detected signals and suitable classification algorithms have to be tested (Luke *et al.*, 2010).

2.4 Data collection

For the purpose of verify if calls cohesion occur when an orca is separated from his group, it was necessary to separate individually each one in the pool A during a night, and distributed the rest of the group in the other two pools (Table 3). Thus, vocalizations events are collected per night (from 18:00 p.m. to 8:00 a.m. next morning) and per pool.

Table 3. Dates of orcas's sleeping configuration.

Dates	POOL A	POOL B	POOL C
From 04 to 05 of February 2016	Adán	Keto Tekoa Morgan	Kohana Skyla
From 26 to 27 of February 2016	Tekoa	Keto, Morgan, Skyla, Kohana, Adán	
From 03 to 04 of March 2016	Keto	Tekoa Morgan Adán	Kohanna Skyla
From 13 to 14 of March 2016	Skyla	Keto Tekoa Adán	Kohana Morgan
From 17 to 18 of March 2016	Kohana	Keto Tekoa Adán	Skyla Morgan

Recording hours were chosen at periods of time that orcas stay completely alone (without their coaches or shows) and days depending on social behavior of the group during the day.

Pools have a total of 12 hydrophones, 4 in each pool: one is situated on the pavement and three on the walls. For this work, it has been used a total of three hydrophones, one on each pool (Figure 6) and each connected to a node. However in pools B and C arose problems with hydrophone recordings, much noise was obtained in the event because the specific algorithm of detection did not fit properly to them.

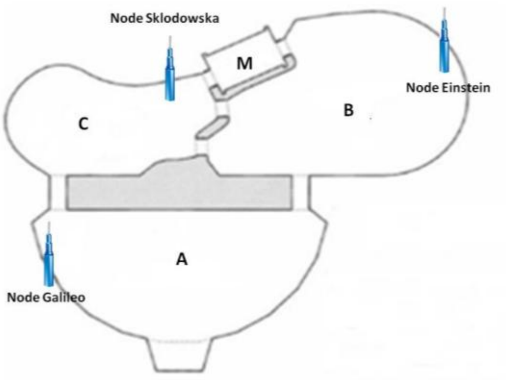


Figure 6. Orca ocean pools distribution (Loro Park), with the hydrophone position and the name of each corresponding node.

To determine from what pool came each sound, dimensional distance distribution (signal-noise relation) was calculated with the sounds that coming to the pool A and have been issued in B and / or C. To do this, a total of 22 sounds that had been emitted safely in the pool B and also recorded in the pool A were used by R Commander 3.2.5.
Dimensional distance distribution was calculated and it was found that, with 95% of confidence, values above 7,088 came from pool A and the rest from pools B or C. It has not been able to distinguish between pool B and C due to electrical noise and problems in digitalization nodes while performing experiments.

The data were manually classified by three persons according to Loro Park Dialect 2015 version (Appendix 1) with the help of Classifier program, created by the team of the ULL. In Classifier two graphs were showed: the event spectrogram (frequency in Hz versus time in seconds) and the wave amplitude (amplitude in microPascals, μPa, versus time in seconds). It allowed hearing the sound emitted too, thereby facilitating the classification. Using this program events are cataloged and stored in *.dat* file and they are copied to a Microsoft Office Excell 2007 file, in which data were based on date and time of sound emission, pool (A or BC), the animal that produced it (if it can be known) (n = 5), the type of call depending on Loro Park Dialect and the mean noise distance. Thus, with this file it could be already begun to process the data.

2.5 Data analysis

The analysis objective was to found call-response sequences, for it is needed to locate calls into a pool (A or BC) with response from the other pool (BC or A) in a range equal or less than 5 seconds. This temporal reference is taken from the study of whistles sequences in orcas by Riesch *et al.*, 2008, which is based on previous analysis (Thomsen *et al.*, 2001, 2002; Riesch *et al.*, 2006). These authors defined *a priori* that a sequence had to consist of at least two whistles ocurring within 5.0 s of each other. For this purpose it has been created a script in R Commander 3.2.5 that, using loops, it returns the exchanged calls between pools in the desired range, obtaining the total number of exchanges and the type of call emitted for each exchange and pool. Then, they were exported to Microsoft Office Excel 2007.

These data were processed with R Commander to created contingency tables and numerical summaries and be able to analyze the data. Finally, there was an independence chi squared test between total vocalizations recorded in the days of study and vocalizations included in cohesion call sequences, taking independence as null hypothesis.

3 Results

Of all the records, almost 30% belongs to the cohesion calls, which occur every day. The total number of analyzed vocalizations in the present study is 4311, may assign with 95% confidence 1589 events to the pool A, and therefore, to the separated orca that produced it.

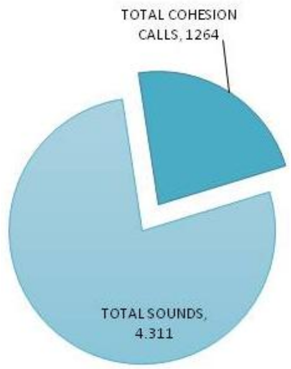


Figure 7. Total counts of calls in the study, including cohesion calls.

They have obtained a total of 632 sequences of cohesion calls (call-response), so a total of 1264 discrete calls. However, it is seen as there is no direct relationship between the number of total calls and cohesion calls during the days of study, that is, not for having more number of total calls there has to be more cohesion calls (Table 4). The day when more cohesive call sequences occur was the day when Tekoa was alone in the pool A.

Table 4. Number and percentages of total calls and cohesion calls sequences per day.

	ADAN Feb.3-4	TEKOA Feb.26-27	KETO Mar.3-4	SKYLA Mar.13-14	KOHANNA Mar.17-18	TOTALES
Total Calls	119	1422	1597	767	406	4311
%	2,76%	32,98%	37,03%	17,78%	9,41%	100%
Cohesion Calls Sequences	10	**522**	**516**	180	36	1264
%	0,79%	41,29%	40,82%	14,24%	2,84%	100%

The orcas in the study produce a total of 17 different types of their discrete calls for cohesion (Figure 8). Regarding to the most common vocalizations we obtain LP07ii with nearly a 30% of use, LP08ii, LP06iv and LP06i.

