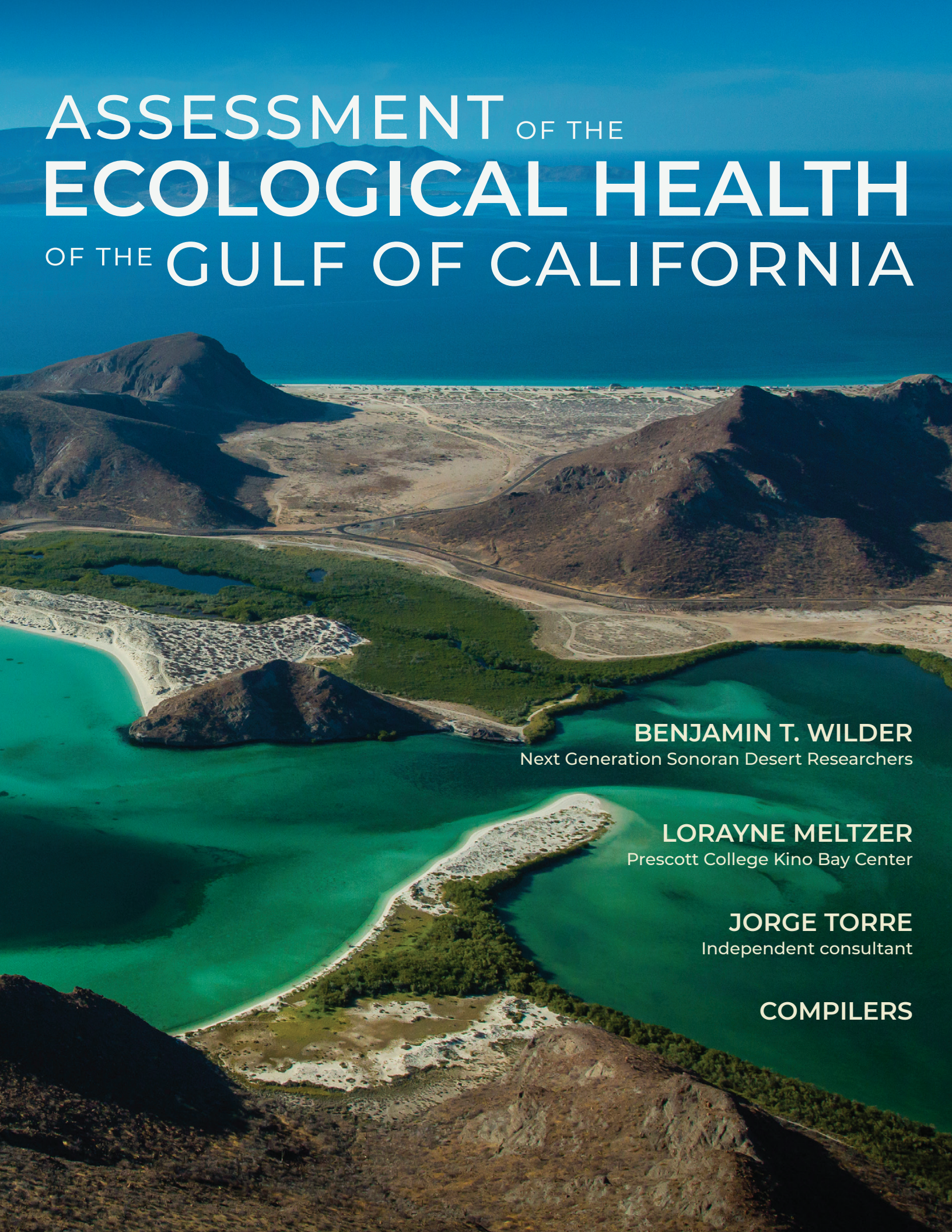
ASSESSMENT OF THE ECOLOGICAL HEALTH OF THE GULF OF CALIFORNIA



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Next Generation Sonoran Desert Researchers

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Independent consultant

COMPILERS

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2025

Assessment of the Ecological Health of the Gulf of California

Benjamin T. Wilder, Lorayne Meltzer, Jorge Torre (Compilers)

2025

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Acknowledgments

This effort would not have been possible without all of the participating researchers who took the time to share their hard-earned insights. Thank you for your contributions and willingness to share. We also greatly appreciate the contributions and feedback of all participants in the session of this topic held at the 2024 N-Gen Summit in Álamos, Sonora. Thank you in particular to the following individuals for their time in the generation of this effort and report: Caitlyn Hall, Elise Maynard, Adrian Munguia-Vega, Héctor Pérez Puig, Ricardo Rodriguez Medina, Mariana Reyna Fabian, Víctor Arturo Ricárdez-García, Paula Sternberg, Peggy Turk-Boyer.

Paola Ramírez created the trends illustration, Diana Zazueta contributed Spanish translation, and Amanda González Moreno did the report design.

Financial support was provided by Prescott College Kino Bay Center.

Photo by: John (Verm) Sherman

Executive Summary

Forty-one long-term ecological research projects by 32 scientists that span biomes, ecosystems, and taxonomic groups throughout the Gulf of California were included in this effort. Of those projects, only three taxa were assessed to be improving, seven stable, 11 degrading, two rapidly degrading, and 18 have undetermined trends. The majority of studies considered here were established since the year 2000, with the Midriff Islands being the focus of over half of all studies. Stable or improving species are almost exclusively terrestrial based (cardón and beetles), or species with land-sea linkages (e.g. sea turtles, fish-eating bat), or primary productivity (krill). In contrast, almost all taxa at higher trophic levels (e.g., crabs, fishes, giant squid, seabirds, sea stars, whales) are degrading, with the exception of osprey, which is stable.

As documented here and in numerous studies, the Gulf of California has experienced notable ecosystem changes due to prolonged periods of anomalous warming events during the last decades, with corresponding declines in the trends of the population sizes of seabirds and especially in several species of whales and dolphins. These changes have been partially attributed to a hypothetical decline in abundance and changes in the plankton community structure related to a progressive increase in sea water temperature. However, the long-term data shows stability in the primary productivity of the Gulf of California. Warming events may be having other direct causes not yet detected. Additionally, sustained industrial and small-scale fishing efforts throughout the Gulf of California have had direct and indirect effects on Gulf of California marine communities, and are likely a significant causative agent of declining populations.

The long-term data sets presented here have robust spatial, taxonomic, and trophic representation. Overall, they show an alarming decline of higher trophic level populations throughout the Gulf of California.

This effort also has identified three areas to focus on going forward to create a fuller picture of the ecological health of the Gulf of California. (1) This dataset is missing information of additional primary productivity measures (e.g., algae, chlorophyll, pelagic fish) and threatened megafauna species such as sharks, totoaba, the vaquita and others. The addition of existing information for both of these gaps should be prioritized. (2) There are also many long-term data sets that were not contributed to this effort, which future endeavors can hopefully incorporate (e.g, mangroves, seagrasses, some seabird studies, etc.). (3) A great deal of effort has been put into long-term ecological studies in the Gulf of California. How is this work going to be supported and continued into the future?

Photo by: John (Verm) Sherman

The continued collection of these data sets, many with relatively recent baselines, will inform the emerging hypothesis of persistent robust and functioning primary productivity and declines in the health of high trophic level species populations due to combined pressures of overfishing and temperature anomalies.

This hypothesis points to an inherent resilience of the processes that have driven the great abundance and diversity of the Gulf of California, captured in the earliest baselines of these datasets. At the same time, it calls our immediate attention to the numerous declines resulting from multiple stressors.

Context of This Report

What is the health status of the marine and coastal ecosystems of the Gulf of California? All life in the Gulf of California, marine and terrestrial, is connected to climatic and oceanographic cycles on the time scale of years to decades. Likewise, connections between ecosystems drive much of the productivity and ecological dynamics of the region.

There is general uncertainty among the public, policy makers, managers, and scientists as to the general status and trajectory of life in the Gulf of California. While change and variability are a constant, what effect is over-fishing having? What effects are being observed in response to global change and increasing variability in sea surface temperatures? What are the background population dynamics of individual species?

These large questions can often be impossible to answer. However, in the Gulf of California there are dozens of long-term ecological studies focused across the region and across study species. These studies, each remarkable on their own, can allow the establishment of baselines to address such large questions.

While the baselines may be different or incomplete, and direct causation often unclear, these long-term studies provide otherwise impossible insights into the status of the Gulf of California, from individual species to the interconnected ecological dynamics of the region.

These data are true gold, not just for science, but for all stakeholders invested in the past, present, and future of the Gulf of California. Despite increasing coordination and outreach efforts these datasets often are unknown, unrecognized, or reside inaccessible in academic silos or within the systems of governmental and civil society organizations.

Photo: Benjamin T. Wilder

This effort is focused on creating a current understanding of available long-term studies, presenting a summary of their findings, and identifying knowledge gaps and priority actions in order to answer the important question – what is the ecological health of the Gulf of California?

Note: This report is based on studies submitted through an open survey. There are some long-term Gulf of California studies missing, which we hope to incorporate in future iterations.

Previous Efforts

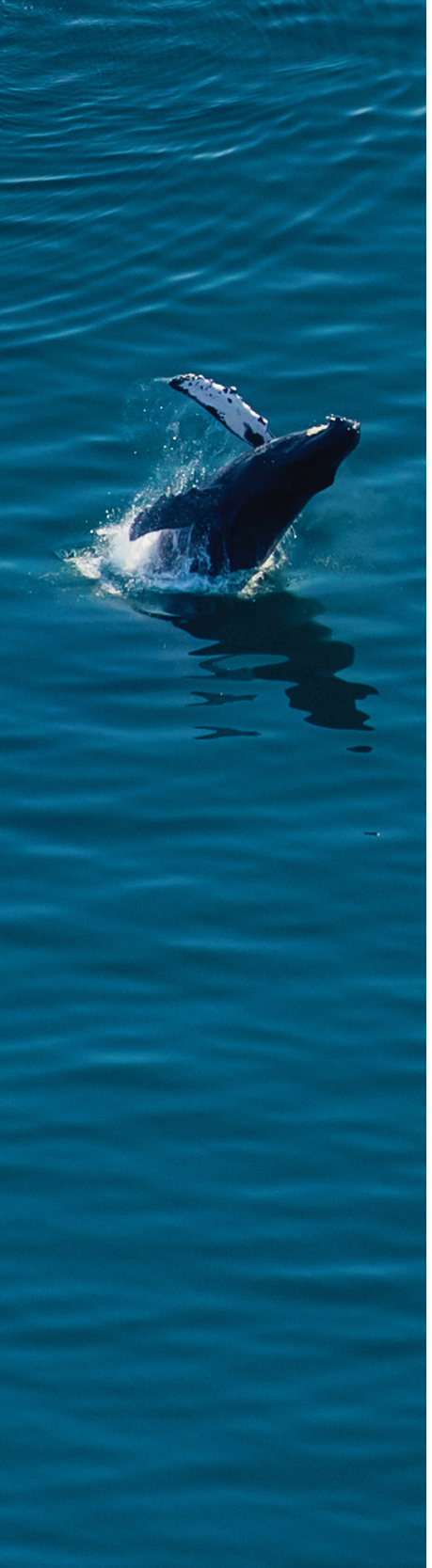
The first formal records of scientific exploration of the Gulf of California date back to 1841, when I. G. Voznesenskii, from the Museum of Zoology of the Imperial Academy of Saint Petersburg, collected plants from Isla Carmen and other sites on the coast of Baja California Sur (Lindsay & Engstrand 2002). From this event, a series of international (e.g., France, UK, USA) and Mexican scientific expeditions continued over the next 180 years. Each of these expeditions have taken “snap-shots” of the health of the Gulf of California. For example, the great abundances of fish, sea turtles, and marine mammals described in scientist’s diaries of 19th century (e.g., Sáenz-Arroyo et al. 2005; Sáenz-Arroyo et al. 2006; Craveri et al. 2018); the scarcity of seabirds in early 20th century due to the impact of *guano* mining, the introduction of rats to the islands, and the collection of eggs (Tershy et al. 1997, Bowen 2000, Bahre & Bourillon 2002); the ecological descriptions of marine communities by E. F. Ricketts and J. Steinbeck during its famous expedition in 1940 aboard the Western Flyer (Steinbeck & Ricketts 1941; Brusca 2020). In the 1970s, more systematic and long-term efforts began to understand the health of specific species populations in the Gulf of California, such as monitoring the seabirds on Isla Rasa (e.g., Velarde et al. 2005) or the restoration of the Cabo Pulmo fish abundance in the 21st century (Aburto-Oropeza et al. 2011), among other efforts that established the baselines we use today.

