**OCEARCH Western North Atlantic Expeditions 2022**

**Science Brief**

***25 Projects, 45 Principal Investigators, 30 Research Organizations***

**1. *Movements of white sharks and other large shark species in the Atlantic Ocean***

**R. Hueter, J. Tyminski – OCEARCH/Mote Marine Laboratory**

**B. Franks – Jacksonville University**

**N. Hussey – University of Windsor**

**C. Braun, S. Thorrold – Woods Hole Oceanographic Institution**

The objectives of this research are to examine fine- and broad-scale movements, habitat use, site fidelity, range, residency, and feeding behavior of white sharks and other large shark species in the northwest Atlantic Ocean using multiple technologies including satellite-linked tagging and passive acoustic telemetry. We are tagging sharks with real-time satellite tags (SPOTs), pop-up satellite archival tags (PSATs), and individually coded acoustic transmitters. Shark movements and behavior are actively tracked with SPOTs and passively tracked using PSATs and acoustic receiver arrays. Movements will be compared with a number of variables including water temperature, fishing activity, and prey species, which include gray seals and North Atlantic right whales in the case of the north Atlantic population of white sharks.

**2. *Oceanographic associations of large pelagic predators in the Atlantic Ocean***

**C. Braun, S. Thorrold – Woods Hole Oceanographic Institution**

**P. Gaube – Applied Physics Laboratory, University of Washington**

Oceanographic features, such as fronts and eddies, comprise the “internal weather” of the ocean. They structure open ocean ecosystems and likely have profound impacts on pelagic food webs. However, the influence of these features on open ocean fish communities, including sharks, remains poorly understood. This study seeks to use a combination of satellite tagging approaches to reconstruct movements of large pelagic sharks in 3D. Observed movements will be co-located to oceanographic features identified using remotely-sensed satellite data, which will improve understanding of how pelagic predators use these ubiquitous structures. By comparing observed patterns of feature use by the predators to satellite observations of ocean currents, temperature and other characteristics, we will link observed behavior to known physical-biological ocean processes. The anticipated results of this work will help inform future efforts to identify and appropriately manage critical oceanic habitats used by pelagic predators. Ultimately, the future of shark management and conservation relies on a comprehensive understanding of movements and critical habitat driven by knowledge of the oceanographic processes that influence species’ distribution and population dynamics.

**3. *Population genetics and comparative analysis of DNA sequence variation in the white shark***

**G. Naylor, S. Corrigan – University of Florida**

**D. Portnoy – Texas A& M University**

Tagging and genetic studies have demonstrated seasonal habitat usage and site-fidelity in a variety of shark species. While site-fidelity involves the repeated use of specific areas and habitats for a variety of functions, including feeding, mating, and parturition, the majority of studies have focused on female philopatry to nursery areas. The heavy focus on female philopatry makes sense from a conservation and management standpoint because the behavior can reduce connectivity, increase genetic structuring within and among populations and have consequences for the sorting of important adaptive variation. However, site-fidelity to feeding grounds, which has been observed in a number of large oceanic species, e.g. whale sharks, tiger sharks and white sharks, has the potential to limit connectivity and facilitate the sorting of localized adaptive variation as well. Our objective is to assess patterns of white shark diversity in the western North Atlantic and calculate kinship and relatedness across all individuals to ask whether increased incidence of kin and/or elevated relatedness values are associated with specific habitat use patterns. In addition, individual composite genotypes will be stored for future use and contribute to studies of population structure on larger scales, as well as be used to estimate effective population size, effective number of breeders, minimum number of female breeders and/or total population census size using a close-kin mark recapture framework.

