

MIGRATORY SPECIES

in the Gulf of Mexico Large Marine Ecosystem

EXECUTIVE SUMMARY

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The Nature Conservancy

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Figure 1. Study area in the Gulf of Mexico Large Marine Ecosystem, and extent of the Deepwater Horizon oil spill in April 2010.



Introduction

Purpose of the Study

Understanding the migratory pathways of fish, sea turtles, marine mammals, and birds is critical not only to species survival, but also to the overall health of the Gulf of Mexico Large Marine Ecosystem. In this report, The Nature Conservancy synthesized information about the pathways of a variety of migratory species in the Gulf of Mexico Large Marine Ecosystem. Our goal is to increase understanding of the migratory strategies and corridors of representative migratory fish, sea turtle, marine mammal, and bird species in the Gulf. Our hope is that information presented in this study will inform and motivate government decision-makers to support further research on migratory pathways in the Gulf and to enact measures for conservation of those pathways to enable the survival of individual species and the protection of the overall health of the Gulf of Mexico ecosystem.

Biological Migration

Biological migration is a highly specialized behavior with origins in the natural selection of species. Migratory pathways range from regional to long-distance movements, typically on a seasonal basis. Although some of the threats to these pathways are well understood, other factors that harm or reduce migratory populations remain poorly and incompletely documented. Migratory species often move across national boundaries, and, therefore, through different governance and political frameworks. This makes their management a complex process.

The Gulf of Mexico Large Marine Ecosystem

The Gulf of Mexico Large Marine Ecosystem (LME) comprises the primary study area of this report. This includes areas from estuarine to marine waters from the west coast of Florida to Texas in the United States, from Tamaulipas to the northeastern part of the Yucatán Peninsula in Mexico, and along the northwestern coast of Cuba.

Plants and Animals in the Gulf of Mexico

The Gulf of Mexico, with 15,419 documented species, (Felder and Camp 2009), ranks as one of the top five ocean areas globally for plants and animals (Ellis et al. 2011). The International Union for Conservation of Nature (IUCN) has listed 52 species of vertebrates that live in the Gulf on the Red List of Threatened Species with a status of critically endangered, endangered, or vulnerable (IUCN 2011). Species migrations play a significant, but not well understood, role in maintaining the health of the Gulf ecosystem.

Our Approach to Mapping Migratory Pathways

Study Process

The Conservancy synthesized data for 26 migratory species of fish, sea turtles, marine mammals, and birds (Table 1). This included gathering existing information from more than 100 biologists and researchers from the U.S., Mexico, Canada, and Cuba. The Conservancy compiled and organized thousands of observation points, hundreds of satellite movement tracks, many spawning and feeding aggregation sites, and numerous spatial threats from a multitude of sources. Using this information, we determined partial migratory corridors, areas of high movement density, occurrence hotspots, aggregations and stopovers, and high threat areas for each species and combined groups of species.

OCCURRENCES AND DISTRIBUTIONS

Point occurrence records were gathered from multiple international and national publicly accessible databases and from collaborating researchers and institutions. Occurrences were aggregated into 20-by-20-kilometer cells across the study area to generate synthesis products of the observation coverage and human survey efforts. The result visually depicts areas in the Gulf with the highest concentrations of records, and when overlaid with species' distributions, it illustrates potential data gaps.

MIGRATORY CORRIDORS AND MOVEMENT DENSITY

Animal movement tracking data, generated using satellite tags and geolocator devices (see Box 1) attached to individual animals, were gathered from the available information on migrating animals (10 marine species and three bird species). Although we made a large effort to gather tracking data for these species, the amount of data, and thus the accuracy of our depiction of pathways, varies greatly depending on the technology used, the species and the location. We recognize that additional pathways or branches of their migratory corridors most likely exist for each species and that the results presented in this report constitute only preliminary and partial corridors.