In the 1990s, interdisciplinary groups were formed to understand the Gulf of California comprehensively, highlighting the efforts of a coalition, formed by 14 conservation organizations, three federal and state government agencies, three protected natural areas and 12 universities and research centers (Enriquez-Andrade et al. 2005). The Coalition promoted the identification and conservation of priority sites based on the analysis of biophysical, socioeconomic, and governance variables (Enriquez-Andrade et al. 2005). There have been other initiatives to understand, communicate, and maintain or improve the health of the Gulf of California, such as the PANGAS project (2005–2016) that proposed and implemented an interdisciplinary research framework for small-scale fisheries in the northern

Photo by: Ralph Lee Hopkins - with aerial support by LightHawk

Gulf of California (e.g., Munguía-Vega et al. 2015); fishery management tools for locally managed marine areas with the production of citizen science in the Puerto Peñasco-Puerto Lobos Coastal Corridor in Sonora by CEDO (Morzaria-Luna et al. 2022); fish refuges in the San Cosme-Punta Coyote Corridor in Baja California Sur by Niapraja (Quintana et al. 2020) or San Pedro Nolasco Island by COBI (Perez-Alarcón et al. 2017); or publicly accessible scientific knowledge established by dataMares for more than a decade. There have been other efforts, but it is important to highlight the Ecological Assessment Scorecards led by CONANP (2010–2014) in 16 natural protected areas and two RAMSAR sites in the Gulf of California (CONANP 2016). Based on a series of workshops with experts, 12 questions were answered about the state and trends of human activities and biodiversity in natural protected areas.

This current effort aims to complement and build on these prior initiatives by (1) identifying long-term ecological studies conducted in the Gulf of California and (2) providing an overview of the trends indicated by these studies. We intend for this effort to support what comes next with a better understanding of different baselines to aid informed decision making.



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Methodology

Photo by: John (Verm) Sherman

SURVEY OVERVIEW

The information presented here is based on a bilingual (Spanish and English) survey conducted in February and March 2024 in preparation for the 2024 N-Gen Summit in April (Wilder et al. 2024), and then again from May through October 2024. See Appendix 1 for the complete survey questions.

The survey was created by Wilder and Meltzer and shared widely among Gulf of California researchers.

We considered the entire body between the Baja California peninsula and the Mexican mainland, the islands, and immediate coastal areas as the Gulf of California. We divided the Gulf of California into the following regions, which were selected by researchers in the survey:

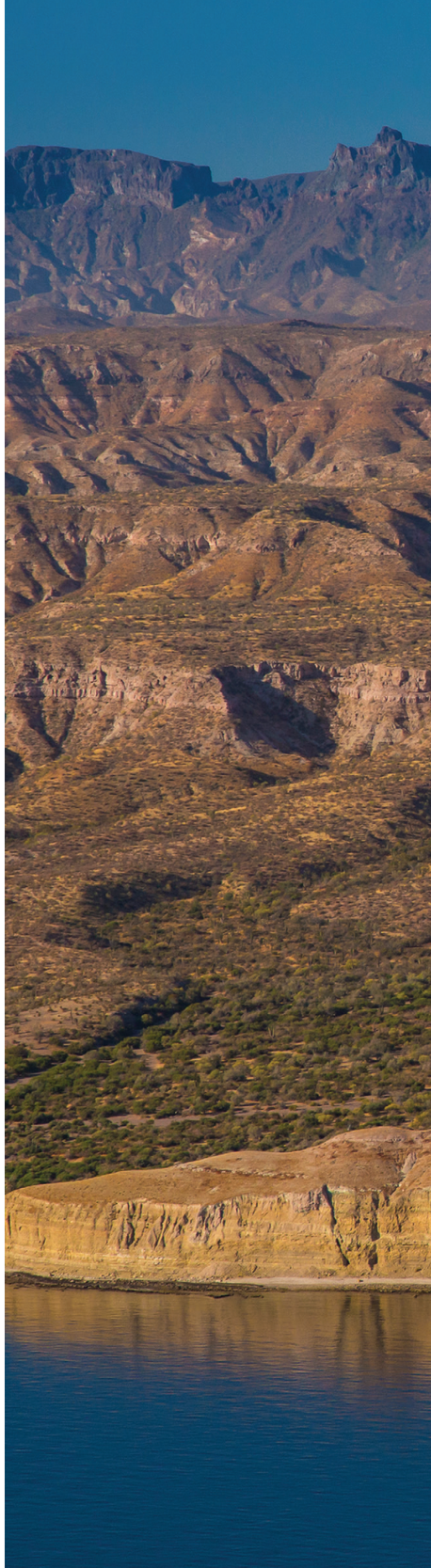
- Upper Gulf
- Midriff Islands
- Mid Peninsula (Bahía de Los Ángeles to Loreto)
- Lower Coastal Sonora and/or Sinaloa (Guaymas and south)
- Lower Coastal Peninsula (Loreto and south)
- Lower Gulf (in Gulf south of Midriff Islands)

The goal of the survey was to:

1. Establish a metadatabase of what long-term studies exist in the Gulf of California (see Participating Researchers and Studies table on page 38).
2. Identify trends across a wide variety of taxonomic groups and studies.
3. Use this information to develop this report to communicate general ecological trends.

The survey had three sections, (1) Researchers, (2) Studies, (3) Trends. In the first section we collected basic data about the scientists, their affiliation, collaborators, and data curation. The Studies section was the core of the survey and is where the scientists shared their work, what taxa were focused on, where, and for how long they have been doing the research. A researcher can enter multiple studies. The final section is where researchers entered the trends they may be observing for each of their studies.

A total of 32 researchers submitted information on 41 studies during the survey period. Not all studies submitted trend information, in those cases, the trends were marked as undetermined. The data submitted is the source information used for this assessment.



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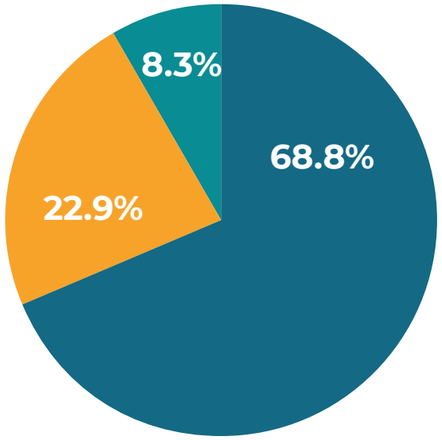
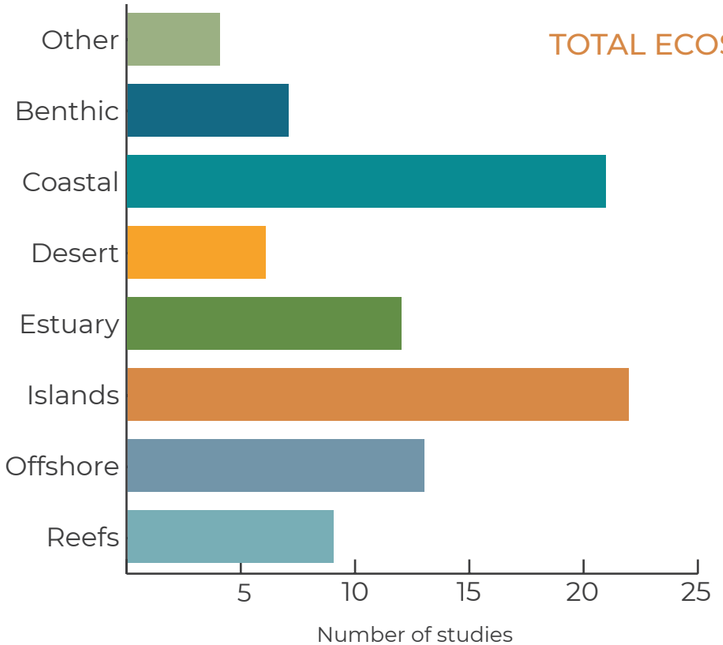
By the Numbers

