

Guadalupe Fur Seal Research and Conservation Planning Workshop



GUADALUPE FUR SEAL Research and Conservation Planning Workshop Laguna Beach, CA, 29-31 March 2023

Workshop Report

The workshop was hosted by Pacific Marine Mammal Center and sponsored by the U.S. Marine Mammal Commission and Massen Greene Foundation.



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Executive Summary

As the Guadalupe fur seal population continues to recover from near extinction, this species is increasingly common in its historical range extending from central México to Washington State but still is primarily found on land in México. Guadalupe fur seals are well protected at Guadalupe Island, the only well-established breeding colony for this species, especially following the Mexican government issuing a complete ban on all ecotourism within this biosphere reserve in May 2022. The same level of protection does not exist at the primary recolonization site (San Benito Archipelago) and islands in the Gulf of California (Farallón de San Ignacio, San Pedro Mártir and Las Ánimas) that Guadalupe fur seals are using in greater numbers each year. In 2016, scientists and managers from México gathered to develop Programas de Acción para la Conservación de Especies (or Action Programs for the Conservation of Species) for Guadalupe fur seals, coordinated by the Comisión Nacional de Áreas Naturales Protegidas (or National Commission for Natural Protected Areas). There has been substantial progress over the last seven years towards accomplishing many of the short and medium term research and conservation objectives of this Action Program. However, a sustainable long-term population monitoring program for this species has not been established. Additionally, no U.S. Recovery Plan exists for this species, which the Endangered Species Act requires National Marine Fisheries Service to develop and implement for listed transnational species and listed species that interact with U.S. fisheries. Both these recovery plan requirement criteria apply to Guadalupe fur seals.

Therefore, there was a clear need to bring together scientists and managers from México and the U.S. to advance our understanding of the Guadalupe fur seal population and enhance binational collaborative efforts to recover and protect Guadalupe fur seals. The first joint México-U.S. Guadalupe Fur Seal Research and Conservation Planning Workshop was held in Laguna Beach, California March 29-31, 2023. Scientists and managers from five Mexican and eight U.S. non-profit organizations or government agencies participated in the workshop. Across five themes, workshop participants prioritized the following research and conservation activities, most of which are currently unfunded or partially funded after 2023:

Population Monitoring

- Perform summer population surveys at Guadalupe Island and San Benito Archipelago every other year; however, the latter also should be assessed in winter (no change to survey plan in 2023)
- Maintain seasonal surveys at islands in the Gulf of California
- Continue tracking the presence of Guadalupe fur seals on islands off California and train other teams to better track Guadalupe fur seal expansion in the U.S.
- Compile and examine resight data from existing flipper tagging and develop a standardized format to record resight data, potentially using an online platform

- Continue documenting dead pups, entanglements and other health findings and collecting opportunistic samples during any field trip (as is feasible)
- Conduct genetic testing to confirm hybridization of individuals at San Miguel Island
- Determine peak pupping and abundance of each age class during the breeding season at Punta Sur, Guadalupe Island (possibly in 2024)
- Refine methods to estimate total population, which may include bringing other metrics into a population model, and adjust the regular survey plan based on the model's needs by forming a small expert working group (possibly by 2025)

Health, Disease, Entanglements and Fishery Interactions

- Test all pinnipeds we handle for avian influenza during the ongoing pandemic
- Develop a simple protocol and datasheet for rangers on the islands to possibly perform field necropsies when research teams are not present
- Focus on using laboratories and building capacity to analyze samples in México
- Publish results from the 2015-2021 Guadalupe Fur Seal Unusual Mortality Event and various other health assessment studies
- Monitor early pre-weaning mortality (October-November) for two additional years

Protections and Threats on/near Mexican Islands

- Focus on outreach and improving collaboration among research teams, government officials and local communities at San Benito Archipelago and islands in the Gulf of California to promote the presence of Guadalupe fur seal refuges and anticipate future species expansion (i.e., work towards what exists at Guadalupe Island)
- Ask the Sociedad Mexicana de Mastozoología Marina (or Mexican Society of Marine Mammalogy) to lead outreach activities involving a multispecies approach

Ecosystem Change, Trophic Ecology, At-sea Dispersal and Human-related Threats At-sea

- Publish sex and age class stable isotope, foraging behavior and habitat use results

Research and Conservation Plan Implementation

- Develop a checklist of what we need to collect in the field associated with each activity and include a timeline of when each activity occurred during each trip
- Rank threats based on best-available information (possibly via a post-workshop survey)
- Create a map of Guadalupe fur seal distribution to demonstrate the need for binational management and that can be easily updated as the species expands to new areas
- Identify short and long term metrics to monitor the impact and effectiveness of recent conservation and management actions at Guadalupe Island
- Secure funding for long term population monitoring and other efforts that are most impactful for species and habitat conservation
- Plan and host another joint U.S.-México Guadalupe Fur Seal Research and Conservation Planning Workshop (possibly in 2025)
- Develop a binational conservation plan that combines science, management, outreach and policy, which can be used to help obtain funding for long term monitoring (i.e., is useful for our needs, and does not need to include all elements of a U.S. Recovery Plan)

Workshop Participants

Centro Interdisciplinario de Ciencias Marinas - Instituto Politécnico Nacional (CICIMAR - IPN)

Fernando Elorriaga-Verplancken*^

María José (Majo) Amador-Capitanachi

Romya (Romy) Cruz (remote)

Miriam Emilia Romero Velázquez (remote)

Cientinela del Mar, A.C.

Casandra Gálvez

Comisión Nacional de Áreas Naturales Protegidas (CONANP)

Donaxi Borjes Flores

Israel Popoca-Arellano (remote)

Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE)

Gisela Heckel

Ariadna Juárez-Ruiz

Grupo de Ecología y Conservación de Islas (GECI)

Julio Hernández-Montoya (remote)

Pacific Marine Mammal Center (PMMC)

Alissa Deming*

Tenaya Norris*^

U.S. Marine Mammal Commission (MMC)

Frances Gulland

NOAA Fisheries, West Coast Region (WCR)

Christina (Tina) Fahy*

Dan Lawson

Chris Yates

NOAA Fisheries, Alaska Fisheries Science Center (AFSC)

Sharon Melin

Jeff Harris

NOAA Fisheries, Pacific Island Fisheries Science Center (PIFSC)

Jason Baker

California Department of Fish and Wildlife (CDFW)

Michelle Horeczko

The Marine Mammal Center (TMMC)

Cara Field (remote)

San Diego Zoo Wildlife Alliance (SDZWA)

Hendrik Nollens (remote)

Foundations of Success (FOS)

Jaclyn Lucas

* Workshop organizing committee, ^ Report authors

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Background

Guadalupe fur seals (*Arctocephalus townsendi*¹ or *A. philippii townsendi*²) were hunted to near extinction in the 1800s and early 1900s³. Since this species was rediscovered in the 1950s, the population has steadily increased but still may be approximately 70% less than pre-exploitation levels, estimated to be up to 200,000 individuals^{4,5}. Currently, Guadalupe fur seals are the only pinniped species inhabiting the California Current System that is protected under the U.S. Endangered Species Act (ESA) as threatened and catalogued as endangered by Mexican law⁶.

Despite their protected status and increasing numbers, accurate and current population estimates for Guadalupe fur seals are lacking because censuses at the only established breeding colony for this species (Guadalupe Island, México) have been sparse and sporadic. From 1955-2022, a 68-year period, there were only 20 fur seal censuses at Guadalupe Island⁷⁻¹¹. Population monitoring has been more consistent at San Benito Archipelago, México, the primary recolonization site for Guadalupe fur seals and located 260 km southeast of Guadalupe Island. As of 2015, 13 censuses have been conducted since the species was rediscovered at this site in 1997^{8,10-15}. Guadalupe fur seals also are found year-round on islands within the Gulf of California, numbering into the hundreds during peak abundance at some sites¹⁶⁻¹⁸. Pup production estimates (1991-2019) resulted in a population estimate of 63,850 individuals in 2019 (range: 57,199-72,631)⁵.

As the population continues to recover, Guadalupe fur seals are increasingly common in their historical range extending from central México to Washington State¹⁹⁻²⁴. In recent years, unprecedented numbers of emaciated Guadalupe fur seals have stranded along the west coast of the U.S. and México, including into the southern Gulf of California²⁵⁻²⁷. Guadalupe fur seals also had significantly decreased neonate masses and survival and lactating females demonstrated increased foraging effort in 2015^{28,29}. These impacts on Guadalupe fur seals have been linked to reduced prey availability caused by anomalously warm waters that persisted across the Northeast Pacific Ocean during this period³⁰⁻³² and caused unprecedented ecosystem-level effects for many species³³⁻³⁷.