**4. *Trophic ecology of white sharks in the western North Atlantic***

**S. Thorrold, C. Braun** **– Woods Hole Oceanographic Institution**

**P. Gaube** **– Applied Physics Laboratory, University of Washington**

Understanding the trophic ecology of white sharks is important because as apex predators, they are likely to have a disproportionate influence on food web structure in coastal oceans. Conventional bulk stable isotope analyses used to determine trophic position (TP) are challenging for highly migratory species, such as white sharks, that move through isotopically distinct food webs and shift diets seasonally and ontogenetically. Recent advances in compound-specific stable isotope analysis (e.g. individual amino acids) have significantly reduced the influence of potentially confounding variables (shifting TP and different isotopic baselines) when determining TP of highly migratory species. Compound-specific stable isotope analyses will be conducted on muscle tissue from sharks sampled on OCEARCH to examine temporal shifts in TP, changes in isotopic baseline values, and/or migration between isotopically distinct habitats.

**5. *Nutritional and trophic biomarkers in sharks sampled in the North Atlantic***

**L. Hoopes – Georgia Aquarium**

**A. Newton – OCEARCH**

Despite their ecological importance as top predators in marine ecosystems, few studies have monitored nutritional parameters in wild sharks. Understanding nutritional markers in free-ranging sharks can lend insight into the health of the animal and reveal clues about their diet in the wild. The goal of this project is to monitor nutritional markers in large pelagic sharks to evaluate health and diet in wild populations. Traditional nutritional parameters like trace minerals and vitamin levels will provide much needed baseline information about the nutritional health of the individual, while other nutritional markers, like fatty acids, can be used as non-invasive tracers in the investigation of diet since polyunsaturated fatty acids cannot be synthesized by sharks and must be obtained from the diet. This technique has the potential to provide information about the different dietary niches occupied by immature and mature animals within a species and on differences across species occupying similar geographical regions.

**6. *Prey identification through assessment of fecal DNA***

**A. Newton – OCEARCH**

**L. Hoopes – Georgia Aquarium**

Reconstructing diets in elasmobranchs have previously depended on either indirect assessments of the food web (stable isotope analysis) or visual identification of prey remains within stomach contents either during post mortem evaluation or through the process of gastric lavage. The latter techniques provide taxonomically crude and, in some studies, biased results and require either animal sacrifice or invasive techniques. Analyzing soft matrix material from fecal samples using DNA based techniques has recently been validated in a number of terrestrial and aquatic vertebrate species as a non-invasive alternative to identify prey items. Our objectives are to 1) determine if molecular techniques can be used to recover prey DNA from fecal samples collected through a cloacal wash technique; 2) to use molecular diagnostic tools to sequence prey DNA from shark feces with generic and species-specific mitochondrial DNA primers and 3) compare these results with tissue stable isotope and plasma fatty acid levels to better define the diet of Northwest Atlantic shark species.

**7. *Microbiome composition of juvenile and adult sharks***

**F. Stewart, Z. Pratte – Montana State University/Georgia Institute of Technology**

**L. Hoopes – Georgia Aquarium**

**K. Ritchie – University of South Carolina, Beaufort**

The bacterial communities (microbiomes) living on animal bodies play a critical role in regulating host development, immune homeostasis and metabolism, and disease state. These communities may also be vectored to human hosts via contact with animals.  The composition of these microbiomes can be shaped by various factors, including diet, life stage, and environmental conditions. Our knowledge of the importance of the microbiome to animal health is well established for certain model species.  However, for most animal groups, the diversity and function of microbiomes are almost completely unexplored.  This is particularly true for marine species, including sharks. Determining the factors that affect shark microbiomes is critical for understanding host fitness, for explaining differences between ecosystems, species, and/or populations, and for understanding the potential for microbiome members to move throughout the environment (or to human hosts) via contact (e.g., via shark bites).  Knowledge of microbiomes from sharks in the natural environment may also inform how we manage captive animals to maximize health. The goals of this study are to 1) identify beneficial and pathogenic microbial taxa associated with internal and external body site niches of juvenile and adult pelagic sharks ; 2) characterize the physiological properties of the microbiomes to identify functional aspects of the shark-microbe relationship; 3) determine if microbiome composition and function can be used to predict diet across differing shark life stages, and 4) assess the relative risk of transferring pathogenic or antibiotic-resistant microbes to humans via shark bites.  These questions will be answered using a combination of field sampling, microbiological methods, and high throughput sequence analysis.  The results will enable a predictive understanding of microbiomes in shark health, ecology, and management.