REGION/BIOME



Marine
Terrestrial
Land-Sea Connections

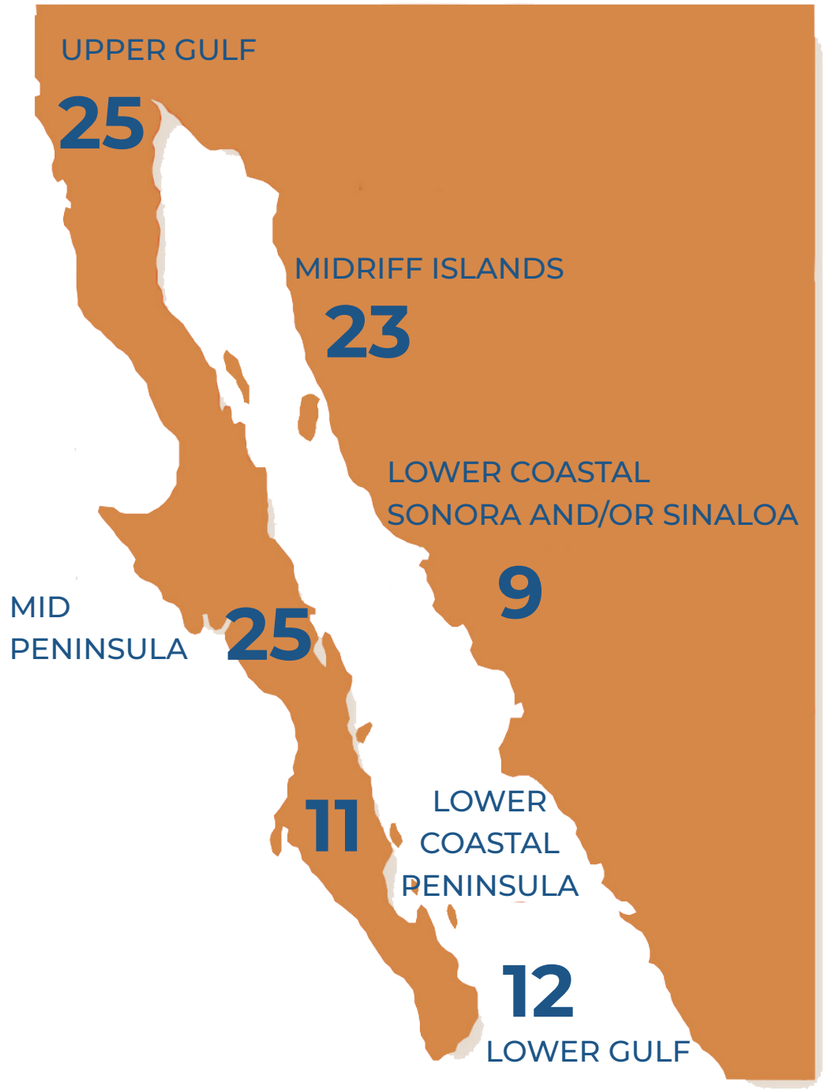
ECOSYSTEM



TOTAL ECOSYSTEMS: 90

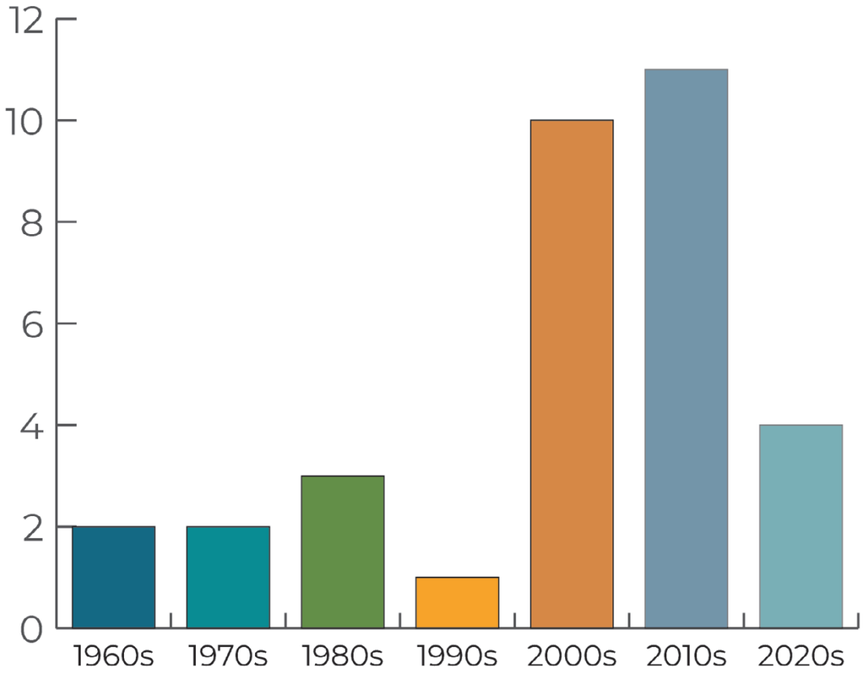
REGIONS OF THE GULF

THE NUMBER OF STUDIES IN THE DIFFERENT REGIONS OF THE GULF OF CALIFORNIA

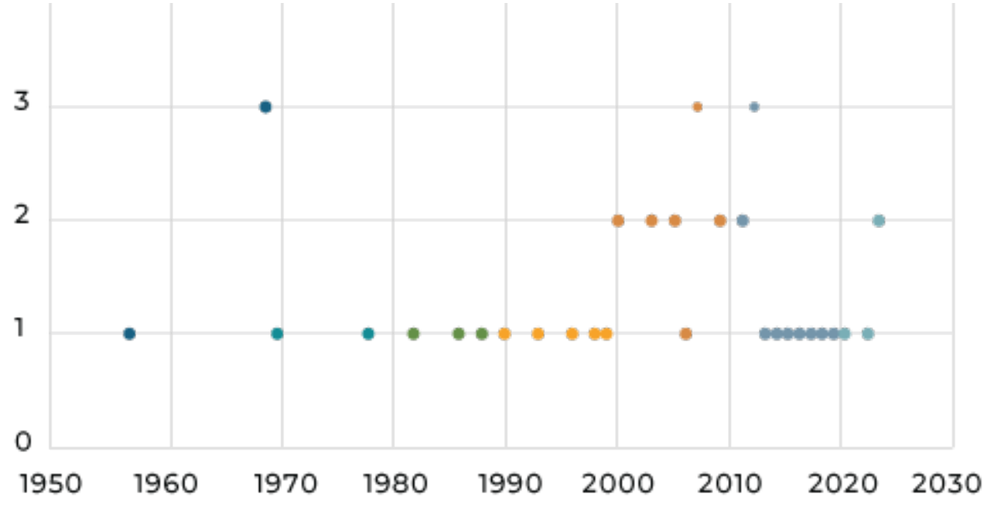


STUDY PERIODS

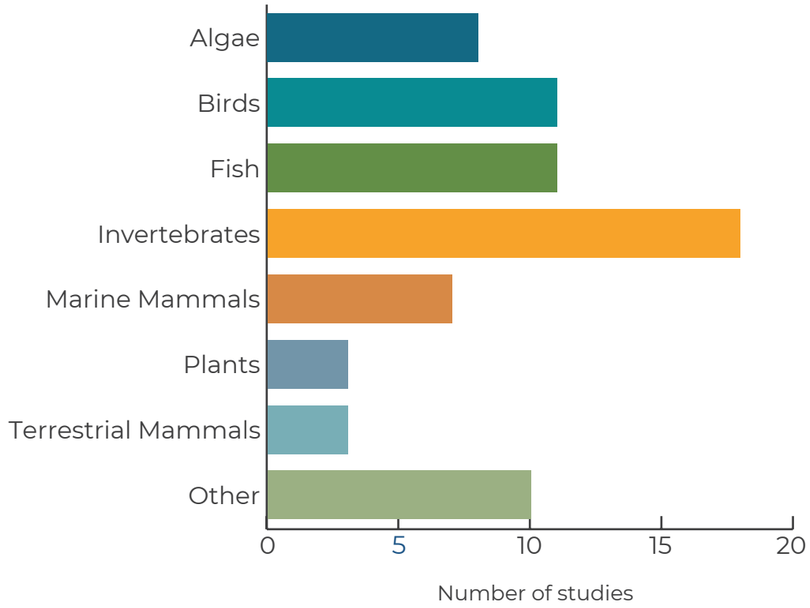
NUMBER OF STUDIES INITIATED PER DECADE



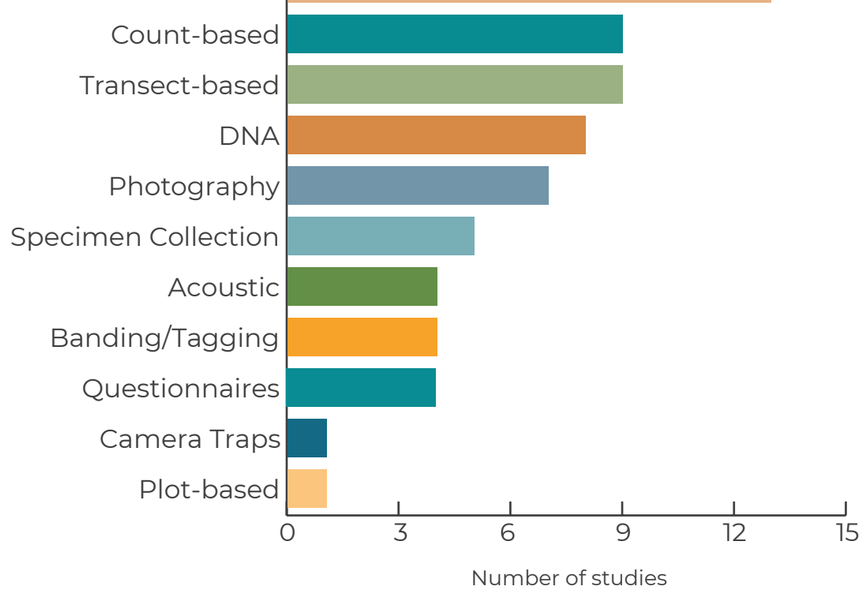
NUMBER OF STUDIES BY START YEAR



TAXONOMIC GROUPS



METHODS



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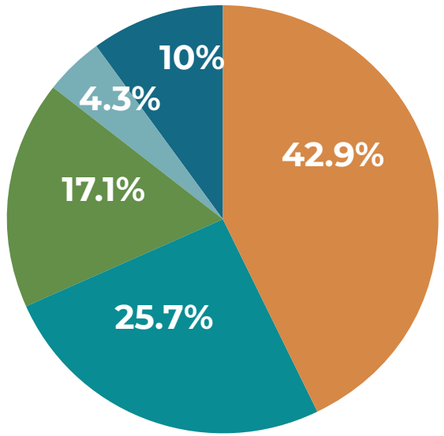

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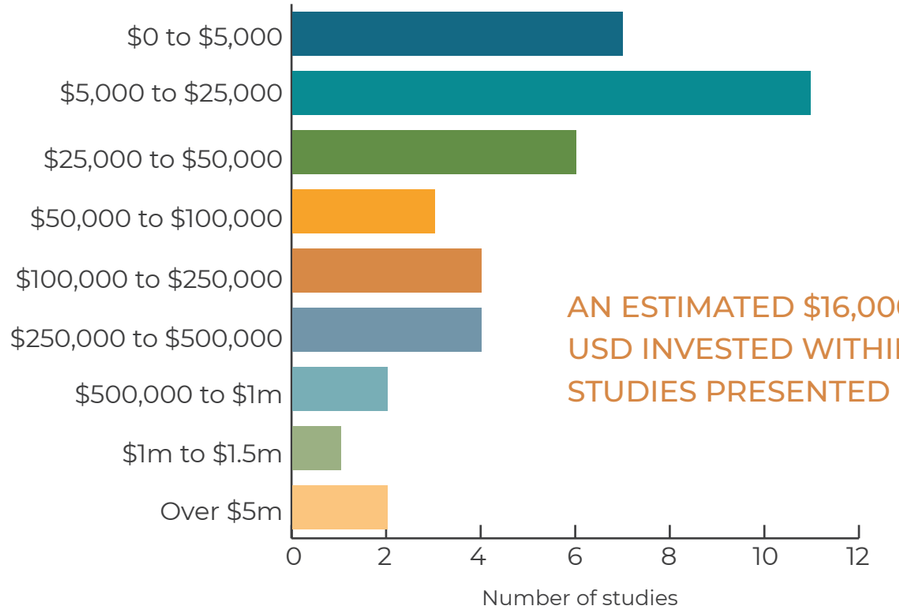
TOTAL FINANCIAL INVESTMENT



AN ESTIMATED $16,000,000 USD INVESTED WITHIN THE 41 STUDIES PRESENTED HERE.