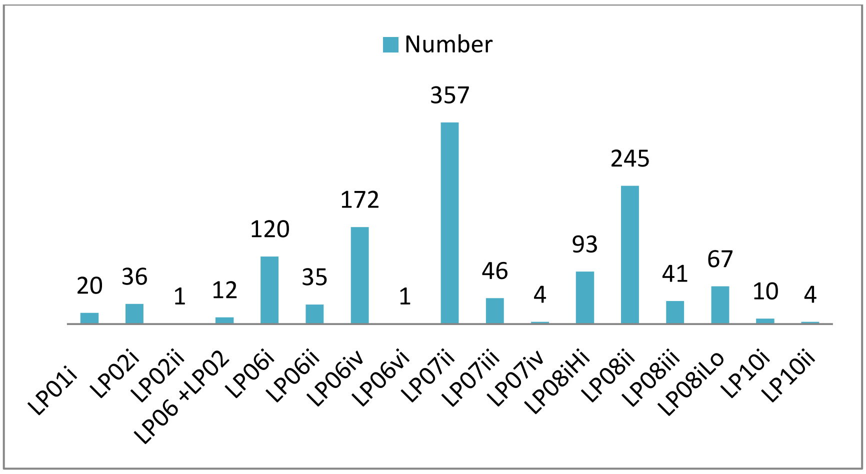


Figure 8. Number of every vocalization type used in calls sequences**.**

Considering the types of vocalizations given in pool A (Table 5), we can know the most common vocalizations for each orca. In this way we obtain that the most usual for Keto is LP07ii, for Tekoa LPO8ii, for Skyla LP07ii and for Kohanna LP07ii. Adán only participates in five sequences, getting a equality in the vocalizations LO06i and LP07ii.

Table 5. Vocalization types used whitin cohesion calls in pool A per orca.

Dialect Calls	Adán	Tekoa	Keto	Skyla	Kohanna
LP01i	0	2	3	0	2
LP02i	0	2	9	0	2
LP02ii	0	1	0	0	0
LP06i	**2**	20	5	0	1
LP06ii	0	5	0	1	0
LP06iv	0	2	0	2	2
LP07ii	**2**	10	**173**	**77**	**7**
LP07iii	0	0	26	0	0
LP07iv	0	0	0	3	0
LP08iLo	0	11	4	0	0
LP08iHi	0	9	38	7	4
LP08ii	0	**163**	0	0	0
LP08iii	0	36	0	0	0
LP10ii	1	0	0	0	0
TOTAL	**5**	**261**	**258**	**90**	**18**

Regarding to the involvement of the orcas to call or respond (Figure 9), Keto is the one that calls the rest of the group more times when he is alone. Skyla also makes more calls than responses. However, Tekoa responds more times than it calls, like Kohanna. Adán only called three times and responded two.

An important fact is that males have participated more actively in the sequences of call-response than females.

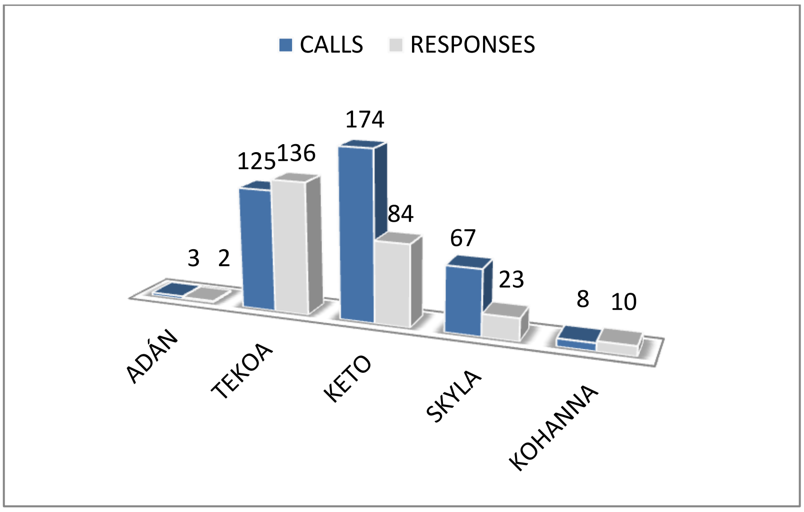


Figure 9. Number of calls and responses per orca.

Examining the sequences call-response from the different pools, it shows that more calls are produced by the pool A (377) than by the pool BC (255) (Table 6 and Table 7). The most frequent vocalization to initiate a call is not the same from a pool than from the other.

In the event of the calls from the pool A, it highlights LP07ii, followed by LP08ii, and whose most frequent sequence is LP07ii-LP06iv (121 times, 32%) and LP08ii-LP08ii (29 times, 8%). The most frequent responses to calls from this pool are LP06iv and to a lesser extent, LP07ii and LP08ii. The most peculiar is that all the sequences which start in A, a 50% starts with LP07ii, and most of them are often responded (66%) with LP06iv.

In the pool B, the most used call is LP06i, followed by LP07ii and LO08ii, and whose sequences are the following ones: LP06i-LP07ii (29 times, 11.4%), LP07ii-LP08ii (18 times, 7%) and LP08ii-LP08ii (21 times, 8.2%) respectively. The most frequent responses to them are LP08ii and LP07ii.

The next step is to analize the most frequent vocalizations LP07ii, LP08ii, LP06iv and LP06i by the orcas. Moreover, 82% of the calls started with LP07ii have been from the pool A, therefore we focussed on this pool to analize such vocalization.

Analyzing the animals, it is found that the 70.7% in the total of times that Keto calls, it makes it with LP07ii, being its most frequent sequence LP07ii-LP06iv in the 81% of the cases. On the other hand, the 88% of the total times that Skyla calls, it makes it with LP07ii too and it is responded with LP8iHi 45.7% of the times and with LP06iv the 35.6%.

