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ABSTRACT

In Marine Mammals, Unusual Mortality Events (UME) occur when mortalities increase above an average annual rate. In 2019 the U.S. National Oceanic and Atmospheric Administration declared a gray whale UME that started in 2019, 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 December 2020 and April 2021 indicated that at least 49 gray whales stranded along the Pacific coast of Baja California and the Gulf of California, Mexico. The majority of the dead whales (59.1%) were encountered in Ojo de Liebre lagoon (LOL) and the surrounding areas. Fifteen of these were female gray whales, 27 were males, and 7 were of undetermined sex. The age classes of the dead whales were: 35 adults, 3 subadults, 5 yearling whales and 6 calves. The number of strandings in 2021 is smaller than in 2019 and 2020, but it is because of less effort made in Ojo de Liebre lagoon due to COVID-19 restrictions, but as in previous years, the gray whale strandings in 2021 appears to be related to a decline in body condition.

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, because of their coastal distribution, stranded gray whales frequently wash ashore and are discovered, rather than being lost at sea (Martínez-Aguilar *et al.*, 2019).

Between 1999 and 2000, a gray whale UME resulted in at least 319 stranded dead whales were discovered in the whales' breeding and aggregation areas in Mexico (NOAA 2020). Some of the stranded whales appeared to be "skinny" and very thin, suggesting that they were suffering from nutritional stress, starvation (LeBoeuf et al. 2000). Moore et al. (2001), suggested that the increase in gray whale mortality at that time was a result of the North Eastern Pacific gray whale population increasing to an abundance level that exceeded the "carrying capacity" of the gray whales' feeding grounds.

In 2019 another increase in gray whale strandings began; 214 gray whale strandings occurred along the North Pacific coast of North America (i.e., México, US and Canada). In response, a second gray whale UME was declared in May 2019 (NOAA 2020). Of those strandings, 81 occurred in México, and was comprised of mainly subadult and adult whales (Martínez-Aguilar *et al.*, 2019). Subsequently, renewed efforts to monitor and report gray whale strandings throughout their range in Mexico were undertaken in 2020 and 2021

METHODS

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 2021 included:

1.- Strandings in Laguna San Ignacio and Bahía Magdalena-Bahía Almejas complex, BCS., during the period from January 15 to April 7, 2020 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).

2.- Strandings from Ojo de Liebre lagoon and Guerrero Negro lagoon, Baja California Sur, and from Manuela lagoon, Baja California, were recorded from January 8th to April 8th of 2021 by Departamento de Ecología of Exportadora de Sal S.A. and CONANP

3.- Seven gray whale stranded inside Gulf of California and Bahía Magdalena, were reported between December 22th to April 5th, 2021 by the "Review of News" on their internet website, and from members of Red de varamientos de la SOMEMMA.

RESULTS

Between december 20 and april 8th of 2021, 49 dead, stranded gray whales were reported: 46 along the Pacific coast of Baja California Peninsula, and 3 inside of Gulf of California (Fig. 1 and Fig. 2). Of these whales, 15 were females, 27 were males, and 7 were of undetermined sex (Fig. 3).

Their age categories were: 35 adults, 3 subadults, 5 yearling and 6 calves, (Fig. 4).

The advanced decomposition of most of these stranded whales (73.4%), prevented determination of their body condition at the time of their deaths (e.g., "good", "fair", or "poor" condition), but other five of them were in poor condition.

Gulf of California

There were three gray whale strandings inside of the Gulf of California during 2021: one in San Felipe, Baja California, one in Playa Nueva Altata, Sinaloa and one in Higuera Blanca, Nayarit (Fig. 1). All of these gray whale strandings were reported in the "media news" and by members of the Red de varamiento SOMMEMA

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 2021, ten stranded dead gray whales were discovered in these areas: 7 males, 1 female and 2 whales of undetermined sex. Two were subadults and eight were adults (Table1). The 2021 stranding's number for the area, is the highest during 2019-2021 UME.

Laguna San Ignacio.

In Laguna San Ignacio, Baja California Sur, during the 2021, six gray whales stranded. Of these, 3 were females, 2 males, and one of undetermined sex. One was a calf and 5 were adults (Table 1).