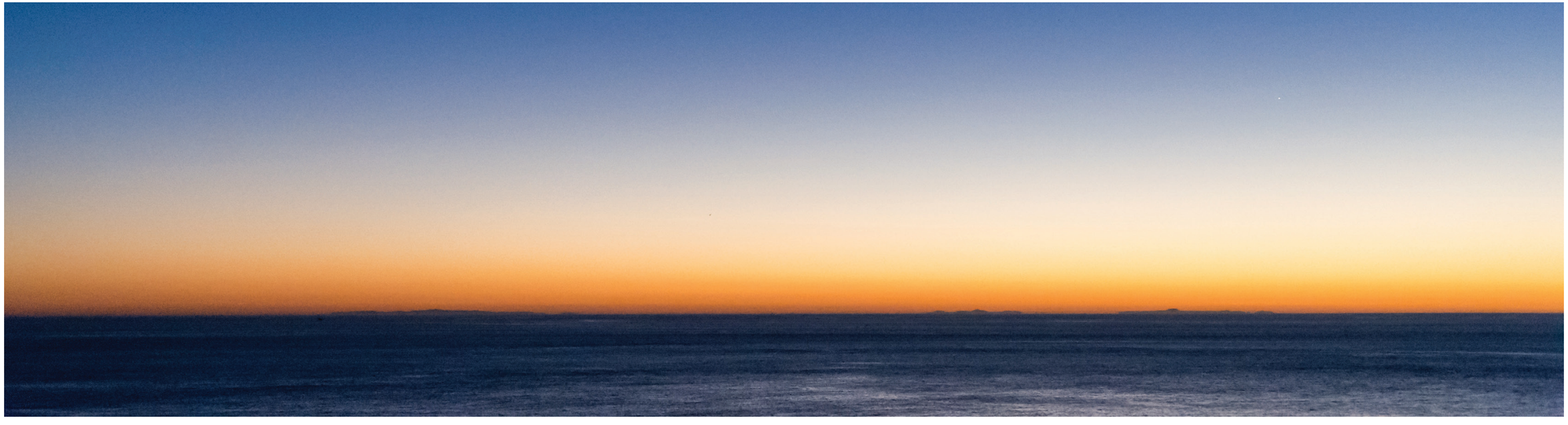
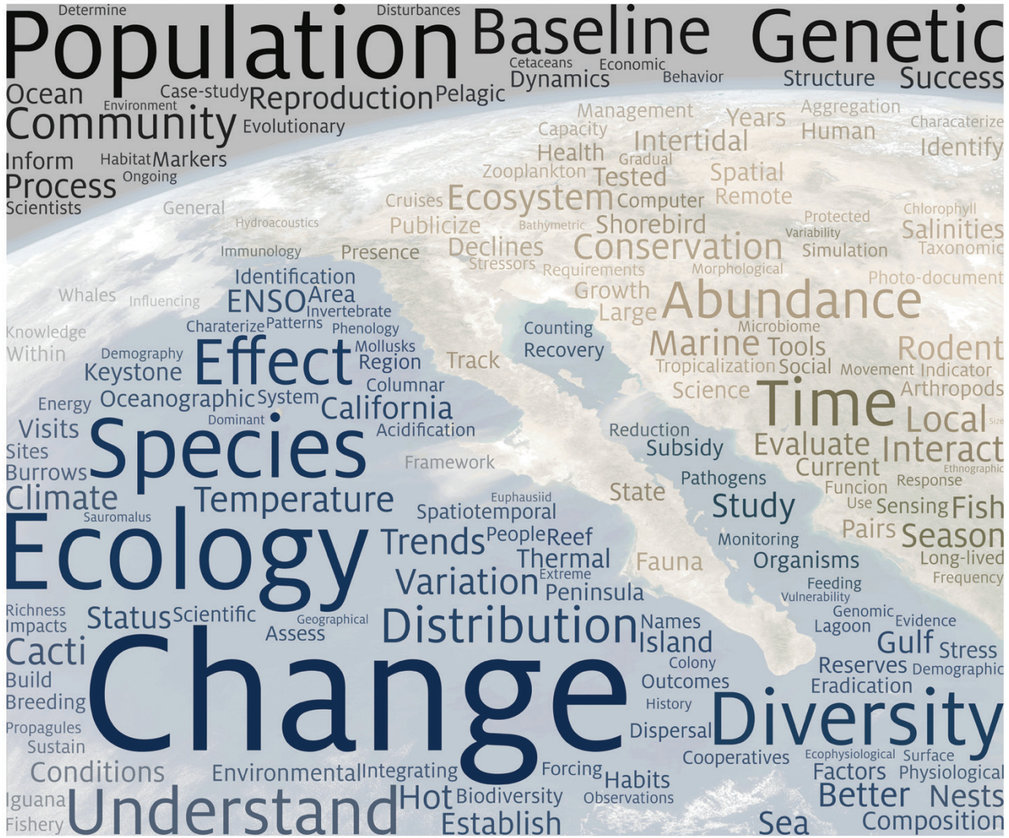


Photo by: John (Verm) Sherman

Goals of Studies



Each of the contributing studies have their own goals, methods, timeframe, and areas of focus. Nonetheless, as long-term studies focused in the Gulf of California, there are many areas of overlap. All contributors gave responses to the question, “In 250 words or less, Please describe the ecological processes you are investigating in this study.” These responses were edited to focus on goal statements and generated into this word cloud.

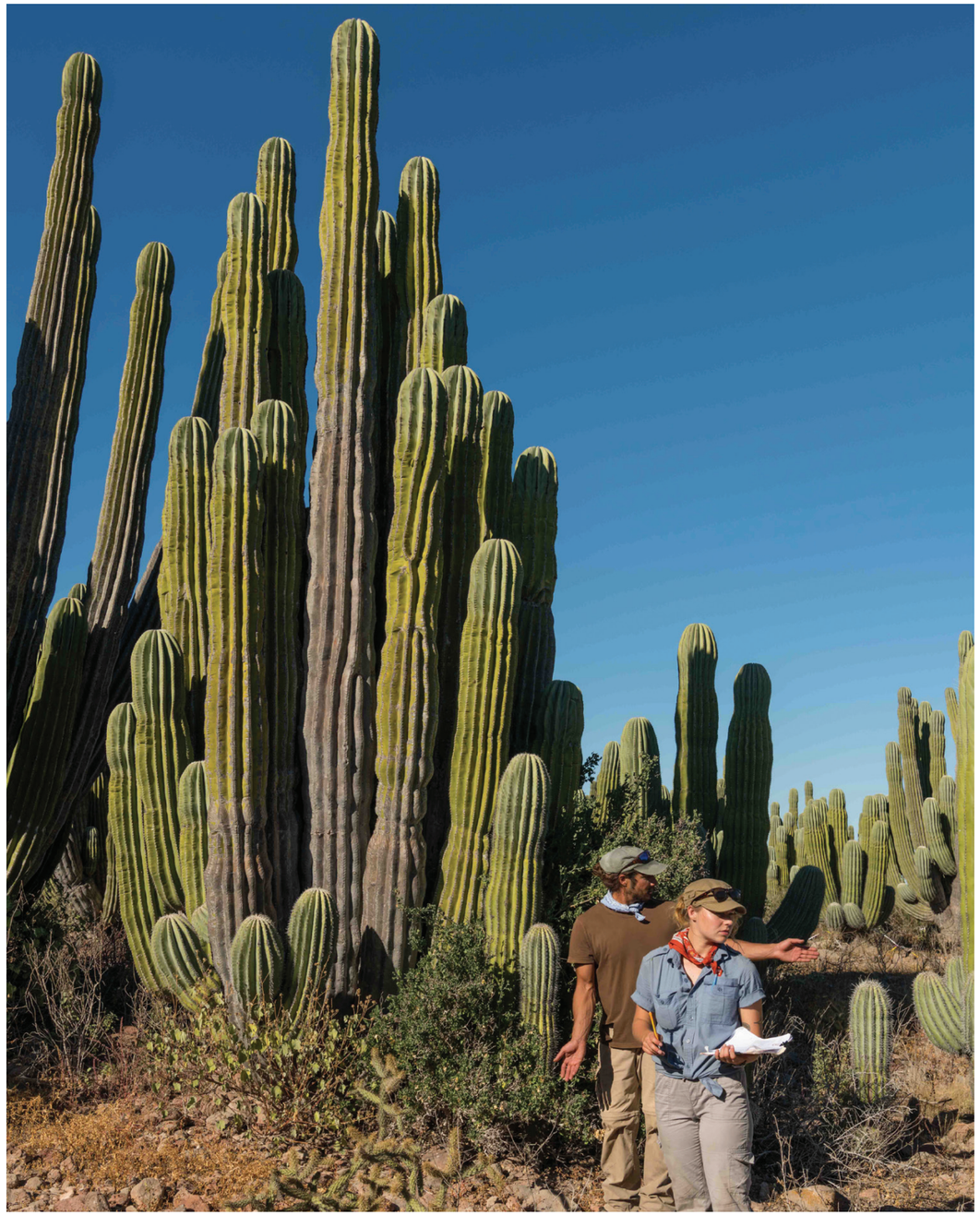


Photo by: John (Verm) Sherman

Long-term Study Species and Trends

Note: This report is based on studies submitted through an open survey. There are some long-term Gulf of California studies missing, which we hope to incorporate in future iterations.

TREND

- Undetermined
- Improving
- Stable
- Degrading
- Rapidly Degrading

YEAR

Years shown indicate when the studies were initiated.

STUDY NUMBER

Study number indicated in **[ ]** corresponds to the table at the end of the report.

Hermit Crab
Barnacles
Gulf Sun Star
Sea Snail
TIDE POOL
44 species of intertidal flora and fauna
1982 [37]

Middling Thread Herring
Bonefish
Round Stingray
77 species of fish and 33 species of invertebrates
2007, 2005 [25, 26]

150 Mollusk Species
1990 [27]

California Brown Pelican
1969 [1]

Sea Stars
1978 [29]

Fin Whale
2003 [22]

Cormorant
2000 [38]

Mexican Giant Cardón
2007 [41]

Heermann's Gull
2011 [35]

Piebald Chuckwalla
2023 [32]

Pacific Oyster
2023 [19]

Osprey
1969 [2]

Tenebrionid Beetles
1988 [36]

California Sea Lion
2011 [14]

Elegant Tern
2019 [23]

Craveri's Murrelet
2018 [37]

Green Sea Turtle
2017 [12]

Warrior Swimming Crab
1986 [9]

Whales and Dolphins
2009 [30, 31]

More than 60 Species of Invertebrates and 90 of Fish
2007 - 2012 [10]

Copepods
Zooplankton
Fish Larvae
Krill
1957 [18]

Over 20,000 operational taxonomic units from 50+ phyla have been identified
2016 [28]

Least Tern
Wilson's Plover
Snow Plover
2006 [11]

Blue Whale
1993 [16]

Fish-Eating Bat
2003 [15]

Holaxonia
Echinoderms
Hexacorallia
1998 [13]

Hawksbill Turtle
2014 [24]

259 Species of Fish
1999 [21]

Jumbo Squid
2012 [33]

What We Know

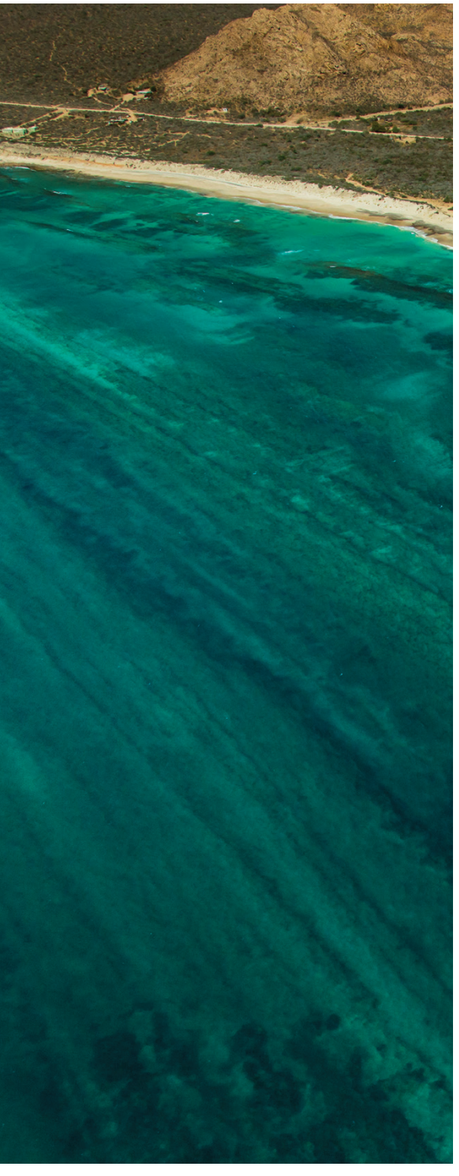


Photo by: Ralph Lee Hopkins - with aerial support by LightHawk

For select marine and terrestrial species with completed trend information, summaries are presented below. These overviews are derived from the individual study entries.