STUDIED BIRDS



BROAD-WINGED HAWK
Buteo platypterus
Highly migratory raptor that can be found in large concentrations along some parts of the Gulf while migrating long distances between the Northern and Southern Hemispheres. LC



OSPREY
Pandion haliaetus
Seriously harmed by effects of pesticides in mid-20th century, have made strong comeback since DDT and toxins banned in 1972. LC

WHOOPING CRANE
Grus americana
Adults rely exclusively on the coastal habitats along the Texas coast to spend the winter. EN





CERULEAN WARBLER
Setophaga cerulea
Migrates across the Gulf between its forest habitats in North and South America each year during spring and fall. VU

AUDUBON'S SHEARWATER
Puffinus lherminieri
Solitary, small seabird that spends most of its life foraging in warm seas. Seldom comes near land in North America. LC





BLACK SKIMMER
Rynchops niger
Flies low with the lower mandible plowing the water and snapping the bill when it contacts a fish. LC



BLACK RAIL
Laterallus jamaicensis
Secretive marsh bird whose status and migrations are not known well. Loss of habitat is considered its main threat. NT



REDHEAD
Aythya americana
Migrates from all over North America to winter in large flocks along the Gulf. Females sometimes lay their eggs in other birds' nests. LC



WOOD THRUSH
Hylocichla mustelina
Highly migratory songbird that travels north across the Gulf more than 4,000 km each spring. A bird that inhabits eastern deciduous forests and has one of the most beautiful songs. NT



JOEL SARTORE/
GETTY IMAGES

STUDIED FISH

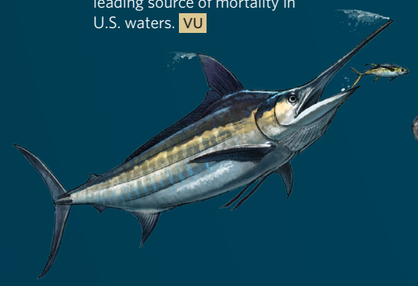


GAG GROUPER
Mycteroperca microlepis
Reef fish for which over-fishing has reduced the proportion of males to females in the Gulf from around 20% to less than 5%. LC



DOLPHIN FISH
Coryphaena hippurus
Open-sea predator that use floating objects and sargassum mats for cover as juveniles, and to find prey as adults. LC

BLUE MARLIN
Makaira nigricans
Prized offshore trophy fish. Particularly vulnerable to bycatch, believed to be the leading source of mortality in U.S. waters. VU



GULF STURGEON
Acipenser oxyrinchus
Can live up to 60 years but they now face signif-icant loss of habitat due to dams on the rivers they use for spawning. NT



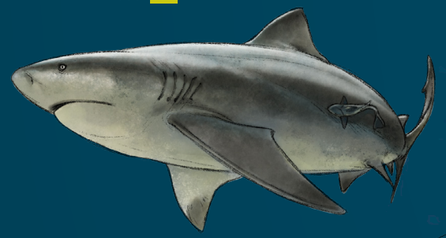


ATLANTIC TARPON
Megalops atlanticus
Highly prized coastal trophy fish facing significant losses to juvenile nursery habitats and its populations. VU

GULF MENHADEN
Brevoortia patronus
The largest fishery by volume in the Gulf of Mexico, they spend the majority of their adult lives nearshore, forming large schools near the surface.



BULL SHARK
Carcharhinus leucas
Large coastal sharks that use estuarine habitats as nursery for their young. They can invade freshwater streams in search for food. NT





WHALE SHARK ▶
Rhincodon typus
The largest fish in the ocean, more than 500 gather every year in the waters of the Yucatán Peninsula, the largest documented aggregation in the world. VU



MUTTON SNAPPER
Lutjanus analis
Inshore species associated with coastal habitats such as seagrass beds, mangroves, and estuarine environments. Adults are also found on offshore reefs. VU

BLUEFIN TUNA
Thunnus thynnus
Northwestern population relies on the Gulf to spawn every spring. The Deepwater Horizon oil spill covered some of the spawning and juvenile development areas. EN



STRIPED BASS
Rynchops niger
River damming and changes to water temperatures can isolate foraging areas from areas of good water quality, thus limiting their range in the Gulf. LC



WILDESTANIMAL/
GETTY IMAGES

Table 1. Species assessed and their conservation status in North America.

The following table synthesizes migratory patterns of 26 Gulf species and highlights the threat to those patterns.