The National Marine Fisheries Service (NMFS) initiated a Status Review of Guadalupe fur seals in 2014, which previously had not been performed since 1984²³. Additionally, no U.S. Recovery Plan exists for Guadalupe fur seals, which Section 4(f) of the ESA requires NMFS to develop and implement for listed transnational species (i.e., species with current and/or historical geographical ranges within the U.S., U.S. Exclusive Economic Zone (EEZ), and/or high seas, and within the waters or the EEZ of one or more foreign country). In 2016, scientists and managers from México gathered to develop Programas de Acción para la Conservación de Especies ([PACE](#), or Action Programs for the Conservation of Species) for Guadalupe fur seals, coordinated by the Comisión Nacional de Áreas Naturales Protegidas (CONANP, or National Commission for Natural Protected Areas)³⁸.

It became clear that bringing together scientists and managers from México and the U.S. would greatly advance our understanding of the Guadalupe fur seal population and enhance binational collaborative efforts to recover and protect Guadalupe fur seals. The original goals of this joint México-U.S. Guadalupe Fur Seal Research and Conservation Planning Workshop were to:

1. Introduce scientists, including students, and government officials to methods and requirements involved in and related to monitoring and managing the Guadalupe fur seal population in México and the U.S.;
2. Present and discuss lessons-learned and recommendations from long term California sea lion (*Zalophus californianus*) and northern fur seal (*Callorhinus ursinus*) population monitoring programs in the Alaska and California Current Ecosystems, and what can be applied to Guadalupe fur seal population monitoring;
3. Discuss funding, logistics and/or cooperative agreements to achieve sustained, long term Guadalupe fur seal population monitoring;
4. Present current Guadalupe fur seal population and other relevant data (collected at Guadalupe Island, San Benito Archipelago and other sites) and evaluate the population status and need for a U.S./México Recovery Plan; and
5. Wrap-up with next steps and task assignments. A Guadalupe Fur Seal Research and Recovery Team will be created, formed by conservation organizations, management agencies and academic institutions from both countries.

Workshop Overview

The first joint México-U.S. Guadalupe Fur Seal Research and Conservation Planning Workshop was held in Laguna Beach, California March 29-31, 2023. Scientists and managers from five Mexican and eight U.S. non-profit organizations or government agencies participated in the workshop. During the workshop, we focused on five topics or themes (Appendix I):

1. Population Monitoring (abundance and distribution)
2. Health, Disease, Entanglements and Fishery Interactions
3. Protections and Threats on/near Mexican Islands
4. Ecosystem Change, Trophic Ecology, At-sea Dispersal and Human-related Threats At-sea
5. Research and Conservation Plan Implementation

This report summarizes key results for recently published studies, unpublished data and other relevant information that was shared during the workshop as well as consensus recommendations and priorities for ongoing and future research and conservation activities.

Population Monitoring

Current and historical abundance and distribution

Guadalupe fur seals currently are consistently found on six islands in the Southern California Current System and Gulf of California (Figure 1). Individuals that were flipper tagged at Guadalupe Island have been found on San Benito Archipelago and on islands in the Gulf of California, but there has not been flipper tagging at the other Guadalupe fur seal colonies.

Historically, there were four to five breeding sites for Guadalupe fur seals throughout their range. The extent of breeding throughout the Guadalupe fur seal historical range in the U.S. (e.g., into Washington State) is unknown because it is difficult to differentiate between otariid (California sea lion, northern fur seal and Guadalupe fur seal) pups via archeological specimen morphology. Through DNA studies with archeological specimens, it is now possible to investigate the historical breeding sites of this species.



Figure 1. Map showing the six islands Guadalupe fur seals consistently use in the Southern California Current System and Gulf of California. Green = breeding site; blue = recolonization site; purple = occasional records; orange = haul-out sites/colonization.

A published study by workshop participant Ariadna Juárez-Ruiz and colleagues estimated the Guadalupe fur seal population at 63,850 individuals in 2019 (range: 57,199-72,631) using pup counts from 1991-2019⁵. Unpublished recent Guadalupe fur seal counts at Guadalupe Island

were performed in 2018, 2019 and 2022 and will be performed in 2023 (Fernando Elorriaga-Verplancken – project principal investigator). From these unpublished counts, the population was estimated to be: 82,052 individuals in 2018, 70,008 individuals in 2019 and 81,124 individuals in 2022. For all these population estimates, a multiplier to estimate total population size from pup counts (4:1 ratio)³⁹ and previously developed substrate-based correction factors (i.e., correct for pups missed during boat-based surveys)⁸ were applied. Additionally, the proportion of each demographic group counted during these 2018-2022 surveys were: 40-51% adult females, 39-46% pups, 4-6% juveniles, 2-6% subadult males, 0-1% adult males and 1-3% unknown age/sex class. These counts were conducted towards the end of the breeding season (end of July or beginning of August) when almost all pups had been born but were not entering the water (or were in very shallow areas) and after adult males had departed the breeding colony.

Combining published and unpublished data, Fernando Elorriaga-Verplancken (project principal investigator) and colleagues have performed counts at San Benito Archipelago every summer since 2009, except 2011, 2016 and 2020-2021^{8,15,25}. There were 5,217 individuals counted at San Benito Archipelago in 2009⁸. The number of Guadalupe fur seals found at this site in the summer steadily decreased to 539-559 individuals in 2017-2018 before rebounding to 5,633 individuals in 2022. Most of the Guadalupe fur seals at this site were juvenile and subadult males (based on morphology and behavior), and less than 30 pups were born annually at San Benito Archipelago (2013-2019) until 2022 when there were 59 pups born. Peak Guadalupe fur seal abundance occurred in the summer (July), presumably because young males were displaced from Guadalupe Island during the breeding season²⁵. Over 90% of Guadalupe fur seals used the northeast side of West Island in 2022, and the other three species of pinnipeds found in México (California sea lions, northern elephant seals and Pacific harbor seals) mostly used other areas of the San Benito Archipelago coastline (Serrano-Rodríguez unpublished data).

Guadalupe fur seals were first sighted on islands in the Gulf of California: in 2008 at Farallón de San Ignacio¹⁸, in 2011 at San Pedro Mártir¹⁷ and in 2019 at Las Ánimas¹⁶. The number of Guadalupe fur seals has steadily increased to over 2,300 individuals at Las Ánimas and 1,700 individuals at Farallón de San Ignacio in spring 2023 (Elorriaga-Verplancken and Estrada-Serna unpublished data). Peak abundance at these two sites is in the spring. Most of the Guadalupe fur seals at Las Ánimas and Farallón de San Ignacio are juveniles and subadult males (based on morphology and behavior), and there are few adult animals of either sex on these islands. Adult, subadult and juvenile males primarily use San Pedro Mártir. There is no official historical records of Guadalupe fur seals using terrestrial sites in the Gulf of California, but sightings may not have been documented properly in the past.

In the Gulf of California and the Mexican Pacific, the number of California sea lions, northern elephant seals and Pacific harbor seals has decreased in the last decades, while the number of Guadalupe fur seals has been increasing.

There was an adult female observed with a pup on San Miguel Island in 1997⁴⁰. Since 2008, 31 Guadalupe fur seals have been observed at San Miguel Island, including 14 presumed hybrid pups born to four females (some of which also are suspected to be hybrids) and three terrestrial males (NOAA Fisheries unpublished data). Copulation to verify suspected breeding with California sea lion males has not been observed, despite using camera traps to monitor these individuals that display high natal site fidelity (i.e., flipper tags were applied to pups and several females returned to the same site to give birth). Hybridization of these individuals has not been confirmed with genetic testing. Biological samples archived for some of these individuals include blood, fur, skin and occasionally orifice swabs.

NOAA Fisheries California Sea Lion Research Program: Lessons learned and recommendations

The large size of the California sea lion population is one of the primary reasons NOAA Fisheries' California Sea Lion Research Program collects certain data and monitors the population in certain ways. This program has conducted annual pup counts since 1972, and this is the one activity they prioritize every year. All animals are flushed during these pup counts that are performed at Point Bennet each year in July by 1-2 people (possible for one person to do these counts, but having two people is ideal). In addition to a one-time pup count each year, population counts (of the entire island and entire range) are performed every 2-5 years (aerial surveys) and daily counts are conducted to determine timing of pupping/breeding (over the breeding season). Vital rates are determined from mark-recapture studies (hot brands are primarily used for this, but flipper tags are a secondary mark), and known-age animals are very important to target management activities (i.e., tells them where to focus efforts).

Health and disease studies are largely projects led by others (i.e., their group is supporting these), and archived samples include teeth, skin and blood on all handled animals. The program's goal is to have focused telemetry, diet and other studies (e.g., contaminants) every 10 years to detect large shifts in movement, diet and exposure to various stressors and threats. Many of these data feed into ecosystem modeling efforts and are used for ecosystem-based management.

Lessons learned and recommendations:

- Establish clear short (2 year), medium (5-15 year) and long (15+ year) term objectives with support from others involved in species management (e.g., NOAA Fisheries West Coast Region for the California Sea Lion Research Program)
- Prioritize management needs (e.g., pup counts and vital rate data)
- Determine the minimum data needed (everywhere, all the time, every animal, etc. is not possible), and it is important to figure out the precision you need in time and space for each data type (all about tradeoffs). Reassess needed precision every year.