Laguna Ojo de Liebre (Scammons lagoon) y Laguna Manuela

These lagoons are located within the northern portion of the "El Vizcaíno Biosphere Reserve." In the winter of 2021, 29 stranded dead gray whales were discovered in these areas, which is 59.1% of the total stranded gray whales reported for Mexico in 2021. Of these stranded whales: 11 were females, 15 were males, and 3 were of undetermined sex (Table 1). The age classes of these whales included: 5 calves, 2 yearling animals, 3 subadults, and 19 adults (Table 1).

DISCUSSION

The number of stranded gray whales reported in Mexican waters since december of 2020 until april of 2021, were smaller than in 2019 and 2020 (81 and 88 respectively), this is because of a less effort made around Ojo de Liebre Lagoon due to COVID-19 restrictions, despite of this situation, the number of strandings in Ojo de Liebre was the highest as it is the main breeding and calving lagoon in México. In addition, the number of strandings in Bahía Magdalena (10), that is the most southern breeding area, was the highest for this place since the UME started and it seems to be related with a “La Niña” event and a bigger number of whales distributed in the south part of the Baja California Peninsula.

The proportion of the sexes of the stranded whales were different in each year. The proportion of females stranded in 2019 decreased from 64.1% (n=52) to 28.4% (n=25) in 2020 and it increased to 42.8% (n=21) for 2021, while the proportion of males increased from 22.2% (n=18) in 2019 to 41.3% (n=36) in 2020 and 44.9% (n=22) for 2021 (Fig. 3). In 2021 the proportion of males and females stranded was almost 1:1 and the number of whales whose sex could not be determined was small (n=6).

The age distribution of stranded gray whales was different for all age categories (calf, yearling, juvenile or sub-adult and adult). For calf category there was an increase in the number of stranded calves, from 2 in 2019 to 13 in 2020 and a decrease to only 6 for 2021 (Fig.4). Before the UME, calf category was the most frequent age class stranded, but the low numbers of dead calves among 2019-2021, is likely related to the overall decline of female-calf pairs observed in Laguna San Ignacio and Bahía Magdalena since 2018 (Urbán et al. 2018, 2019, 2020).

The proportion of yearling whales stranded, went from 31.1% in 2019 to 22.7% in 2020 and had a reduction to only 6.1 % in 2021, for subadults category the trend was similar been the proportion of 25.9% in 2019 to 27.2% in 2020 and also having a reduction to 10.2% in 2021 (Fig 4).

However, the proportion of adults stranded went from 37% in 2019 to 32.9% in 2020 and increased to 71.4% in 2021, this may have relation with the greater amount of food that the adults need to carry out their functions.

In 2021, same as to the two previous years, most of the body conditions of stranded whales could not be determined, due to the advanced decomposition of the carcasses, but 10% of the whales stranded in fresh and moderated condition were in poor body condition. The changes in the composition of the strandings of gray whales could be related to a decline in overall body condition of the whales from 2018 to 2020 (Ronzón-Contreras et al. 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

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 and the differences in search effort conducted, mainly due to COVID-19 restrictions in 2020 and 2021.

