Monitoring Status and Trends of Long-lived Marine Vertebrates as a Measurable Indicator of Restoration and Long-term Health of the Gulf of Mexico Ecosystem

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Galleria IV, The Westin Galleria-Houston, Houston, Texas

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Special Session

Monitoring Status and Trends of Long-lived Marine Vertebrates as a Measurable Indicator of Restoration and Long-term Health of the Gulf of Mexico Ecosystem

February 16, 2015
9:00 AM – 6:00 PM
Galleria IV, The Westin Galleria-Houston, Houston, Texas

9:00-9:10 ***Introduction to the Session***, Pamela Plotkin

9:10-9:30 ***Gulf of Mexico Long-term Monitoring Programs Case Study: Assessment of Marine Vertebrate Monitoring Programs and Gap Analysis***, Matt Love, Alexis Baldera, Chris Robbins and Bob Spies.

9:30-9:50 ***Moving Towards a Region-wide Avian Monitoring Framework for the Northern Gulf of Mexico***, Randy Wilson, Mark Woodrey and John Tirpak.

9:50-10:10 ***Tarpon Spawning and Larval Transport in the Northern and Eastern Gulf of Mexico***, Jonathan M. Shenker, Mitchell Roffer and Aaron Adams.

10:10-10:30 ***Sea Turtle Monitoring in Pelagic and Neritic Habitats in the Gulf of Mexico***, Michael Bresette, Jonathan Gorham and Kate L. Mansfield.

10:30-10:50 ***Passive Acoustic Monitoring of Dolphins in the Gulf of Mexico: 2010 to 2013***, Kaitlin E. Frasier, Sean M. Wiggins, Danielle Harris, Tiago A. Marques, Len Thomas, Karlina P. Merkens and John A. Hildebrand.

10:50-11:10 ***Dispersal and Behavior of Oceanic-stage Sea Turtles in Oil-impacted Habitat of the Gulf of Mexico***, Kate L. Mansfield and Nathan Putman.

11:10-11:30 ***Behavioral Patterns of Common Bottlenose Dolphins in Galveston, Texas***, Alexandria E. Rivard.

11:30-11:50 ***Migratory Corridors of Adult Female Kemp's Ridley Turtles in the Gulf of Mexico***, Donna J. Shaver, Kristen Hart, Ikuko Fujisaki, Cynthia Rubio, Autumn Sartain, Jaime Peña, Patrick Burchfield, Daniel Gomez Gamez, Raul de Jesus Gonzalez Diaz Miron, Hector J. Martinez Ortiz and Jaime Ortiz.

11:50-1:00 ***Lunch***

1:00-1:20 ***Evolutionary Toxicology: Transgenerational Effects of Contaminant Exposure***, John W. Bickham.

1:20-1:40 ***Health Assessment of Common Bottlenose Dolphins (*Tursiops truncatus*) in Barataria Bay, La., following the Deepwater Horizon Oil Spill***, Leslie B. Hart, Cynthia R. Smith, Teri K. Rowles, Forrest I. Townsend, Randall S. Wells, Brian C. Balmer, Michael M. Fry, Marina Ivančić, Mandy C. Tumlin, Eric S. Zolman and Lori H. Schwacke.

1:40-2:00 ***Changes in Immune Functions Associated with the Deepwater Horizon in Bottlenose Dolphins in the Northern Gulf Of Mexico***, S. DeGuise, M. Levin, E. Gebhard, L. Jasperse, J.T. Saliki, L. Burdett Hart, C. Smith, S. Venn-Watson, F. Townsend, R. Wells, B. Balmer, E. Zolman, T. Rowles and L. Schwacke.

2:00-2:20 ***Polycyclic Aromatic Hydrocarbon Biomarkers in Deep Sea Fishes and Sharks in Association with the Deepwater Horizon Oil Spill Occurrence***, Arianne Leary, Jim Gelsleichter and R. Dean Grubbs.

2:20-2:40 ***Effects of the Deepwater Horizon Oil Spill on Gulf Fish Populations: What Have We Learned?*** Jim Gelsleichter, Arianne Leary, R. Dean Grubbs, M. Heithaus, J. Marcus Drymon, D. Kerstetter and R.E. Hueter.

2:40-3:00 ***The Fragility of Recovery: Implications of the Dramatic Reduction of the Kemp's Ridley Population Growth Rate since 2010***, Selina Heppell.

3:00-3:20 ***Tag-acquired Sperm Whale Dive Behaviors Reveal Unexpected Changes in Benthic Foraging Around Macondo Spill Site – a Potential Long-term Issue***, Bruce Mate, Ladd Irvine and Martha Winsor.

3:20-3:40 ***Quantitative Declines in Mesophotic Reef Fish Abundance and Shifts in Community Structure across the Threshold of the Deepwater Horizon Event: Temporal and Spatial Contrasts***, K.J. Sulak, P. Dixon, M. Randall, M. Price and U. Nash.

3:40-4:00 ***Changes in the Foraging Strategy of Kemp's Ridley (*Lepidochelys kempii*) Sea Turtle Populations in the Northern Gulf of Mexico Post Deepwater Horizon Spill***, Kimberly Reich, Donna J. Shaver, Claire Iseton, Melania Lopez-Castro, Christopher Schmitt and Michael J. Hooper.

4:00-4:20 ***Presence of Deep-Diving Cetaceans in the Gulf of Mexico during and Following the Deepwater Horizon Oil Spill***, J. Hildebrand, S. Baumann-Pickering, K. Frasier, J. Trickey, K. Merkens, S. Wiggins, M. McDonald, T. Marques, D. Harris and L. Thomas.

4:20-4:40 ***The 2014 Kemp's Ridley Stock Assessment: Reduced Nesting or Reduced Nesters?*** Benny Gallaway and William Gazey.

4:40-5:00 ***Using Passive Acoustic Monitoring to Evaluate Acute Impacts and Chronic Influences of the Deepwater Horizon Oil Spill on Large Whale Species***, Aaron N. Rice, Jamey T. Tielens, Janelle L. Morano, Bobbi J. Estabrook, Yu Shiu and Christopher W. Clark.

5:00-5:20 ***Gulf of Mexico Migratory Species: A Baseline for Conservation and Restoration***, Jorge Brenner, Carly Voight and David Mehlman.

5:20-5:40 ***Self-help Marine Animals: Engaging Marine Mammals in Research that Aims to Protect Them***, Chris Simoniello, Stephanie Watson, Barbara Kirkpatrick and Robert Currier.

5:40-6:00 ***Dolphins Modify Behaviors Due to Human Activity in an Important Foraging Habitat***, Sarah Piwetz and Bernd Würsig.

Gulf of Mexico Long-term Monitoring Programs Case Study: Assessment of Marine Vertebrate Monitoring Programs and Gap Analysis.