**8. *Antibiotic-producing bacteria associated with white sharks***

**K. Ritchie – University of South Carolina, Beaufort**

Bacterial resistance to antibiotics is a growing, major problem for human medicine. Studies exploring innate immunity via bacterial associations play an important role in identifying mutualistic interactions between bacteria and host organisms, and how this can be applied for human medical therapies. The objectives of this study are to survey bacteria associated with the epidermal surfaces of white sharks to: (1) address bacterial roles in innate immunity; and (2) to investigate elasmobranches as a novel source of antibiotics. Bacteria are being cultured, purified and screened against 8 human and 3 marine pathogens for antibiotic potential.

**9. *Assessing the health of Atlantic shark populations***

**A. Newton – OCEARCH**

**M. Hyatt – Wildlife Conservation Society/New York Aquarium**

**N. Stacy – University of Florida**

**G. Montano – SeaWorld and Busch Gardens Species Preservation Laboratory**

Blood chemistry and hematological parameters are important components of monitoring the health of wild populations. In marine species we cannot rely on outward physical or behavioral changes to infer health as they are difficult to observe. The health status of an individual animal can influence its response to handling. Population health provides critical insight into the physiological effects of environmental and anthropogenic stressors, underlying disease issues and factors that could impact population dynamics. These are critical baselines to collect in the face of a changing ocean and for most elasmobranch species there is a paucity of baseline values. The objectives of this study are to perform baseline health assessments on elasmobranchs in the Northwest Atlantic including physical exam, ultrasound, hematology, plasma chemistry, and acute phase protein levels, to establish relative normal reference ranges for a variety of species and to investigate hematologic and plasma indicators of inflammation or disease to determine the health status of populations and explore environmental and anthropogenic impacts.

**10. *Physiological effects of capture stress in the white shark***

**A. Newton – OCEARCH**

**N. Mylniczenko, C. Wheaton – Disney’s Animals, Science and Environment**

**M. Hyatt – Wildlife Conservation Society/New York Aquarium**

**O. Shipley – University of New Mexico**

**B. Franks – Jacksonville University**

**R. Hueter, J. Tyminski – OCEARCH/Mote Marine Laboratory**

Understanding white shark post-release survivorship is critical to understanding the potential impact of fisheries interactions on population growth and determining appropriate policies for protection. A detailed assessment of the physical and physiological effects of capture and their subsequent impacts on survivorship is needed. The objectives of this study are to document the primary and secondary stress response of white sharks to capture, air exposure and handling through: (1) documenting the neuroendocrine response by quantifying plasma catecholamines and 1α - hydroxycorticosterone; (2) quantifying relative acid-base, electrolyte, metabolite and osmotic disturbances in the blood; (3) documenting fight intensity through accelerometry; (4) examining immediate and delayed post-release behavior as revealed by satellite tracking; (5) exploring relationships between primary and secondary stress response, fight intensity and survival.

**11. *Reproduction in white sharks***

**J. Gelsleichter – University of North Florida**

Little is known of the reproductive biology of the white shark in the western North Atlantic. We are taking advantage of direct access to live animals in the wild to obtain blood for the analysis of reproductive hormones (estradiol and progesterone for females, testosterone for males) using commercially available chemiluminescence immunoassays. In addition, ultrasound technology is being used to assess the reproductive status of females. In males, clasper characteristics will be qualified and quantified. Our objectives are to assess reproductive condition, reproductive cycle, gestation period, and fecundity. Of particular interest is to survey locations in the western North Atlantic that are serving as sites for white shark mating and pupping.