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Tables and Figures

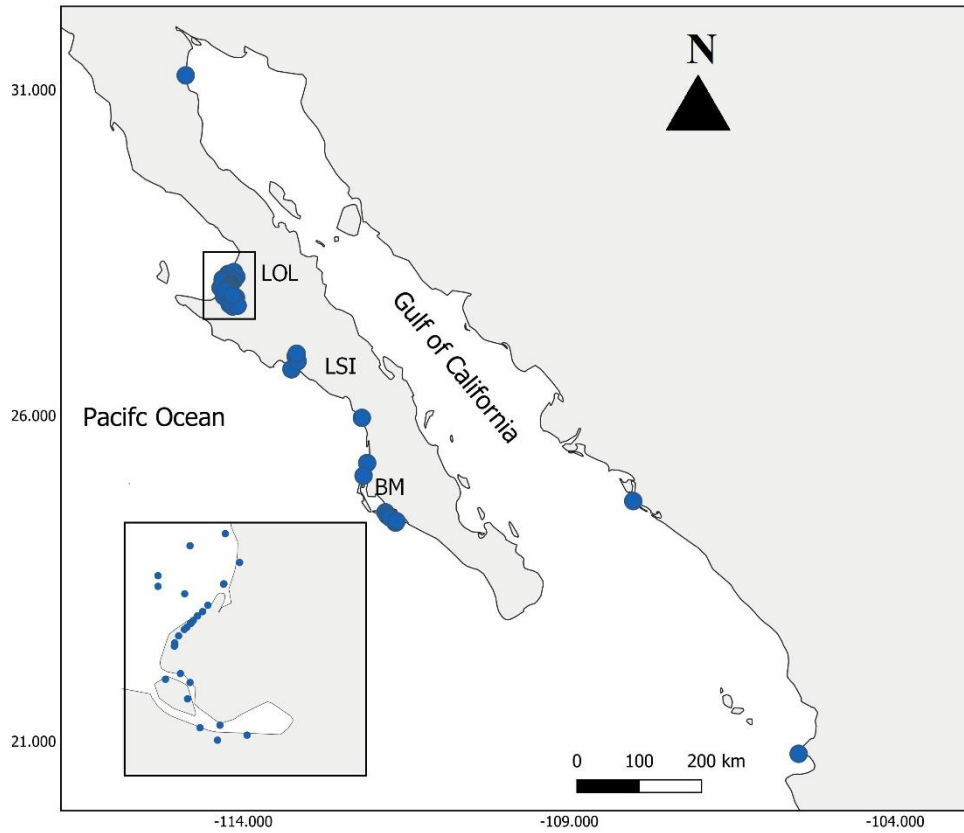


Figure 1. Distribution of gray whales stranded in Baja California Peninsula, in Mexico. from December 2020 to April 2021. (the zoom square corresponds to Ojo de Liebre lagoon (Scammon's lagoon) at the bottom, Guerrero Negro lagoon in the middle and Manuela Lagoon at the Top)

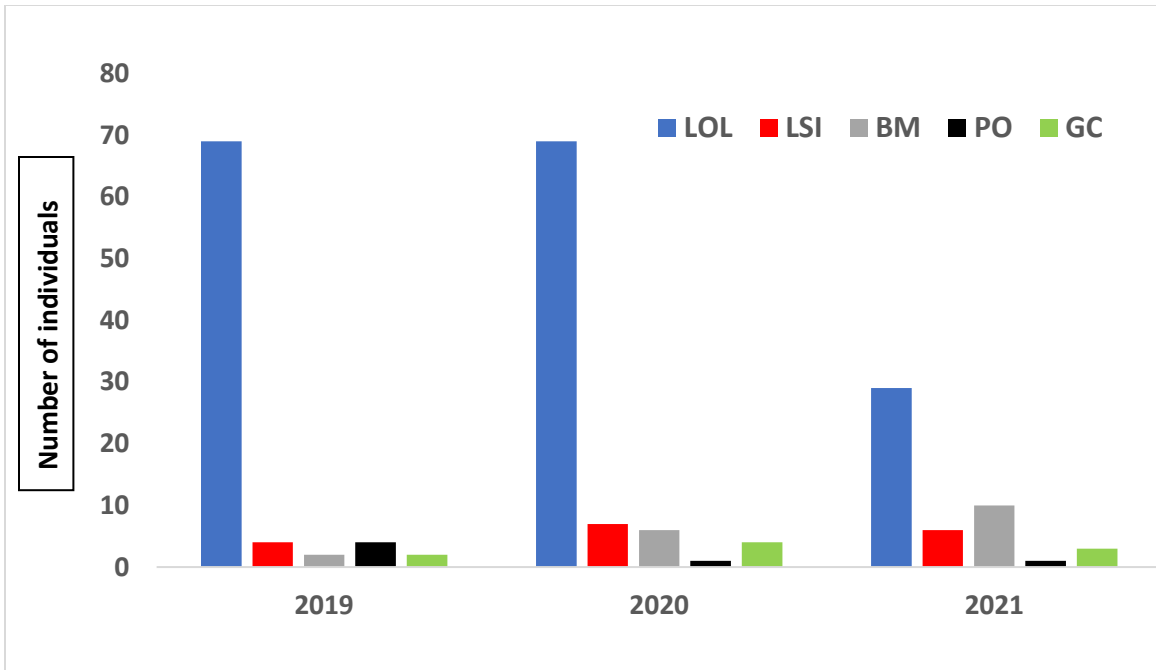


Figure 2. Total number of gray whales stranded in Mexico by area, during (2019-2021) UME. LOL (Ojo de Liebre lagoon), LSI (San Ignacio lagoon), BM (Bahía Magdalena), PO (Ocean Pacific), GC (Gulf of California)

