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Abstract

Unusual Mortality Events (UME) occur when mortalities of marine mammals increase above an average annual rate. In 2019 the U.S. National Oceanic and Atmospheric Administration declared a gray whale UME that started that year, along the North Pacific Coast of North America. Examination of some of the stranded whales suggested that a decline in body condition may have contributed to the increase in gray whale mortality but the cause is still undetermined. Gray whale stranding records collected in Mexico between January 1st and April 7th of 2022 indicated that at least 47 gray whales stranded along the Pacific coast of Baja California, Mexico. As in previous years, most of the strandings (n=32) occurred in Ojo de Liebre lagoon (LOL) and the surrounding areas. From the total number, 19 of these were female gray whales, 26 were males, and 2 were of undetermined sex. The age classes of the dead whales were: 33 adults, 6 subadults, 5 yearling whales and 3 calves. The number of strandings in 2022 is smaller than previous years, but the calving season and search effort in the field has not yet finished.

Introduction

The strandings and deaths of marine mammals can be related to natural or anthropogenic causes (Cardenas, 2004; Evans, 1987). Gray whales migrate and aggregate along and on the relatively shallow continental shelf waters of North America. During the last two decades, two UMEs have been declared: the first in 1999-2000, with at least 319 stranded dead whales discovered in the breeding and calving areas in Mexico, and the second UME during 2019-2021 with 226 stranded whales discovered (NOAA, 2020; Martínez-Aguilar *et al*, 2021). Some of the stranded whales appeared to be "skinny", suggesting that they were suffering from nutritional stress (LeBoeuf *et al.*, 2000). For the 1999-2000 UME, Moore *et al.* (2001), suggested that the increase in gray whale mortality was a result of the Northeastern Pacific gray whale population increasing to an abundance level that exceeded the "carrying capacity" of the gray whales' feeding grounds. After

the 2019 UME was declared, renewed efforts to monitor and report gray whale strandings throughout their range in Mexico were undertaken.

Methods

As in previous years (2019-2021), information (date, position, location, sex, age class, body length and physical condition) on dead stranded gray whales was collected from three sources. The age for each stranded whale was estimated from each whale's body length and categorized with age length criteria established by the UME stranding investigating panel: calves (less than 7.9- m); yearlings (8 - 8.9 m); sub-adults from (9-11 m for males, and 11.6 m for females); and adults (larger than 11.1 m for males and 11.7 m for females).

Sources of stranding data for 2022 included:

- 1.- Strandings from Ojo de Liebre lagoon and Guerrero Negro lagoon, BCS, and from Manuela lagoon, Baja California, were recorded from December to April 7th of 2022 by Departamento de Ecología of Exportadora de Sal S.A. and CONANP "El Vizcaíno".
- 2.- Strandings in Laguna San Ignacio and Bahía Magdalena-Bahía Almejas complex, BCS., during the period from January 15 to April 4, 2022 were recorded by researchers from the Laguna San Ignacio Ecosystem Science Program (LSIESP) and Marine Mammals Research Program / Universidad Autónoma de Baja California Sur (PRIMMA/UABCS).
- 3.- Three gray whales stranded along the Pacific coast of Baja California Peninsula were reported during February of 2022 by members of Red de Varamientos of the Sociedad Mexicana de Mastozoología Marina (SOMEMMA) and from the "Review of News" on their internet website.

Results

Between January 1st to April 7th of 2022, 47 dead, stranded gray whales were reported in Baja California (Fig. 1 and Fig. 2). Of these whales, 19 were females, 26 were males, and 2 were of undetermined sex (Fig. 3). Their age categories were: 33 adults, 6 subadults, 5 yearling and 3 calves, (Fig. 4). The advanced decomposition of most of these stranded whales (78.7%), prevented determination of their body condition at the time of their deaths (e.g., "good", "fair", or "poor" condition), but six of these whales were freshly dead and were determined to be in poor body condition or emaciated.

Laguna Ojo de Liebre (Scammon's lagoon) y Laguna Manuela

These lagoons are located within the northern portion of the "El Vizcaíno Biosphere Reserve." In the winter of 2022, 31 stranded dead gray whales were discovered in these areas, which is 65.9% of the total stranded gray whales reported for Mexico in 2022. Of these stranded whales: 11 were females, 19 were males, and 1 undetermined sex (Table 1). The age classes of these whales included: 3 calves, 4 yearling animals, 4 subadults, and 20 adults (Table 1).