**12. *Semen analysis of white sharks***

**M. Hyatt – Wildlife Conservation Society/New York Aquarium**

**L. Penfold, J. Wyffels – South Eastern Zoological Alliance for Reproductive Conservation (SEZARC)**

**J. Gelsleichter – University of North Florida**

Little is known on standardized semen collection and analysis in white sharks. Sperm motility, viability, and morphology not only can add to the health assessment, but also to predict sperm maturation and time to breeding. Understanding the reproductive seasonality of mature male sharks through the use of ultrasonographic assessment of the testes and secondary reproductive organs, along with satellite tracking and reproductive hormone analysis, may help identify the reproductive season and breeding grounds of North Atlantic white sharks.

**13. *Characterization of sperm DNA fragmentation in the white shark***

**G. Montano, A. McDonnell, T. Robeck – SeaWorld and Busch Gardens Species Preservation Laboratory**

Percentage of sperm DNA integrity or fragmentation has been used in multiple mammalian and bony fish species as indicators of male fertility. The validity of this technique is being evaluated for other shark species at SeaWorld. This reproductive parameter has never been assessed in wild sharks before. Baseline data will be collected for white sharks so the data can be used as reference points for oceanic health evaluations and comparison with other sharks in the wild.

**14. *Body burdens and molecular responses to contaminants in Atlantic sharks***

**L. Crawford – Stony Brook University**

**D. Adams – Cape Canaveral Scientific**

**M. Giraudo – Environment and Climate Change Canada**

The objective of this research is to provide an integrated analysis of the accumulation of contaminants and cellular impacts of mercury, persistent organic pollutants (POPs), and per- and poly-fluoroalkyl substances (PFAS) on Atlantic sharks. Previous studies have quantified the body burdens of mercury, POPs, and PFAS in sharks and their relatives; however, very few studies have investigated the potential influences of these contaminants on sharks. Muscle tissue samples from Atlantic sharks will be analyzed for mercury, POP, and PFAS content. Additionally, we will evaluate differential RNA expression of a suite of transcripts known to be associated with mercury, POP, and PFAS exposure and effects using quantitative polymerase chain reaction (qPCR) to determine if important biological pathways may have been modified by contaminant exposure. Further, measurement of protein biomarkers of contaminant exposure and effect will be performed in muscle tissue to assess the levels of oxidative stress and energy metabolism.

**15. *Assessing metal contaminants and oxidative stress in large sharks***

**G.K. Bielmyer-Fraser, B. Franks – Jacksonville University**

The objectives of this project are to assess metal concentrations and oxidative stress biomarkers in large shark species. Metals enter marine systems via a variety of anthropogenic inputs. Although some metals are essential for normal physiological processes, exposure to excess metal concentrations can result in metal bioaccumulation in marine biota and can have toxicological consequences. Unfortunately, tissue metal concentrations in many shark species are unknown. Reference levels are needed to determine the impact of environmental change and pollution on these species. Physiological responses, such as oxidative stress, have been a reported consequence of metal exposure in many aquatic organisms. These responses can have negative impacts on overall health. Shark muscle and plasma will be examined for a suite of metals including: aluminum, cadmium, copper, nickel, lead, silver, selenium, and zinc. Muscle will also be measured for anti-oxidant enzymes associated with metal exposure including: superoxide dismutase, catalase, glutathione reductase, and glutathione peroxidase, along with lipid peroxidation. This study will increase knowledge about metal accumulation and physiological effects in these top-level carnivores.