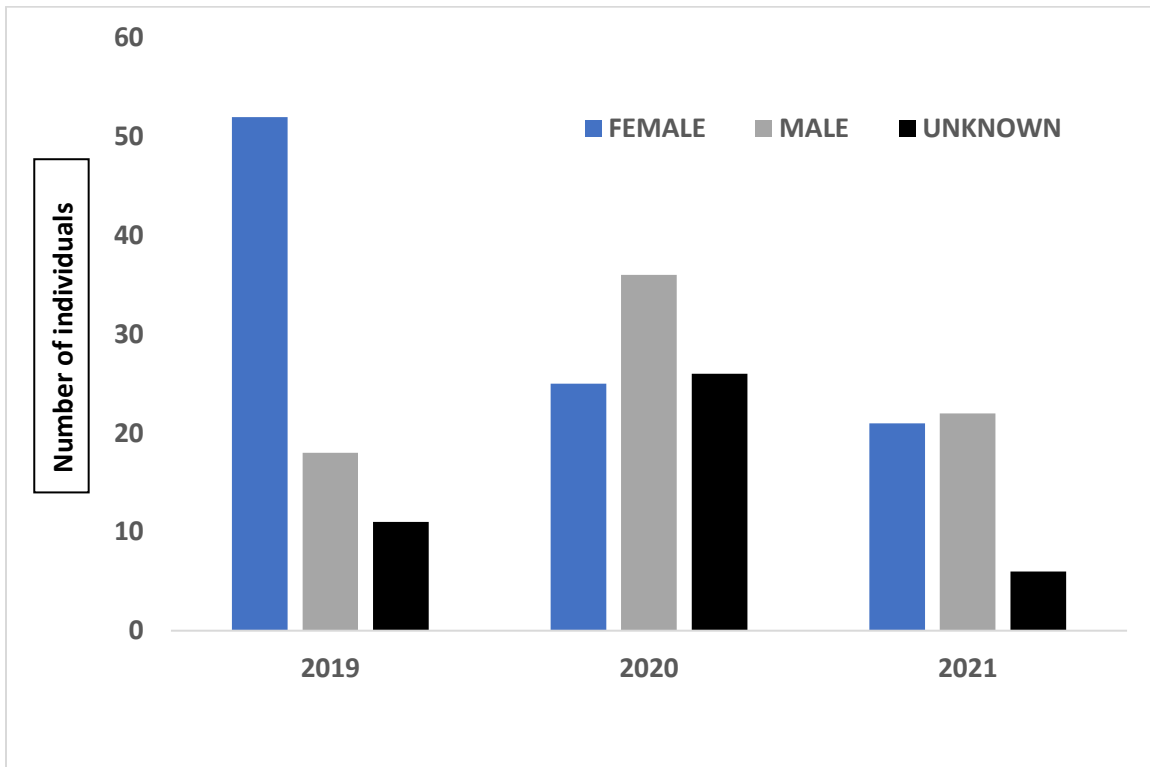


Figure 3. Total number of gray whales stranded in Mexico by sex during (2019-2021) UME