67% of the calls initiazed with LP08ii have been from the pool A, belonging the 100% of these calls to Tekoa, being the most frequent sequence LP08ii-LP08ii. Checking the calls which were made from the pool BC, it is noted that all of them belong to the day when Tekoa was alone in the pool A, agreeing about 54% of the cases the sequence LP08ii-LP08ii.

As Tekoa makes more responses than calls, it is also analyzed the responses made with LP08ii by the pool A, 100% belonging to Tekoa. It is remarkable that, appart from the sequence LP08ii-LP08ii, the day when the group called Tekoa they used the sequence LP06i-LP08ii, and when Tekoa was the one that called, the sequence was LP08ii-LP07ii.

In the case of LP06iv the responses have been analyzed due to it is where appears more frequently. 84.8% are given the day when Keto called from the pool A and 15.2% the day when Skyla called.

LP06i is one of the most frequent in calls, but not by the individuals in pool A. This kind of calls from the pool BC has been registered the days when Keto (50%), Tekoa (41.6 %) and Skyla (6.6 %) were in the pool A.

Table 6. Call sequences from pool A with their corresponding response in pool BC.

	LP01 i	LP02 i	LP06+ LP02	LP06i	LP06 ii	LP06 iv	LP06 vi	LP07 ii	LP07 iii	LP07 iv	LP08 iLo	LP08 iHi	LP08 ii	LP08 iii	LP10 i	LP10 ii	Accumulated frequency
CALL IN POOL A	**RESPONSE IN POOL BC**																
LP01i	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
LP02i	7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8
LP02ii	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
LP06i	0	0	0	4	1	1	0	7	0	0	1	0	1	0	1	0	16
LP06ii	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	4
LP06iv	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	4
LP07ii	0	3	4	8	3	**121**	1	10	1	0	5	**29**	0	0	3	0	**188**
LP07iii	0	3	2	1	3	0	0	1	1	0	1	0	0	0	0	0	12
LP07iv	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
LP08iLo	0	0	0	1	1	0	0	1	0	0	1	0	2	0	0	0	6
LP08iHi	1	4	0	2	1	22	0	1	0	0	2	1	2	0	1	1	38
LP08ii	0	5	0	**14**	3	0	0	**17**	1	0	7	1	**29**	3	0	0	**80**
LP08iii	0	0	0	1	0	0	0	5	1	0	0	0	8	1	0	0	16
LP10ii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Accumulated frequency	8	15	6	32	12	**146**	1	**47**	6	1	17	31	**43**	4	7	1	377

Table 7. Call sequences from pool BC with their corresponding response in pool A.

	LP01i	**LP02i**	**LP06i**	**LP06 ii**	**LP06 iv**	**LP07 ii**	**LP07 iii**	**LP07 iv**	**LP08 iLo**	**LP08 iHi**	**LP08 ii**	**LP08 iii**	**Accumulated frequency**
CALL IN POOL BC	**RESPONSE IN POOL A**												
LP01i	2	0	0	0	0	3	0	0	0	0	0	0	5
LP02i	4	1	1	0	0	1	0	0	0	0	1	0	8
LP06+ LP02	0	0	0	0	0	3	3	0	0	0	0	0	6
LP06i	0	0	6	1	1	**29**	3	0	1	3	14	2	**60**
LP06ii	0	0	1	0	0	6	1	0	0	2	7	0	17
LP06iv	0	1	0	0	0	8	5	0	1	5	0	0	20
LP07ii	0	0	2	0	0	9	0	0	3	6	**18**	3	**41**
LP07iii	0	1	0	0	0	7	2	1	0	1	2	0	14
LP08iLo	0	1	0	0	0	9	0	0	3	0	17	5	35
LP08iHi	0	0	0	0	0	0	0	0	0	2	2	0	4
LP08ii	0	1	2	1	0	2	0	0	1	1	**21**	10	**39**
LP08iii	0	0	0	0	0	0	0	0	0	0	1	0	1
LP10i	0	0	0	0	1	2	0	0	0	0	0	0	3
LP10ii	0	0	0	0	0	2	0	0	0	0	0	0	2
Accumulated frequency	6	5	12	2	2	**81**	14	1	9	20	**83**	20	255

Based on these results, it has studied the participation of these vocalizations in the total calls and responses (Figure 10) obtaining for LP07ii a greater intervention in calls than in responses, the same as LP06i. On the contrary, LP08ii and LP06iv appear more in responses than in calls, although in the case of LP08ii is fairly balanced.

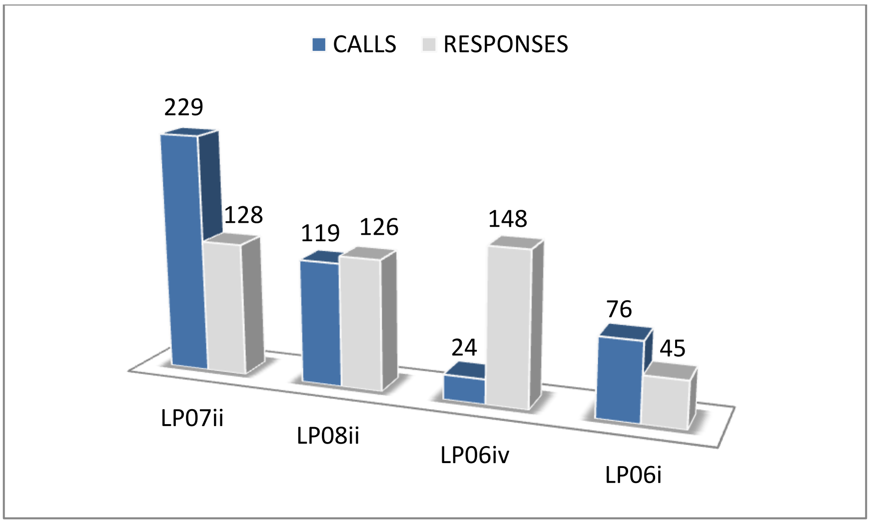


Figure 10. Distribution of the use of the most frequent vocalizations observed in calls sequences from pool A and BC, divided in calls and responses.