Matt Love, Alexis Baldera, Chris Robbins and Bob Spies

The Ocean Conservancy

The Oil Pollution Act requires restoration of injured natural resources and lost services caused by the Deepwater Horizon (DWH) oil spill. The DWH Oil Spill Natural Resource Trustees need to know the status of injured resources to determine whether recovery strategies are performing and what changes to those strategies might be necessary to improve performance. Evaluation of recovery requires integration of long-term monitoring of injured resources, from high trophic level organisms to changes in the physical, chemical and biological drivers of the Gulf of Mexico marine ecosystem. Existing marine monitoring programs could serve as building components of an integrated monitoring program framework. Development of such a program should be organized around a conceptual model of the Gulf of Mexico large marine ecosystem with key indicators of ecosystem function identified to serve as for recovery. Ocean Conservancy is assessing monitoring programs in the Gulf to identify those that include injured resources or monitor important drivers and to identify important gaps in coverage based on identification of monitoring priorities or needs. We are documenting the resources monitored as they relate to NRDA injury categories, the spatial and temporal coverage of the monitoring programs along with the sampling frequency and other related information. We will present preliminary results of our assessment and gap analysis for marine vertebrates, with our initial conclusions on long-term monitoring needs under a DWH Damage Assessment and Restoration Program.

Moving Towards a Region-wide Avian Monitoring Framework for the Northern Gulf of Mexico.

Randy Wilson[1], Mark Woodrey[2] and John Tirpak[3]

[1]U.S. Fish and Wildlife Service

[2]Coastal Research and Extension Center-Mississippi State University/Grand Bay National Estuarine Research Reserve

[3]U.S. Fish and Wildlife Service

Birds are a conspicuous and remarkable natural resource of the Gulf of Mexico. Hundreds of species and millions of individual birds are supported by barrier islands, beaches, marshes, near-shore and offshore waters and coastal forests. Although many avian monitoring projects have been implemented, scientist and conservationist lack a comprehensive and coordinated approach to monitoring avian resources across the northern Gulf of Mexico. To address this need, an ambitious plan is being developed by a small consortium of researchers, managers, coordinators, and administrators representing a subset of state and federal agencies, NGOs, universities, and partnerships across the northern Gulf of Mexico. This group has been working to define a vision and process for developing the role of bird monitoring in achieving integrated, efficient, and effective Gulf of Mexico management and recovery. To date we have identified the goals, objectives, and metrics of success for the program through a Structured Decision Making approach, and now have a mostly completed SDM decision tool by which we can judge the appropriateness of proposed monitoring packages. Specifically, this integrated monitoring program will serve multiple goals, including monitoring long term responses to anthropogenic and natural drivers, detecting unpredicted changes in status and trends, and detecting response to conservation and management actions. The monitoring plan is expected to be long term in nature, taxonomically diverse in scope, and to cover the Gulf of Mexico from freshwater to pelagic zones. The team anticipates using identified objectives to (1) facilitate communication regarding avian monitoring needs; (2) guide develop of a comprehensive, coordinated monitoring strategy; and (3) utilize the objectives and value models to develop a prioritization tool to assist funding agencies.

Tarpon Spawning and Larval Transport in the Northern and Eastern Gulf of Mexico.

Jonathan M. Shenker[1], Mitchell Roffer[1,2] and Aaron Adams[1,3]

[1]Florida Institute of Technology

[2] Roffer's Ocean Fishing Forecasting Service

[3] Bonefish and Tarpon Trust

Tarpon (*Megalops atlanticus*) support one of the most popular and valuable coastal recreational fisheries in Florida and the Gulf of Mexico. Larvae recruit into coastal marsh nursery habitats in peninsular Florida and along the northern shoreline of the Gulf of Mexico, but the spawning sites where the larvae are produced are unknown. Identifying the spawning habitats and larval transport pathways is critical for evaluating connectivity among regional populations, characterizing temporal/spatial patterns in regional recruitment, and assessing the vulnerability of spawning and early life stages to major anthropogenic events such as the Deep Water Horizon (DWH) oil spill and climate change. To begin answering these questions, we accessed the SEAMAP Ichthyoplankton Survey conducted in the Gulf of Mexico since the 1980s. The National Marine Fisheries Service provided us with the 650+ elopomorph larvae collected during their sampling cruises. We identified the larvae to species, and measured and determined their developmental state. Sixty of the larvae were identified as tarpon, 1 as bonefish (*Albula* sp.), and the majority as ladyfish (*Elops saurus*). Data from the SEAMAP samples identifies two primary tarpon spawning regions in the Gulf. In late spring through summer, newly spawned yolk-sac and early (<10 mm) leptocephali were found along the edge of the continental shelf of peninsular Florida, over 100 miles from the coastline. In late summer/early fall, newly hatched tarpon yolk-sac leptocephali were found clustered at the edge of the continental shelf just south of the Mississippi River Delta, including the region of the DWH spill. Larger (>10 mm) larvae occurred further inshore around the periphery of the Gulf of Mexico, apparently on their migration to their coastal nurseries. To further examine the pattern of tarpon spawning off peninsular Florida, we conducted an ichthyoplankton survey

June 2014. Plankton sampling was conducted along transects extending across the shelf west of Boca Grande Pass, FL, which supports a famous tarpon fishery on what appears to be a pre-spawning aggregation of adult tarpon. Newly-hatched yolk-sac leptocephali were captured at two of the sampling sites, 120 miles offshore. Backtracking the apparent drift of these larvae enabled us to identify their likely spawning site along the outer continental shelf. These data show that juvenile tarpon in nursery marshes are derived from regional spawning activities. Further, spawning and recruitment in this region is vulnerable to anthropogenic impacts to the Gulf of Mexico ecosystem.

Sea Turtle Monitoring in Pelagic and Neritic Habitats in the Gulf of Mexico.

Michael Bresette[1], Jonathan Gorham[1] and Kate L. Mansfield[2]

[1]Inwater Research Group

[2]Marine Turtle Research Group, University of Central Florida

We conducted surveys and capture efforts to assess abundance of sea turtles in two distinct habitats in the Gulf of Mexico: pelagic *Sargassum* habitat offshore of Venice, Louisiana and shallow neritic habitat in the Big Bend region of Florida. Quantitative data on sea turtle abundance were gathered using Haphazard Unmarked Nonlinear Transects (HUNT) and repeatable linear transects to produce sightings per unit effort. Sea turtles were captured using dip net or rodeo methods. During sampling efforts in 2013/2014, 191.2 km of HUNTs were conducted in pelagic habitat off Venice. 79 neonate sea turtles were observed for an estimate of abundance of 0.37 turtles per transect km. In the Big Bend region, 213.7 km of HUNTs were conducted from 2012-2014 and 346 sea turtles were observed for an estimate abundance of 1.62 turtles/km. An additional 294 sightings were recorded during 40.8 km of fixed, linear transects for an abundance estimate of 7.2 sea turtles/km. 30 green turtles, 16 Kemp's ridley, 2 loggerheads and 2 hawksbills were captured in pelagic habitat off Venice. Green turtle straight carapace length (SCL) ranged from 13.3-25.4 cm, Kemp's ridley SCL ranged from 14.6-20.2 cm, loggerhead SCLs were 12.3 and 14.7cm and two hawksbills had SCLs of 15.3 and 15.9 cm. 100 turtles were captured in the Big Bend region of Florida including 56 Kemp's ridley, 41 green turtles and 3 loggerheads. Kemp's ridleys ranged in size from 26.9-54.5 cm SCL, green turtle SCL ranged from 26.4-55.8 cm and loggerhead SCLs were 69.0-94.8 cm. This study aims to fill in knowledge gaps in our understanding of sea turtles in the gulf and identifies the need to establish index sites to monitor sea turtle populations at risk in the Gulf of Mexico.