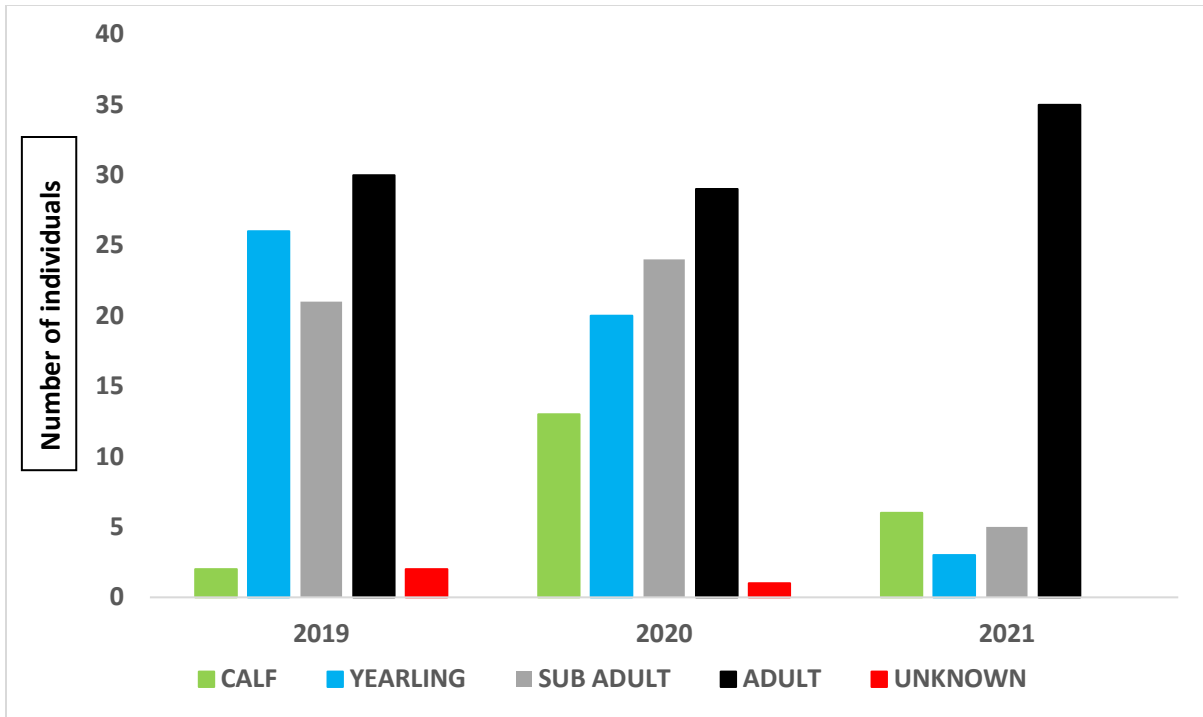


Figure 4. Total number of gray whales stranded in Mexico by age categories during (2019-2021) UME

Table 1. Data from gray whales stranded in México from December 2020 to April 2021. (Field Id: 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; (BCS. =Baja California Sur;M=Male, F= Female Unk=Unknown). The empty cell in Field ID corresponds to data from news, newspapers and the Web.

Date	Field ID	Province	Sex	Age Class	Length	Condition code	Locality	Latitude	Longitude	How Observed
8-Jan-21	LOL-001	BCS	M	Adult	11.85	Advanced decomposition	Isla Arena, Laguna Ojo de Liebre	28.17111	-114.23444	Beached
11-Jan-21	LOL-002	BCS	F	Yearling	8.9	Advanced decomposition	Flotando en la Laguna Ojo de Liebre	27.81055	-114.11388	Floating
22-Jan-21	LOL-003	BCS	F	juvenile-subadult	9.5	Advanced decomposition	Punta Mariscal, Laguna Ojo de Liebre	27.71083	-114.1575	Beached
29-Jan-21	LSI-001	BCS	M	Adult	12.6	Fresh	Isla Ana, Laguna San Ignacio	26.70779	-113.25967	Beached
29-Jan-21	LSI-002	BCS	Unk	calf	---	Skeleton	Isla Ana, Laguna San Ignacio	26.71232	-113.26234	Beached
30-Jan-21	NAY-001	Nayarit	Unk	yearling	---	Live	Higuera Blanca, Nayarit	20.80666	-105.48194	Floating
08-feb-21	LSI-003	BCS	M	Adult	11.58	Moderated Decomposition	Frente a Isla Garza, Laguna San Ignacio	26.92844	-113.18246	Floating /Beached
09-feb-21	LOL-004	BCS	F	Calf	5.5	Fresh	Flotando en la Laguna Ojo de Liebre	27.95916	-114.34972	Floating
09-feb-21	LOL-005	BCS	F	Calf	4.5	Advanced decomposition	Lagunita del Dátil, Guerrero Negro	27.77777	-114.24111	Beached
11-feb-21	LOL-006	BCS	F	Yearling	7.7	Advanced decomposition	Isla Arena, Laguna Ojo de Liebre	28.20138	-114.14416	Beached
11-feb-21	LOL-007	BCS	Unk	Calf	5	Advanced decomposition	Isla Arena, Laguna Ojo de Liebre	28.04722	-114.24805	Beached
11-feb-21	LOL-008	BCS	Unk	Calf	4.15	Moderated decomposition	Isla Arena, Laguna Ojo de Liebre	28.09388	-114.31611	Beached
11-feb-21	LOL-009	BCS	M	juvenile-subadult	9.3	Advanced decomposition	Isla Arena, Laguna Ojo de Liebre	28.06694	-114.31638	Beached