						GLOBAL		USA	MEXICO	CUBA	CANADA
GROUP	SUBGROUP	SPECIES	SCIENTIFIC NAME	SUBSPECIES	ENDEMIC[1]	IUCN[2]	G-RANK[3]	ESA[4]	NOM-059-ECOL[5]	RESOLUTION 160[6]	COSEWIC[7]
Fish	Coastal	Atlantic tarpon	*Megalops atlanticus*			VU	G5				
		Bull shark	*Carcharhinus leucas*			NT	G5				
		Gag grouper	*Mycteroperca microlepis*			LC	GNR				
		Gulf menhaden	*Brevoortia patronus*		●		GNR				
		Gulf sturgeon	*Acipenser oxyrinchus*	*desotoi*		NT	G3T2	TH	Ex		
		Mutton snapper	*Lutjanus analis*			VU					
		Striped bass	*Morone saxatilis*			LC	G5				SC
	Pelagic	Blue marlin	*Makaira nigricans*			VU	GNR				
		Bluefin tuna	*Thunnus thynnus*			EN	GNR				EN
		Dolphin fish	*Coryphaena hippurus*			LC	GNR				
		Whale shark	*Rhincodon typus*			VU	GNR		TH	II	
Sea Turtle	Coastal	Green	*Chelonia mydas*			EN	G3	EN**	EN	I	
		Kemp's ridley	*Lepidochelys kempii*			CR	G1	EN	EN		
		Loggerhead	*Caretta caretta*			EN	G3	TH***	EN	I	
	Pelagic	Leatherback	*Dermochelys coriacea*			VU	G2	EN	EN	I	EN
Marine Mammal	Coastal	West Indian manatee	*Trichechus manatus*	*latirostris (Florida), manatus (Caribbean)*		VU	G2	EN	EN	I	
	Pelagic	Sperm whale	*Physeter macrocephalus*			VU	G3G4	EN	SP		NAR
Bird	Neartic-Neotropical	Broad-winged hawk	*Buteo platypterus*	*platypterus, cubanensis (Cuba), brunnescens (Puerto Rico)*		LC	G5		SP	I	
	Neartic-Neotropical	Cerulean warbler	*Setophaga cerulea*			VU	G4			II	EN
	Neartic-Neotropical	Osprey	*Pandion haliaetus*	*carolinensis (migratory), ridgwayi (Caribbean resident)*		LC	G5			I	
	Neartic-Neotropical	Wood thrush	*Hylocichla mustelina*			NT	G5			II	TH
	Neartic-Temperate	Black rail	*Laterallus jamaicensis*	*jamaicensis*		NT	G3G4	*	EN	II	
	Neartic-Temperate	Black skimmer	*Rynchops niger*	*niger*		LC	G5			II	
	Neartic-Temperate	Redhead	*Aythya americana*			LC	G5				
	Neartic-Temperate	Whooping crane	*Grus americana*			EN	G1	EN	EN		EN
	Pelagic	Audubon's shearwater	*Puffinus lherminieri*	*lherminieri*		LC	G4G5				

Note: 1 Endemic in the Gulf of Mexico;
2 IUCN Red List of Threatened Species: CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, LC = least concern;
3 NatureServe Global Conservation Status (G-rank): G1 = critically imperiled, G2 = imperiled, G3 = vulnerable, G4 = apparently secure, G5 = secure, GNR = rank not yet assessed;
4 Endangered Species Act (ESA): EN = endangered, TH = threatened, * = Under Review in the Candidate or Petition Process, ** = in FL and TH in other Gulf states, *** = in the Northwestern Atlantic and endangered in other areas outside the Gulf;
5 Native Flora and Fauna Species Protection Rule NOM-059-ECOL: Ex = extirpated, EN = endangered, TH = threatened, SP = special protection;
6 Resolution 160 of the Council of Ministries of Species of Special Significance: Appendix I = endangered or critically endangered species, Appendix II = vulnerable and species of high ecological value;
7 Committee on the Status of Endangered Wildlife in Canada (COSEWIC): EN = endangered, TH = threatened, SC = special concern, NAR = not at risk.

Source: COSEWIC cosewic.gc.ca; Endangered Species Act fws.gov/endangered; IUCN red Listiucnredlist.org; NatureServe Explorer explorer.natureserve.org; NOM-059-ECOL biodiversidad.gob.mx/especies/pdf/NOM_059_SEMARNAT_2010.pdf; Resolution 160 medioambiente.cu/legislacionambiental/resoluciones/R-160-11-CITMA.pdf.

Box 1. Animal movement tracking techniques and tools.

The vastness of the ocean limits the ability to observe its plants and animals. The table below shows the online movement tools that are currently available to track marine animals in the Gulf of Mexico region.