- Strive for consistent monitoring but adapt when needed with a period of overlap between the “old” and “new” method (e.g., continue ground counts, develop correction factors, add drone counts; or if peak abundance at Las Ánimas is in March, could scale back to survey only in March after this is well established).
- It can take time to settle into a consistent monitoring plan, and the first ~5 years will be trial and error/figuring out long term monitoring methods (e.g., when will the animals be on the beach to observe tags/brands most easily?)
- It does not have to be all or nothing, simpler is often better and archive samples even if there is no current funding for analyses.
- Establish a long term data management workflow and plan (i.e., think about how you are going to pass data onto others, including the next generation)
- Think beyond one species (i.e., as an island, ecosystem or bi-national community)
- Look at oceanography before the field season and how environmental events may impact plans/scheduling (this can change what the plan is for California sea lion monitoring on a given trip)
- To study without disturbing the population (or to minimize disturbance), use stationary/mobile blinds, stationary cameras and/or drones (weather dependent)

Best alternatives for Guadalupe fur seal mark-recapture studies (more challenging for species that cannot be branded):

- Invest in a really good digital camera and use Allflex tags (best retention and can read these for 10 years)
- Consider the use of radio-frequency identification (RFID) tags as a second mark on fur seals paired with detection via drones in the future (the technology is not advanced enough yet). RFID tags also could be embedded in the flipper tags.
- Tag loss is not independent and recapturing to re-tag an animal is difficult because foraging trip duration often exceeds the time the team is in the field
- Use very high frequency (VHF) flipper tags to determine attendance patterns (and know how long you need to be in the field). These do not work on California sea lions (rip them out), but they might work better on fur seals.
- Consider tagging juveniles or adult females (not just pups) because tags only last 10 years and you do not have to wait for them to become adults to determine adult survival rates
- Need to figure out what you need and how long you need resights

Northern fur seal population monitoring in Alaska: Lessons learned and recommendations

There is a long history of commodification and “harvest”-based management for northern fur seals in Alaska (1786-1984). Over time, the management objectives changed significantly but monitoring stayed the same or was slow to adjust. There are impressive scientific results (1000s of papers) for northern fur seals but not much on the management side (i.e., no management

actions for this stock since 1984). The drivers of the post-female harvest trends (significant decrease in abundance at the Pribilof Islands) remain unknown. Survival rates, reproductive rates and age structure, all of which are needed to understand population dynamics, also are less well estimated for northern fur seals, especially compared with California sea lions.

For management actions, we can try to manage people, but not animals. We can protect islands with pinniped rookeries. For example, northern fur seals need room to recover so managers could try closing rookeries during the breeding season (Pribilof Islands would ideally be less industrialized because the human population has grown, which has increased disturbance; where there is lesser human presence, the fur seal population is recovering; and there has been no previous protection of the rookeries and fur seals are flushed during key periods). For many threats, it is difficult to identify viable management actions (e.g., for fishery interactions, there may be little we can do to manage people besides closing fisheries).

Lessons learned and recommendations:

- Balancing consistency and flexibility (e.g., legacy of adult male counts; pup production estimates using shaving and resights is very expensive and creates a lot of disturbance)
 - Critically evaluate value of long term time series
 - Separate parameters/metrics from methods (e.g., for pup production, can use updated method (drones or freely available satellite imagery, e.g., www.planet.org, with a transition period); huge shift to do this but now only using drones at Bogoslof Island)
 - Population trend should not affect what you do, unless the population reaches a threshold (gets too big or small) where change is appropriate (but include period of overlap to tie together studies when method changes and account for error)
- Anonymous versus individual-based (e.g., flipper tagging, pup mass)
 - Mark-resight encounter histories provide much more information, but require vastly greater effort, expense and long term commitment
 - Be wary of starting what cannot be sustained (e.g., flipper tagging studies are much easier to launch than to sustain)
 - Uncertainty for some vital rates may remain, especially for large populations when resights are limited in scope (due to tag loss, emigration, etc.)
 - Consider options for short term mark/resight/resample studies
 - For some metrics, anonymous samples may not be as useful and repeated measures of individuals may provide more insight and reduce biases. For example, follow pups and re-weigh (short term resampling) to know you are not weighing when they have recently nursed and have a belly full of milk.
- Hard to get representative samples on land (e.g., adult female distribution is not random, not capturing representative population for telemetry studies)

- If similar for Guadalupe fur seals, consider biased but consistent sampling over time (e.g., only instrument robust females with white whiskers)
- Mismatch between management and monitoring (e.g., diagnosing the St. Paul decline)
 - Need to determine what your management goals are and then collect the metrics that tell you when to intervene. For example, to know what the cause of the decline is, need age-specific survival, fecundity, age structure and female abundance, but have pup production, adult male counts and apparent survival.
 - Need to adapt more quickly when new mandates
- Difficult to pull together overlapping but disparate datasets after the fact (Jeremy Sterling is working on this and could be consulted to learn more about other recommendations and lessons learned, especially about foraging ecology approaches)

Additional Guadalupe fur seal population monitoring program considerations

During the workshop, we discussed what it would take for San Benito Archipelago or another colony to be considered a “rookery” and how important it is to label a site as such. For Steller sea lions along the U.S. West Coast, a “rookery” has long been defined as having more than 50 pups born annually for at least five years and some degree of pup survival, but this entire stock is only 5,000 individuals. For Guadalupe fur seals, the population is much larger, and of the 59 pups born at San Benito Archipelago in summer 2022 (first year with >30 pups born here), only 10 pups were observed in February 2023. Instead of using number of pups to define a “rookery”, we could use: (1) percentage of pups relative to the total colony over a consistent period (best approach), (2) intrinsic growth rate, or (3) density of animals. It is important to keep in mind that greater protection at islands may be necessary before they can become a breeding colony (e.g., aggressive behavior from young males towards pups likely will stop once enough structure is established among the colony, making it important to minimize disturbance that would break up the structure). It also is possible that oceanographic conditions around San Benito Archipelago may not be able to support a Guadalupe fur seal breeding colony; however, local conditions likely are not a limiting factor because this species, including lactating females, is capable of dispersing from their colonies to distant foraging grounds²⁷.

There have been several attempts to count Guadalupe fur seals and develop correction factors using drones, but drones are difficult to use because of the lack of contrast between the animals and terrain (in addition to other universal logistical constraints related to weather, battery life, etc.). As part of the 2019 census at Guadalupe Island, Tenaya Norris, Fernando Elorriaga-Verplancken and a team flew a drone to test using infrared imagery, visual imagery and video during portions of the boat- and land-based surveys and have greater than 12,000 visual and thermal images that have not been analyzed. At the workshop, we agreed this is an area we should explore more, especially with rapid improvements to automate pinniped counts and size classifications using machine learning. We also should develop a correction factor between drone

and ground counts to mitigate disturbance in the future. However, drones might not be an effective tool to use at San Benito Archipelago and other colonies where few pups are born (many or all of these pups might not be detected as they hide in cracks or below boulders).

Comisión Nacional de Áreas Naturales Protegidas (CONANP) goes to Guadalupe Island every month but has many activities and projects to focus on during these trips. It is sometimes difficult for research teams (Fernando Elorriaga-Verplancken and colleagues) to go to Guadalupe Island every year, and it may not be necessary to go this frequently. California sea lion pup counts on San Miguel Island occur every year, but northern fur seal pup counts are performed every other year at the Pribilof Islands and every four years at Bogoslof Island (due to cost, difficulty to travel to these islands, etc.). The frequency depends on what your management priorities are, and for Guadalupe fur seals, it is most critical to track the recovery process, changes to the growth rate and not lose sight of the other colonies for population counts (e.g., may do 5-6 surveys in 1 year to determine seasonal fluctuation at these other colonies).

Pup counts are the gold standard for population monitoring, but it is usually more important to know the number of mature/reproductive females. Therefore, adult females might be the most important age class to count regularly to monitor the population. Some advantages to this approach is that mature females are larger and may be easier to count (especially using drones) and the number of adult females is more stable (pups born every year can vary dramatically). Disadvantages include needing to account for mature females on foraging trips and in the nearshore water around the island.

It is necessary to monitor the population throughout an entire breeding season to first determine how many females are actually giving birth and create a birth timing curve, especially because this was last done in 1987-88⁴¹. This also would be used to know when to go to the island for peak timing of each age/sex class (e.g., if only plan to count adult females), and it is important for population models (e.g., do not know much about fecundity in Guadalupe fur seals, and assume it is 65-75%, similar to other species).

For a mark-recapture program to be effective, we need to be able to commit to annual resight efforts (can mark every other year but have to resight every year) when the majority of animals are available (concentrated effort during the summer but will need to do some trials to figure this out for Guadalupe fur seals and needs depend on the question). Ideally, we would determine survival rates for all age classes, but if we have to prioritize, it is most important to determine survival rates for young animals (most variable survival), but only if we can search all the places animals may be (otherwise results may not be accurate). It is recommended that we start small with a pilot project during strategic periods of the year to determine if Guadalupe fur seals return to specific sites like California sea lions do and it might be worth analyzing existing resight data statistically, even if there are not a lot of data, of resights from past tagging efforts.