Laguna San Ignacio

In Laguna San Ignacio, Baja California Sur, there were 12 gray whales stranded during the 2022 winter, which is the highest number since the strandings records started in 2009 in this area. Of these, 7 were females, 4 males, and one of undetermined sex. One was a yearling and 11 were adults (Table 1). Six of these whales were determined to be in poor condition (emaciated).

Bahia Magdalena-Bahia Almejas complex

This complex includes the areas from south to north, Bahia Almejas, Bahía Magdalena, Cabo San Lazaro and Canal de Santo Domingo. In the winter of 2022, only one stranded dead gray whale, a subadult female, was discovered in these areas (Table1).

Pacific Coast of Baja California

This includes the region from the Tijuana coast to Cabo San Lucas west coast, except the main breeding lagoons. During this year there were 3 gray whale strandings reported; one in Isla San Lazaro, and 2 more along the Baja California west coast at Ensenada and Rosarito, and all of them were males, with 2 adults and one subadult.

Gulf of California

While there were some sightings of gray whales inside of Gulf of California, during the first three months of 2022, there were no strandings reported from this area

Discussion

The number of stranded gray whales reported in Mexican waters during the first three months of 2022, was slightly less than in 2021 (n=55), nevertheless the breeding and calving season and the search effort in the field has not yet finished.

As seen in previous years, the number of strandings in Ojo de Liebre was the highest as it is the main breeding and calving lagoon in Mexico, but due to the long time between surveys to discover strandings in this area, almost all of carcasses were in a state of advanced decomposition so the body condition could not be assessed. In addition, the number of strandings in Laguna San Ignacio (n=12) is the highest recorded since the UME of 1999-2000. Of the total strandings that occurred in San Ignacio lagoon, six were fresh and were in poor body condition, and 2 of these whales were seen alive in days previous to their deaths.

Comparing data from 2022 against the data from 2019-2021, the proportion of the sexes of the stranded whales were higher for males in 2020, 2021 and 2022 and only during 2019 was the number of females stranded triple than the number of males. (Fig. 3). The age distribution of stranded gray whales was different for all age categories (calf, yearling, juvenile or sub-adult and adult). The most common category during the 2019-2022 UME was adults, followed by subadults, and may be related to the greater amount of food that the adults need to carry out their functions (migrating, breeding or calving). In contrast, before the UME, calves were the most frequent age class stranded, but the low numbers of dead calves observed in 2019-2021, is likely related to higher proportion of mature females stranding in 2019, and the overall decline of female-calf pairs observed in Laguna San Ignacio and Bahía Magdalena since 2018 (Urbán et al. 2018, 2019, 2020). Similar decreases in numbers of calves were seen in the gray whale breeding lagoons in the years following the UME of 1999-2000 (Le Boeuf et al. 2002; Gulland et al. 2005; Urbán *et al.*, 2003, 2011).

Similar to the two previous years, in 2022 most of the body conditions of stranded whales could not be determinate due to the advanced decomposition of the carcasses. However, in 2022, 12.9% of the whales stranded were in fresh and moderated condition and these were determined to be in poor body condition when they died.

The number of reported gray whale strandings is likely an underestimate of actual mortalities, because of the differences in detectability, the dimensions of the area where the gray whales are distributed along the Baja California Peninsula, an undetermined number may drift out to sea and do not arrive on the coastal beaches, and the differences in search effort conducted in all areas (Martínez-Aguilar *et al.*, 2021).