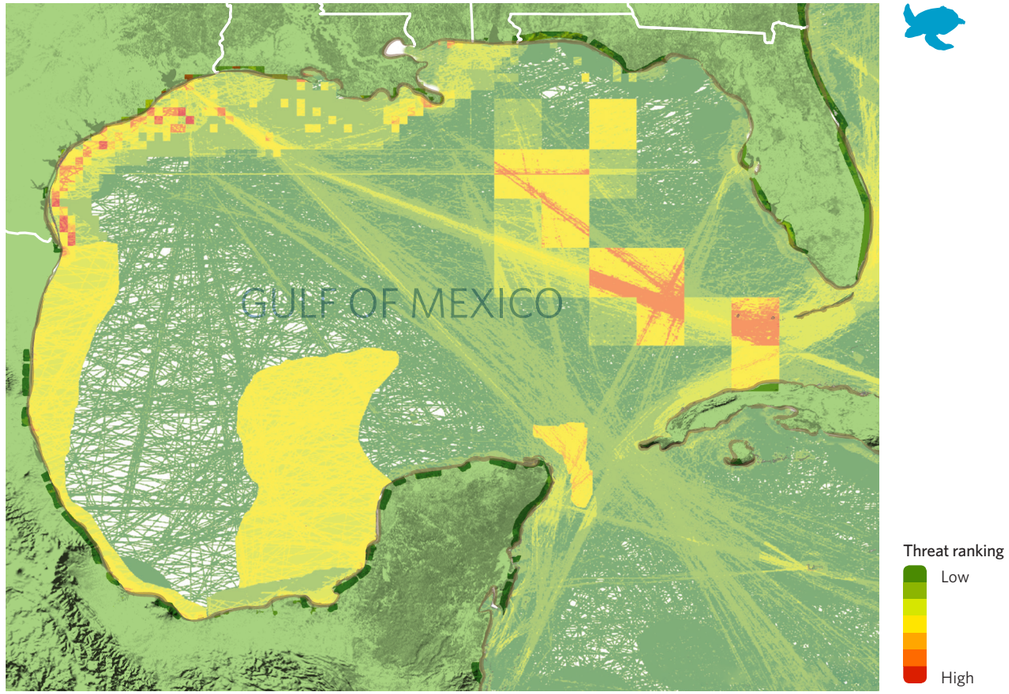
NAME	TYPE	LINK	BONY FISH	SHARK	SEA TURTLE	MARINE MAMMAL	BIRD
Animal Telemetry Network - Integrated Ocean Observing System	Acoustic/ Satellite	oceanview.pfeg.noaa.gov/ATN/					
GulfTOPP - Tagging of Pelagic Predators*	Satellite	gulftopp.org					
Guy Harvey Research Institute - Nova Southeastern University	Satellite	nova.edu/ocean/ghri					
Motus Wildlife Tracking System	Radio	motus-wts.org					
Movebank	All	movebank.org					
OBIS SEAMAP - Duke University	Satellite	seamap.env.duke.edu					
Ocean Tracking Network	Acoustic	oceantrackingnetwork.org					
OCEARCH**	Satellite	ocearch.org					
RJ Dunlap Marine Conservation Program - University of Miami	Satellite	rjd.miami.edu/education/ virtual-learning					
Seaturtle.org	Satellite	seaturtle.org/tracking/					
Wildlife Tracking***	Satellite	wildlifetracking.org/					

Note: *GulfTOPP site is a private site for researchers working with NOAA in tracking marine vertebrates for NRDA in the Gulf of Mexico
**OCEARCH has an app for smart phones
***Wildlife Tracking is a service of seaturtle.org

THREAT ANALYSIS

Although fish, sea turtles, marine mammals, and birds in the Gulf of Mexico face numerous threats, we identified specific threats that may represent barriers to completing their migratory cycles. These threats were identified, weighted, and in some cases, mapped using information from recovery plans, management plans, threat assessments, the scientific literature and expert review. Examples include: By-catch and wetland and mangrove loss for marine fish; dams for anadromous fish; vessel collisions for marine mammals: wetland and forest loss and the growth of urban areas for birds; longline fishing and beach light pollution for sea turtles.

Figure 2. Sea turtle threats.