**16. *Microplastic trophic transfer and plastic-associated toxin exposure in N. Atlantic elasmobranchs***

**A. Newton – OCEARCH**

**M. Hyatt – Wildlife Conservation Society/New York Aquarium**

**M. Giraudo – Environment and Climate Change Canada**

**L. Hoopes – Georgia Aquarium**

Microplastics are now present in every marine environment and have emerged as a significant environmental threat and specific health concern for marine organisms. Ingestion, either directly or through trophic transfer from contaminated prey, can result in direct digestive tract damage, poor nutritional absorption and exposure to waterborne toxins, heavy metals and persistent organic pollutants (POPs) that are passively attracted to microplastics. High levels of microplastics have been reported in mesopelagic fishes in the Northwest Atlantic. Direct ingestion has been confirmed in a variety of filter-feeding megafauna (mobulid rays, filter-feeding sharks, baleen whales) and trophic transfer has been confirmed in marine mammals (grey seals). To date microplastic exposure has not been demonstrated in non-filter feeding elasmobranchs. As apex predators, elasmobranchs are at risk of exposure through trophic transfer from contaminated prey items. The goal of this study is to determine the impact of microplastics on Atlantic elasmobranch species through fecal evaluation and toxicologic analysis of blood and tissue samples. As part of a multi-institutional study, fecal samples, blood samples and small tissue samples will be collected non-lethally from a variety of elasmobranch species through routine cloacal flush, caudal sinus venipuncture and skin/muscle punch biopsy respectively. Blood and tissue samples will be evaluated for heavy metals and persistent organic pollutants. Fecal samples will be mesh fractionated and enzymatically digested to allow visual documentation of microplastics within the sample by microscopy. Polymer type of plastic fragments will be further identified by spectroscopy. In addition to documenting microplastics exposure, correlations between particle presence, size, type and contaminant exposure will be determined.

**17. *Ectoparasites of white sharks and other shark species***

**S. Bullard – Auburn University**

Ectoparasites commonly infect white sharks and are primarily represented by siphonostomes (Siphonostomatoida, Copepoda). Few of the parasite species are exclusive parasites of white sharks, but rather they are species which also infect a variety of other sharks and not necessarily those species with the closest phylogenetic ties to the white shark. The wide-ranging travels of large white sharks may provide an opportunity for such species-rich infections by placing the potential host in a wide variety of different habitats throughout the year where other, less migratory sharks and their ectoparasites exist. With the above in mind, the primary purpose of this project is to collect baseline ectoparasite data (parasite species presence, abundance, and infection site) from large white sharks and other widely ranging shark species, to see if the aforementioned cases represent anomalies or a more general characteristic of sharks worth further investigation.

**18. *Visual physiology of white sharks***

**C. Bedore – Georgia Southern University**

The capabilities of sensory systems are correlated to the physical properties of the habitat in which they are used. To understand the sensitivity of white shark visual systems, we will (1) record shark eye size and total length and (2) model the sensitivity of the visual system, and (3) correlate eye size (sensitivity) to light habitat estimated from satellite tag data as sharks migrate between shallow and deep water, as well as across ocean basins. Understanding visual sensitivity of white shark eyes will help us to understand how these sharks forage and migrate in a wide range of spectral habitats.

**19.** ***Chemical tracer-based insights into North Atlantic white shark food web interactions***

**D. Madigan, N. Hussey – University of Windsor**

**O. Shipley – University of New Mexico**

**L. Hoopes – Georgia Aquarium**

North Atlantic white sharks move through a wide range of ecoregions, interacting with coastal and pelagic food webs from the Gulf of Mexico to Newfoundland. As apex predators, white sharks modulate food webs, both directly via predation and indirectly via behavioral modulation of predators and prey. Given white sharks feed on benthic, demersal, and pelagic prey including teleosts, elasmobranchs, cephalopods, and marine mammals, their influence on North Atlantic food webs (and the magnitude of energetic resources provided by those food webs) is difficult to predict and/or quantify. Various chemical tracers can elucidate regional foraging ecology (δ13C and δ15N), benthic versus pelagic prey sources (δ34S), and, particularly in pelagic waters, depth of foraging (δ202Hg and Δ199Hg). This study will perform ‘ecosampling’ in regions used by North Atlantic white sharks, sampling copepods and forage fish (food web base) as well as higher trophic level prey (*e.g.*,large fish and elasmobranchs). The purpose of systematic ecosampling efforts at white shark tagging locations will be to compile an archived sample database to be used in ongoing and emergent studies on the trophic ecology of North Atlantic white sharks.For example, regional prey samples will complement ongoing studies using compound specific analysis of individual amino acids, fatty acids and fecal DNA for diet reconstructions. This approach can also lend insight into the ecological importance of observed focal areas (NASFA, MA, and Nova Scotia), allowing estimates of prey preference in these regions (e.g., teleosts, seals) and, in turn, reveal the degree to which sharks exert top-down influence on these systems. The archived database can be cooperatively used for multiple ongoing OCEARCH projects, but will also be made available to the broader research community.