To conclude, the chi squared independence test among the total vocalizations including in the sequences, with 95% of confidence, returned a p-value of 0.1062 and so, there are no meaningful differences as to reject the null hypothesis, being the samples independent from each others.

4 Discussion

Combining different stereotyped vocal signals into specific sequences increases the range of information that can be transferred between individuals (Riesch *et al.*, 2008). In this way, of the 4312 discrete calls vocalizations collected for this study, we have obtained that 1264 of them correspond to sequences of call-response, associable to cohesion calls between the orcas. These interactions could also be due to socialization actions, considering that the separation between the pools is nothing more than a door with bars. However, there are too many interactions, so that is not assumed that all of them were socializing. Also, there have been a greater number of calls by individuals in the pool A, which supports the hypothesis that they are related to group cohesion actions more than socialization.

Futthermore, Ojeda (2015) carried out an analysis about the vocal behaviour with the Loro Park orcas and she realized that their dialect changed depending on the day and the night, turning out a greater vocalization of LP08ii and LP07ii during the night, when orcas are separated by the different pools. In this study it is confirmed that these vocalizations are more frequent, and also appear others (LP06iv and LP06i) to a lesser extent. If we compare these data with the vocalizations of orcas in the pool A, we obtain that LP07ii vocalization is the most used call for Keto, Skyla and Kohanna, and LP08ii is the most common for Tekoa.

It is verified that some frequent discrete calls vocalizations are given more than other ones and in turn, it is also appreciated a preference to use different call-response sequences according to the animal, with the exception of Adan and Kohanna that were not very participatory during nights when they were alone, so we can't extract a general pattern action with the available data.

The most peculiar case is Tekoa, in which the 100% of his calls started with LP08ii and his responses with LP08ii when it was alone in the pool A. It results very relevant due to cohesion calls had only been described in birds, land mammals and other cetaceans, but never in orcas. Most of the studies agree about there are calls or whistles (depending on the specie) that help to maintain the cohesion of the group and often provide individual marks, as described Mumm *et al.*. (2014) in giant sea lions. These individual signatures that for captivity bottlenoise dolphins, Janik and Slater (1998) called signature whistles, which take place when one of the animals is separated from the rest of the group (voluntarily or involuntarily) and it is also produced by the rest of the group when some of them is separated. However, these signature whistles are usually not copied and they are hardly produced when the animals are not separated according to authors. Therefore, it may be LP08ii vocalization was a signature call made by Tekoa, but this would have to make a more exhaustive study about it. Moreover, it is unlikely that only Tekoa has individual signature because of the sequences used by Keto and Skyla are very similar to each other and their most frequent vocalizations coincide, so it wouldn´t be about individual signatures, at least in this case.

Just like cohesion calls haven´t been described or tested in orcas, there are studies in which the sequences of vocalizations among stereotyped sounds have been investigated. Riesch *et al.* (2008) made a detailed analysis of sequences in stereotyped whistles with orcas in the nature based on vocal sequences, are often comprised of repetitions of similar stereotyped calls by different members within a social group and are probably used to coordinate group movements (Ford, 1989; Miller *et al.,* 2004). In our case, almost the 50% of vocalizations included in the sequences belong to LP07ii and LP08ii vocalization, and they take 70.7% if LP06i and LP06iv are included. Besides Keto, Skyla and Kohanna combine very similar sequences. Nevertheless, these sequences haven´t been used (or at least entirely) to coordinate movements but to maintain the cohesive group when one of the components wasn´t with them.

According to Ford (1989, 1991) and Thomsen *et al.* (2002), most social sounds in killer whales are pulsed calls, which are thought to help maintain the cohesion of the group, coordinate behaviours, and mediate group recognition. Within the pulsed calls, the kind of sound they use for cohesion are the discrete calls. The present vocalizations in the cohesion sequences in this study meet the requirements described by Miller (2006) for wild orcas, in which discrete calls can be quite intense (>160dB re: 1μpa at 1m).

The available bibliograpy about discrete calls it is suggested that they are proportionally most often used during behaviours where animals are widely spaced out such as traveling and foraging, and probably function as long-range contact signals and in group affiliation (Ford, 1989, 1991; Miller *et al.*, 2004). Other authors such as Kenneth (1976) or Ford (1998) maintain that discret calls are still good as signals of contact in the pools (cohesion) and of coordination of activities. In our case, the discrete calls are carried out in limited distances, but it must also be taken into account that the orcas in our study can´t travel or hunt, and it may be they continued using them to maintain the cohesion of the group.

Nevertheless, this experiment seems to suggest that only a small part of the discret calls are used for cohesion. The rest of the clasified calls in the study have more functions apart from cohesion, which may be to socialize, group coordination or behavioral activities.

The males can seem more vocal than the females. This could be because the frequency of the vocalizations is reduced with the hierarchy: they exchange less cohesion calls when it is higher in the hierarchy. Or it could also be due to sexual dimorphism, being males more vowels than females. Within this rule, Adán should be excluded, that was especially in silent the night when he was alone in the pool A. However, during the Ojeda (2015) study, Adán was extraordinarily vocal during the night when he was alone, which may indicates that there are other effects that can be having influence in the number of vocalizations per animal: social, personality, behaviour, stress, etc. In this way, Castellote and Fossa (2006) comment that there is an extensive body of literatura documenting that the vocalization rate, types of vocalization, and acoustic structure within a call type may vary with stressful contexts such as aggression, panic, social separation, and levels of stress hormones in species such as rodents, primates and domestic pigs, but in captive marine mammals remains unstudied.

5 Conclusion

The conclusions drawn from this study should be viewed with caution, since they belong to a group on only five animals:

It has been checked that the distribution of the whole vocalizations recorded during the nights of study are independent from the vocalizations distribution founds in the sequences. It appears to be differences between the use of the different discrete calls that form the dialect of a orcas group. It would be necessary to investigate more about the use of discrete calls in different social contexts to resolve the specific use of each of them.