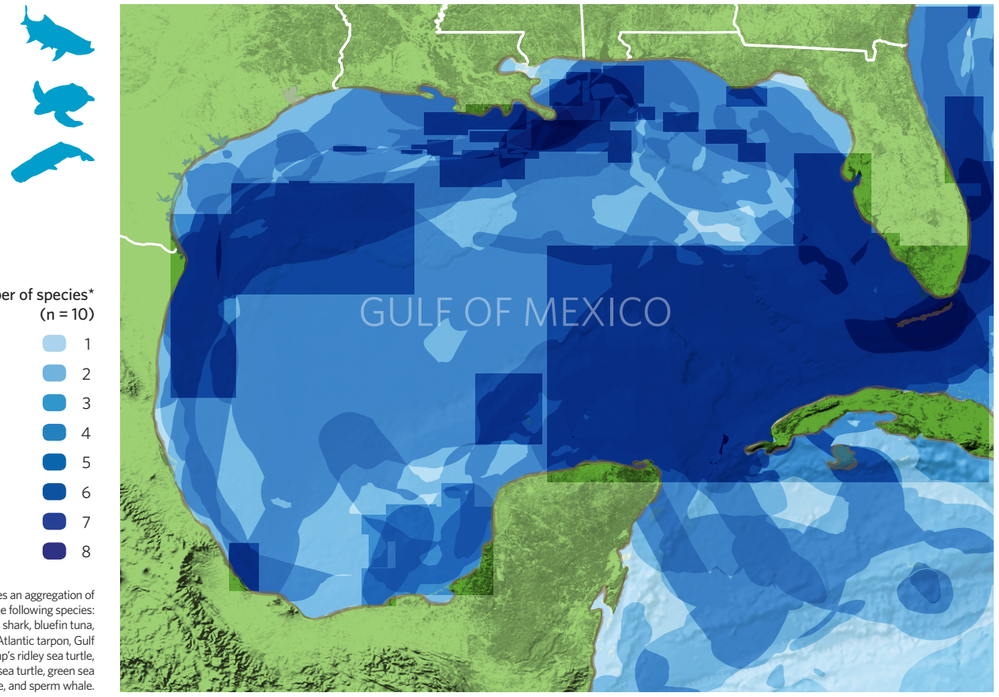


Key Findings

This assessment synthesizes large amounts of existing information and spatial data to identify the migratory pathways of fish, sea turtles, marine mammals, and bird species in the Gulf of Mexico LME. Key findings relevant to the management of migratory species in the Gulf are summarized below.

- Overall the study confirms that the Gulf of Mexico LME is an exceptionally important region for the migration of marine animals and birds and that these migratory pathways are critical components of the Gulf as a whole and connected ecosystem.
- There are four areas of the Gulf that are particularly significant migratory "blueways", making them a focus for future conservation efforts. These are: the area off the Mississippi River delta; south Florida and the Florida Strait; the northern area of the Yucatán Peninsula; and northwestern Cuba (see Figure 3).

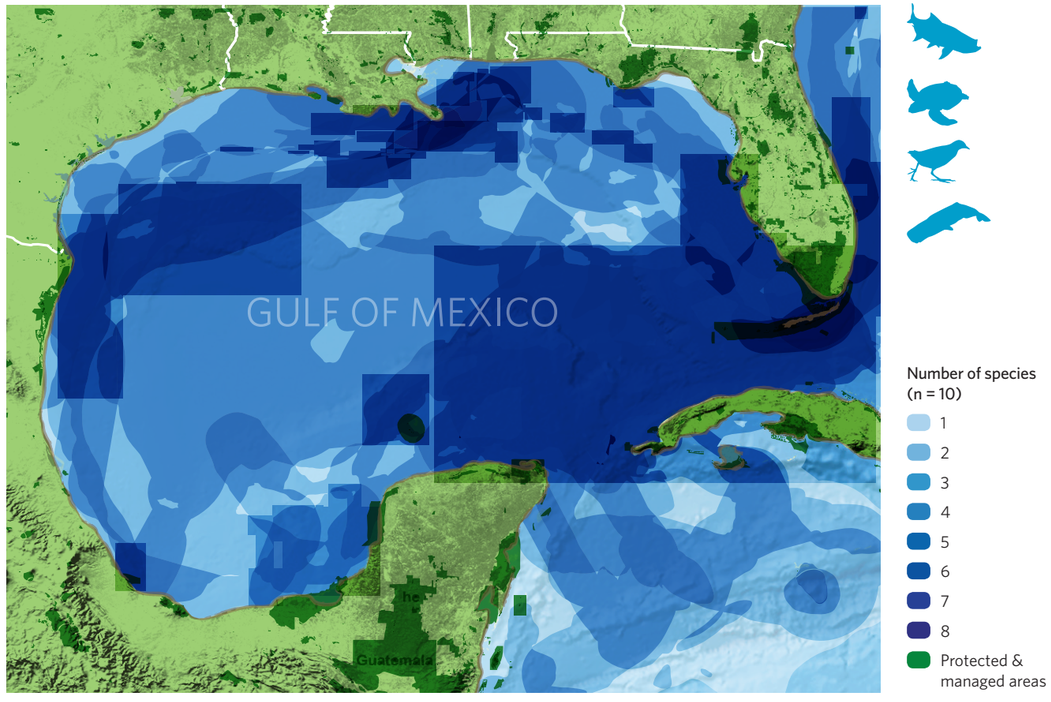
Figure 3. All marine species partial corridors.