**20. *Evaluating the abundance, sex, size class and ID of white sharks with baited remote underwater video surveys, acoustic telemetry, and eDNA***

**M. McComb-Kobza – Ocean First Institute**

**N. Hussey, D. Madigan, J. Fotso Tagne – University of Windsor**

**D. Chapman – Mote Marine Laboratory**

Baited remote underwater video (BRUVs) are among the most effective noninvasive techniques for visual sampling of bony fishes and elasmobranchs (sharks, rays, and skates). Video surveys can confirm species presence, individual ID, sex, and can also be used to calculate “catch” per unit effort (CPUE) to estimate relative abundance. The objective of this project is to confirm the presence, abundance and ID of white sharks in the North Atlantic using BRUVs in combination with other detection methods. Environmental DNA (eDNA) collected via water samples at deployment sites will serve as an additional tool to confirm the presence or absence of white sharks via detection of DNA fragments in seawater. Underwater acoustic receivers (Vr2Ws) will be attached to the BRUV frame to detect any previously acoustically tagged sharks. Twin lasers will be attached to the BRUVs as a tool to measure the sharks. Individual white sharks captured by the BRUV will be identified based on dorsal fin morphology (notches or scars), unique body markings, and sex and the data will be entered into a North Atlantic white shark database along with its location. Video footage will be compared to sharks caught and tagged by OCEARCH to better understand if captured sharks overlap with those recorded on BRUVs. Data collected from BRUVs, eDNA, and acoustic receivers will be used to assess differences in the detection rate bias between methods and to determine if using these methods in concert provides a more holistic view of white shark presences and abundance. This study will increase our knowledge of the abundance and activity patterns of white sharks in the North Atlantic and the best methods for future surveillance.

**21. *Heart function in white sharks: an echocardiographic assessment***

**A. Newton – OCEARCH**

**N. Lai – University of California, San Diego**

**D. Abel – Coastal Carolina University**

Heart function in sharks differs fundamentally from that in other vertebrates in several ways. Most notably, the pericardial space surrounding the shark heart is capacious, the pericardial walls are relatively non-compliant, and sharks possess a pericardial pressure-relief valve known as the pericardial-peritoneal canal. The interplay of these structures helps regulate heart function according to circulatory needs, e.g. facilitating increased blood circulation when in pursuit of prey. Furthermore, sharks have four different types of hearts based primarily on morphology of the ventricle, which in turn varies by activity level and swimming speed among sharks. We propose to use ultrasound to characterize cardiac dynamics of White Sharks and other sharks differing in heart type and pericardial characteristics, and apply the results to integrating heart structure and function in these species. Results will have applications in comparative physiology and stress responses.

**22. *Establishing a metabolomics baseline for white sharks***

**E. Christiansen – North Carolina Aquariums**

**M. Stoskopf – North Carolina State University**

There is an important need to develop better ways to monitor and assess the health of both captive specimens and wild populations of sharks. This project will use advanced NMR metabolomics techniques to look at key metabolites of white sharks, establishing a baseline fingerprint for the species. 1H-NMR based metabolomics is a research tool that allows characterization of a range of small molecule metabolites of an animal. Development of a metabolomic fingerprint for white sharks in the wild would be a powerful tool for comparing to individuals of this or other shark species displaying signs of illness. Making a record of time upon capture will offer the opportunity to examine variations related to capture stresses that may help refine the baseline fingerprint and obtain a better understanding of stress markers in white sharks. Baseline metabolomics information obtained from this research will also be a useful tool for more advanced understanding of the nutritional needs and adequacy of diets of wild, free-roaming white sharks, and other opportunistically caught species. Blood will be collected from the ventral caudal vein of white sharks and processed for NMR analysis using methanol-chloroform extraction to determine the concentration of relevant metabolites.