GENERAL OVERVIEW

Biodiversity & Conservation (throughout Gulf of California)

| Stable

Rick Brusca

Rick Brusca shares, “Over my past 50 years of working in the Gulf, my general impression is that the region remains environmentally quite healthy. The biggest issues, both correctable (in theory) are unsustainable fishing and localized anthropogenic-influenced runoff to the sea (creating low-oxygen regions). It remains to be seen if ocean warming impacts the Gulf. Key reasons why the Gulf remains quite healthy are: influence of Mexican civil society organizations and academics, extreme tidal flushing from the open Pacific, long stretches of minimally inhabited coastline on both the east and west shores of the Gulf.

I do not know of a single species that has gone extinct in the Gulf of California. Of those that have been impacted (by overharvesting), nearly all have significant refugial populations somewhere in the Gulf. Even the most threatened species, the vaquita porpoise, now has a glimmer of hope with the further emplacement of benthic “hook devices” that are keeping the totoaba fishers out of the area.”

Marine biodiversity of eukaryotes (animals, plants, and any living species with nucleus and organelles inside its cells) (throughout Gulf of California)

| Undetermined

Adrian Munguia-Vega

Diversity levels in the Gulf of California estimated with novel environmental DNA techniques are orders of magnitude higher than previously estimated. Diversity levels from the mesophotic (-30 to -200m), mesopelagic (-200 to -1,000 m) and the deep sea are equal or even higher than in shallow coastal areas (0 to -30 m), although the communities themselves are quite distinct. This trend is more related to the lack of information from deep areas of the Gulf as opposed to any environmental impact. Tropicalization (i.e., warmer temperatures changing species composition) of the Central Gulf of California and changes in latitudinal and bathymetric distribution of multiple species are observed but seem transient. These warming induced events do shift ecological communities and local food webs. The effects in heavily impacted sites by human activities (pollution, overfishing, habitat loss, and fragmentation) are more long-lived but still reversible if stressors are mitigated. Since the dataset is still less than a decade, it is hard to say if some of the trends represent interannual or long-term trends. Overall reductions observed range from 20–40% lower compared to baselines from less impacted sites (Cerrillo-Espinosa et al. 2024; Mac Loughlin et al. 2024). This is a work in progress...

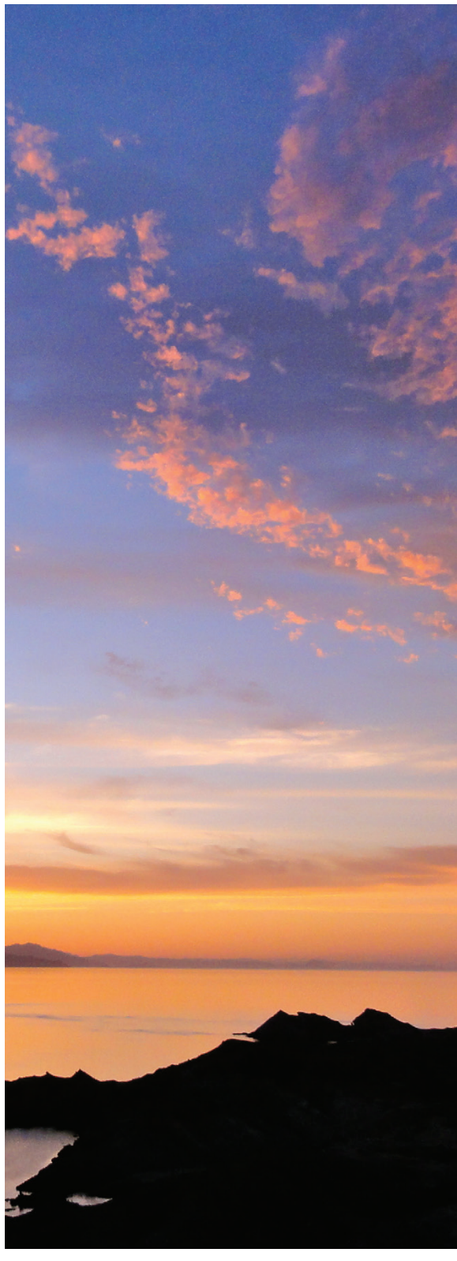


Photo by: Benjamin T. Wilder

Photo: Benjamin T. Wilder

PRIMARY PRODUCTIVITY

Zooplankton, krill (euphausiids), copepods, (Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa)

| Stable

Jaime Gómez Gutiérrez

The Gulf of California has shown notable ecosystem changes due to prolonged periods of anomalous warming events during the last decades, evidenced by the declining trend in the population size of several species of megafauna. These changes have been partially attributed to a hypothetical decline in abundance and changes in the plankton community structure in the epipelagic (surface to -100 m) ecosystem related to a progressive increase in sea water temperature. The moving average of monthly sea surface temperature (SST) anomalies between 1854–2023 indicate an increasing trend from 1956-to-present. Moreover, the moving average of SST anomalies between 1956 and 2023 shows an increase from 1990 to 2023, indicating prolonged warming trends in the Gulf of California.

We investigated whether there is evidence of a long-term decline in the zooplankton volume and euphausiid (planktonic shrimplike marine crustaceans) abundance over the last six decades (1957–2019). The baseline of this study were the four oceanographic cruises carried out by Scripps Institution Oceanography (SIO) (Dr. Edward Brinton) in the Gulf of California during February, April, May, and August 1957. They are the most comprehensive zooplankton cruises carried out in the Gulf of California. That data set was kindly shared with us by Dr. Mark Ohman (SIO-University of California San Diego). The publication of these four cruises was published in Brinton and Townsend (1980).

The euphausiids contributed up to 15% of the total zooplankton abundance in the Gulf of California, numerically dominated by copepods (planktonic crustaceans) and chaetognaths (planktonic worms). The zooplankton volume (54 cruises) and euphausiid abundance (44 cruises) recorded between 1957 and 2019 showed that daytime–nighttime scales and seasonal (cold–warm) were the main modes of temporal variability. Contrary to our expectations, latitudinal gradients were statistically insignificant. The highest median zooplankton volume and euphausiid abundance was recorded during the cold season (December–June) based on nighttime samples. The decadal comparison of the euphausiid abundance, after removing the seasonal and daytime–nighttime variability, showed an insignificant decline during the last six decades, suggesting resilience of the euphausiid community in the Gulf of California, numerically dominated by *Nyctiphanes simplex* (85.3%) and *Hansarsia difficilis* (6.8%), despite a long-term increase in SST.

We rejected the hypothesis of an impoverishment of the euphausiid abundance in the Gulf of California during the last six decades. However, the zooplankton volume recorded during the diurnal cold season showed a slight, but significant decrease during the last two decades; it was the period with lowest zooplankton volume recorded during the last 60 years. This means that overall, euphausiids were resilient to multi-decadal sea surface warming observed during the last six decades, while zooplankton volume was not. Euphasiid abundance has a non-significant inter-decadal change when combining all data results, as they experience a slight decline in abundance during the cold

Photo by: Ramiro Arcos Aguilar

Photo by: John (Verm) Sherman

Photos by (top to bottom):
Benjamin T. Wilder

season, and an increase during the warm season. This means that changes between cold and warm seasons have decreased from 1950 to present in the Gulf of California.

Macrofauna populations have shown remarkable sensitivity to these prolonged periods of anomalous warming, such as the approximately 65% population decline in 12 of the 13 breeding colonies of Sea Lions (*Zalophus californianus*) between 1978 and 2019 in the Gulf of California (Adame et al., 2020). A study of sighting histories using mark-recapture models showed a population decline of Blue Whales (*Balaenoptera musculus*) from 1985 to 2019 in the Gulf of California likely indicating Blue Whales' decline in usage of the Gulf of California (Whittome, et al. 2024). Paradoxically, our evidence of zooplankton volume and euphausiid biomass medians collected during the last six decades do not show a clear declining trend of those variables. We actually hypothesized a median declining trend of zooplankton volume and euphausiid abundance due to global warming. However, we have evidence that the median has not significantly changed since 1957 to present after accounting for day-night and thermal seasonal natural variability. We think these variables remain overall stable during the last six decades.

MARINE MEGAFAUNA

Whales and Dolphins (Midriff Islands)

| Rapidly Degrading

Héctor Pérez Puig

In ongoing studies that include regular cetacean monitoring surveys in the Midriff Island Region, there has been a general and marked decrease in the number of cetacean sightings over the past eight years. This includes sightings of Fin Whales (*Balaenoptera physalus*), Bryde's Whales (*Balaenoptera edeni*), and Common Dolphins (*Delphinus delphis*). In addition, group size of common dolphins has generally decreased. Since 2015, Sperm Whales (*Physeter macrocephalus*) and Short-finned Pilot Whales (*Globicephala macrorhynchus*), both previously abundant in the region, have effectively disappeared due to the population collapse of their prey species, the Humboldt Squid (*Dosidicus gigas*) in the Midriff region and throughout the Gulf of California. Another disturbing trend is the increased observation of emaciated individuals in most cetacean species observed; most notably in Blue Whales (*Balaenoptera musculus*) and Bottlenose Dolphins (*Tursiops truncatus*).

Cetaceans (Canal de las Ballenas)

| Undetermined

Gisela Heckel

This two-year study recorded a slight decrease in Fin Whale (*Balaenoptera physalus*) abundance, which was attributed to a weak El Niño during those years.

Hawksbill Sea Turtle (*Eretmochelys imbricata*) (Lower Coastal Peninsula and Lower Gulf)

| Improving

Lourdes Martinez Estevez

Mangroves are a particularly important feeding habitat for Hawksbill Sea Turtles as they provide a greater quantity and diversity of food and shelter to juveniles and adults.

Photos by: Benjamin T. Wilder

Photo by: Glenn Thompson

Fishing refuges have turned out to be a positive strategy for the conservation of these sea turtles (greater number of individuals identified). Hawksbills have very restricted ranges and high fidelity to their habitats. This presents a great opportunity for their conservation, and at the same time a great threat if the habitats on which they depend on are degraded. The marine habitats on the islands are very important for Hawksbill Turtles since the isolation with the peninsula provides them with additional protection. Hawksbill Turtles, despite being rarer than other sea turtle species, are recovering. However, this recovery depends strongly on coastal fishing activities, surveillance, and the state of mangroves and reefs. The recovery is not the same throughout the Gulf of California and are still far from the species being no longer in danger of extinction.

Fish-eating Bat (*Myotis vivesi*) (throughout Gulf of California)

| Stable

José Juan Flores Martínez

This work is primarily extending baseline information on this species. The Fish-eating Bat (*Myotis vivesi*) has been recorded on 36 islands (17 are new reports) with maternity roosts on 19. A primary roost on Isla Partida Norte was estimated to have a population of ca. 30,000 individuals in 2003. In general the populations of this species do not show evidence of decrease, though it is considered vulnerable due to the location of their populations easily being degraded by human activities.

California Sea Lion (*Zalophus californianus*) (Islas San Pedro Nolasco, San Pedro Mártir, Isla San Esteban, and San Jorge)

| Stable

Ana Luisa Rosa Figueroa Carranza and Jesús Ventura Trejo

The number of individuals has fluctuated between 50 and 150 individuals since 2011. The trends seem to have a relationship with oceanographic phenomena.

MARINE INVERTEBRATES AND FISH

Rocky reef communities (Lower Gulf)

| Rapidly degrading (Echinoderms, *Hexacorallia*, *Holaxonia*), Degrading (fish)

Fabio Favoretto and Benigno G. Guerrero M.