More frequent vocalizations than others are given in the sequences and at the same time, also some preference is shown to use different call-response sequences depending on the animal, except Adán.

Of the analyzed data can not conclude whether the orcas use signature calls such as the dolphins or if they have common cohesion calls. We have evidence in both directions, so it should be investigated further to see because an animal uses an own cohesion call and the rest use other.

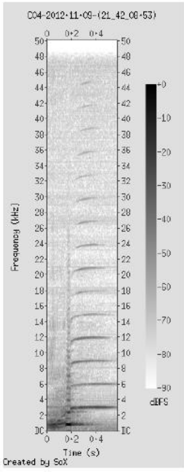
It is observed some tendency to a greater cohesion communication by males than by females.

The limitations of the study are due to problems with the recordings of the hydrophone considering that it was obtained much noise in the event due to the specific algorithm of detection did not adjust correctly to B and C pools. As soon as this problem is solved, more accurate conclusions may be made.

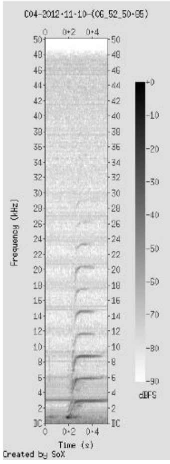
Future recommendations for this study is to analyze the vocal behaviour throughout the day to check if the named cohesion calls are used also throughout the day and to verify if they are exclusively for cohesion or have other functions.

6 Appendix 1

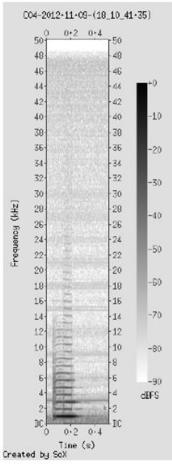
Below there is a summary of Loro Park Dialect 2015 version.



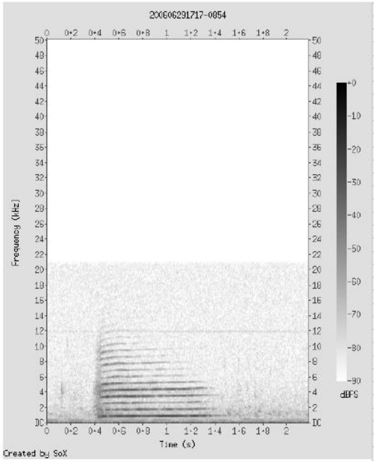
LP01i



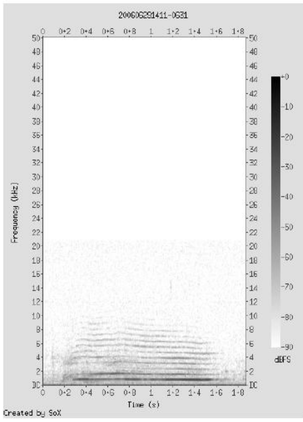
LP01ii



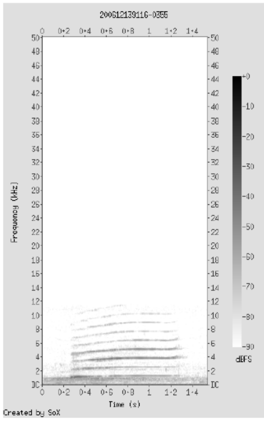
LP02i



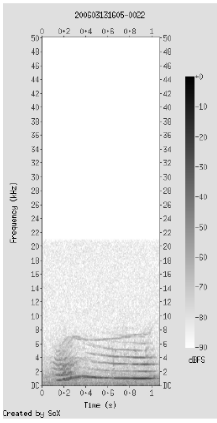
LP02ii



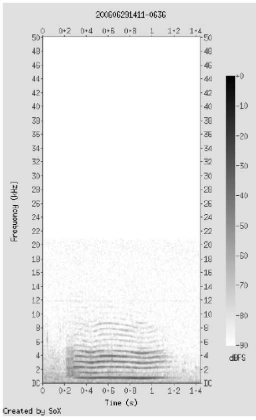
LP02iii



LP02iv



LP03i



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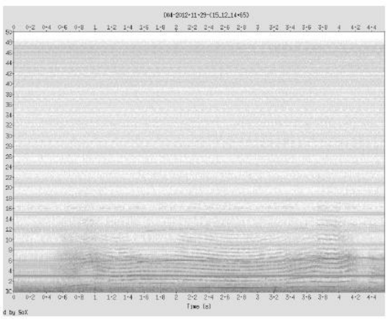
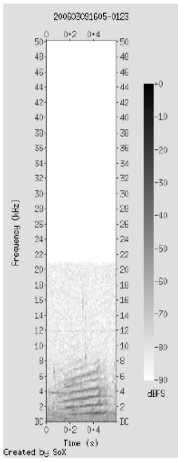
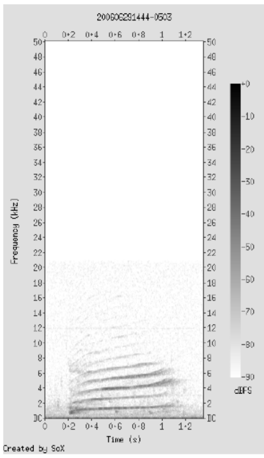


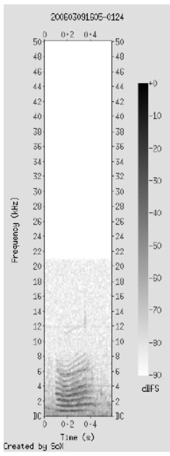
LP03iii



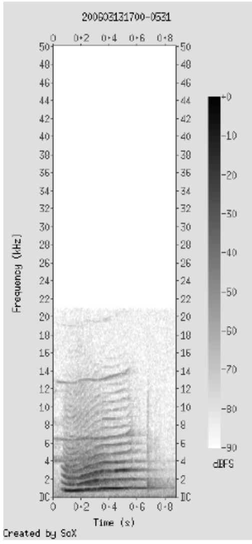
LP04i



LP04ii



LP04iii



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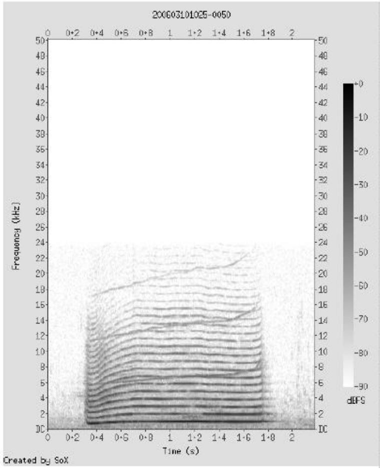