Passive Acoustic Monitoring of Dolphins in the Gulf of Mexico: 2010 to 2013.

Kaitlin E. Frasier[1], Sean M. Wiggins[1], Danielle Harris[2], Tiago A. Marques[2], Len Thomas[2], Karlina P. Merkens[3] and John A. Hildebrand[1]

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[3]NOAA/NMFS Pacific Islands Fisheries Science Center

Dolphin populations were monitored at five sites in the Gulf of Mexico from 2010 to 2013, using High-frequency Acoustic Recording Packages (HARPs). Two sites on the continental shelf allowed monitoring of near-shore species, including bottlenose dolphin (*Tursiops truncatus*) and Atlantic spotted dolphin (*Stenella frontalis*). Three sites located on the continental slope focused on pelagic species including Risso's dolphin (*Grampus griseus*), pilot whales (*Globicephala* sp.) and oceanic stenellids (*Stenella* spp.). The HARPs passively recorded delphinid echolocation clicks continuously for up to ten months at a time. Ship-based towed array recordings of echolocation clicks produced by visually identified species were also collected in the region. Echolocation clicks from these identified recordings were compared to those detected in long term recordings. Frequency content and inter-click interval were used to putatively identify echolocation clicks to genus or species. Site-specific click detectability was calculated via an acoustic propagation model: the probability of detecting echolocation clicks at each HARP site was estimated by Monte Carlo simulation, accounting for uncertainty in sound propagation, source level and ambient noise. These probabilities were then used to estimate the true number of clicks produced at each site on a weekly basis for long term trend analysis. Diel and seasonal patterns are visible in the click time series', as are potential longer term trends in the multi-year records at some sites.

Dispersal and Behavior of Oceanic-stage Sea Turtles in Oil-impacted Habitat of the Gulf of Mexico.

Kate L. Mansfield[1] and Nathan Putman[2]

[1]Marine Turtle Research Group, University of Central Florida

[2]NOAA Fisheries, National Marine Fisheries Service, Southeast Fisheries Science Center

Background—from the time hatchlings depart nesting beaches and enter oceanic waters, virtually nothing is known about their *in situ* behavior, habitat use, and distribution until they return to coastal areas years later as larger juveniles. Given their small size, oceanic juveniles are nearly impossible to observe via traditional methods (e.g., aerial surveys). Using novel telemetry methods, we satellite tracked wild-caught oceanic stage juvenile sea turtles within the regions of the Gulf of Mexico (GOM) impacted by the 2010 *DWH* oil spill. Our objectives were to: (1) quantify the fine-scale dispersal, habitat use, and movements of wild-caught oceanic stage sea turtles; (2) characterize the turtles' in-water habitats; and (3) quantify and model active vs. passive behavior of these small oceanic turtles.

Methods—between 2011-2014, we outfitted 48 oceanic-stage juvenile sea turtles (12-29 cm straight carapace length) with 9.5-gram solar-powered satellite tags and tracked their movements for 10-140 days. Four species of turtle were tracked, including Kemp's ridley (n=20), green (n=24), hawksbill (n=2) and loggerhead (n=2); all turtles were wild-caught, captured offshore in the eastern and north eastern GOM in association with *Sargassum* habitat. Tagged turtles were released in the vicinity of their capture sites, with up to 12 individuals released per location. Pairs of passive oceanographic surface drifters were deployed with each release to characterize the local oceanic conditions (currents) and to test whether oceanic turtle movements can be predicted solely by ocean surface circulation. We analyzed the movements of turtles and drifters using a high-resolution ocean circulation model to derive swimming velocity along the tracks.

Results—nineteen turtles (n=11 Kemp's ridleys; n= 8 greens) exhibited plasticity in habitat selection from offshore oceanic to nearshore neritic habitats, possibly documenting an ontogenetic shift in habitat use. Offshore green turtles were significantly smaller than those

entering nearshore waters. Calculated swimming velocities of turtles and drifters differed significantly in both speed and orientation. There were broad-differences in swimming behavior among the species we tracked: loggerheads were most strongly oriented (mean Rayleigh r = 0.51), followed by greens (mean Rayleigh r = 0.47), Kemp's ridley (mean Rayleigh r = 0.34) and hawksbills (mean Rayleigh r = 0.22). The mean Rayleigh r value for drifters was 0.39 (n=26). Kemp's ridleys adopted headings that promote retention within the GOM and over the Continental Shelf whereas green and loggerhead tended to orient in ways that facilitated dispersal into oceanic waters; one of each species were even tracked into the North Atlantic. Hawksbills circulated primarily within large-scale oceanographic features.

These data represent some of the first satellite tracks for wild-caught oceanic stage sea turtles and provide experimental confirmation that oceanic stage turtles are not 100% passive drifters. Turtles found in the northeastern GOM may be at a critical developmental juncture, shifting from one ontogenetic stage to another. Our data and methods are central to producing species-specific predictions of habitat use and movement models, and represent a critical starting point for more realistic assessments of oil spill impacts on an otherwise poorly understood life-stage of sea turtles.

Behavioral Patterns of Common Bottlenose Dolphins in Galveston, Texas.

Alexandria E. Rivard

Texas A&M University at Galveston

The objective of this study is to establish a behavioral baseline for common bottlenose dolphins (*Tursiops truncatus*) in the Galveston, Texas area based on quantifiable patterns. This area is subjected to vessel traffic entering the ship channels and at risk for oil spills. The Galveston-Port Bolivar ferry was used as a platform for assessing variations in group behavior in the Galveston and Houston Ship Channels. Between June 1 and November 30, 2014, 1,412 hours of observation were conducted. Resting behavior occurred significantly more frequently than expected in Bolivar; traveling, more frequently in the passage; and foraging more frequently in Galveston ($p < 0.01$). Traveling dominated in open water ($p < 0.01$). Foraging was most prevalent in the morning and resting in the evening ($p < 0.01$). Group size deviated significantly across the assessed factors in a negative binomial hurdle model ($p < 0.01$). Calves were equally common in all three zones but more common in foraging groups and less in resting groups ($p < 0.01$). Groups with calves were most frequently found at intermediate distances to shore ($p < 0.01$) and in the morning ($p < 0.01$). Vessel activity was highest in Galveston and lowest in Bolivar, and decreased from the morning to afternoon to evening ($p < 0.01$). These data provide a behavioral activity budget for an easily observed apex predator; such baselines are critical to establishing the health of the ecosystem following an environmental disaster.

Migratory Corridors of Adult Female Kemp's Ridley Turtles in the Gulf of Mexico.