In Favoretto et al. (2022), we show how a known ecological boundary underwent a northward shift of 1.5° latitude because of an average 1°C gradual warming over the last decade (2010–2020) and extreme marine heatwaves that were threefold more frequent. Such a shift homogenized environmental conditions and reconfigured rocky reef communities that can best be described as tropicalization. Species with tropical affinities tend to increase within the Gulf, whereas species with temperate affinities tend to decrease.

Invertebrates recorded a 35% decrease in overall abundance and cold-water corals are decreasing both in richness and abundance. Conversely, we are observing an

Photos by: John (Verm) Sherman

increase in species with subtropical-tropical affinities like stony corals with warm water affinities (e.g. *Pocillpora* or *Porites*, which is increasing in abundance northward) with a reduction of cold-water species during the last El Niño.

The fish community shows a 43% net decrease in richness since 2010. In 2016 and thereafter, a slow recovery is observed. This trend is observed for both commercially important and non-commercial species, suggesting that this decrease is not associated with fishing effort. A 17% decrease in richness is observed after 2010, while the average biomass was 1.29 tons per hectare, compared to the expected average of 2.28 tons per hectare. The effect of warming was significant (p=0.001), explaining up to a 43% loss in biomass (0.99 tons per hectare).

90 taxa of fish and 60 taxa of invertebrates (Isla San Pedro Mártir)

| Stable (Fish), Degrading (Invertebrates)

Comunidad y Biodiversidad, A.C.

For San Pedro Mártir Island, results indicate a general decrease in invertebrate richness over time, while fish display a fluctuation over the years. It is also observed that the diversity values of invertebrates in 2022 are higher than those of the first 5 years (2007–2012) of monitoring, while for fish, the values are higher in the first two years.

The commercially important invertebrates species, Sea Cucumber (*Isostichopus fuscus*) and Spiny Oyster (*Spondylus limbatus*) are decreasing. However, the Leopard Grouper (*Mycteroperca rosacea*) and Yellow Snapper (*Lutjanus argentiventris*) present stable abundances and average sizes increased between 2007 and 2017.

Photos by: Michael Ready

Humboldt Squid (*Dosidicus gigas*) (Lower Gulf)

| Degrading

Carlos Robinson

This project researched the dynamics of the pelagic ecosystem of the Gulf of California over the past 15 years. In October 2012, extreme anomalous oceanographic conditions were encountered in the Gulf. We observed increases in sea temperature and low chlorophyll concentrations never seen before. The most evident anomaly was the extreme reduction in the coat length of mature squids, from 80 cm to 20 cm. The Gulf of California has had an important change in the oceanography and biology, due to a significant drop in the strength of the spring winds that have reduced upwelling intensity. The effect of this warming and nutrient impoverishment of the Gulf has been particularly evident in the Humboldt Squid. This species supported an important fishery in the area for many years – however, this activity no longer exists with the subsequent loss of hundreds of jobs. This anomalous period of low winds, high temperature, and low productivity continues to this day. The next step in the research is to know what effects it may have or has had on other oceanographic processes, fisheries, and components of the pelagic ecosystem of the Gulf of California.

Mollusks as used and known by the Seri people (Midriff Islands, Upper Gulf)

| Degrading

Cathy Moser Marlett

The Comcaac (Seri People) have historically lived tied to the desert and sea worlds, which were intimately known, as their

Photo by: John (Verm) Sherman

Photo by: Benjamin T. Wilder

Photo by: John (Verm) Sherman

lives depended on that knowledge. Today, newer generations are losing the Seri language, which is directly tied to a huge loss of knowledge of the natural world, reflected in loss of terminology. I have found that few Seri children can identify marine mollusks (or their uses) by their Seri names, and their use as household food has decreased significantly. From general observation, the use of marine mollusks mainly involves their sale to commercial purchasers, specifically meat from Pen Shells (*Atrina maura*, *A. tuberculosa*) and the Pink Murex snail (*Hexaplex erythrostomus*), with occasional sale of clams to individuals rather than commercial buyers. From the extensive piles of murex shells around El Desemboque de los Seris, Punta Chueca, and Bahía de Kino, it is evident to me that there is serious overfishing happening, but I have not investigated this except for some spontaneous conversations.

Gulf Sun Star (*Heliaster kubinijii*) (Upper Gulf and Midriff Islands)

| Degrading

Edward H Boyer

There was a large *Heliaster* population crash in 1979–80, some areas of recovery but not in all areas where it was formerly abundant. Recovery has been spotty and indicates continued sensitivity to sea surface temperatures. In other studies on various intertidal invertebrates one finding is the decline in large, predatory gastropods such as *Murex* and other similar species that are subject to human collection. A similar trend is seen in octopuses – across different species, all seem to be less abundant. In the case of *Heliaster*, following the initial crash, there was a decline of 90% or more in abundance in many study sites.

Warrior Swimming Crab (*Callinectes bellicosus*) (throughout Gulf of California)

| Degrading (Guaymas to Yavaros), Stable (Bahía de Kino), Stable (Upper Gulf)

Miguel Á. Cisneros-Mata

Overall per capita productivity fell in the 1990s and is recovering in recent years. The crab in Sonora has a metapopulation structure: sink in the Upper Gulf and source in southern Sonora. This is important for fisheries management.

MEGAFLORA

Cardón (*Pachycereus pringlei*) (Isla San Pedro Mártir)

| Improving

Benjamin T. Wilder

Since the first data point in 2007, this population of cardón cacti has been one of the most healthy measured throughout its range as indicated by regeneration index (number of individuals below 1 m in height) of two-thirds and a density of 3,183 plants /ha, compared to an average of 151 plants/ha in Baja California and 59 plants/ha in Sonora. These data points have stayed consistent on the island across sampling periods (2007, 2012, 2017, 2022). In addition, repeat photos show healthy growth of the plants, though there are fluctuations in growth rate between periods. On the island the plants grow out (put on new arms), rather than up after a height of ca. 5 m. The demographic trend in general is that of a healthy and expanding population.

Photo by: John (Verm) Sherman

Photo by: John (Verm) Sherman

Photo by: Alan Harper

SEABIRDS AND SHOREBIRDS

Double-crested Cormorant (*Nannopterum auritum*) (Isla Alcatraz)

| Degrading

Waterbird Monitoring Program, Prescott College Kino Bay Center

There is a clear pattern of fewer nests (2010–11, 1,968 nests and in 2023–24, 622, with very low numbers in 2013–2015) and fewer individuals fledging (2018–19, 56% fledging success, 2021–22, 28% success). There are also fewer chicks per nest.

Craveri's Murrelet (*Synthliboramphus craveri*) (Islas Alcatraz and San Pedro Mártir)

| Stable

Waterbird Monitoring Program, Prescott College Kino Bay Center

The number of nests and productivity of this species has been consistent on Alcatraz Island and is recovering on Isla San Pedro Mártir.

Brown Pelican (*Pelecanus occidentalis*) (Isla Alcatraz)

| Degrading

Waterbird Monitoring Program, Prescott College Kino Bay Center

The number of Brown Pelican nests has varied over the years on Isla Alcatraz. In the early years of the study from 2005 to 2010 the highest number of nests was recorded in 2007–2008 with 1,367 nests. Thereafter, this number decreased until in 2013, after which there was no nesting for three consecutive years. In 2016–2017 the colony returned and has remained relatively stable since then, with a slight increase in the last three years 2021, 2022 and 2023. In 2024, the productivity of the colony declined drastically.

Brown Pelican (*Pelecanus occidentalis*) (throughout Gulf of California)

| Degrading

Daniel W. Anderson

There was an extensive breeding collapse in 2014 related to the anomalous BLOB of warm water in the Eastern Pacific. There has been gradual recovery, especially since 2019. The gradual recovery of Gulf of California breeding populations is speculated to most closely be related to commercial fisheries competition (bycatch and food depletion).

Osprey (*Pandion haliaeetus*) (throughout Gulf of California)

| Stable

Daniel W. Anderson

Osprey have undergone a major shift in the last three to four decades from nesting on natural substrates to nesting on various electrical and other power poles and towers, and their numbers are apparently stable.

Snowy Plover (*Anarhynchus nivosus*) (Lower Coastal Sonora and/or Sinaloa)

| Degrading

Medardo Cruz-López

During the 19 years that the study has been carried out, we have witnessed the degradation of the habitat of the

Photo by: John (Verm) Sherman

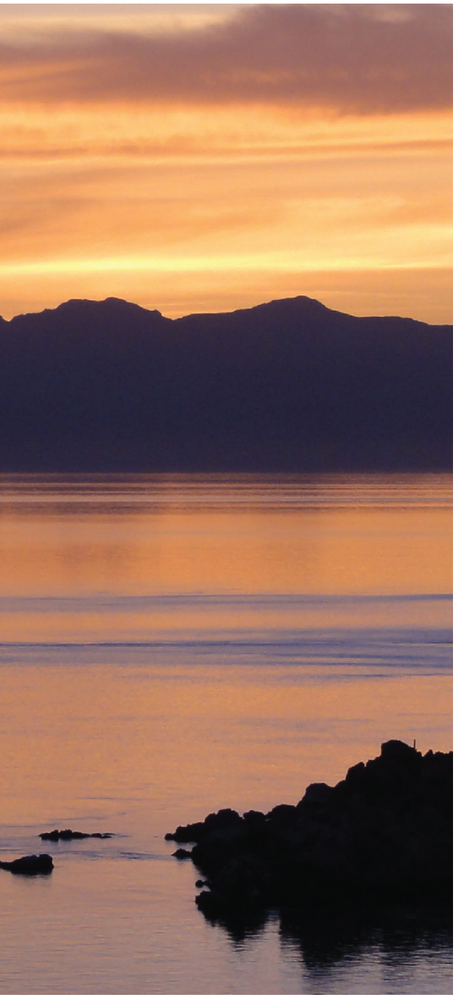


Photo: Benjamin T. Wilder

Bahía de Cueta, Sinaloa. In particular, a series of ponds that were used for salt production (180 hectares) have silted up, affecting the hydrology of the site. These ponds are used by hundreds of shorebirds during migration (autumn and spring) and due to the low availability of water during these periods, the presence of shorebirds has decreased considerably. We have documented an average decline of 27% in the number of shorebirds using the ponds at the Antigua Salina de Ceuta. Breeding numbers have also declined. For example, we observed declines of around 60% in Snowy Plover breeding birds. Similarly, other species that breed at the site have declined in numbers (Wilson's Plover, *Anarhynchus wilsonia*; Killdeer, *Charadrius vociferus*; Black-necked Stilt, *Himantopus mexicanus*; Least Tern, *Sternula antillarum*), but detailed analyses of these changes have not been undertaken.

A similar response is occurring during reproduction (April to July), where conditions change in a few weeks (high rates of water evaporation), affecting the nestlings in extremely dry years. In addition, the sedimentation of the tidal water inlet channel has allowed the establishment of mangroves that has resulted in the loss of a considerable area that was used for nesting by at least four species of shorebirds and one seabird.

PATHOGENS

Various taxa (Upper Gulf, Mid Peninsula (Bahía de Los Ángeles to Loreto), and Lower Gulf (in Gulf south of Midriff Islands)

| Undetermined

Ricardo Rodríguez Medina

This work has provided initial baseline information. An increase is observed in the number of publications referring to pathogen-host studies in the Midriff Island region during the last three years. The reported and refined information shows 451 records of pathogens on the islands, classified into 85 genera. Through an exhaustive bibliographic review, covering the period 2000 to 2021, 451 records of pathogenic agents georeferenced to the Gulf of California region were identified: 66.16% of the records correspond to bacteria, 19.73% to ecto/endoparasites, 11.90% to viruses and 2.21% to protozoans. Of the total records, 387 indicate the host species in which they were identified, with 12 host genera reported (7 mammals, 3 birds and 2 reptiles). The pathogenic agents are taxonomically distributed in 85 genera, of which 60 have been identified with zoonotic potential.