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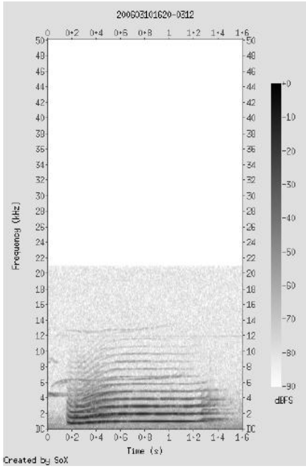
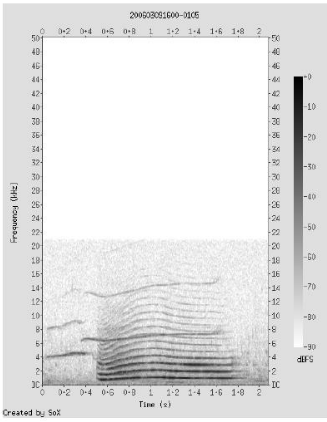
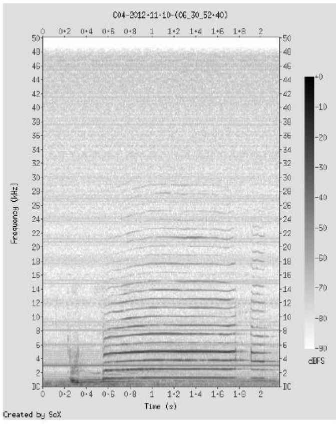


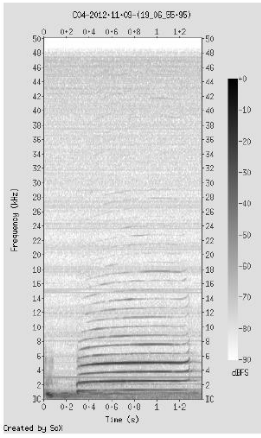
LP05iii



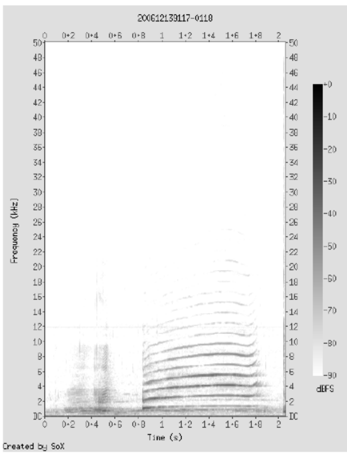
LP05iv



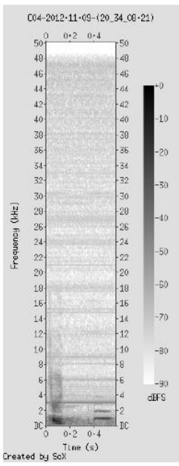
LP06i



LP06ii



LP06iii



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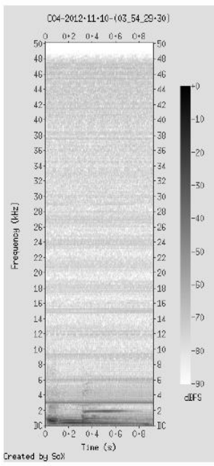

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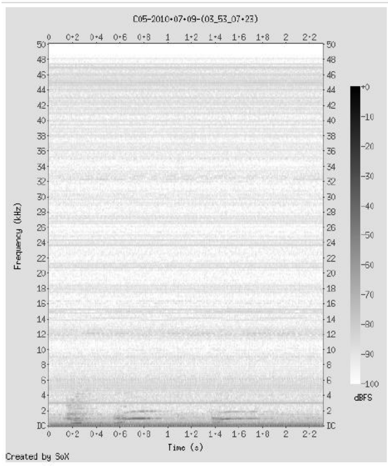

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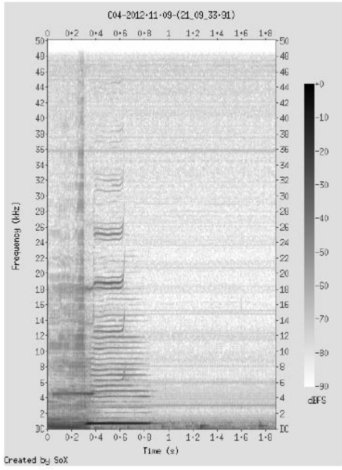

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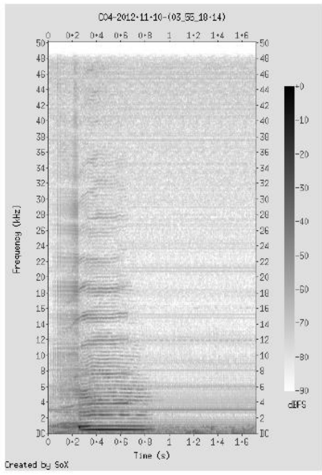

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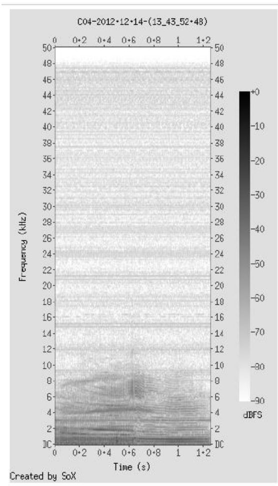