Mark-resight studies usually aim to flipper tag (mark) 1-2% of the pups born in the area that is the focus for resighting animals but survival rates also need to be considered (e.g., look at survival rates of other *Arctocephalus* and back calculate sample size needed for tagging). For Guadalupe fur seals, these activities would occur at Punta Sur, the southern tip of Guadalupe Island that is a relatively flat peninsula, and about 2,000-3,000 pups are born here every year. Ideally, tagging would occur when pups are weaning (would miss pup mortality, but typically this is pretty low), and we could double-tag males using one color and females using another to get sex ratio (even when cannot read tag number).

In the U.S., stock assessments are based on a fixed range, but the stock could be moving in or out of this range (i.e., what looks like a change in abundance, is actually a change in distribution). There is fairly consistent pinniped monitoring on many islands along the U.S. West Coast to detect the likely future northward shift of Guadalupe fur seals. For example, the U.S. Navy conducts annual pinniped surveys, primarily for California sea lions, at the Channel Islands they own (San Nicolas and San Clemente Islands) and Point Blue Conservation Science has a consistent presence on the Farallon Islands to support long term pinniped (primarily northern elephant seals and northern fur seals) and seabird monitoring programs. Guadalupe fur seals are occasionally observed on these islands, but more training is needed to help some of these teams better distinguish Guadalupe fur seals from California sea lions and northern fur seals. It also will be important to educate teams about the preferred habitat of Guadalupe fur seals (rocky areas with caves and crevices, often on the east side of islands, which offer protection from the sun and swells). There may need to be some adjustments to current monitoring efforts for California sea lions and other pinnipeds to better detect Guadalupe fur seals. We likely need to rely on detecting range shifts from ground surveys because distinguishing between these species during large scale aerial surveys would be difficult.

It is predicted that by 2050 California sea lions will lose a substantial amount of habitat and be displaced from San Miguel Island due to sea level rise. Habitat changes on the Mexican islands also are expected to be dramatic with sea level rise. Therefore, it may be important to determine what terrestrial habitat might be available for Guadalupe fur seals in the future and where they may expand to in the U.S. and México.

Workshop recommendations for ongoing/future Guadalupe fur seal population monitoring

Short term priorities (over the next two years):

- Perform summer population surveys at Guadalupe Island and San Benito Archipelago every other year; however, the latter also should be assessed in winter. By the end of the workshop, we agreed we should not change the survey plan for 2023 (count pups and all age classes in the end of July and beginning of August).

- Maintain seasonal surveys at islands in the Gulf of California, especially at Las Ánimas and Farallón de San Ignacio
- Continue tracking the presence of Guadalupe fur seals on islands off California (San Miguel Island and others) while monitoring other pinniped populations and improve the ability of teams to better track Guadalupe fur seal expansion (train to better identify Guadalupe fur seals, educate about the preferred habitat, etc.)
- Compile and examine resight data we have from existing flipper tagging and develop a standardized format to record resight data, potentially using an online platform
- Continue documenting dead pups, entanglements and other health findings and collecting opportunistic samples during any field trip (as is feasible)
- Conduct genetic testing to confirm hybridization of individuals at San Miguel Island
- Determine peak pupping and abundance of each age class during the breeding season at Punta Sur, Guadalupe Island (possibly in 2024)
- Refine methods to estimate total population, which may include bringing other metrics into a population model (e.g., bring in other age classes and account for animals in the water, which are not needed if only using pup counts), and adjust the regular survey plan based on the model's needs by forming a small expert working group (possibly by 2025)

Medium to long term priorities:

- Convene a working group at the next workshop (tentatively planned for 2025) to revisit designing a mark-recapture program
- Explore alternative survey methodologies, such as using drones, freely available satellite imagery and machine learning image processing, with an overlapping period if we transition some surveys from boat or land based to drone/satellite imagery surveys
- Determine adult female attendance patterns, possibly using VHF flipper tags, at Punta Sur, Guadalupe Island
- Perform terrestrial habitat mapping at islands in the U.S. and México to investigate where Guadalupe fur seals may expand to and what habitat may be available for this species in the future with sea level rise and displacement by/of other pinnipeds
- Perform DNA studies using archeological specimens to examine historical breeding sites

Health, Disease, Entanglements and Fishery Interactions

Assessing Guadalupe fur seal health at Guadalupe Island

As part of her Ph.D. dissertation (CICIMAR – IPN), Casandra Gálvez compared the hematology and serum chemistry of adult female (n = 21), juvenile (n = 25), weaned pups (n = 59) and neonates captured on Guadalupe Island in 2016 and 2017 and weaned pups that stranded in the U.S. (n = 16). Neonates had significantly lower hematocrit values ($40.9 \pm 1.2\%$) than all other age

classes (weaned pups $46.2 \pm 1.6\%$, juveniles $45.5 \pm 0.8\%$, adult females $45.5 \pm 2.7\%$). Stranded weaned pups had significantly lower hematocrit values ($35.9 \pm 5.3\%$, range 26.7-47.1%) than all animals captured on Guadalupe Island, but there were no interannual differences. Juveniles had significantly lower white blood cell counts (mean: $4.2 \times 10^3/\mu\text{l}$, range: $3.2-6.2 \times 10^3/\mu\text{l}$) than weaned pups (mean: $7.0 \times 10^3/\mu\text{l}$, range: $6.2-8.0 \times 10^3/\mu\text{l}$) and adult females (mean: $7.1 \times 10^3/\mu\text{l}$, range: $5.2-8.3 \times 10^3/\mu\text{l}$) at Guadalupe Island and stranded weaned pups (mean: $7.0 \times 10^3/\mu\text{l}$, range: $3.9-14.0 \times 10^3/\mu\text{l}$). White blood cell counts were higher for weaned pups and adult females in 2016 compared with 2017, which may be related to changes in prey availability and/or prey diet and hence parasite exposure.

There also are a number of ongoing Guadalupe fur seal health assessment studies. Miriam Romero (master's thesis in progress at CICIMAR – IPN) will be investigating body mass, trace elements (copper, iron, etc.) and serological exposure to several infectious agents, including *Toxoplasma gondii*, *Sarcocystis neurona*, *Leptospira* spp. and *Brucella* spp., in wild-caught and stranded Guadalupe fur seals. Andrea Legorreta (bachelor thesis in progress) is examining trauma, including marine debris and fishery gear entanglements, in Guadalupe fur seals at Guadalupe Island and will be trying to determine what types of fisheries are interacting with this species. Xitali de La Rosa (bachelor thesis in progress) is investigating microplastics and found 100% of feces collected from Guadalupe fur seals in 2021 had microplastics (fibers and foam). Alopecia and neoplasia also are being investigated by Casandra Gálvez and colleagues. In the Gulf of California, hook and line entanglements are more common than gillnet entanglements.

2015-2021 Guadalupe Fur Seal Unusual Mortality Event in California, Oregon and Washington

This Unusual Mortality Event (UME) began in California in 2015 and expanded to include strandings in Oregon and Washington in 2019. From January 1, 2015 to September 2, 2021, a total of 715 live and dead Guadalupe fur seals stranded during this event. In California, strandings peaked April through June, and strandings peaked May through July in Oregon and Washington. The vast majority of animals that stranded during this event were recently weaned pups that were approximately 9-13 months old. All these animals were emaciated or malnourished (7.6 ± 0.1 kg body mass), and many also had secondary bacterial and parasitic infections. Other common health findings included entanglements, domoic acid intoxication, alopecia of guard hairs and anemia. In 2015-2021, 9% of GFS that stranded along the U.S. West Coast were entangled, primarily in multifilament netting. Confirmed and probable entanglement and/or fishery interaction cases were more commonly found in Washington, with many more suspect cases in all three states. Domoic acid testing was performed on 60 Guadalupe fur seals that stranded in California from 2015-2019. Of these, 20 animals (33%) tested positive for domoic acid (0.4-12,305 ng/g, no clinical signs observed and additional testing is pending). Cara Field (TMMC) and colleagues are investigating the cause(s) of the alopecia and anemia. Anomalously warm waters, or marine heatwaves, have persisted across the Northeast Pacific

Ocean in recent years. These heatwaves, and the resulting prey shifts, likely caused the UME but the continued increase in Guadalupe fur seal strandings along the U.S. West Coast also can be linked to range expansion as the population grows.

Guadalupe fur seal interactions with U.S. fisheries

The Hawaii-based shallow-set swordfish longline fishery (<100 m depth, 24-71 km set length and 1000s of hooks) uses large circle hooks and fish bait (not squid), fishes at night 2,000 nmi from the west coast of North America and has 100% observer coverage. Guadalupe fur seal interactions (hooked in the head, mouth/jaw or flipper) with this fishery include: 1 in 2015, 3 in 2017 and 7 in 2020. All these interactions occurred between October 31st and December 5th and all were released alive (disentangled/de-hooked or with gear present). Although not very many Guadalupe fur seals are being caught in this fishery, they are ESA listed and while there is an incidental take permit for Guadalupe fur seals, there is no take cap or condition of closure.