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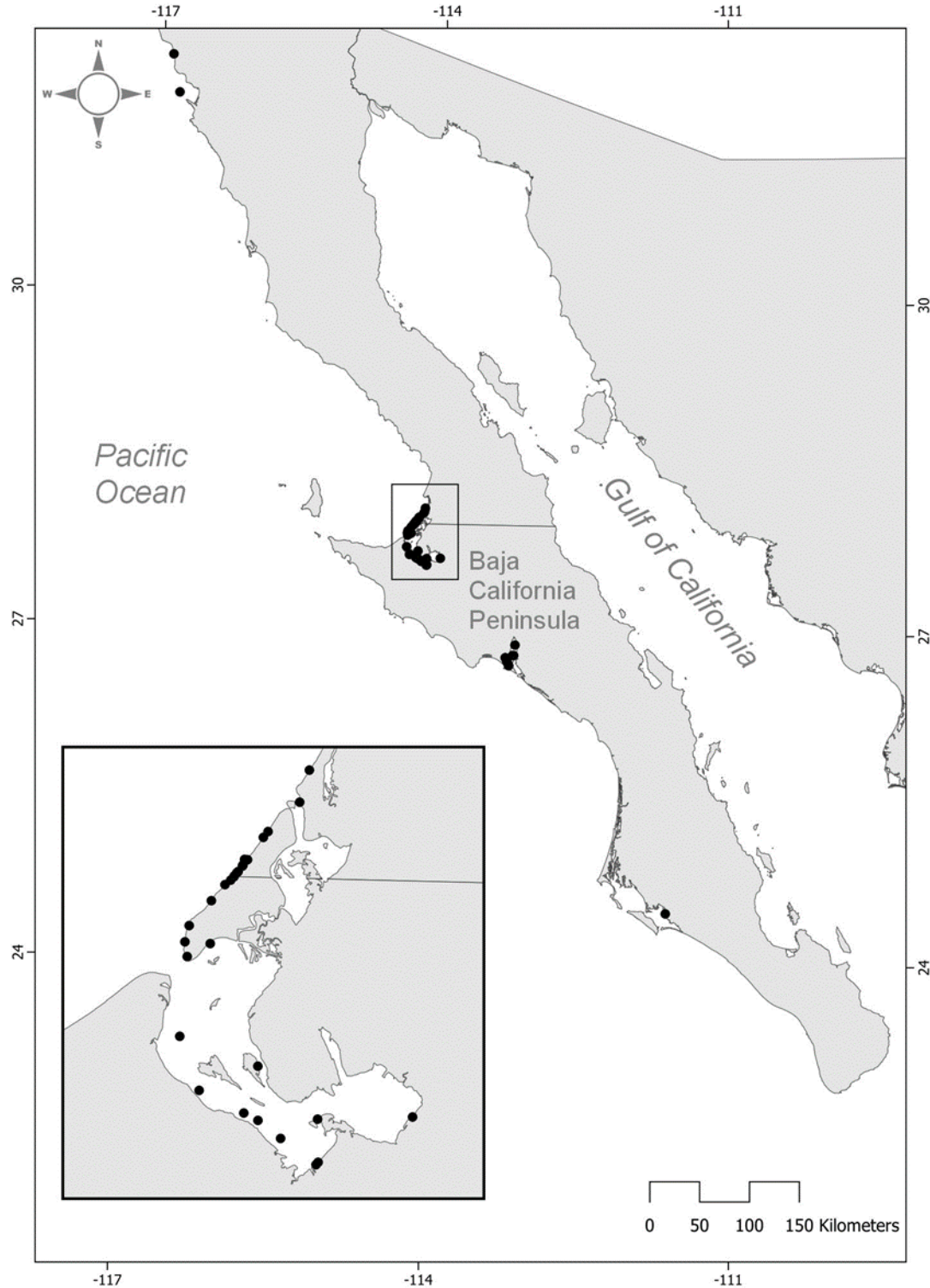
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Tables and figures

Figure 1. Distribution of gray whales stranded in Baja California Peninsula, in Mexico from January to April 7th of 2022. (zoom square corresponds to Ojo de Liebre lagoon (Scammon's lagoon) at the bottom, Guerrero Negro lagoon in the middle and Manuela Lagoon at the Top).