*Map indicates an aggregation of corridors for the following species: bull shark, whale shark, bluefin tuna, blue marlin, Atlantic tarpon, Gulf sturgeon, Kemp's ridley sea turtle, loggerhead sea turtle, green sea turtle, and sperm whale.

- Results of this species corridor assessment suggest that some species of coastal fish, sea turtles, and marine mammals may use deeper parts of the ocean to migrate and complete specific phases of their life cycles, such as reproduction and foraging. In addition, pelagic species of fish and sea turtles may come to near-shore waters and estuaries as part of their life cycles.
- Less than 1 percent of the identified aquatic corridors, and less than 20 percent of the area of priority migratory bird stopovers, are covered under existing protected and other managed areas in the three countries bordering the Gulf.

Figure 4. Overlap of partial corridors of ten aquatic species, and managed and protected areas. Less than one-percent of the corridor area of these species is protected.



- Most of the knowledge is also biased toward species that have an economic value, such as those that are part of commercial and recreational fisheries in North America.

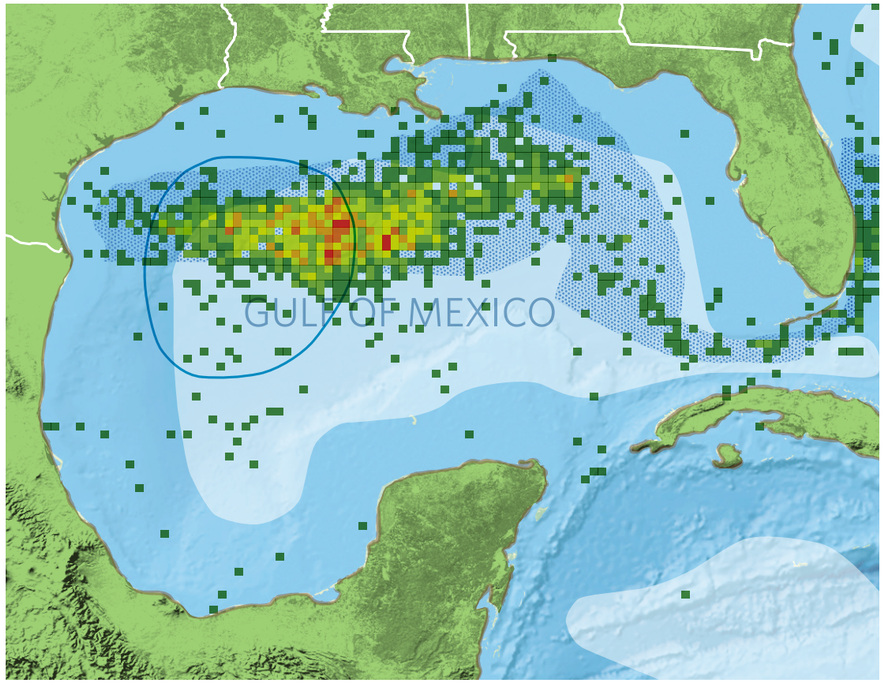
- The *Deepwater Horizon* oil spill disaster in April of 2010 created a temporary major disruption of the migratory patterns of a variety of marine animals and birds migrating through the northern Gulf. The spill left beached, superficial, dissolved, and deep deposits of oil in the water.
- There is a significant gap in knowledge of the southern Gulf of Mexico. The majority of the available knowledge of species occurrence, distribution and movements is biased toward the northern Gulf and the United States.

Figure 5. Summary of observations of black skimmer. Note the disproportion of data available in domestic and international databases for the northern (>99%) and southern (<1%) Gulf of Mexico regions.



- Multiple species have populations that limit their ranges in the Gulf to specific areas, including the sperm whale (resident population in the northern Gulf), and the whooping crane wintering on the Texas coast. These populations may require special management to maintain their viability. Examples of species with populations partially dependent on the Gulf as habitat are bluefin tuna, Kemp's ridley sea turtle, and Redhead. Due to the specific habitat requirements and resulting limited ranges of these species, their populations are especially vulnerable to threats occurring in the Gulf.