Workshop recommendations for ongoing/future Guadalupe fur seal health assessments

Short term priorities (over the next two years):

- Test all pinnipeds we handle for avian influenza during the ongoing pandemic. A nasal swab (live) or lung tissue (dead) should be collected (put in viral transport media and into a freezer quickly, or if cannot freeze quickly, put in RNAlater) and sent to an approved laboratory in each country (same for all other wildlife species).
- Develop a simple protocol and datasheet for rangers on the islands to possibly perform field necropsies when research teams are not present
- Focus on using laboratories and building capacity to analyze samples in México. This is especially important right now for avian influenza testing and because Guadalupe fur seals are a CITES Appendix I species and CITES import between México and the U.S. was recently closed. There are approved laboratories to send samples in many countries, including México, for specific diseases and pathogens (World Organisation for Animal Health Reference Laboratories: <https://www.woah.org/en/what-we-offer/expertise-network/reference-laboratories/>).
- Publish results from 2015-2021 Guadalupe Fur Seal Unusual Mortality Event
- Publish various results from other Guadalupe fur seal health assessment studies, including trace elements and infectious disease results (Miriam Romero – M.Sc. student)
- Monitor early pre-weaning mortality (October-November) for two additional years (to have 4 years total)

Medium to long term priorities:

- Prospective sampling should focus on diseases Guadalupe fur seals may be more exposed to as they expand north and overlap increasingly with California sea lions and that can

cause large scale mortality or epidemics (transmissible between animals), including herpesvirus (collect genital swab), hookworm (collect feces) and leptospirosis (collect serum). Brucellosis is interesting and should be a higher priority because it can cause reproductive failure. Toxoplasmosis is interesting but cannot be passed from animal to animal (cannot cause an epidemic) so might be lower priority.

- Collect and archive these samples even if they cannot be analyzed yet (establish baseline). Milk has not been collected from adult females but may be a sample to prioritize for nutritional testing.
- Develop a guide and train the West Coast Marine Mammal Stranding Network and others to better determine the type and source of fishery gear in the U.S. and México. It is also important to keep in mind that when we see an entangled animal, that animal has survived and these data are skewed (many drown in nets, die from hooks perforating organs, etc.).
- With improved field testing capabilities, we also might be able to run qPCR in the field or import DNA/RNA extracts (archive as multiple aliquots).
- Microbiome and metagenomic studies also should be considered (more exploratory).

Protections and Threats on/near Mexican Islands

Comisión Nacional de Áreas Naturales Protegidas (CONANP) contributes to the preservation and sustainability of biodiversity and natural resources in México through the administration and management of 186 Natural Protected Areas (NPA) together with the local communities. There are 19 NPA in the Baja California Peninsula and North Pacific region, each with various levels of terrestrial and/or marine protection. The budgets are different for different protections, even within the same NPA, and each NPA can have more than one protection level. These are the levels that are most relevant to Guadalupe fur seal conservation and management:

- Flora and Fauna Protection Areas – for habitat protection, some sustainable and extractive activities are allowed, some exploitation of resources, complex management
- Biosphere Reserves – for species protection and habitat protection, have communities living within the NPA, high endemism and restoration processes, some sustainable and extractive activities allowed
- National Parks – most restricted, mainly for tourism, no extractive activities and no one lives within these NPA

The primary human activities that pose the greatest threat to Guadalupe fur seals on/near Mexican islands are:

- Ecotourism, including humans swimming with pinnipeds (especially at islands in the Gulf of California), viewing/photographing pinnipeds from land (especially at San Benito Archipelago) and great white shark cage diving (previously at Guadalupe Island);

- Sportfishing and interactions with fisheries (e.g., hooking and entanglements); and
- Introduction of invasive species that have the potential of spreading diseases.

Boats (of specific length) visiting these NPA must have tracking devices, which CONANP uses along with other tools to monitor vessel activities near the islands and determine if boats are fishing or passing through the NPA. Additionally, all islands in México are federally owned.

Existing conservation and management at/near islands around the Baja California Peninsula

Guadalupe Island is a NPA with a resident artisan fishing community that targets abalone and California spiny lobster (*Panulirus interruptus*). The terrestrial and nearshore marine environment (12 nmi from shore) at Guadalupe Island (1 island and 5 islets) was protected as a biosphere reserve beginning in 2005 (Reserva de la Biosfera Isla Guadalupe). The first Reserva de la Biosfera Isla Guadalupe Management Program was established in 2011, and this management program was updated on January 9, 2023. A permit is required to go onto Guadalupe Island, and tourists are not allowed to go on land at all.

Beginning in May 2022, new regulations issued by CONANP and the Mexican government took effect that banned all ecotourism activities in the Reserva de la Biosfera Isla Guadalupe (e.g., no sportfishing or great white shark cage diving tours). Most of these tourism boats were coming from San Diego, California. These closures were accomplished through a written action plan that was established and turned into a legally binding document. There also is a good relationship between the fishing community and CONANP at Guadalupe Island, and these closures were being supported by the fishing community (e.g., some sharks were approaching their boats and divers more frequently and aggressively in recent years). A number of high profile incidents (e.g., sharks getting caught in cages) also generated support for this ban. There has been some negative media attention about the closures and so far lawsuits have been managed/dismissed.

San Benito Archipelago is part of the Reserva de la Biosfera Islas del Pacifico de Baja California, a biosphere reserve with terrestrial and marine protection that includes 21 islands and 97 islets. For this entire reserve, there are only nine CONANP rangers and other staff (small staff for a large number of islands). Similar to Guadalupe Island, the artisan fishing community at San Benito Archipelago targets abalone and lobster. Tourism at San Benito Archipelago has been increasing (mostly viewing/photographing animals from land; it is difficult to swim with pinnipeds at this site).

There are 898 islands in the Gulf of California that have terrestrial protections only as part of the Islas de Golfo de California Área de Protección de Flora y Fauna, with the first 20 meters of water from shore regulated by a specific agency (La Zona Federal Marítimo Terrestre, ZOFEMAT, or Federal Maritime Terrestrial Zone). Additional protections could be added to one

or more of the islands in this NPA. For example, there are terrestrial and marine protections at 1 island and 2 islets as part of the Reserva de la Biosfera Isla San Pedro Mártir. Ecotourism on some islands may be minimal because of their remoteness (e.g., Las Ánimas is 3-h roundtrip from La Paz).

Workshop recommendations for ongoing/future conservation and management at/near islands around the Baja California Peninsula

The Reserva de la Biosfera Isla Guadalupe is the gold standard for what can be done to protect Guadalupe fur seals (and other species and habitat) with a small staff but positive relationships between park rangers, fishers and conservation groups. The 2016 PACE focused on determining the possible impacts of tourism and other human activities and limiting or regulating these activities at Guadalupe Island. The next step is to focus on the other islands Guadalupe fur seals use, and the PACE can be used as justification for additional protection in surrounding waters at other islands. We need to collate current knowledge and identify key information gaps, such as needing to:

- Determine if fishery interactions occur close to the islands or during foraging trips
- Determine if human presence at islands impacts Guadalupe fur seal occurrence or behavior (by human activity and animal age class)
- Develop ecotourism best practices based on science (e.g., level of activity that is acceptable) and apply what is used for other fur seals species (since fur seals are expanding in many areas)

We discussed a number of possible options for regulations:

- There are regulations for whale watching in México and similar regulations could be developed for Guadalupe fur seals (e.g., distance to maintain when swimming with them). Alternatively, one official standard regulating swimming with pinnipeds and cetaceans could be issued in México (e.g., when whale watching was regulated, dolphin swimming activities began, and the same is being seen with California sea lions and Guadalupe fur seals). This would require someone beginning a proposal and needs to include a public consulting process. For whale watching, an annual permit and a report at the end of each year is required, but enforcement is difficult because there are few personnel (many regulations, but not a lot of enforcement).
- Dynamic closures during breeding season or critical periods (e.g., peak abundance in non-reproductive sites) are a possibility but would need to be discussed further with key stakeholders.

We agreed that the best approach is to start with outreach because nature-oriented tourists are open to new information and likely to follow the rules if they know them, ecotourism is a powerful tool for conservation, in-water disturbances may be minimal and Guadalupe fur seals

are returning to places that they did not used to be and are coexisting with humans. Therefore, more extreme measures (regulations or closures) may not be needed, but researchers should continue working with CONANP to make science-based tourism and sport fishery regulation recommendations.