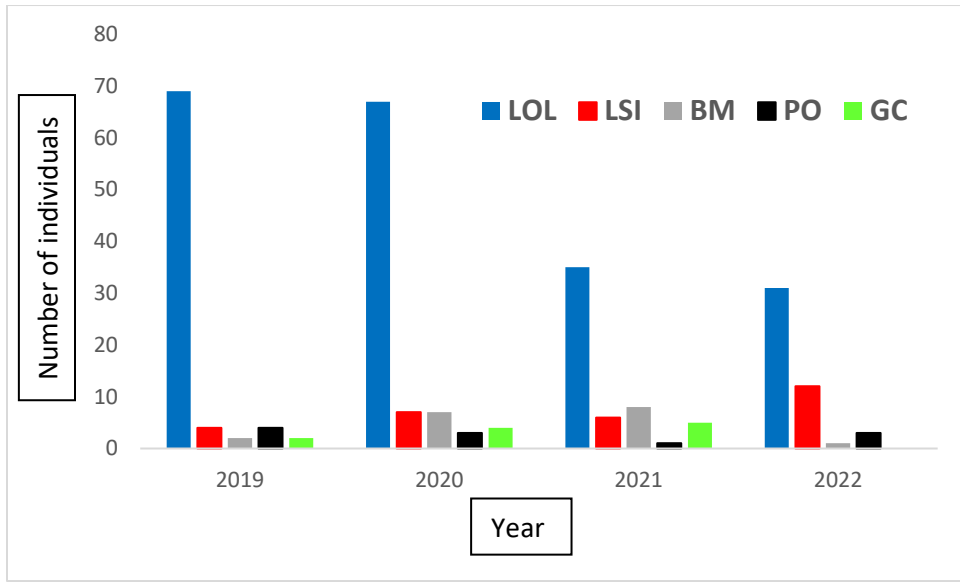


Figure 2. Total number of gray whales stranded in Mexico by area, during (2019-2022) UME. LOL (Ojo de Liebre lagoon), LSI (San Ignacio lagoon), BM (Bahía Magdalena), PO (Ocean Pacific), GC (Gulf of California).

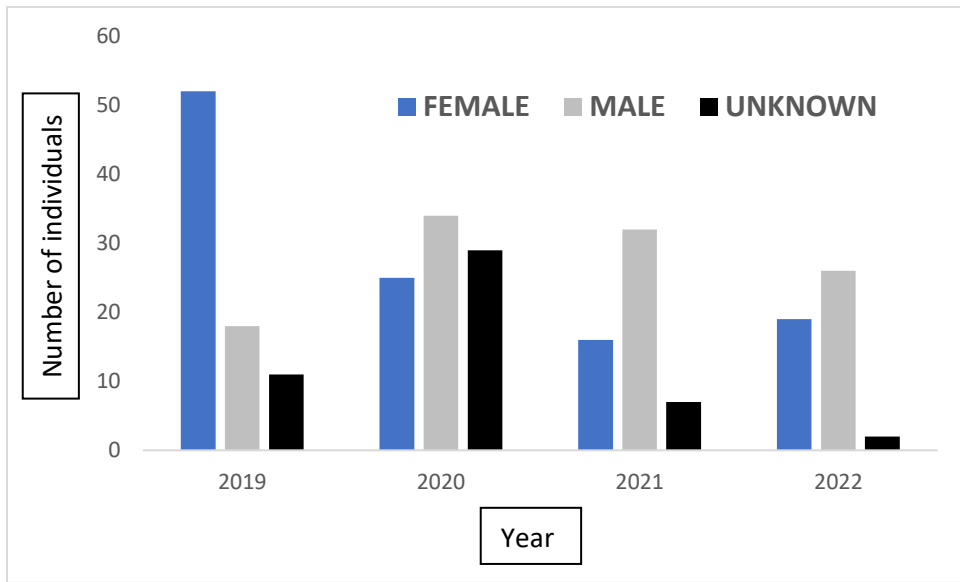


Figure 3. Total number of gray whales stranded in Mexico by sex during (2019-2022) UME