**23. *Sensory specializations underlying shark predation***

**C. Allard, N. Bellono – Harvard University**

Sharks can detect and discriminate incredibly specific environmental signals to find prey, mates, or facilitate navigation. For example, these fishes can discriminate between exceedingly weak bioelectric signals, such as those from prey, based on their physiological state. By exploiting the specialized sensory systems of sharks, we are investigating how sensory receptor cells are molecularly tuned to filter subtle differences that specify the most salient environmental signals. Our goal is to use a comparative approach across elasmobranch species with distinctive behaviors, such as the predatory white shark, in distinct physiological conditions to investigate how sensory cell proteins are modulated by behavioral state to affect cellular signal transduction. We will use genetic profiling, electrophysiological, and expression cloning methods to probe cellular signaling cascades and their contribution to cellular electrical tuning. We will then leverage these defined signaling cascades to ask whether *in vivo* modulation of cellular tuning determines frequency selectivity in behaving animals. This approach will reveal how integrative cellular signaling contributes to sensory discrimination.

**24. *Animal-borne VMT-accelerometer linked packages to determine the extent of fission-fusion dynamics and broad scale ecosystem interactions of North Atlantic white sharks***

**N. Hussey, D. Madigan – University of Windsor**

**B. Franks – Jacksonville University**

The combined application of high-resolution accelerometers with VMTs (VEMCO Mobile Transceivers) in animal-borne packages is now providing novel insights in species interactions under natural conditions that were previously impossible to observe. VMTs are a miniaturized version of a standard fixed acoustic telemetry receiver that can be mounted on fish and marine mammals to passively document interactions with other tagged individuals (conspecifics and prey). When combined with accelerometers, behaviors during interactions recorded by the VMT can be examined to infer the type of interaction, i.e. evasion or predation. The objective of this project is to equip white sharks with animal-borne packages (including combined VMT and accelerometer) to examine (i) the extent of interactions with tagged conspecifics both at known aggregation sites and along migratory paths (i.e. exploring the prevalence of fission fusion dynamics) and (ii) the scale of interactions with fish and mammals equipped with acoustic transmitters across its North Atlantic range, ranging from reef/benthic and pelagic fish, large predatory teleost and sharks to seals. Through examining acceleration-derived data, inference on the type of interactions occurring will be made to further demystify the ecological role of this apex predator.

***25. Pilot study to Examine Shark Fecal Excretions for Pharmaceutical Contaminants***

**D. Keil - Montana State University**

**F. Stewart, Z. Pratte – Montana State University/Georgia Institute of Technology**

The vast majority of wastewater treatment plants do not have the technology capable to remove all active pharmaceutical compounds and illicit drugs from human waste that enter these treatment systems.  Consequently, active drugs and metabolites may enter freshwater rivers, lakes, groundwater, and oceans through release of human wastewater effluent. Pharmaceutical contamination of surface waters is a global issue. As groundwater, surface waters and the ocean are the ultimate sinks for pollutants such as pharmaceuticals, it is crucial to learn if these contaminating drugs and corresponding metabolites affect aquatic organisms. Drugs are distinct from other bioactive chemical pollutants, such as pesticides or biocides, because pharmaceuticals are generally not intended to destroy organisms. Instead, many pharmaceuticals modify physiology and behavior as has been established in several fish studies.   It is not clear if marine organisms at the top of the food chain such as sharks, may also suffer significant exposure to pharmaceutical contaminants from coastal sewage release or affected food sources that may bioaccumulate drugs. This study proposes to quantitate approximately 70 drugs and corresponding metabolites in available shark fecal excretions. Much like sewage samples, it is anticipated that if sharks have been exposed to pharmaceutical drugs in their environment, then the parent compound and/or metabolites may also be confirmed in this sample.