Donna J. Shaver[1], Kristen Hart[2], Ikuko Fujisaki[3], Cynthia Rubio[1], Autumn Sartain[4], Jaime Peña[5], Patrick Burchfield[5], Daniel Gomez Gamez[5], Raul de Jesus Gonzalez Diaz Miron[6], Hector J. Martinez Ortiz[5] and Jaime Ortiz[5]

[1]National Park Service, Padre Island National Seashore

[2]U.S. Geological Survey, Southeast Ecological Service Center

[3]University of Florida, Ft. Lauderdale Research and Education Center

[4]Cherokee Nation Technology Solutions, contracted to the U.S. Geological Survey, Southeast Ecological Science Center

[5]Gladys Porter Zoo

[6]Acuario de Veracruz

Background - Kemp's ridley (*Lepidochelys kempii*) is the most endangered sea turtle species in the world and has been the focus of bi-national conservation efforts since 1978. Prior to 2010, the bi-national restoration project documented promising signs of success, and population models projected continued increases in the number of nests at 12-18% per year through 2029 assuming continued high egg survival. However, since 2010, the growth rate in the number of nests both in Mexico and in Texas has declined to near zero although egg survival has remained high. Understanding at-sea habitat-use is vital to investigating possible causes of this troubling and unexpected population trend. In addition, knowing locations of important at-sea foraging habitat and migratory corridors may reveal locations where protection should be concentrated. Although several publications detail results of earlier Kemp's ridley tracking work (see Shaver and Rubio 2008), more sophisticated analytical and modeling tools are now available. In particular, when switching state-space modeling (SSM; Jonsen et al. 2005) is used with satellite-tracking data, the results can reveal when and where turtles are in 'migration' versus 'foraging' behavioral mode. Subsequently, data summaries using SSM output can reveal locations of key foraging sites (see Hart et al. 2012, Shaver et al. 2013) and migration corridors (Jonsen et al. 2006).

Methods - In this study, 137 Kemp's ridley turtles were outfitted with satellite transmitters after nesting in Padre Island National Seashore, Texas, USA (n=89); Rancho Nuevo, Tamaulipas, Mexico (n=24); Veracruz, Mexico (n=23); and, Gulf Shores, Alabama, USA between 1997 and 2014. Rancho Nuevo is the epicenter of nesting for the Kemp's ridley population; Padre Island National Seashore is near the northern extent of the documented historic nesting range, and Veracruz is the southern extent of the historical nesting range. Tracking data were analyzed using SSM and outputs were used to identify migration corridors for adult females.

Results - Most females tracked for more than a few months migrated away from the nesting beach after the nesting season was over. Post-nesting turtles exhibited coastal movements in Gulf of Mexico waters less than 68 m deep. Most migrated to waters off upper Texas, Louisiana, Mississippi, and Alabama. Some nesters migrated to Florida, including a few Texas nesters that migrated as far the Florida Keys. In the southern Gulf of Mexico, a few nesters migrated to as far as the Yucatan Peninsula. A larger portion of the Mexico nesters migrated to the southern Gulf of Mexico than did the Texas nesters.

Conclusions - This data set represents the longest-term (18 year) and most comprehensive (n=137 transmitters) for this species. The migratory corridors documented were repeatedly used over time. Combined with tracking results for adult females in Texas (Seney and Landry 2008, Shaver and Rubio 2008, Shaver et al. 2013), these findings document that near-shore waters of the entire Gulf of Mexico coastline, in the USA and Mexico, must be considered important migratory and foraging habitat for this species. Furthermore, they underscore the vital importance of northern Gulf of Mexico waters to adult female Kemp's ridley turtles, and thus to conservation of the entire population.

Evolutionary Toxicology: Transgenerational Effects of Contaminant Exposure.

John W. Bickham

Battelle Memorial Institute

Evolutionary Toxicology is the study of the effects of chemical pollutants on the genetics of natural populations. Research in Evolutionary Toxicology uses experimental designs familiar to the ecotoxicologist with matched reference and contaminated sites and the selection of sentinel species. It uses the methods of molecular genetics and population genetics, and is based on the theories and concepts of evolutionary biology and conservation genetics. Population genetic impacts that have been observed in organisms exposed to pollutants include (1) genome-wide changes in genetic diversity, (2) changes in allelic or genotypic frequencies caused by contaminant-induced selection acting at survivorship loci, (3) changes in dispersal patterns or gene flow which alter the genetic relationships among populations, and (4) changes in allelic or genotypic frequencies caused by increased mutation rates. It is concluded that population genetic impacts of pollution exposure are emergent effects that are not necessarily predictable from the mode of toxicity of the pollutant. Thus, to attribute an effect to a particular contaminant requires a careful experimental design which includes selection of appropriate reference sites, detailed chemistry analyses of environmental samples and tissues, and the use of appropriate biomarkers to establish exposure and effect. This paper summarizes previous field studies in Azerbaijan that document these effects in aquatic animals, and discusses current studies focused on the development of new molecular methods (eDNA, genomics) in marine species for monitoring genetic biodiversity.

Health Assessment of Common Bottlenose Dolphins (*Tursiops truncatus*) in Barataria Bay, La., following the Deepwater Horizon Oil Spill.

Leslie B. Hart[1], Cynthia R. Smith[2], Teri K. Rowles[3], Forrest I. Townsend[4], Randall S. Wells[5], Brian C. Balmer[1], Michael M. Fry[6], Marina Ivančić[2], Mandy C. Tumlin[7], Eric S. Zolman[1] and Lori H. Schwacke[1]

[1]National Centers for Coastal Ocean Science, National Oceanic and Atmospheric Administration

[2]National Marine Mammal Foundation

[3]Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

[4]Bayside Hospital for Animals

[5]Chicago Zoological Society c/o Mote Marine Laboratory

[6]Department of Biomedical and Diagnostic Sciences, College of Veterinary Medicine, University of Tennessee

[7]Louisiana Department of Wildlife and Fisheries

Thirty-two stocks of bottlenose dolphins (*Tursiops truncatus*) inhabit the bays, sounds, and estuaries of the Gulf of Mexico. Understanding potential impacts of an oil spill on bottlenose dolphins or other cetaceans presents both a physical and logistical challenge as these large mammals are difficult to sample in the wild. Fortunately, bottlenose dolphin research over the past several decades has established field methods for capture-release health assessments and an understanding of baseline health information across multiple dolphin stocks inhabiting southeast US bays, sounds, and estuaries. Following the 2010 Deepwater Horizon oil spill, bottlenose dolphin capture-release health assessments were conducted in Barataria Bay, Louisiana (BB), a site that was heavily oiled, to understand potential sublethal effects. Exposure to oil and petroleum compounds has been linked to adverse health conditions in wildlife and laboratory animals, including hematological changes, lung disease, and adrenal dysfunction. Bottlenose dolphins were briefly captured and given health evaluations during the summers of 2011, 2013, and 2014. Hematological and serum chemical analytes, adrenal hormones, and mass to length ratio as an indicator of body condition were compared to 95th percentile

reference intervals to identify abnormal measures. Pulmonary health and reproductive status was evaluated using ultrasonography. The prevalence of cases was calculated for each sampling event and compared to a reference site, Sarasota Bay, FL (SB), where no oil was reported and bottlenose dolphin health assessments have been conducted for over nearly three decades. BB dolphins sampled in 2011 had a significantly higher prevalence of inflammation ($p=0.004$), hypoglycemia ($p=0.011$), abnormal iron ($p=0.011$), and liver dysfunction ($p=0.022$) than SB dolphins sampled during the same year. Even more notable, serum cortisol concentrations in 44% of BB dolphins were below minimum values reported from SB as well as other southeastern US sites. A high proportion of BB dolphins also had poor body condition (25%) and were five times as likely to have moderate-severe lung disease ($p=0.044$) as compared to the reference site. Follow-up studies in 2013 and 2014 have revealed that the prevalence of at least some of the previously observed abnormalities has decreased. These findings demonstrate the utility of studies to investigate sublethal effects in large marine vertebrates following oil spill events to fully understand longer term impacts and potential population consequences.