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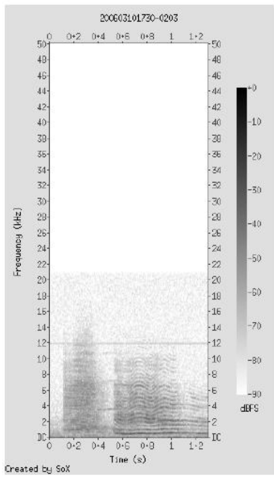

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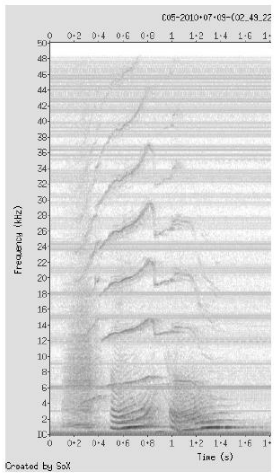

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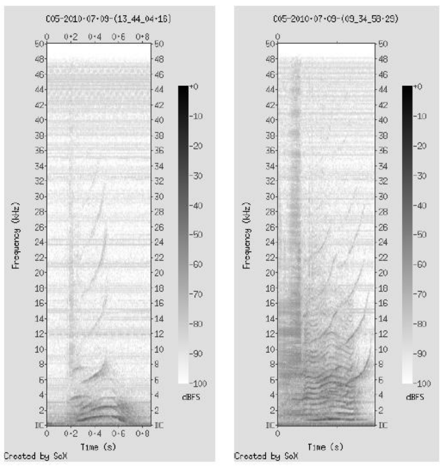

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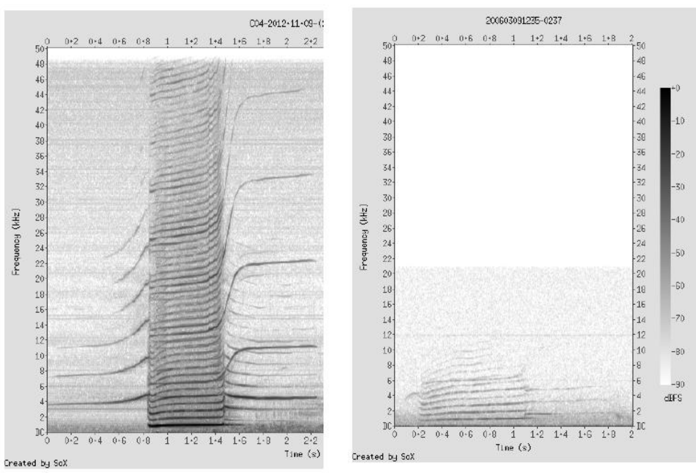

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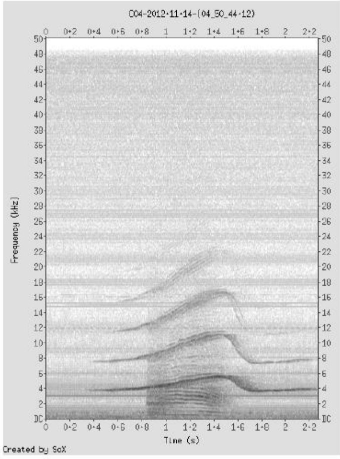

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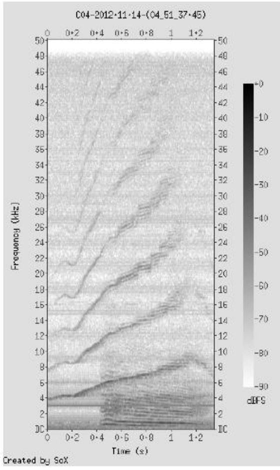

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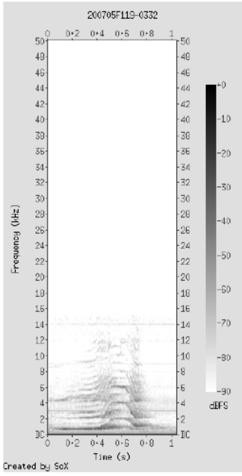

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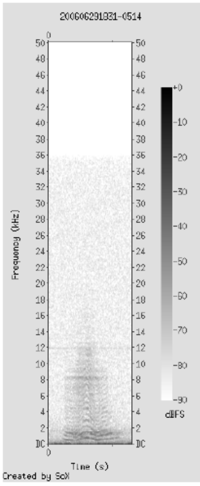

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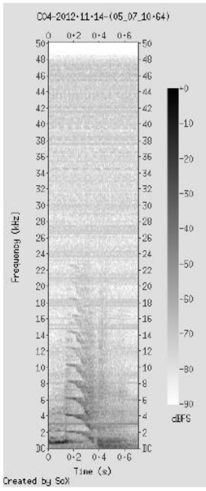

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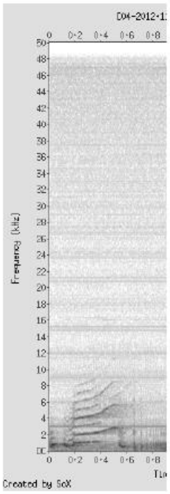

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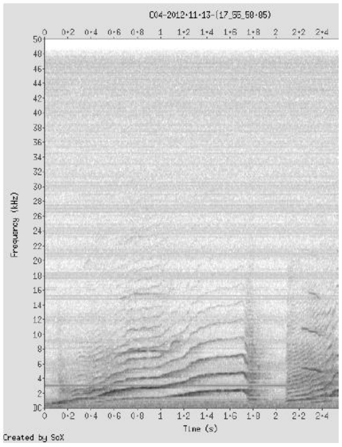

LP011i

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Descripción detallada de las actividades desarrolladas durante la realización del TFT

Para la realización del estudio "Análisis de las llamadas de cohesión en *Orcinus orca* (Linnaeus, 1758)" estuve de prácticas en la Fundación Loro Parque, concretamente en el Departamento de Educación, situado en el edificio de la Fundación. Las dos primeras semanas estuve clasificando eventos ya clasificados para coger práctica y que Javier viera si se me daba bien. A partir de entonces participamos con los físicos de la Universidad de la Laguna preparando el programa informático con el que trabajaría cuando tuviera datos. Sin embargo, como los datos dependían del comportamiento de las orcas resultó ser un poco complicado.