During the workshop, we identified these short to medium term activities to improve collaboration among research teams, government officials and local communities at other islands to work towards what exists at Guadalupe Island (highlight the importance of these sites as “refuges” for Guadalupe fur seals):

- Ask for a CONANP park ranger to join research teams on field trips to San Benito Archipelago and other islands
- Increase outreach with the fishing community at San Benito Archipelago when on the island to survey, providing posters with information, among other resources (e.g., GEI spends one week on Cedros Island and gives talks to the community, focusing on children/schools)
- Develop informational leaflets for fishing communities and ecotourist companies (biologists on these) that explain morphological (include photos) and behavioral differences between Guadalupe fur seals and California sea lions (emphasize human safety), describe critical areas and times for each pinniped species at each site and include QR code with more information
- Encourage tourists to observe Guadalupe fur seals and other pinnipeds at certain locations and times, from certain distances, etc.
- Develop other outreach material/content, including using underwater and above-water video, audio (vocalizations), pelts/specimens, animated satellite tracks, live video when we are on the island and/or webcam (but no Wi-Fi) and social media (need approval from CONANP; fishing community on Guadalupe Island has a Facebook group; YouTube page with entanglement and other video)
- Create an “awareness month of the Guadalupe fur seal”

Informational wooden signs may be more effective at certain places to minimize people wandering into certain areas but can be difficult to install in national parks/protected areas. Informational wooden signs may be a particularly effective tool at San Benito Archipelago. The management plan for the Reserva de la Biosfera Islas del Pacifico de Baja California is currently being updated, and it may be possible to include installation of pinniped viewing signs and other conservation actions in this management plan.

Guadalupe fur seals will continue to find new terrestrial sites, especially because there are many islands near existing colonies, and adding protections every time this species colonizes a new site may be inefficient and can alienate the community (e.g., uproar from the public with each new closure/restriction). A conservation plan for Guadalupe fur seals should anticipate future

expansion (i.e., not be reactive). For example, we may want to increase outreach with fishers before animals arrive at a new site. Additionally, some of these activities, especially those involving a multispecies approach, should be led by the Sociedad Mexicana de Mastozoología Marina (SOMMEMA, or Mexican Society of Marine Mammalogy).

Ecosystem Change, Trophic Ecology, At-sea Dispersal and Human-related Threats At-sea

Mortality and body growth during extreme environmental variability

These studies were led by Casandra Gálvez and published in her master's thesis, Ph.D. dissertation (both at CICIMAR) and a peer-reviewed journal article²⁹. In 2013-2016, length, girth and mass were collected from pups during the early nursing season to study the effects of persistent warm water anomalies and chronic food web disruptions on the growth of Guadalupe fur seals. Individuals were first captured as neonates with umbilical cords (100-150 individuals per breeding season) and recaptured every 13-15 days until they were 60 days old (in 2013, only first capture). Using a hierarchical Bayesian model of Guadalupe fur seal weight anomalies as a function of sea surface temperature (SST) anomalies, for every 1°C increased in SST there was a 1.7 kg decrease in pup mass gain. The lowest inferred birth mass and mass gain was in 2014, followed by 2015, while the greatest mass values were observed during 2016. Early mortality of Guadalupe fur seal pups also was determined in 2013-2016. Causes of mortality included trauma, stillbirths/prematurity, emaciation, drowning and infectious disease. The greatest mortality rate was in 2015 (15% of pups born at Punta Sur) and emaciation was more common in 2015 (54%) than 2014 (22%) and 2013 (9%). Marine heatwaves in the Northeast Pacific decreased Guadalupe fur seal body mass and survival in 2014 and 2015 at Guadalupe Island.

Sea surface temperature as a predictor of Guadalupe fur seal pup production

This study was led by Ariadna Juárez-Ruiz and published in her Ph.D. dissertation (at CICESE) and a peer-reviewed journal article⁵. The effect of sea surface temperature on pup production was examined using 12 published and unpublished pup counts at Guadalupe Island (1991-1993, 2006-2019). Boat-based counts were corrected using substrate-based correction factors⁸, and a birth-timing sigmoidal model was used to estimate total pup production each year and model a long term pup production trend. The results showed that Guadalupe fur seal pup production increased exponentially over the last three decades without reaching an asymptote, which suggests that the species was still in a recovery phase in 2019. The annual growth rate of 8.4% estimated for the 1991-2019 period is greater than the 5.9% estimate for 1984–2013⁷, which indicates a steep increase in pup production in recent years that still was less than those estimated

for other recovering fur seal populations. An ecological model with SST anomalies as a predictor of pup production proportional anomaly was developed and can be divided into four parts:

1. Positive effect of slightly cold years ($<-0.2^{\circ}\text{C}$) on pup production
2. Negative effects on pup production under normal to slightly warm conditions (-0.16 to 0.6°C). Approximately $\sim 60\%$ of the pup production observations fell within this range.
3. Slight positive effect of moderately warm conditions (~ 0.6 to 1.3°C) on pup production
4. Slight negative effect of extreme warming ($>1.4^{\circ}\text{C}$) on pup production

Pup counts were not available during the coldest years and are needed to corroborate pup production predictions during cold years.

Foraging segregation by sex and age class in Guadalupe fur seals from Guadalupe Island and San Benito Archipelago, México

This study is being led by Romyna Arysbeth Cruz Vallejo as part of her Ph.D. dissertation (in progress at CICIMAR – IPN). This study aims to fill a critical knowledge gap by providing the first isotopic signatures for all Guadalupe fur seal age and sex classes. Fur samples were analyzed for carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) stable isotopes from 146 Guadalupe fur seals in 2014-2020 (5 adult males, 2 subadult males, 36 adult females, 29 juvenile females, 30 juvenile males and 44 pups). Pups had the lowest $\delta^{13}\text{C}$ values, adult females had the lowest $\delta^{15}\text{N}$ values and juveniles had the largest isotopic polygon area. The isotopic niches indicated: adult females foraged in specific areas at higher latitude, juvenile males had greater foraging trip dispersion, adult/subadult males had larger dispersal capacity along the inshore-offshore gradient and maternal tissue catabolism required to synthesize milk was observed for pups. There were no significant differences between the isotopic niches of juvenile and adult females. This study demonstrates that there was isotopic niche partitioning between Guadalupe fur seal sex and age classes, which may be related to foraging segregation, the high dispersal capacity of this species and/or the energetic requirements and life history traits of each sex/age class and may be a possible strategy to decrease intra-population competition for resources, favoring the continued recovery of the species.

Vibrissae also are being analyzed to determine isotopic signature changes over time for each fur seal (results pending). All isotope information has or will be matched with telemetry outputs for individuals with both types of data.

Wild-caught Guadalupe fur seal telemetry and environmental data analysis plans

María José Amador-Capitanachi (Ph.D. dissertation in progress at CICIMAR – IPN) is studying the foraging behavior and habitat use of Guadalupe fur seals from Guadalupe Island using satellite telemetry and oceanographic characterization of their foraging grounds. In 2016-2020, 143 Guadalupe fur seals were satellite tagged at Punta Sur, Guadalupe Island (2016: 5 weaned

pups; 2017: 13 weaned pups, 10 juvenile males, 10 juvenile females, 5 adult females; 2018: 10 juvenile males, 10 juvenile females, 15 adult females; 2020: 30 weaned pups, 10 juvenile males, 10 juvenile females, 15 adult females). Transmission durations were $83 \text{ d} \pm 46 \text{ d}$. The foraging strategies (diving behavior, foraging trip metrics, etc.) of lactating females currently is being analyzed in relation to pup mass and environmental conditions (sea surface temperature, chlorophyll a, sea surface height, bathymetry, etc.) using R statistical software. The ontogeny of foraging behavior and habitat use also will be investigated along with environmental conditions and coupled with stable isotope data.

Guadalupe fur seal utilization distributions and at-sea human-related threats

For various funding agency reports, Tenaya Norris (TMMC/PMMC) performed initial analyses of the telemetry data María José Amador-Capitanachi will be analyzing more thoroughly. Overall, Guadalupe fur seals broadly used the California Current System, primarily north of Guadalupe Island. Adult and juvenile females primarily traveled north, and juvenile females remained closer to shore (<800 km) than adult females (up to 1,400 km). A greater number of juvenile males were found south of the island compared with adult and juvenile females. Juvenile males also remained within 500 km of the coast of North America. Integrating dive histogram data with locations for non-pups revealed that there was substantial nighttime diving, and likely foraging, along portions of the tracks that might have been associated with transiting to and from the island if only location data were used (directed, relatively straight path of travel), including within U.S. Navy ranges. Weaned pups traveled north of Guadalupe Island, and only two pups briefly spent time south of the island. Pups were the only animals that traveled north of 41°N . In contrast to non-pups, many of the tags attached to pups stopped transmitting between $37\text{-}48^\circ\text{N}$ while these animals were still traveling northward on nearly linear paths and at approximately the same transit speeds, suggesting they may have traveled farther north than their tracks indicated. Pups remained within 600 km of the coast with many using nearshore areas over the continental shelf.