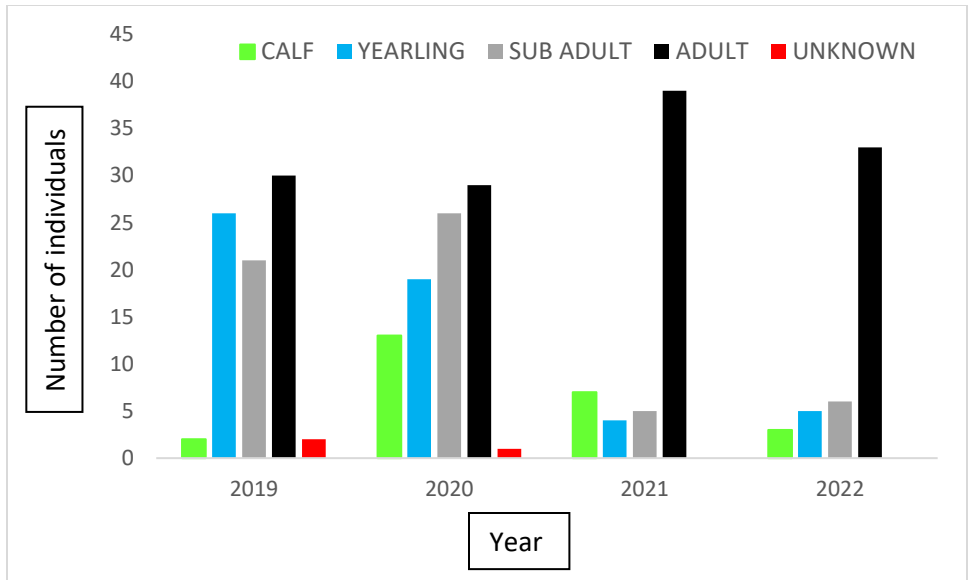


Figure 4. Total number of gray whales stranded in Mexico by age categories during (2019-2022) UME

Table 1. Data from gray whales stranded in México (Baja California and Baja California Sur) from January to April 2022. (Institution: ESSA/REBIVI are data collected by Exportadora de Sal S.A and Biosphere Reserve El Vizcaíno; PRIMMA are data collected by Marine Mammals Research Program and Laguna San Ignacio Ecosystem Science Program.

Date	Field ID	Sex	Age Class	Condition code	Locality	Latitude	Longitude	Institution
13-Jan-22	LOL-002	Male	subadult	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	28.06083	113.15530	ESSA, CONANP
13-Jan-22	LOL-003	Female	Adult	Fresh Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	27.68583	114.07250	ESSA, CONANP
26-Jan-22	LSI-001	Male	Adult		Isla Ana, Laguna San Ignacio	26.47892	-113.1582	PRIMMA/LSIESP
04-feb-22	LOL-004	Male	Adult	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	28.02250	114.18530	ESSA, CONANP
04-feb-22	LOL-005	Female	Adult	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	28.02278	114.18970	ESSA, CONANP
04-feb-22	LOL-006	Female	Adult	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	27.99972	114.20470	ESSA, CONANP
04-feb-22	LOL-007	Female	Adult	Fresh	Isla Arenas, Laguna Ojo de Liebre	28.00083	114.20420	ESSA, CONANP
04-feb-22	LOL-008	Male	Calf	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	27.99528	114.20920	ESSA, CONANP
04-feb-22	LOL-009	Male	Yearling	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	27.93444	114.26860	ESSA, CONANP
04-feb-22	LOL-010	Female	Subadult	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	27.91306	114.27420	ESSA, CONANP
06-feb-22	LSI-002	Male	Adult	Alive - Fresh	Punta piedra, Laguna San Ignacio Faro de la Isla Todos Santos,	26.78399	-113.2442	PRIMMA/LSIESP
06-feb-22	ENS-001	Male	subadult	Advanced Decomposition	Ensenada Isla San Lázaro, Nte de Bahía Magdalena	31.81444	116.81310	Erika Fuentes
07-feb-22	ISL-001	Male	Adult	Advanced Decomposition		24.82944	112.27970	Francisco Gómez
08-feb-22	ROS-001	Male	Adult	Advanced Decomposition	Campo López, al sur de Rosarito BC	32.15464	116.89876	Carmen Gutierrez
09-feb-22	LSI-003	Male	Adult	Moderated decomposition	Isla Gaviota, laguna San Ignacio	26.91999	-113.1583	PRIMMA/LSIESP
11-feb-22	BM-001	Female	subadult	Advanced Decomposition	Las cuevitas - Bahía almejas	24.49875	-111.6263	PRIMMA/LSIESP
15-feb-22	LSI-004	Female	Yearling	Moderated decomposition	Punta piedra, Laguna san ignacio	26.78818	-113.2375	PRIMMA/LSIESP
15-feb-22	LSI-005	Female	Adult	Fresh	Isla Abaroa, Laguna San Ignacio	26.76437	-113.2349	PRIMMA/LSIESP