Photo by: Servando López

Participating Researchers and Studies

STUDY #	NAME	STUDY	TAXA	YEAR INITIATED	STATUS	REGION(S)	TREND
1	Daniel W. Anderson	Ecology and conservation of the California Brown Pelican	California Brown Pelican (*Pelecanus occidentalis californicus*)	1969	ongoing	Upper Gulf, Mid Peninsula, Lower Gulf	Degrading
2	Daniel W. Anderson	Ecology and conservation of the Osprey	Osprey (*Pandion haliaeetus*)	1969	ongoing	Upper Gulf, Mid Peninsula, Lower Gulf	Stable
3	Xavier Basurto	National diagnostic of fishing organizations	All commercially caught marine species are relevant here.	2015	ongoing	Upper Gulf, Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa, Lower Coastal Peninsula, Lower Gulf	Undetermined
4	Xavier Basurto	The social effects of marine protected areas	Our study affects all marine species in marine protected areas (upper Gulf, Loreto, Espiritu Santo, Cabo Pulmo) in the Gulf of California	2013	2016	Upper Gulf, Mid Peninsula, Lower Coastal Peninsula	Undetermined
5	Xavier Basurto	Adaptive capacity and sustainability of self-governed fishing organizations	All commercially harvested species in the western shore of Baja California Sur	2000	2024	Lower Coastal Peninsula	Undetermined
6	Edward H. Boyer	Intertidal ecology	Gulf Sun Star (*Heliaster kubinijii*), and dozens of other species of marine intertidal invertebrates	Earliest part was early 1970s, most recent data sets from early 1990s	ongoing	Upper Gulf, Midriff Islands	Degrading
7	Richard C. Brusca	Biodiversity & conservation in the Sea of Cortés	All marine species in the Gulf of California	1969	ongoing	Upper Gulf, Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa, Lower Coastal Peninsula, Lower Gulf	Stable
8	Alberto Búrquez	Ecology and biogeography of columnar cacti	Pachycereeae, Flora and vegetation	2012	ongoing	Midriff Islands, Lower Coastal Sonora and/or Sinaloa, Mid Peninsula	Undetermined
9	Miguel Á. Cisneros-Mata	Warrior Swimming Crab fishery in Sonora	Warrior Swimming Crab (*Callinectes bellicosus*)	1986	ongoing	Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa, Lower Coastal Peninsula, Lower Gulf	Degrading

STUDY #	NAME	STUDY	TAXA	YEAR INITIATED	STATUS	REGION(S)	TREND
10	Comunidad y Biodiversidad, A.C.	Underwater monitoring associated with marine reserves in the Gulf of California	During the monitoring, the diversity of species is recorded, with more than 60 species of invertebrates and 90 species of fish.	Isla San Pedro Nolasco (2011), Reserva de la Biosfera Isla San Pedro Mártir (2007), Puerto Libertad (2012), Parque Nacional Bahía de Loreto (2008). We have data from other sites in the Gulf of California, but the time series are no longer than three years.	Even though data collection has been discontinuous, through collaborations with protected natural areas, monitoring has continued in the mentioned sites.	Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa	Stable
11	Medardo Cruz-López	Breeding ecology of the Snowy Plover (*Anarhynchus nivosus*) at Ceuta Bay	Snowy Plover (*Anarhynchus nivosus*) Wilson's Plover (*Anarhynchus wilsonia*) Least tern (*Sternula antillarum*)	2006	ongoing	Lower Coastal Sonora and/or Sinaloa	Degrading
12	Michelle María Early Capistrán	Connecting the past with the present: Long-term assessment of Black Sea Turtle abundance in the Gulf of California.	East Pacific Green Turtle (*Chelonia mydas*)	2017	ended 2021	Mid Peninsula	Undetermined
13	Fabio Favoretto	Warming and marine heatwaves tropicalize rocky reefs communities in the Gulf of California	Echinoderms, Hexacorallia, Holaxonia	1998	ongoing	Lower Gulf	Rapidly Degrading
14	Ana Luisa Rosa Figueroa Carranza	California Sea Lion population trend monitoring off the coast of Sonora	California Sea Lion (*Zalophus californianus*)	2011	ongoing	Midriff Islands	Stable
15	José Juan Flores Martínez	Conservation of the Fishing Bat *Myotis vivesi*	Fish-eating Bat (*Myotis vivesi*)	2003	ongoing	Upper Gulf, Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa, Lower Coastal Peninsula, Lower Gulf	Stable
16	Diane Gendron	Long-term time series on Blue Whales in the southwest Gulf of California	Blue Whale (*Balaenoptera musculus*)	1993	ongoing	Lower Coastal Peninsula	Undetermined
17	Diane Gendron	Sperm Whales in the Gulf of California	Sperm Whale (*Physeter macrocephalus*)	1996	2012	Midriff Islands	Undetermined
18	Jaime Gómez Gutiérrez	Decadal trends of zooplankton volume and euphausiid abundance indicate zooplankton resilience in the Gulf of California (1957–2019)	Zooplankton, krill (euphausiids), copepods, fish larvae	1957	2022	Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa	Stable

STUDY #	NAME	STUDY	TAXA	YEAR INITIATED	STATUS	REGION(S)	TREND
19	Silvia Gómez Jiménez	Environmental variables of estuarine zones in northwestern Mexico and their impact on the ecophysiology of invertebrates	Pacific Oyster (*Crassostrea gigas*)	2023	ongoing	Midriff Islands	Undetermined
20	Silvia Gómez Jiménez	Photodocumentation of marine cetaceans in the region of the Midriff Islands	Fin Whale (*Balaenoptera physalus*), Humpbck Whale (*Megaptera novaeangliae*)	2022	ongoing	Midriff Islands	Undetermined
21	Benigno Gustavo Guerrero Martínez	Warming and marine heatwaves tropicalize rocky reefs communities in the Gulf of California	Fish, 259 species	1999	ongoing	Upper Gulf, Mid Peninsula, Lower Coastal Peninsula, Lower Gulf	Degrading
22	Gisela Heckel	Diversity and distribution of cetaceans in Ballenas Channel and Los Ángeles Bay: Fin Whale and euphausiid distribution	Fin whale (*Balaenoptera physalus*), Bryde's Whale (*Balaenoptera edeni*), Long-beaked Common Dolphin (*Delphinus delphis*), Bottlenose Dolphin (*Tursiops truncatus*), Risso's Dolphin (*Grampus griseus*), Euphausiids (*Nyctiphanes simplex*)	2003	2005	Midriff Islands	Undetermined
23	Misael Daniel Mancilla Morales	Microbiome in Seabirds from Isla Rasa, Gulf of Califronia	Heermann's Gull (*Larus heermanni*), Elegant Tern (*Thalasseus elegans*), Royal Tern (*Thalasseus maximus*)	2019	ongoing	Midriff Islands	Undetermined
24	Lourdes Martínez Estevez	Ecology and conservation of Hawksbill Sea Turtles in the Gulf of California, Mexico	Hawksbill Sea Turtle (*Eretmochelys imbricata*)	2014	ongoing	Lower Coastal Peninsula, Lower Gulf	Improving
25	Hem Nalini Morzaria-Luna	Fish community structure of two estuaries in the northern Gulf of California. Ensenada, B.C.	77 species of fish	2007	2011	Upper Gulf	Undetermined
26	Hem Nalini Morzaria-Luna	Benthic invertebrate community structure in coastal wetlands	33 species of invertebrates	2005	2006	Upper Gulf	Undetermined
27	Cathy Moser Marlett	Mollusks as used and known by the Seri people	More than 150 mollusk species are identified by Seri names, many having multiple names.	1990	ongoing	Midriff Islands, Upper Gulf	Degrading
28	Adrian Munguia-Vega	A 3D map of marine biodiversity of eukaryotes from the Gulf of California	Over 20,000 operational taxonomic units from 50+ phyla have been identified	2016	ongoing	Midriff Islands, Mid Peninsula, Lower Coastal Sonora and/or Sinaloa, Lower Coastal Peninsula, Lower Gulf	Undetermined
29	Peter Raimondi	Long term Intertidal Monitoring of the Intertidal in the Gulf of California	Sea Stars (*Heliaster*), many low to mid intertidal species	1978	intertidal monitoring stopped in 2009. *Heliaster* data are form 2020-2022	Upper Gulf	Undetermined

STUDY #	NAME	STUDY	TAXA	YEAR INITIATED	STATUS	REGION(S)	TREND
30	Héctor Pérez Puig	Cetacean richness and diversity in the Eastern Midriff Islands Region of the Gulf of California.	Whales and Dolphins	2009	ongoing	Midriff Islands	Degrading
31	Héctor Pérez Puig	Spatial and temporal distribution of cetaceans in the Eastern Midriff Islands Region in the Gulf	Whales and Dolphins	2009	ongoing	Midriff Islands	Rapidly Degrading
32	Melissa Plasman	The ultimate challenge to climate change: Extremophilic iguanas of the Sonoran Desert as a model for assessing the response of herbivorous island reptiles to an even warmer climate.	Piebald Chuckwalla (*Sauromalus varius*)	2023	ongoing	Midriff Islands	Undetermined
33	Carlos Robinson	Resilience of the ecosystems, fisheries and marine-based economy under a persistent anomalous warm and low-productivity regime in the Gulf of California	Humboldt Squid (*Dosidicus gigas*)	2012	ongoing	Lower Gulf	Degrading
34	Ricardo Rodríguez Medina	Analysis of the occurrence and pathogen-environment interaction in diseases of mammals, birds and reptiles of the Gulf of California islands.	12 species of mammals, birds, and reptiles	2020	2021	Upper Gulf, Mid Peninsula, Lower Gulf	Undetermined
35	Enrico A. Ruiz	Demographic history of Heermann's Gull *Larus heermanni* (Charadriiformes: Laridae) from late Quaternary to present: Effects of past climatic changes in the Gulf of California	Heermann's Gull (*Larus heermanni*)	2011	ongoing	Upper Gulf	Degrading
36	Drew M. Talley	Spatial Subsidy in Island Ecosystems	Tenebrionid beetles, Darkling Beetles	1988	ongoing	Mid Peninsula	Improving
37	Peggy J. Turk Boyer	Seasonal and long term trends in rocky intertidal flora and fauna, Puerto Penasco, Sonora	44 species of intertidal flora and fauna	1982	2000, with one transect done in 2012 and possibility of continuing	Upper Gulf	Undetermined
38	Waterbird Monitoring Program, Prescott College for Cultural and Ecological Studies	Double-crested Cormorant nest count and productivity surveys on Alcatraz Island, Gulf of California, México	Double-crested Cormorant (*Nannopterum auritum*)	2000 (nest counts), 2018 (productivity)	ongoing	Midriff Islands	Degrading

STUDY #	NAME	STUDY	TAXA	YEAR INITIATED	STATUS	REGION(S)	TREND
39	Waterbird Monitoring Program, Prescott College for Cultural and Ecological Studies	Reproductive success of Craveri's Murrelets on Alcatraz Island and San Pedro Mártir Island.	Craveri's Murrelet (*Synthliboramphus craveri*)	2018	ongoing	Midriff Islands	Stable
40	Waterbird Monitoring Program, Prescott College for Cultural and Ecological Studies	Population status of the Brown Pelican (*Pelcanus occidentalis*) on Alcatraz Island.	Brown Pelican (*Pelecanus occidentalis*)	2005	ongoing	Midriff Islands	Degrading
41	Benjamin T. Wilder	Cardones of Isla San Pedro Mártir	Cardón (*Pachycereus pringlei*)	2007	ongoing	Midriff Islands	Improving

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APPENDIX 1.