Changes in Immune Functions Associated with the Deepwater Horizon in Bottlenose Dolphins in the Northern Gulf Of Mexico.

S. De Guise[1, 2], M. Levin[1], E. Gebhard[1], L. Jasperse[1], J.T. Saliki[3], L. Burdett Hart[4], C. Smith[5], S. Venn-Watson[5], F. Townsend[6], R. Wells[7], B. Balmer[4, 7], E. Zolman[4], T. Rowles[8] and L. Schwacke[4]

[1]University of Connecticut

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[8]Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

The explosion of the Deepwater Horizon oil exploration platform in 2010 resulted in an unprecedented release of oil in the Gulf of Mexico. Comprehensive health assessments were conducted on bottlenose dolphins in Barataria Bay, LA (BB), in 2011, 2013 and 2014, as well as in Mississippi Sound, MS (MS), in 2013, to assess potential health effects resulting from exposure to oil. Results were compared to those for Sarasota Bay, FL (SB), dolphins not exposed to oil (sampled in 2011, 2012, 2013 and 2014). After accounting for the immunomodulating effects of previous exposure to morbillivirus, assessment of immune functions demonstrated a consistent and significant increase in T lymphocyte proliferation in BB 2011 compared to SB, as well as a significant increase in B cell proliferation in BB 2011 and 2013. Neutrophil phagocytosis was increased in BB 2011 while monocyte phagocytosis was reduced in BB 2013 and MS, but not in BB 2011. The Th1 cytokines IL-2, IL-12 and INFγ, and the Th2 cytokines IL-5, IL-10 and IL-13, were reduced in BB 2011, while IL-4 was increased 3 fold, in BB 2011 compared to SB. These changes in immune functions were generally compatible with those documented in other species upon exposure to oil or PAHs, and consistent in time and space with exposure to oil from DWH. The changes in T cell functions and the cytokine balance tilted towards a Th2,

rather than Th1 response, in particular, would be compatible with an increased susceptibility to intra-cellular bacteria such as Brucella, which has been associated with peri-natal dolphin mortalities in the same area. Our study highlights the need for assessing subtle, sub-clinical aspects of health to understand potential ongoing and future consequences of exposure to oil spills.

Polycyclic Aromatic Hydrocarbon Biomarkers in Deep Sea Fishes and Sharks in Association with the Deepwater Horizon Oil Spill Occurrence.

Arianne Leary[1], Jim Gelsleichter[1] and R. Dean Grubbs[2]

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The Deepwater Horizon Oil Spill (DWH) released nearly 5 million barrels of liquid petroleum into the Gulf of Mexico, making it one of the largest oil spills in U.S. history. At a depth of about 1,500 meters, this spill created a unique yet challenging research opportunity. It is vital to determine the effects on Gulf wildlife from oil-related pollutants, particularly the polycyclic aromatic hydrocarbons (PAHs), which are the most toxic components of oil. Due to the rapid metabolism of these compounds, a variety of PAH biomarkers such as PAH detoxification enzymes and products of PAH metabolism were used to evaluate health effects from the oil spill in deep sea fishes collected from 2011-2014. In particular, study focused on four species of sharks, *Centrophorus* cf. *niakang, Centrophorus cf. granulosus, Squalus cubensis* and *Squalus cf. mitsikurii* and three bony fish species, *Lopholatilus chamaeleonticeps, Urophycis cirrata* and *Urophycis floridana* abundant in the NE Gulf of Mexico. Animals were evaluated for inducible PAH-metabolizing enzymes, specifically cytochrome P4501a1 (Cyp1a1) and glutathione-S-transferase (GST) in the liver, as well as PAH metabolites in the bile. Enzymatic assays for both Cyp1a1 and GST were used to indicate exposure. PAH metabolite concentrations in bile were determined using fixed wavelength fluorescence to indicate PAH metabolism. Activity of Cyp1a1, considered the most robust biomarker of PAH exposure, was greater compared to reference sites in both *Squalus* spp. and *Urophycis* spp. These species also had higher Cyp1a1 activity in earlier sample periods as well as *L. chamaeleonticeps*, which had higher levels compared to other species. GST activity also varied by time in some species, however, patterns were inconsistent among species and difficult to interpret. Yet overall enzymes levels were low compared to previous studies on shallow dwelling species. PAH metabolite levels, specifically petrogenic PAHS, mirrored the trends observed for Cyp1a1 with a further spatial trend. *U. cirrata* collected closer to the origin of the DWH had higher PAH concentrations compared to

those at further distances and reference sites. Some of these levels were higher than previously reported for anthropogenic polluted sites. Results indicate exposure and metabolism of petrogenic PAHs with some trends supporting relationships to the DWH. This study suggests that *L. chamaeleonticeps* experienced higher levels of exposure and metabolism compared to other species within this study. This is likely explained by their burrowing habits, which could increase exposure to lipophilic pollutants that associate with sediment, such as PAHs. Current study supports exposure and metabolism of PAHs in several abundant NE Gulf deep sea species. Yet additional studies are required to determine origin of PAHs.

Effects of the Deepwater Horizon Oil Spill on Gulf Fish Populations: What Have We Learned?

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As the largest oil spill in history in U.S.-controlled waters, the Deepwater Horizon (DWH) Oil Spill resulted in extensive contamination of Gulf of Mexico waters. This poses significant health risks to numerous marine wildlife populations, from deepwater species residing in offshore waters within and/or adjacent to the primary contamination zone to coastal species residing in regions impacted by onshore transport of oil. Given the population-level impacts that have occurred in some wildlife species as a result of chronic exposure to oil constituents from prior oil spills (e.g., Exxon Valdez oil spill), it is critical to monitor the health of Gulf fish to assess the full impacts of the DWH Oil Spill on these animals. Therefore, to address this problem, we have conducted several studies geared towards determining if deepwater, pelagic, and/or coastal fish populations in the northeast Gulf of Mexico are being exposed to and are experiencing effects of exposure to polycyclic aromatic hydrocarbons (PAHs), which are generally considered to be the most toxic constituents of oil. Methods: To accomplish this, we have examined several biomarkers of PAH exposure and effects in multiple Gulf elasmobranch and teleost species collected from deepwater, pelagic, and coastal areas impacted by the DWH Oil Spill, including activity of the PAH-metabolizing biotransformation enzymes, cytochrome P450 1a1 and glutathione-S-transferase, and biliary concentrations of PAH metabolites. PAH biomarker levels were compared with those measured in elasmobranchs and teleosts collected from unimpacted reference locations on the west Florida shelf and southeast U.S. coast, as well as

data from “pre-spill” samples collected from Alabama and northwest Florida. Results and Conclusions: Levels of some biomarkers were significantly greater in certain fish species from oil-impacted locations compared with those from reference sites, suggesting that northeast Gulf fish are exhibiting physiological effects of comparatively greater oil exposure. There were also temporal and spatial variations in PAH biomarker levels in northeast Gulf fish that support the notion that some species experienced transient effects from the DWH Oil Spill. However, overall PAH biomarker levels were still comparable with those previously observed in fish from typical human-impacted locations perhaps indicating that heighted oil exposure and metabolism is still below the threshold necessary to elicit higher level responses. Furthermore, differences in biomarker levels comparable to those detected in oiled and reference site locations have also been observed in fish from the northeast Gulf and other locations on the southeast U.S. coast prior to the oil spill, raising the possibility that they may reflect traditional differences in pollutant levels in these regions rather than a catastrophic event such as the DWH Oil Spill. Given these findings, the degree of impact that the DWH Oil Spill has had on large elasmobranchs and teleosts in the northeast Gulf of Mexico remains in question.