11-feb-21	LOL-010	BCS	F	Adult	12.3	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.91611	-114.27388	Beached
15-feb-21	BM-003	BCS	M	Adult	12.2	Advanced Decomposition	Isla Creciente	24.35898	-111.66963	Beached
19-feb-21	BM-004	BCS	M	Adult	---	Advanced Decomposition	Lengua	24.51327	-111.82047	Beached
23-feb-21	LOL-011	BCS	Unk	calf	3.8	Moderated Decomposition	El esterito, laguna Ojo de Liebre	27.82805	-114.2975	Beached
23-feb-21	LOL-012	BCS	F	Adult	14	Advanced Decomposition	Laguna Ojo de Liebre	27.70416	-114.20888	Floating
23-feb-21	LOL-013	BCS	F	Adult	13.5	Advanced Decomposition	Los paredones, Laguna Ojo de Liebre	27.6725	-114.16444	Beached
24-feb-21	COM-001	BCS	M	Adult	12	Advanced decomposition	Las Barracas, Comondú	25.9626	-112.1818	Beached
25-feb-21	BM-005	BCS	F	Adult	12.4	Moderated Decomposition	Isla Creciente	24.35474	-111.66371	Beached
26-feb-21	BM-006	BCS	M	Adult	11.2	Moderated Decomposition	Lopez Mateos	25.26956	-112.10074	Beached
26-feb-21	BM-007	BCS	M	Adult	12.7	Moderated Decomposition	La Florida	25.07532	-112.15643	Beached
26-feb-21	SIN-001	Sinaloa	M	Adult	12	Advanced decomposition	Playa, Nueva Altata	24.6857	-108.0195	Beached
01-mar-21	BC-001	BCS	M	Adult	12.3	Advanced Decomposition	San Felipe, Baja California	31.2198	-114.8841	Beached
02-mar-21	LOL-014	BCS	M	Adult	12.7	Advanced Decomposition	Punta mariscal. Laguna Ojo de Liebre	27.685	-114.08805	Beached
02-mar-21	BM-008	BCS	M	Adult	12.7	Advanced Decomposition	Isla Margarita	24.46228	-111.78851	Beached
02-mar-21	BM-009	BCS	M	Adult	ND	Advanced Decomposition	Isla Margarita	24.42837	-111.74345	Beached
02-mar-21	BM-010	BCS	M	Adult	ND	Moderated Decomposition	Isla Creciente	24.37736	-111.65182	Beached
04-mar-21	LOL-015	BCS	M	Adult	12	Advanced Decomposition	Playón, Laguna Manuela	28.1275	-114.10694	Beached

12-mar-21	LSI-004	BCS	F	Adult	12.2	Advanced Decomposition	Islas, Laguna San Ignacio	26.90818	-113.19733	Beached
24-mar-21	LSI-005	BCS	F	Adult	12.67	Advanced Decomposition	La Freidera, Laguna sna Ignacio	26.83083	-113.16805	Beached
26-mar-21	LSI-006	BCS	F	Adult	12.45	Advanced Decomposition	Zona norte, Laguna San Ignacio	26.94689	-113.18155	Floating
6-Apr-21	LOL-016	BCS	F	Adult	13	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	28.07277	-114.14722	Beached
6-Apr-21	LOL-017	BCS	M	Adult	11.1	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	28.07166	-114.14805	Beached
6-Apr-21	LOL-018	BCS	M	Adult	12.6	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	28.01833	-114.18888	Beached
6-Apr-21	LOL-019	BCS	M	Adult	12	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	28.00222	-114.20277	Beached
6-Apr-21	LOL-020	BCS	M	Adult	12.6	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.99111	-114.21472	Beached
6-Apr-21	LOL-021	BCS	F	Adult	12.3	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.97888	-114.22611	Beached
6-Apr-21	LOL-022	BCS	M	Adult	13	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.97333	-114.23027	Beached
6-Apr-21	LOL-023	BCS	M	Adult	12.5	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.97083	-114.23305	Beached
6-Apr-21	LOL-024	BCS	M	Adult	11.6	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.96138	-114.2425	Beached
6-Apr-21	LOL-025	BCS	M	Adult	11.6	Moderated Decomposition	Isla Arena, Laguna Ojo de Liebre	27.95638	-114.24888	Beached
6-Apr-21	LOL-026	BCS	F	Adult	13.5	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.93972	-114.26333	Beached
6-Apr-21	LOL-027	BCS	M	Adult	12	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.92138	-114.27388	Beached
6-Apr-21	LOL-028	BCS	M	juvenile-subadult	10.5	Advanced Decomposition	Isla Arena, Laguna Ojo de Liebre	27.91333	-114.27416	Beached
8-Apr-22	LOL-029	BCS	M	Adult	12.5	Advanced Decomposition	Playa Los gabachos, Laguna Ojo de Liebre	27.84527	-114.16111	Beached