Figure 6. Bluefin tuna summary of observations and distribution.



The migratory pathways of species with populations that are partially dependent on the Gulf, such as the bluefin tuna, are especially vulnerable to threats.

Summary of observations and distribution of bluefin tuna. Warmer colors indicate the approximate location of the spring spawning area.

- Migrations in the Gulf occur constantly throughout the year. While the majority of birds migrate regularly during the spring and fall between their breeding and wintering areas, other species have more varied timing for their migratory movements. Fish species migrate throughout the year, sea turtles primarily migrate in late spring and summer and marine mammals migrate primarily during the winter.

Figure 7. Migration timing of a) sea turtles, and b) birds in the Gulf of Mexico region.

A) SEA TURTLES

GULF MIGRATION PERIODS

SPECIES	LIFESTAGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Green	Adult female					MIGRATION		NEST IN FL		MIGRATION			
Green	Juvenile	FORAGE IN WARM AREAS		MIGRATE TO AGGREGATIONS			FORAGE NEAR COAST				MIGRATE TO WARMER AREAS		FORAGE IN WARM AREAS
Kemp's ridley	Adult female				MIGRATION		NEST IN GULF		MIGRATION				
Kemp's ridley	Juvenile	FORAGE IN WARM AREAS		MIGRATE TO AGGREGATIONS			FORAGE NEAR COAST			MIGRATE TO WARMER AREAS			FORAGE IN WARM AREAS
Leatherback	Adult female				MIGRATION		NEST IN NW ATLANTIC		MIGRATION				
Loggerhead	Adult female				MIGRATION		NESTING SEASON IN USA (FL)				MIGRATION		

In foraging areas · At nesting beaches · Migration period

This table represents a simplified account of migration timing for sea turtle species in the Gulf of Mexico. Adult females will not nest or migrate every year. For those females that do nest, the time of nesting varies. For example, some Kemp's ridley sea turtles start migrating in March and nest on beaches in late April, while others may migrate in April and nest in May.

B) BIRDS

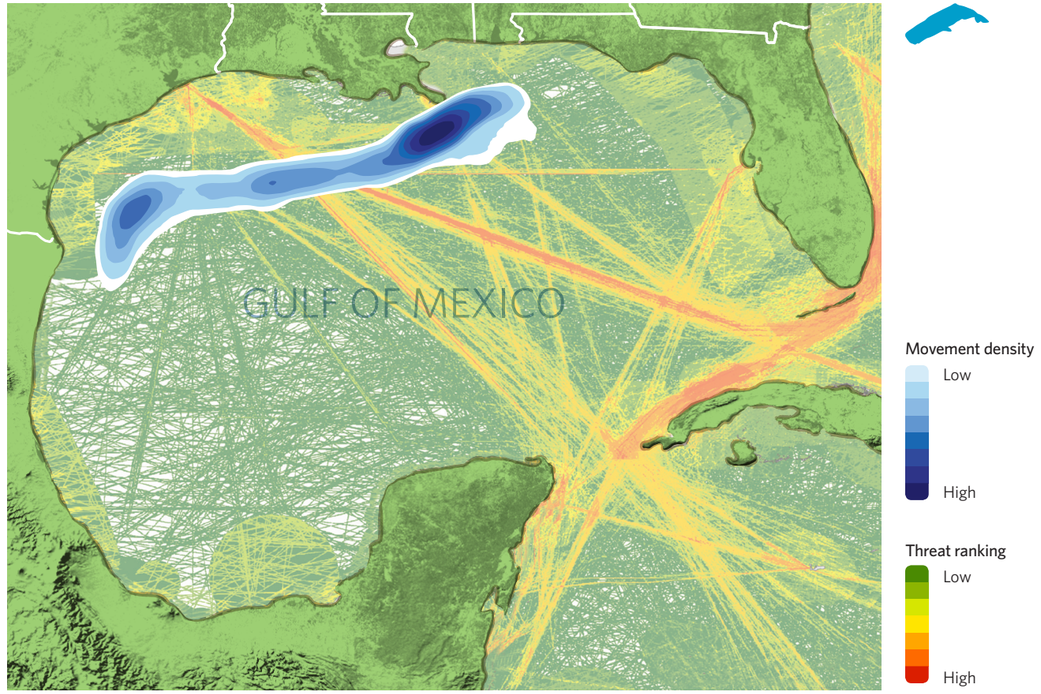
GULF SPRING MIGRATION · GULF FALL MIGRATION