ECOLOGICAL HEALTH OF THE GULF OF CALIFORNIA SURVEY

[* = requerido]

Section 1. Researcher Information / Información del investigador
Please enter your personal information. / Por favor ingresa tu información personal.

Name*

Email*

Affiliation (select from dropdown menu) / Afiliación (seleccione del menú desplegable)*
Options:
- Government
- Academia
- Non-Governmental Organization
- Independent
- Business
- Other

Who does the data belong to? (can have multiple selections) / ¿A quién pertenecen los datos? (puedes tener múltiples selecciones)*
Options:
- Organization
- Individual
- Other

Which country are you based in? / ¿En qué país estás basado?*
Options:
- Mexico
- United States
- Other

List any key collaborators as part of this work. / Enumere los colaboradores clave como parte de este trabajo.*
[open text]

2. Study Information / Información del estudio
In this section, please respond to the prompts for each study for which you have a substantial data set. Each study is one submission, so you will need to submit multiple survey for each study. / En esta sección, responde a las indicaciones para cada estudio para el cual tengas un conjunto de datos sustancial. Cada estudio es una presentación, por lo que deberás enviar varias encuestas para cada estudio.

Researcher Name*
[Populated by names entered in Section 1]

Study Name / Nombre del estudio*
[open text]

Taxonomic group (select from the drop down options, can have multiple selections) / Grupo taxonómico (seleccione de las opciones desplegables, (puedes tener múltiples selecciones))*
Options:
- Marine mammals
- Terrestrial mammals
- Fish
- Birds
- Plants
- Algae
- Invertebrates
- Others

Please enter the scientific and common name(s) of your study species (if multiple species, can enter more than one) / Por favor ingresa el nombre científico y común de tu especie de estudio (si hay varias especies, puede ingresar más de una).*
[open text]

Biome (can have multiple selections) / Bioma (puede tener múltiples selecciones)*
Options:
- Terrestrial
- Marine
- Land-Sea connections

Ecosystem (can have multiple selections) / Ecosistema (puede tener múltiples selecciones)*
Options:
- Estuary
- Islands
- Desert
- Reefs
- Benthic
- Offshore
- Coastal
- Other

Region of the Gulf of California (can have multiple selections) / Región del Golfo de California (puede tener múltiples selecciones)*
Options:
- Upper Gulf / Alto Golfo
- Midriff Islands / Gradnes Islas
- Mid Peninsula (Bahía de Los Ángeles to Loreto)
- Lower Coastal Peninsula (Loreto and south)
- Lower Coastal Sonora and/or Sinaloa (Guaymas and south)
- Lower Gulf (in Gulf south of Midriff Islands)

Please describe where your study is focused using place names / Describe dónde se centra tu estudio utilizando nombres de lugares.*
[open text]

Does you study occur in connection with any human communities. If so, which ones? / ¿Su estudio ocurre en conexión con alguna comunidad humana? ¿De ser asi, cuales?
[open text]

Please upload a map of your study sites [optional] / Adjunte un mapa de tus sitios de estudio *[opcional]*

What are the core methods of your study? (can have multiple selections) / ¿Cuáles son los métodos centrales de tu estudio? (puedes tener múltiples selecciones)*
Options:
- acoustic
- banding/tagging
- camera traps
- count-based
- DNA
- photography
- plot-based
- questionnaires
- specimen collections
- transect-based
- Other

What year did this project start / ¿En qué año empezó este proyecto?*
[open text]

What year did this project end, or is it ongoing? / ¿En qué año finalizó este proyecto o está en curso?*
[open text]

How frequently is data taken? / ¿Con qué frecuencia se toman los datos?*
[open text]

Data Curation / Procesamiento y almacenamiento de datos

How is the data of this study curated? (select from options, can have multiple selections) / ¿Cómo se seleccionan los datos de este estudio? (selecciona entre opciones, puede haber múltiples selecciones)*
Options:
- Public repository
- Digitized (on a personal computer)
- Hard copy
- Special collections
- Published

If you use a public repository, which one(s)? / Utilizas un repositorio-almacén público, ¿cuál(es)?
[open text]

If you have published on this study please share the reference(s) to the relevant publications / Si ha publicado sobre este estudio, comparte las referencias de las publicaciones relevantes.
[open text]

Goals of Research / Objetivos de la investigación

Please describe the ecological processes you are investigating in this study (250 words or less). / Describe los procesos ecológicos que estás investigando en este estudio (250 palabras o menos).*
[open text]

Finances / Finanzas

In order to have a general sense of the scale of investment in long-term research in the region, estimate the total amount of funding (in USD) invested in your work collectively over the years (including personnel costs). (select from options) [optional]
Options:
- $0 to $5,000
- $5,000 to $25,000
- $25,000 to $50,000
- $50,000 to $100,000
- $100,000 to $250,000
- $250,000 to $500,000
- $500,000 to $1m
- $1m to $1.5m
- Over $5m

3. Trends / Tendencias
For each of the studies you have provided information for, please describe the most important trends you see in your data set since you have been collecting data.
[Select your name and each study you entered, one by one, to fill in the requested information.]

Para cada uno de los estudios de los que has proporcionado información, describe las tendencias más importantes que observas en tu conjunto de datos desde su recopilación.
[Selecciona tu nombre y cada estudio que ingresaste, uno por uno, para completar la información solicitada.]

Researcher*
[Populated by names entered in Section 1]

Study Name*
[Populated by studies entered in Section 2]

Qualitatively describe the trend(s) you have observed in 250 words or less / Describe cualitativamente las tendencias que has observado en 250 palabras o menos.*
[open text]

Quantitatively describe the trend in 250 words or less And/Or upload an image/file below / Describe cuantitativamente la tendencia en 250 palabras o menos y/o adjunta una imagen/archivo a continuación*
[open text]

Upload a figure(s) to help describe the quantitative pattern [optional] / Adjunta una(s) figura(s) para ayudar a describir el patrón cuantitativo *[opcional]*

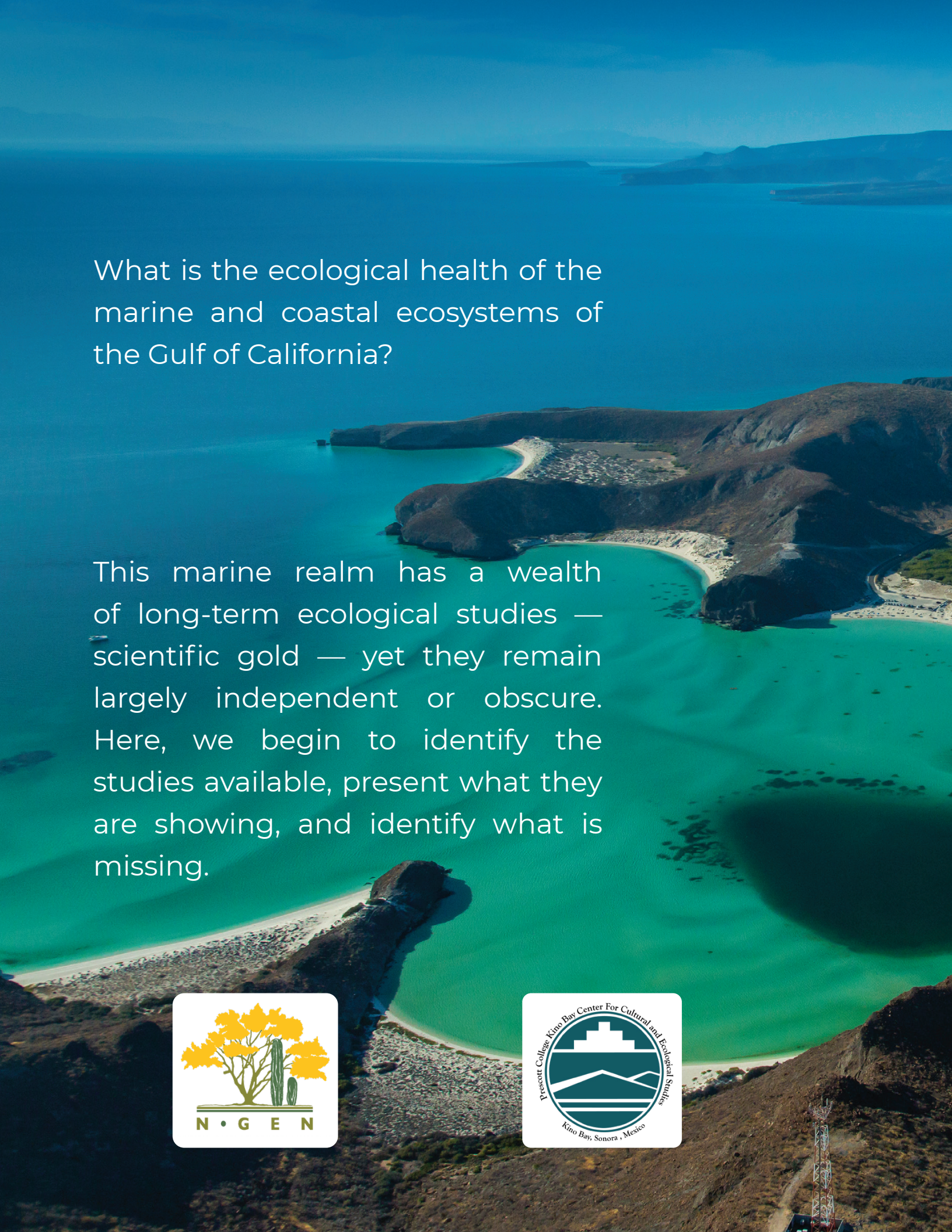
Categorize the trends you are observing. Please select one of the following options to categorize the trajectory of this trend. These six options are defined in the adjacent figure*
Options:
- Rapidly Improving
- Improving
- Stable
- Degrading
- Rapidly degrading
- Undetermined

If you have multiple trends that you are observing within this study please elaborate. (e.g. if one species in the study is stable, but others are in decline) / Si tiene múltiples tendencias que está observando en este estudio, explíquelas.
[open text]

Select type of baseline used / Seleccione el tipo de línea base utilizada*
Options:
- Established from your own data set
- Established by previous data or information
- Not yet established
- Unable to establish

Please briefly describe the baseline type selected above that you are using as context for the trend assessment / Describa brevemente la línea base que seleccionaste arriba aque está utilizando como contexto para la evaluación de tendencias*
[open text]

Statement	Score
Conditions appear to be changing at a rate that will lead to an improved state within five years.	Rapidly improving
Conditions are improving.	Improving
Within the bounds of normal variation, no consistent changes are anticipated from either anthropogenic or other sources.	Stable
Conditions are degrading.	Degraging
Conditions appear to be changing at a rate that will lead to a degraded state within five years.	Rapidly degrading
There is insufficient information to establish a basis for the trend, or data are highly variable and trends cannot be distinguished.	Undetermined



What is the ecological health of the marine and coastal ecosystems of the Gulf of California?

This marine realm has a wealth of long-term ecological studies — scientific gold — yet they remain largely independent or obscure. Here, we begin to identify the studies available, present what they are showing, and identify what is missing.

N • G E N

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