The Fragility of Recovery: Implications of the Dramatic Reduction of the Kemp's Ridley Population Growth Rate since 2010.

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In the years since 2010, our once rebounding population has taken a dramatic turn, from a 15-18% per year increase to a 5% decrease. The nest number dropped more dramatically in 2010 than had ever been recorded, but the population was expected to rebound quickly. Instead, the nest number has become much more variable, with another decrease in 2014. The probability of reaching our initial goal of 25,000 nests, which should have been reached this year, is currently zero. While there are many factors that may have contributed to a reduction in the rate of recovery, a sudden reversal of the population growth rate is unexpected due to "population momentum", where the number of nests should continue to be fueled by large cohorts of hatchlings produced in the early 2000s. Even if carrying capacity has been reduced since the 1940s, when population estimates were much greater, it is unlikely that a long-lived species would experience such dramatic and rapid changes in population growth and variability in response to density. However, because only the number of nests and hatchlings are monitored thoroughly, it is difficult to determine if the change is due to an increase in mortality and/or a decrease in the reproductive rate, where the latter could be a reduction in nesting frequency or nests per female. There is a desperate need to measure the annual survival rate of adult turtles and recruitment to the nesting population through tagging and monitoring on the nesting beaches. Likewise, better estimates of growth and mortality of juvenile turtles over time could help us diagnose changes in population recovery when they occur. For now, funding should be re-instated for the bi-national recovery project, with an emphasis on vital rate research and nest protection throughout the species' range.

Tag-acquired Sperm Whale Dive Behaviors Reveal Unexpected Changes in Benthic Foraging around Macondo Spill Site – a Potential Long-term Issue.

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Baseline satellite-monitored tagging studies of sperm whale movements in the Gulf of Mexico (GOM) began during the Sperm Whale Seismic Study (SWSS 2001-2005) and resumed during/after the Macondo oil spill (2010-2013). Both studies documented movements with 'location-only' (LO) Argos tags (previously reported). In 2011 and 2013 we also used 11 Advanced Dive Behavior (ADB) tags with time-depth-recorder to continuous record depth profiles (1-s and 2-m resolution), Fastloc-GPS and tri-axial accelerometer-magnetometer to describe body orientation, including lunges, a proxy for foraging effort. ADB tags detach from the whale at pre-set times (or earlier, up to 45 d), float to the surface, and are recovered to download records. Knowing the GPS position of each dive, it is possible to relate the whale's dive depth with the bottom depth. In this analysis, we used ADB data to describe sperm whale foraging effort and possible consequences of the Macondo spill on sperm whale distributions. Sperm whales eat squid (18 estimated GOM species). ADB-recorded lunges occurred almost exclusively during the deepest part of dives for an average 26d. Lunge events/dive were amazingly inconsistent, as sperm whales covered large areas, suggesting sparsely distributed, high-density aggregations of squid. A ~4,000 sq.km oblong of low-use habitat (LUH), including the DWH site, was identified from 2011 LO-tagged whale movements (with a SW-NE axis) between females in deeper waters and those on the upper slope. The LUH coincides with modeled surface distribution of spilled oil (NE) and 1,000m deep oil droplets (SW) that may also estimate bottom contamination. We identified three dive types: deep foraging near the bottom, mid-water foraging, and transiting (without Area Restricted Searches or lunges). Five of six whales with the most extensive data preferred bottom feeding. One whale with much bottom lunging on the continental slope circumnavigated the LUH with >85% of dives along the deep-water (south) side categorized as "transit" and only a few mid-water lunges, indicating that very few squids were encountered. Sperm whales likely prefer bottom foraging because

squids there are abundant enough to make the longer and deeper dives “cost effective”. The squids are likely foraging on demersal fish. We hypothesize sperm whales do not bottom feed in the LUH because bottom contamination has reduced bottom-dwelling fish, thus affecting the distribution of squids and whales. These new findings suggest possible long-term effects and the need to monitor the duration of such effects. If the observed effect becomes a long-term loss of habitat, then there should be more concern about cumulative trophic cascade effects from subsequent spills where bottom contamination might restrict available habitat enough eventually for population level consequences.

Quantitative Declines in Mesophotic Reef Fish Abundance and Shifts in Community Structure across the Threshold of the Deepwater Horizon Event: Temporal and Spatial Contrasts.

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The Deepwater Horizon (DWH) event created a time marker across which to evaluate ecosystem change and oil spill impact in the northeastern Gulf of Mexico. Mesophotic shelf-edge reefs (60-90 m depth) off Mississippi and Alabama lay beneath the area of surface oil for up to 45 days. The community of site-attached reef fishes and soft corals was impacted - with pathways remaining unresolved. This study reports statistically significant changes in reef fish abundance, biomass, species richness, and dominance order across the DWH threshold for Alabama Alps Reef (AAR) and Roughtongue Reef (RTR), in contrast
to two West Florida control reefs, Coral Trees Reef and Madison-Swanson South Ridge Reef, outside the area of oil. GLIMMEX analysis in a BACI framework was used to contrast 2010 and 2011 post-DWH ROV quantitative video transect fish count data with pre-DWH USGS 1997-2003 quantitative ROV baseline data. The primary focus of this study was the numerically-dominant anthiine planktivore reef fish group, typically comprising >85% of the total fish fauna for NEGOM mesophotic reefs. These small seabasses are surprisingly long-lived, display age-related sex change that would delay re-population, and are the primary food base for all larger predators on mesophotic reefs. They depend on continuous plankton delivery from surface waters, sufficient ambient illumination for visual particle picking in the water column, and heterogenous rock reef structure and living structure (tall soft corals) as shelter habitat. Direct and indirect impacts upon all site-attached AAR and RTR mesophotic reef fishes were potentially compounded by substantial impacts upon tall soft corals, the recovery of which will effect fish re-population.

Changes in the Foraging Strategy of Kemp's Ridley (*Lepidochelys kempii*) Sea Turtle Populations in the Northern Gulf of Mexico Post Deepwater Horizon Spill.