Together these data indicate that:

- Nearshore human-related activities (restricted to continental-shelf waters) pose minimal risk to non-pups and greater risk for weaned pups. These include oil/gas development and spills, commercial shipping/other vessel traffic, military activity (e.g., sonar and exercises) and aquaculture.
- Human-related activities offshore of the continental-shelf waters pose greater risk for non-pups and minimal risk for weaned pups. This includes alternative energy development with two offshore wind energy lease areas along the coast of California in areas that are highly used by Guadalupe fur seals.
- Nearshore and offshore human-related threats for Guadalupe fur seals include fisheries interactions, marine debris/trash and contaminants/microplastics

Workshop recommendations for ongoing/future foraging ecology, habitat use and other ecosystem change studies

Short to medium term priorities (over the next four years):

- Publish foraging segregation by sex and age class stable isotope results (from fur and vibrissae samples, Romyna Arysbeth Cruz Vallejo – Ph.D. student)
- Publish foraging behavior, habitat use and oceanographic characterization of foraging grounds results (using existing satellite telemetry data, María José Amador-Capitanachi – Ph.D. student)
- Evaluate if peaks strandings along the U.S. West Coast match up with below average predicted pup production from the ecological model

Medium to long term priorities:

- Continue stable isotope, diet and other prey-based studies, which may include examining Guadalupe fur seal diet at different locations and in non-summer months (currently only have data from the summer) and assessing the nutritional content of fur seal prey (e.g., energy content from the summer and fall is radically different, fish become higher in energy content later in the season, some of this has been done by Ariadna Juárez-Ruiz: flying squid have lower nutritional content than jumbo squid)
- Continue telemetry studies, including analyzing the overlap between Guadalupe fur seals and various threats, especially related to fisheries interactions and entanglements in fishing gear and marine debris, and developing a plan for future satellite tagging efforts, which likely will prioritize instrumenting additional lactating females and weaned pups at Guadalupe Island (two groups we have limited data from). Instrumenting fur seals at other sites than Guadalupe Island to determine if these animals use similar areas is a lower priority because as a first step, less expensive methods (e.g., flipper tagging) can be used to determine the exchange of individuals between colonies. We may then transition to instrumenting animals every 10 years to detect large shifts in movement patterns.
- Pursue more range-wide, large-scale ecosystem studies, including investigating the impact of opposing population trends of other pinnipeds on Guadalupe fur seals (e.g., California sea lions in the Gulf of California) and stable isotope and habitat use overlap and segregation for pinnipeds inhabiting the California Current Ecosystem (i.e., use free-ranging Guadalupe fur seals, California sea lions and northern fur seals in México and the U.S. in a comprehensive trophic/foraging ecology analysis). The sister partnership between the Channel Islands and Guadalupe Island could help with these studies.

Research and Conservation Plan Implementation

As part of the overview of monitoring and managing the Guadalupe fur seal population in México and the U.S., more information was provided at the workshop about the PACE³⁷:

- There is a table of activities in the PACE (Appendix II) and progress has been made on many of the short term and some of the medium term objectives, including:
 - Promote studies on abundance and population trends and health
 - Promote studies that identify the effects of climate change and environmental conditions on the Guadalupe fur seal population (abundance, trophic ecology, pup production and health, among others)
 - Implement campaigns aimed at users of the Natural Protected Areas on the legal provisions for the protections of the marine environment and endangered species
 - Preparation of informative material to promote the knowledge and protection of the Guadalupe fur seal
 - Develop manuals of good practices for the development of tourist-recreation observation activities of the Guadalupe fur seal
- There was no plan to update the PACE at the time of the 2016 meeting.
- There was no defined time periods for short, medium and long term goals, but short term were to be accomplished before the next breeding season.
- The priority of each action was dependent on the difficulty levels and/or the expected time needed to collect data and make inferences, especially for studies based on survival rate and long term trend analysis.

A first step at the workshop was discussing what we are trying to develop in terms of products (e.g., a U.S. Recovery Plan, a monitoring plan or something else). In México, research and conservation aspects are joined through PACE and focus on activities and goals that actively work towards Guadalupe fur seal recovery. PACE is not legally binding but can justify work being done to move towards legal protections. For example, at Las Ánimas, tourists swim with the fur seals and the government cannot do anything about it because the surrounding water is not protected for this NPA (only the terrestrial habitat is protected). Therefore, part of this plan we are developing could highlight the importance of extending protected area into the water at Las Ánimas and potentially other NPA in the Gulf of California. We understand that this label change (including water protection) can be long and complicated. Alternative strategies include an increase of social awareness.

Guadalupe fur seals are listed under the ESA and as such are required to have a recovery plan to address threats to the population, which must include certain information (e.g., site-specific management activities, objectionable measurable criteria and estimates of time/costs required to achieve the plan's goal). Funding is not always available as part of a recovery plan. For depleted marine mammals stocks in the U.S. (not ESA-listed), there are conservation plans that also establish what measures should be taken to monitor and support species recovery. Conservation and recovery plans are working towards the same goal (a conservation plan is a lower level). A binational conservation plan between the U.S. and México would be a non-binding agreement that is useful for both countries.

We also need to be thinking about how to monitor the impact and effectiveness of any conservation/management action using short and long term metrics. Many of the management actions at Guadalupe Island are new (e.g., tourism and sport fishery closures were put in place less than one year ago), but CONANP and others are starting to transition from gathering information about threats and implementing actions based on this information to now evaluating how these conservation strategies are working. Some important questions to address: Is the population continuing to recover?, Are we seeing fewer entanglements?, Is the public getting involved/aware of what is happening? (e.g., surveys to gauge how people feel about Guadalupe fur seals, etc.). On the last population survey at Guadalupe Island (summer 2022), there appeared to be fewer human interaction injuries after tourism was closed on the island (sportfishing was previously occurring right next to the colony). This constitutes a solid example of management decisions that have had a positive impact on the population.

For Guadalupe fur seal conservation and management, these are the top questions and priorities for managers in México and the U.S.:

- CONANP needs to know:
 - How many are there?
 - Where are they found?
 - What are they doing (age class, behavior, terrestrial habitat, etc.)?
 - What are the interactions with and impacts of human activity?
- NOAA needs to know:
 - Can we characterize good terrestrial and marine habitat for potential recolonization of Guadalupe fur seals in the U.S.?
 - Who should we begin talking with to make sure we are prepared for and ready to monitor expansion into the U.S.?
- NOAA also recommended we use the threats assessment in the recent Status Review to guide other key management priorities.

Various researchers also added these top questions and priorities for Guadalupe fur seal conservation and management:

- How will the expected California sea lion habitat loss and displacement from San Miguel Island impact Guadalupe fur seals and can we predict pup production 20 years out (modeling into the future)?
- What terrestrial habitat (with well-known characteristics) might be available for Guadalupe fur seals in the future and where may they expand to in the U.S. and México?
- Why isn't more pupping happening at San Benito Archipelago or other sites?
- Currently, there is a fishery for market squid but not for jumbo squid in the U.S. With ocean warming, squid may be more abundant/accessible to fisheries in the future and/or squid fisheries may move to new areas (e.g., northward with warm water). How can we

be prepared to manage possible increased future fisheries interactions, especially given there is currently no observer coverage for the U.S. market squid fishery?

Workshop recommendations for research and conservation plan implementation

We decided to focus on working towards a final product that is useful for our group. This plan does not need to have a specific format or includes certain elements. The plan will combine science, management, outreach and policy in one document and be a binational conservation plan (i.e., not a recovery plan, as defined by the ESA). There is a Northern Fur Seal Conservation Plan (that has not been updated in a while), and this plan and the PACE may be a good starting point for a binational conservation plan for Guadalupe fur seals. This plan can be used to help obtain funding for long term monitoring and may be adopted by NOAA Fisheries as a U.S. Recovery Plan.

In terms of funding this work, we discussed applying for Section 6 funding (U.S. states compete for NOAA funding for ESA-listed species) through University of California, Davis or another California state university rather than the California Department of Fish and Wildlife (CDFW workshop participant recommendation). Other possible funders include NOAA Fisheries (outside of Section 6), National Polytechnique Institute in México (internal funds), other government agencies and private foundations, as well as the Society for Marine Mammalogy. We should prioritize funding population monitoring and other efforts that are most impactful for species and habitat conservation.

All participants that attended the workshop are interested in continuing to be involved in Guadalupe fur seal research and conservation planning efforts. Additionally, we are tentatively planning to convene another joint U.S.-México Guadalupe Fur Seal Research and Conservation Planning Workshop, possibly in 2025 and hosted by the Pacific Marine Mammal Center. During this workshop, we will plan to have breakout sessions for a deeper dive into mark-recapture study design and other priority topics.