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Broad-winged hawk												
Cerulean warbler												
Osprey												
Wood thrush												
Black rail												
Black skimmer												
Redhead												
Whooping crane												
Audubon's shearwater												
Combined												

Occasional migrant · Regular migrant · Peak of migration

- The so-called dead zone (low oxygen water) south and generally west of the mouth of the Mississippi River is a recurrent summer event and potential threat to maintaining migratory pathways that requires further investigation.
- There are few multinational agreements that provide operational protection to migratory species across the region, despite the wide-ranging character of many important species. Although a number of international and national laws and treaties exist to conserve plants and animals, including organisms that migrate, the main focus of conservation implementation remains management of national priorities within national boundaries.
- The main threats to migratory species of fish and sea turtles are from fisheries by-catch and habitat loss. Although the latter is a major threat to manatees and birds, the main threat to the marine mammals assessed is vessel collision, and the main threat to the bird species assessed is the hazard of traversing urban areas and habitat loss. Whale shark threats are very similar to those of the large whales.

Figure 8. Sperm whale partial corridor and threats. The straight-line features represent the contribution of navigational shipping lanes to their threats.



STUDIED SEA TURTLES

GREEN
Chelonia mydas
The largest of all hard-shelled sea turtles, and the only marine turtles whose adults exclusively eat plants. EN





LEATHERBACK
Dermochelys coriacea
408 autopsy records found the presence of plastic in 34% of deceased leatherbacks, the largest of all sea turtles. VU



LOGGERHEAD ▼
Caretta caretta
In the southeastern U.S., about 80% of loggerhead nesting occurs in six Florida counties. Bright lights on highly developed beaches confuse nighttime nesting habits. EN



KEMP'S RIDLEY
Lepidochelys kempii
Considered the smallest sea turtle in the world. They synchronize their nesting at specific beaches in Tamaulipas, Mexico. CR



JOEL SARTORE, NATIONAL GEOGRAPHIC PHOTO ARK/GETTY IMAGES



REINHARD DIRSCHERL/ GETTY IMAGES

STUDIED MARINE MAMMALS



WEST INDIAN MANATEE
Trichechus manatus
Approximately 27% of manatee deaths in Florida between 1974 and 2012 were attributed to human-related causes. VU



SPERM WHALE ▲
Physeter macrocephalus
The largest cetacean that migrates primarily in the northern Gulf, where it has a semi-resident population of about 500 whales. VU



The Way Forward

The Gulf of Mexico LME is an extraordinarily important area for marine migratory species. These migrations are critical to the interconnection of the Gulf ecosystem. Our findings have only scratched the surface of understanding animal migration in the Gulf, but we hope that they spur additional research to document the full extent of Gulf migration and identify conservation actions that protect the life cycles of a wide range of important migratory species. Particular attention is needed to the four most significant "migratory blueways" identified in this study and to determining whether additional similar locations exist in the Gulf.

Although the basic biology and distribution for many species is known, the vast majority of knowledge focuses on places and stages at which animals spend most of their time. Not enough attention has been paid to their time traveling from place to place and to the threats to their survival associated with those journeys and with the aggregations of organisms that are often part of their migratory cycles. A further bias of past research has been a focus on the coastal temperate regions, which in some cases may constitute only half or less of the life cycles of some species migrating between temperate and tropical areas. Understanding the drivers of migration, the threats encountered and seasonal interactions is imperative to increasing the viability of the populations of migratory species.

One of the first steps in assessing the migratory connectivity of populations is to be able to track their movements. New tracking technology is making it possible to assess the movements of a growing number of species (see Box 1). These tracking tools not only provide a deeper understanding of the habitats they use while migrating, they also document multiple environmental stressors (such as water quality and areas of conflict with human activities) that can influence their survival. These tools can be used to evaluate the extent to which environmental or management problems impact migratory processes.

This report highlights the need for more research that will use these new tools and other evolving science to build on the creative and successful work done by the field researchers who produced the data behind this report. More work is needed, as well, to compile the data in ways that can guide the conservation and management practices of the United States, Mexico, and Cuba to protect the exceptional biodiversity of their shared resource—the Gulf of Mexico LME.

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For complete technical study please visit www.nature.org/gulf