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Background - The Kemp's ridley sea turtle is the most endangered species of sea turtle in the world. Our understanding of Kemp's ridley ecology depends in part on our ability to identify geographic regions used by animals for foraging. In the field of ecology, stable isotope analyses in conjunction with satellite tagging are being used increasingly to investigate feeding habits. These techniques are especially useful when applied to migratory species that are difficult to study using conventional methods. Here we use these methods with scute samples to assess changes in foraging strategies from Kemp's ridley sampled in 2010 (the Deepwater Horizon Spill year) and the two subsequent post-spill years.

Methods - Scute samples were collected between 2010 and 2012 from two regions. Samples were obtained from 44 Kemp's ridley sea turtles nesting at a long-term study site on the lower Texas Coast (Padre Island National Seashore) and on the upper Texas Coast (Galveston Island to Surfside Beach). No Kemp's ridley turtles included in this study were sampled more than once. We used a 6mm (dia.) sterile biopsy punch to remove each scute sample from the dorsal surface (oldest scute) to the origin (newest scute). Two samples were obtained from the posterior and anterior ends of the second lateral scute. Tissues were stored in 70% ethanol until preparation for stable isotope analysis.

Results - Statistical analyses (confidence intervals) of δ13C values indicated differences between the oldest posterior layers of turtles sampled in 2010 and the three newest anterior layers of turtles sampled in 2011 and 2012. ANOVA confirmed the significance of these differences ($F_{3,96}=4.76$, $p=0.004$). There was not a difference between the oldest posterior and the newest anterior layers in 2010. The post hoc pairwise comparison t-tests showed that the δ13C values

of the oldest posterior layers sampled in 2010 differed significantly from the newest anterior layers of 2011 and 2012. Within the newest layers, δ13C values were significantly different between 2010 and 2011 and between 2010 and 2012 anterior layers. There was not a significant difference between the newest anterior layers of 2011 and 2012. The confidence intervals did not indicate differences in δ15N values between the oldest posterior layer of 2010 and the newest anterior layers of 2010, 2011 or 2012. ANOVA confirmed that differences between these groups were not significant ($F_{3,96}=0.18$, $p=0.910$).

Conclusions - There was a substantial decrease in δ13C values in scutes obtained from 2011 and 2012 Kemp's ridley turtles and indicative of post-oil spill foraging, compared to those from 2010 which are indicative of foraging the year of the spill. This difference indicates that the turtles changed foraging habitat from 2010 to 2011 and 2012. The lack of significant differences in the δ15N isotope values between these years suggests no appreciable change in trophic feeding level.

Presence of Deep-Diving Cetaceans in the Gulf of Mexico during and Following the Deepwater Horizon Oil Spill.

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Background: Deep-diving cetaceans are an important component of the Gulf of Mexico ecosystem. These long-lived animals, including sperm whales, dwarf and pygmy sperm whales, and at least three species of beaked whales, forage in offshore and deepwater habitat, with presence in the region of the Deepwater Horizon Oil Spill. Due to their extended and deep foraging dives, these species are difficult to study with visual surveys but are readily detected by passive acoustic monitoring.

Methods: Long-term passive acoustic monitoring at three sites along the continental slope, provides records of cetacean presence during and following the oil spill. High-frequency Acoustic Recording Packages (HARPS) recorded wideband (10 Hz - 100 kHz) acoustic data beginning in May 2010. One recording site was located near the Deepwater Horizon site, one was located to the west of the spill near Green Canyon, and one was located to the south of the spill off the Florida Escarpment. Acoustic data were scanned for echolocation clicks and classified for deep-diving cetacean species. Using parameters for cetacean sound production and acoustic detection range, estimates were made of population density by species.

Results: Time-series are presented for deep-diving cetacean presence in the Gulf of Mexico from May 2010 to September 2013. Higher rates of sperm whale detections were found in the northern Gulf of Mexico than in the southern Gulf of Mexico, whereas, beaked whales were found at their highest densities in the southern Gulf of Mexico. Gervais' beaked whale was the dominant beaked whale species detected at the northern Gulf of Mexico sites whereas Cuvier's beaked whale was the most detected species at the southern site. The number of acoustic detections varies across time at each site but without a strong seasonal pattern.

Conclusions: The relationship between cetacean presence and environmental parameters help provide an understanding of the ecology of these species as well as potential impact of the oil spill.

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The 2014 Kemp's Ridley Stock Assessment: Reduced Nesting or Reduced Nesters?

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Background: Coincident with the 2010 Deep Water Horizon oil spill, unprecedented levels of Kemp's ridley sea turtles stranded on northern Gulf of Mexico beaches, and nesting on the primary nesting beaches plummeted far below expected levels. High levels of strandings have continued since 2010 but nesting recovered to approximately 2009 levels in 2011, and improved slightly in 2012. A stock assessment was conducted which indicated that a large mortality event occurred in 2010, but that the population should once more exhibit a trend of increase from 2013 and beyond. That has not happened, rather the population declined sharply in 2013.

Methods: A new stock assessment was conducted under the auspices of the Gulf of Mexico Fishery Management Council, drawing upon the Kemp's ridley stock assessment model developed in 2013. This model is a population dynamics synthesis model which integrates historical Kemp's ridley data from multiple sources, including shrimp trawl effort to provide estimates of shrimp trawl mortality. The new assessment evaluated additional scenarios, including 1) three stock-recruitment options; 2) the potential that a new source of ongoing mortality is present; and 3) the potential that the number of nests-per-adult-female is dependent on the size of the benthic population.

Results: The latter model provided the best fit to the data. Further, the preliminary estimate of actual nesting in 2014 is consistent with model projections.

Conclusions: The implication is that a large population, in combination with reduced prey levels, has increased the remigration interval. On average, it may take longer for turtles to reach a body condition threshold enabling migration and nesting than has been the case in the recent past. If this explanation is correct, nesting may be highly variable in the future dependent on feeding conditions on the foraging grounds.

Using Passive Acoustic Monitoring to Evaluate Acute Impacts and Chronic Influences of the Deepwater Horizon Oil Spill on Large Whale Species.

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The Deepwater Horizon Oil Spill (DWHOS) raised the immediate question of what the impacts of a potentially major environmental crisis would be on long-lived, apex predators in the Gulf. In response to the DWHOS, we deployed 22 acoustic recorders across the Northern Gulf of Mexico for 18 months to monitor populations of Bryde's whales and sperm whales. Sensors were deployed in areas previously associated with Bryde's whale and sperm whale occurrence. With these long-term recordings, we determined temporal patterns of whale acoustic occurrence, relative spatial occurrence of animals, and the estimated density and abundance of these two species. Both Bryde's whales and sperm whales were regularly detected throughout the entire recording period. Bryde's whale acoustic detections occurred on the West Florida Shelf, while the highest level of sperm whale detections occurred in the Mississippi Delta region. Both species showed multiple-months long oscillations in their patterns of occurrence. There was a decrease in occurrence of sperm whales immediately after the spill, followed by an increase in occurrence several months later. However, that same pattern repeated again 10 months later. The cyclical nature of whale species occurrence suggests a strong role of environmental and oceanographic factors influencing food availability, rather than being influenced by the presence of oil. These basic ecological influences need to be taken into account in evaluating oil-spill related impacts to marine mammals. Long-term ambient noise analysis of these recordings revealed pervasive activity from geophysical seismic surveys, often detected across broad expanses of the Gulf and ranges of at least 700 kilometers. The chronic influences of these elevated ambient noise levels on ecologically important activities of whales, such as communication, foraging and navigation, have not been assessed. The complex nature of determining occurrence using acoustic data from sensor networks, the cyclical fluctuations of