Short to medium term priorities (over the next four years):

- Develop a checklist of what we need to collect in the field associated with each activity and include a timeline of when each activity occurred during each trip
- Rank threats based on best-available information, with workshop participants contributing input, possibly via a post-workshop survey. Top threats include the presence of one rookery, climate change, food availability, genetic variability, interactions with fisheries, emerging diseases, oil spills and sea level rise.
- Create an official map of Guadalupe fur seal distribution with terrestrial habitat and marine habitat to demonstrate the need for binational management and that can be easily updated as the species expands to new areas

- Identify short and long term metrics to monitor the impact and effectiveness of recent conservation and management actions at Guadalupe Island
- Secure funding for long term population monitoring and other efforts that are most impactful for species and habitat conservation (easy to develop a plan but need money to sustain it and this is often difficult to fund)
- Plan and host another joint U.S.-México Guadalupe Fur Seal Research and Conservation Planning Workshop (possibly in 2025)
- Develop a binational conservation plan that combines science, management, outreach and policy, which can be used to help obtain funding for long term monitoring (i.e., is useful for our needs, and does not need to include all elements of a U.S. Recovery Plan)

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Appendix I. Workshop Agenda

Wednesday, March 29th

- 9:00 - 12:00 Visit Pacific Marine Mammal Center - optional
- 13:00 - 13:30 Welcome and Logistics - Alissa Deming/Glenn Gray
Marine Mammal Commission Opening Remarks - Frances Gulland
Workshop Goals - Fernando Elorriaga-Verplancken/Tenaya Norris/Tina Fahy
- 13:30 - 14:15 Introductions - All
- 14:15 - 17:00 Theme - Overview of monitoring and managing the Guadalupe fur seal population in México and the U.S.
Facilitator: Fernando Elorriaga-Verplancken

Time	Who	Topic
14:15 - 14:45	Fernando Elorriaga-Verplancken	Overview of Guadalupe fur seal biology, ecology and the 2016 Programas de Acción para la Conservación de Especies (PACE) meeting
14:45 - 15:05	Fernando Elorriaga-Verplancken	Overview of Guadalupe fur seal research and monitoring activities
15:05 - 15:20	All	Break
15:20 - 15:40	Donaxi Borjes Flores	Conservation and management at Guadalupe Island
15:40 - 16:00	Tina Fahy	Guadalupe fur seal conservation and management in the U.S.
16:00 - 17:00	All Tenaya Norris	Questions Introduce and begin discussion of the draft Action Program for Species Conservation outline

17:00 - ? Dinner/Mixer at Workshop Venue - provided

Thursday, March 30th

8:00 - 9:00 Breakfast/Coffee at Workshop Venue - provided

9:00 - 12:30 Theme: Population monitoring
 Facilitator: Fernando Elorriaga-Verplancken

Time	Who	Topic
9:00 - 9:15	Fernando Elorriaga-Verplancken	Guadalupe fur seal population monitoring results
9:15 - 9:25	Jeff Harris	Guadalupe fur seal monitoring at San Miguel Island
9:25 - 9:40	Sharon Melin	California sea lion and northern fur seal population monitoring in California - lessons learned and recommendations
9:40 - 9:55	Jason Baker	Northern fur seal population monitoring in Alaska - lessons learned and recommendations
9:55 - 10:30	All	Questions and Discussion - prioritize research and conservation objectives and activities for regular counts
10:30 - 10:45	All	Break
10:45 - 12:30	All	Discussion - prioritize research and conservation objectives and activities for regular counts

12:30 - 13:30 Lunch - provided

13:30 - 15:00 Theme: Population monitoring - continue
 Facilitator: Fernando Elorriaga-Verplancken

13:30 - 15:00	All	Discussion - prioritize research and conservation objectives and activities for pup survival/mass/ growth, mark-resighting program, vital rates, etc.
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15:00 - 15:15 Break

15:15 - 16:45 Theme: Health, Disease, Entanglements and Fishery Interactions
 Facilitator: Tenaya Norris

Time	Who	Topic
15:15 - 15:20	Casandra Gálvez	Wild-caught Guadalupe fur seal health assessment

15:20 - 15:25	Tenaya Norris	Unusual Mortality Events and health data/results from stranded Guadalupe fur seals in the U.S.
15:25 - 15:30	Tina Fahy	Guadalupe fur seal interactions with U.S. fisheries
15:30 - 16:45	All	Questions and Discussion - prioritize research and conservation objectives and activities

16:45 - 17:00 Daily wrap-up

18:30 - ? Dinner (sit-down) at Workshop Venue - provided

Friday, March 31st

8:00 - 9:00 Breakfast/Coffee at Workshop Venue - provided

9:00 - 10:15 Theme: Human-related threats on/near Mexican islands
Facilitator: Fernando Elorriaga-Verplancken

Time	Who	Topic
9:00 - 9:10	Donaxi Borjes Flores	Human-related threats on land/near islands and levels of natural resource/habitat protections for islands around the Baja California Peninsula
9:10 - 10:15	All	Questions and Discussion - rank/prioritize threats and prioritize for research and conservation objectives and activities

10:15 - 10:30 Break

10:30 - 12:30 Theme: Ecosystem Change and Human-related Threats At-sea
Facilitator: Tenaya Norris

Time	Who	Topic
10:30 - 10:40	Cassandra Gálvez	Ocean warming anomalies and Guadalupe fur seal pup body mass
10:40 - 10:50	Ariadna Juárez	Sea surface temperature as a predictor of Guadalupe fur seal pup production

10:50 - 11:00	Romya (Romy) Cruz	Guadalupe fur seal stable isotope results
11:00 - 11:05	María José (Majo) Amador-Capitanachi	Wild-caught Guadalupe fur seal telemetry and environmental data analysis plans
11:05 - 11:10	Tenaya Norris	Human-related threats at-sea and Guadalupe fur seal utilization distributions
11:10 - 12:30	All	Discussion - prioritize research and conservation objectives and activities

12:30 - 13:30 Lunch - provided

13:30 - 16:30 Theme: Research/Conservation Plan Implementation
Facilitator: Fernando Elorriaga-Verplancken

Time	Who	Topic
13:30 - 15:15	All	Further refine draft Action Program for Species Conservation outline: <ul style="list-style-type: none"> Rank threats (high and low, now and future) and priorities to investigate further Determine short (2 yr), medium (5 yr) and long term (10 yr) research and conservation goals/priorities Begin developing implementation schedule (5 yr priorities, costs, etc.) Discuss funding options/sources for population monitoring, other research, conservation plan coordinator position(s), etc.
15:15 - 15:30	All	Break
15:30 - 16:30	All	Discuss plan implementation: <ul style="list-style-type: none"> Outreach/education activities Enforce existing regulations Research and conservation team Next steps and task assignments

16:30 - 17:00 Workshop wrap-up

~18:00 - ? Dinner (informal, smaller group) - provided

Appendix II. Activity table from the Programas de Acción para la Conservación de Especies (PACE, or Action Programs for the Conservation of Species) for Guadalupe fur seals, translated into English with green highlighting for objectives where progress has been made since the 2016 meeting.

Activity	Indicator	Means of Verification	Term		
			Short	Medium	Long
Integral Habitat Management					
Integrate a comprehensive maritime spatial planning scheme that strengthens the zoning of the Natural Protected Areas (NPA) marine polygons and identifies critical areas for the development of vital functions of the Guadalupe fur seal	Scheme developed and applied	Establishment of zones with controlled navigation to protect critical areas for pinnipeds, especially Guadalupe fur seals			
Install signage within the NPA polygon to prevent damage to the marine habitat by pollution and other environmental nautical contingencies	Signage Installed	Register of installed signs			
Species Conservation and Management					
Promote studies on abundance and population trends for Guadalupe fur seals that provide relevant information to implement better management measures	# Projects supported	Technical reports and refereed publications			
Promote studies on population dynamics and health of the population of the Guadalupe fur seal in its area of distribution that provides robust information for decision-making on protection and conservation	# Projects supported	Technical reports and refereed publications			
Collaborate with the fishing sector to adopt measures to reduce the bycatch of Guadalupe fur seals in the artisanal fisheries that take place in the Isla Guadalupe Biosphere Reserve and the San Benito Archipelago	Bycatch assessment program in operation	Fishing logs/reports of observers onboard			
Carry out, in collaboration with the fishing sector, research and technology transfer for improvement of fishing gear that provides greater efficiency and selectivity in the use of fisheries	Projects carried out on technology transfer	Inventory of fishing gear with selectivity and efficiency characteristics			
Promote the development of scientific studies that identify the effects of climate change and environmental	# Projects supported	Technical reports and refereed publications			

conditions on the Guadalupe fur seal population					
Social and Cultural Participation in Conservation					
Implement dissemination campaigns aimed at users of the NPA on the legal provisions applicable to the Guadalupe Biosphere Reserve and the San Benito Archipelago for the protections of the marine environment and endangered species, particularly the Guadalupe fur seal, as well as regulations on waster and protection of marine habitat	Number of campaigns carried out by region	Periodic surveys and dissemination materials			
Preparation of informative material to promote the knowledge and protection of the Guadalupe fur seal	Number of materials and copies distributed with informative content about the biology and other relevant aspects of the Guadalupe fur seal in all tourist boats and the SEMAR base on Guadalupe Island	Informative materials			
Recommendation on the status of the species to the IUCN and NOM-059-SEMARNAT-2010	Document of the IUCN working group and NOM-059-SEMARNAT-2010 regarding the classification status of the Guadalupe fur seal				
Implement a training program for tourism service providers that operate within the NPA to avoid harmful practices for the Guadalupe fur seal	Number of trained tourism providers	Dissemination materials Workshop minutes			
Economics of Conservation					
Diagnosis of the interest to take advantage of the observation of Guadalupe fur seals at Guadalupe Island	Surveys and numerical data of the percentage of companies and tourists interested in the activity of observing the fur seal at Guadalupe Island	Working Group: CONANP-Guadalupe and CONANP-headquarters			
Develop manuals of good practices for the development of tourist-recreation observation activities of the Guadalupe fur seal	Manuals prepared and disseminated among the providers of tourist services				