15-feb-22	LOL-011	Female	Adult	Advanced Decomposition	Laguna Ojo de Liebre	27.65944	-114.12610	ESSA, CONANP
15-feb-22	LOL-012	Female	Adult	Advanced Decomposition	Laguna Ojo de Liebre	27.69167	-113.93310	ESSA, CONANP
16-feb-22	LSI-006	Unknown	Adult	Fresh	Punta piedra, Laguna san ignacio	26.79661	-113.2401	PRIMMA/LSIESP
17-feb-22	LSI-007	Female	Adult	Advanced Decomposition	Campamento Kuyima, Laguna San Ignacio	26.82559	-113.1703	PRIMMA/LSIESP
21-feb-22	LSI-008	Female	Adult	Fresh	Campamento Kuyima, Laguna San Ignacio	26.82636	-113.1802	PRIMMA/LSIESP
22-feb-22	LOL-013	Male	Yearling	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	28.09944	-114.11060	ESSA, CONANP
22-feb-22	LOL-014	Female	Yearling	Advanced Decomposition	Isla Arenas, Laguna Ojo de Liebre	28.14167	-114.09750	ESSA, CONANP
25-feb-22	LSI-009	Female	Adult	Fresh	Bajo del Mapache, Laguna San Ignacio	26.80433	-113.25510	PRIMMA/LSIESP
28-feb-22	LSI-010	Male	Adult	Fresh	Isla Abaroa, Laguna San Ignacio	26.76700	-113.23804	PRIMMA/LSIESP
15-mar-22	LSI-011	Female	Adult	Advanced Decomposition	Canal del Cardón, Laguna San Ignacio	26.73358	-113.21931	PRIMMA/LSIESP
15-mar-22	LSI-012	Female	Adult	Advanced Decomposition	Canal del Cardón, Laguna San Ignacio	26.73358	-113.21931	PRIMMA/LSIESP
28-mar-22	LOL-030	Female	subadult	Moderated decomposition	La escuela, laguna Ojo de Liebre	27.68224	-114.16003	PRIMMA/LSIESP- ESSA
29-mar-22	LOL-031	Male	Adult	Advanced Decomposition	La choya, Laguna Ojo de Liebre	27.62953	-114.07014	PRIMMA/LSIESP- ESSA
29-mar-22	LOL-032	unknown	Calf	Advanced Decomposition	La choya, Laguna Ojo de Liebre	27.62627	-114.07317	PRIMMA/LSIESP- ESSA
06-abr-22	LOL-015	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	27.89389	-114.27030	ESSA, CONANP
06-abr-22	LOL-016	Male	Yearlin	Moderated decomposition	Isla Arenas, laguna Ojo de Liebre	27.96778	-114.23690	ESSA, CONANP
06-abr-22	LOL-017	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	27.91167	-114.23690	ESSA, CONANP
06-abr-22	LOL-018	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	27.98917	-114.21750	ESSA, CONANP
06-abr-22	LOL-019	Female	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.00500	-114.20060	ESSA, CONANP
06-abr-22	LOL-020	Female	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.00667	-114.19860	ESSA, CONANP
06-abr-22	LOL-021	Male	Calf	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.01412	-114.19250	ESSA, CONANP
06-abr-22	LOL-022	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.01444	-114.19220	ESSA, CONANP
06-abr-22	LOL-023	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.01556	-114.19170	ESSA, CONANP
06-abr-22	LOL-024	Male	Adult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.05222	-114.16280	ESSA, CONANP
06-abr-22	LOL-025	Male	Subadult	Advanced Decomposition	Isla Arenas, laguna Ojo de Liebre	28.06000	-114.15610	ESSA, CONANP
06-abr-22	LOL-026	Male	Adult	Advanced Decomposition	Isla Conchalito, laguna Ojo de Liebre	27.78944	-114.27810	ESSA, CONANP

06-abr-22	LOL-027	Male	Adult	Advanced Decomposition	Cerca de Paredones, laguna Ojo de Liebre	27.71944	-114.24750	ESSA, CONANP
06-abr-22	LOL-028	Male	Adult	Moderated decomposition	Perdones, laguna Ojo de Liebre	27.69139	-114.18110	ESSA, CONANP
07-abr-22	LOL-029	Male	Adult	Advanced Decomposition	lagunita del dátil, Laguna Ojo de Liebre	27.75306	-114.16220	ESSA, CONANP