La primera vez que separaron a las orcas y tuvimos grabaciones de una noche fue dos semanas antes del periodo de finalización de mis prácticas. Además el programa informático también daba problemas puesto que era nuevo totalmente, todavía no lo tienen acabado. Los eventos (un evento es como un sonido producido por ellas) grabados por el hidrófono de la piscina A los detectaba, pero en la piscina B y C no reconocía ningún sonido.

Al finalizar las prácticas, Javier me envió en Mayo los datos clasificados y comencé a tratarlos con el R Commander 3.2.5, con la ayuda de Javier y de Antonio Sanchez Navas (profesor del Departamento de Estadística de la Universidad de Cádiz). Una vez tuve los datos que necesitaba para mi estudio en un Excel, los analicé y comencé a redactar el TFT.

Formación recibida

Durante mi estancia conocí el dialecto de las orcas del Loro Parque (cada pod de orcas tiene su propio dialecto), así como su evolución desde que llegaron en 2006 hasta ahora. Aprendí a clasificar los distintos tipos de sonidos y posteriormente estrené el programa Classifier, que es un novedoso programa que, en un futuro, reconocerá automáticamente los sonidos producidos por las orcas y será capaz de clasificarlos sin necesidad de que una persona se tenga que poner a clasificar uno por uno. Este programa ha sido elaborado por Fernando Rosa y dos miembros más de la Facultad de Física de la Universidad de La Laguna, colaborando con Javier Almunia en representación del Loro Parque.

Por tanto no sólo aprendí a manejar un programa sino que participé en la mejora del mismo, y espero que en un futuro lo desarrollen correctamente ya que podría ser de mucha ayuda.

También asistí a un gran número de charlas sobre orcas o sobre dialectos de otros animales, tanto en la fundación como en la Universidad. El resto de formación que he recibido ha sido autodidacta: leer artículos y artículos. Y en cuanto al R Commander, los comandos que utilicé ya los conocía de asignaturas dadas durante la carrera.

Nivel de integración e implicación dentro del departamento y relaciones con el personal.

Tan sólo conozco a mi tutor, y nunca he participado ni me he implicado en el Departamento. Esto se debe a que estoy de SENECA en la ULPCG, a donde fui tan sólo con el proyecto pendiente. No tenía que hacer ninguna asignatura por lo que no conocí a los profesores. Al llegar a la ULPGC me advirtieron de que para hacer un TFT, normalmente los alumnos hacen prácticas en empresas y de ahí desarrollan el TFT. Entonces fue cuando me admitieron en las prácticas del Loro Parque Fundación (Tenerife), y ya no fui más a la Facultad ni a Gran Canaria, excepto el día que fui a buscar un tutor para el TFT y José Juan se ofreció amablemente. Desde enero hasta marzo estuve en Tenerife, y de ahí me fui a mi casa (en la Península) a redactar el proyecto. No me he integrado en el Departamento por que no he tenido la oportunidad, pero me encantaría conocer más sobre los proyectos pendientes del Departamento
En cuanto al personal, tan sólo he conocido a las secretarias y a Miriam, y el trato ha sido estupendo. Siempre me han ayudado en todo lo que he necesitado y me han ofrecido multitud de facilidades.

En el Loro Parque, desde el primer momento me sentí muy cómoda con Javier y con el resto del equipo. Son unos grandes profesionales en su sector, muy entregados a su trabajo.

Aspectos positivos y negativos más significativos relacionados con el desarrollo del TFT

Los aspectos positivos son:

- Cumplir el primero de mis sueños, ver a una orca. Tuve la oportunidad de verlas de lejos y hablar con los entrenadores para que me contaran sobre su personalidad y asi resolver muchas preguntas que tenía sobre ellas.

- Adquirir conocimientos sobre la especie *Orcinus orca*, tanto sobre el comportamiento vocal, alimentación, distribución, su situación en cautividad, hábitos comportamentales… y además he tenido la oportunidad de estar presente unos meses durante la obtención de datos.
- Al realizarse en inglés, hay muchas más oportunidades de poder presentar el TFT en simposios y congresos.
- Estoy muy contenta con los resultados de mi TFT puesto que es el primer estudio del mundo en cuanto a llamadas de cohesión en orcas, y los resultados son coherentes.
- El Loro Parque es una empresa importante, haber hecho prácticas en la misma es relevante en el Curriculum Vitae.

Los aspectos negativos son:

- No poder haber acabado el TFT durante mi estancia en el Loro Parque. Desde el 5 de marzo que acabé las prácticas hasta el 21 de Mayo no pude tocarlo, ya que me faltaban los datos con los que elaborar el TFT.
- El mal funcionamiento de los hidrófonos de las piscinas B y C. Si el algoritmo hubiera funcionado bien, el estudio sería más fiable y contundente. Se podría haber obtenido mucha más información.
- Estando de SENECA, llega un punto en el que no sabes si eres de una facultad o de otra, y todavía más si no conoces a ningún profesor de la Universidad de destino. Es complicado necesitar ayuda y no saber a quién acudir.

Valoración personal del aprendizaje conseguido a lo largo del TFT

He aprendido a reconocer el dialecto de las orcas del Loro Parque, pero como cada grupo de orcas tiene su propio dialecto. De todas formas, ya sé cómo y por qué se analizan, así como el tratamiento de los datos obtenidos y la multitud de salidas que se les puede dar. Asimismo, tengo ligeros conocimientos acerca de su distribución, alimentación, hábitos comportamentales, reproducción, etc. Espero que en un futuro próximo pueda trabajar con ellas en libertad.

He comprendido que el que la sigue la consigue. Si luchas por algo, a pesar de que cueste lo acabas consiguiendo. También te das cuenta de que en el TFT, al igual que en todo a partir de ahora, hay que ser autodidacta. No esperes que nadie te vaya a dar algo hecho.