whale occurrence, and the lack of baseline ecological data, combined with other potential stressors in the Gulf, further increases the difficulty of assessing long-term ecological impacts from the oil spill. Future efforts to study Gulf of Mexico marine mammal ecology with acoustic data hold a great deal of potential. However, a more systematic, long-term commitment to spatially and temporally appropriate surveys is required to achieve adequate understandings of the ecology of these long-lived animals. In attempting to understand the impact of the oil spill on marine mammals and other long-lived species in the Gulf, instead examining the impact of an individual stressor, such as an oil spill, we need a more holistic paradigm that takes into account cumulative impacts from multiple stressors (i.e. oil spill, seismic airguns, drilling activities, shipping, tonic loads, climate change, etc.) in the Gulf of Mexico.

Gulf of Mexico Migratory Species: A Baseline for Conservation and Restoration.

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The Nature Conservancy

Migration is a specialized behavior that has its origins in the natural selection processes of species. Migrations have emerged as an ecological need for many species and can take many forms. Marine organisms migrate for various reasons, primarily: feeding, reproduction and climatic condition avoidance. Understanding the migratory mechanisms of species, habitat usage and potential threats encountered while migrating constitute urgent conservation needs; which are highly interconnected to the survival of many species and should address the identification of species migratory patterns, homing and spatial dynamics, and obstacles to reach specific locations and habitats. Migrations are important from the perspective of conservation biology because: 1) migration is energetically costly, requiring fish and other marine organisms to develop specific morphological, behavioral and physiological adaptations, 2) species homing to natal areas aids in maintaining locally adapted genotypes, and 3) it constitutes a functional adaptation that increases survival of the species and growth of individuals to complete their life cycle.

In the Gulf of Mexico, migratory organisms range from abundant but minuscule zooplankton to invertebrates to vertebrates such as fish, sea turtles, mammals and birds. The Nature Conservancy is working with a number of partner institutions and researchers to increase the understanding of marine migratory species in the Gulf of Mexico, their migratory strategies, movement corridors and stepping stones used during migrations. In addition, an analysis of threats, as well as the barriers, that impact their ability to complete their migratory cycles will be identified. This study has integrated a base line of 26 species of valuable transboundary/multijurisdictional biodiversity (2 sharks, 9 bony fish, 4 sea turtles, 2 marine mammals, and 9 birds) into a comprehensive database of species distribution, aggregations, migratory tracks and threats. A considerable number of these species are considered long-lived

marine vertebrates that are able to represent the diversity of elements, processes and spatial extents used to migrate in the Gulf and to/from the Gulf Large Marine Ecosystem. This analysis will also increase our ability to understand and respond to oil and gas and other industry related stressors (e.g. whale shark, tarpon, blue marlin, grouper, sea turtles, manatee, sperm whale, osprey, whooping crane). The species' baseline was used to derive spatial hotspots for diversity, distribution ranges, aggregations, migrations and threats, and to create migratory corridors. Corridors were derived using spatial kernel window and density spatial methods in GIS for the species with sufficient and adequate data using the following criteria: 1) number of tracks (e.g. over 200 loggerhead sea turtle tracks), 2) geographic coverage (e.g. northern vs. southern Gulf geographic gaps), and 3) identifiable seasonal routes (e.g. whale shark and blue marlin global movements). Corridors were analyzed in conjunction with the extent of spatial threats that may represent barriers for completing the species' migratory cycles. This project provides a series of science-based recommendations to increase the viability of these populations and opportunities for conserving their capacity to migrate along the Gulf of Mexico. Results from this study aim at improving our capacity to assess and manage the areas that these species depend on and suggest a series of geographic priorities for restoring the habitats they use during aggregations and as stepping stones while migrating in the Gulf.

Self-help Marine Animals: Engaging Marine Mammals in Research that Aims to Protect Them.

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Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA)

Significant advances in animal telemetry have created new ways to monitor the status and trends of marine vertebrates, particularly their responses to environmental stressors. One exciting development is the ability to engage diverse organisms in the very research that aims to protect them. By coupling tracking technologies with environmental sensors, animals are helping scientists better understand the habitat they occupy and gain insight to how they may alter their behavior or migration patterns in response to the environment. The Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA) is working with regional partners to identify ways to increase the spatial scale of animal telemetry in the Gulf of Mexico and to establish data-sharing protocols among those engaged in telemetry activities. The effort is closely linked with the U.S. Integrated Ocean Observing System's investment in a national Animal Telemetry Network (ATN) and supports the Ecosystem Monitoring element of the GCOOS Build-out Plan, a long-term vision, with associated costs, of a comprehensive, user-driven Gulf of Mexico Observing System. Identified benefits of building an ATN network include distributed costs to promote affordability, leveraging opportunities, expanded sensor coverage resulting in higher data resolution, and long-term baseline data against which to evaluate animal responses to environmental change.

Dolphins Modify Behaviors Due to Human Activity in an Important Foraging Habitat.

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The narrow (from 370m to 950m wide) 6.5km long Galveston Ship Channel (GSC) is a congested waterway that supports large-scale shipping, commercial fishing, dolphin tourism, and recreation where human activity and common bottlenose dolphins (*Tursiops truncatus*) converge with potentially negative consequences. Elevated land-based tracking was conducted along the GSC in June-August 2013 using a digital theodolite and Pythagoras software, totaling 31 days and 158 hours of effort. A total of 278 dolphin groups were tracked for a total of 56.58 hours. Data were filtered and binned to reduce pseudoreplication. From a sample size of 221 binned tracks, each 10 minutes in duration, dolphin groups were observed foraging without fisheries during 27% of sampling intervals, foraging behind commercial trawlers 23% (total foraging time =50%), socializing 35%, resting 11% and travelling 4%, indicating an important foraging habitat. Of the 221 binned tracks, 94 (42%) tracks included vessels that were <45m from the focal dolphin group, including 21 accounts of boats operating directly through a focal group. When vessels were present within 45m, dolphin mean swimming speed increased (from 1.82±1.05SD km/hr to 2.64±1.49SD km/hr), reorientation rate decreased (from 46.52±27.21SD deg/min to 41.06±28.56SD deg/min), and linear movement increased (from 0.52±0.30SD to 0.61±0.33SD). Dolphin behavior varied greatest in the presence of dolphin tourism boats (mean swimming speed =3.41±0.80SD km/hr) and commercial trawlers (mean swimming speed =3.27±1.91SD km/hr). Field observations support quantitative analysis that bottlenose dolphins modified their behaviors in the presence of vessels, particularly during fast and erratic vessel approaches when dolphins were observed diving prematurely with increased dive durations. We suggest that this behavioral harassment (as defined by the US. Marine Mammal Protection Act of 1972) in the GSC may be detrimental to the short-term functioning of the members of

this population with potential long-term consequences to physiological health.

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