

rates, increasing the cost of the transport keeps VCO₂ levels elevated, suggesting the cost to maintaining efficiency in the midst of increased work results in increased oxygen debt. We hypothesize that as the level of work increases, the ability of the body to sequester CO₂ into bicarbonate diminishes due to an inability for the proton buffering process within the blood and muscles to keep pace with increasing CO₂ production. Therefore, CO₂ may be a more sensitive physiological marker when examining the metabolic cost of foraging.

Autonomous Recorder Based Monitoring of Marine Mammal Acoustic Behaviors in Relation to Mid-Frequency Active Sonar and other Variables

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Passive acoustic data were collected from nine Marine Autonomous Recording Units (MARUs) deployed in a rectangular array 60-150 km off Jacksonville FL, USA. Units were deployed for 26 days during fall 2009, and 37 days in winter 2009-2010. The study area coincides with the U.S. Navy's planned Undersea Warfare Training Range (USWTR). Data were manually reviewed using the MATLAB program Triton to create long-term spectral averages (LTSAs) and spectrograms, which were used to log marine mammal vocalization events, man-made noise and mid-frequency active sonar. Patterns and probabilities of vocalization events by species or species groups were characterized and related to sonar activities. Seasonal and diel patterns were qualitatively characterized. Vocalizations were detected for minke whales, North Atlantic right whales, sei whales, humpback whales, sperm whales, the blackfish group, and delphinids. Minke whale vocalization events occurred almost continuously during the winter deployment period but absent in fall. Right whale events occurred mostly during winter at shallow-water sites, but unexpectedly, also were detected at deep-water sites. Sperm whale events occurred exclusively near the continental shelf break, and exhibited a strong diel pattern with almost all vocalizations occurring between dusk and dawn. Less obvious patterns were apparent for delphinid events, probably because identification to the species level was not possible. Minke whale events had a strong negative relationship with sonar events when data from all sites were combined. These results provide an initial assessment of marine mammal occurrence and distribution within the U.S. Navy's planned USWTR and provide important insights on the presence or absence of species-specific vocal responses to sonar events. Ongoing work includes using automated classification methods to identify delphinid whistles to species, and working with researchers at St. Andrews University to develop robust statistical approaches for analyzing the relationship between mid-frequency active sonar and vocal behaviors of marine mammals.

Optimising fishery yields and bycatch levels across fishing gears

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Management of fisheries aims to sustainably optimize yield or profits, usually by controlling fishing effort in one way or another. In recent decades minimizing bycatch of non-target vulnerable species has also become important and is often achieved through effort restrictions for specific gears, technical changes or a mixture of both. Yet fisheries typically impact more than one vulnerable species, so that effort constraints on one gear type to protect one species can lead to increases in

effort and bycatch of another species in another gear type. A broader focus is required if risks are to be spread among the various non-target vulnerable species groups while maintaining fishery yields. We explore ways of optimizing fishing effort between fisheries with different impact levels on different vulnerable species to maintain bycatch levels below harmful thresholds while maintaining yields. We investigate the relationship between fishing effort and bycatch for different vulnerable species including porpoises, seals and elasmobranchs, taking account of relevant covariates such as fleet, area, and fishing métier. These relationships enable us to predict bycatch levels for multiple species resulting from different levels of fishing effort in different métiers. Using PBR-based methods for marine mammals and life-history-based methods for elasmobranchs, we set limits for 'allowable bycatch' for these populations. We then explore the consequences when fishing effort levels varies between different métiers, to determine whether current fish catch levels can be maintained while respecting 'safe levels' of bycatch for multiple vulnerable species simultaneously. Results are presented graphically and indicate (a) current levels of beam trawling in some UK areas may not be compatible with conservation targets for some elasmobranch species (e.g. blonde rays *Raja brachyura*) (b) re-allocating effort to gillnetting in order to alleviate pressure on these species could result in unacceptable levels of grey seal (*Halichoerus grypus*) bycatch.

The use of deep water berths and the effect of noise on bottlenose dolphins in the Shannon Estuary cSAC

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The Shannon Estuary on the West Coast of Ireland is one of Europe's premier deep water berths catering for ships of up to 200,000 deadweight tonnage. Additionally the area is currently Ireland's only designated candidate Special Area of Conservation (cSAC) for Bottlenose dolphins under the EU Habitats Directive. Long-term Static Acoustic Monitoring (SAM) was carried out at five deep water jetty locations in the estuary at Money Point, Tarbert, Foynes, Aughinish and Shannon Airport. SAM was carried out using C-PODs. A total of 1,963 C-POD days were monitored across each of the five sites over an 18 month period. Additionally, between June and September 2012, a noise monitoring network using the LIDO system was deployed at Tarbert Jetty following an EPA funded collaboration between the GMIT and UPC. This included an SMID digital hydrophone which was connected to an embedded SBC that performed the data analysis including noise measurement in 3rd octave bands centred on 63 and 125 Hz as highlighted under the EU Marine Strategy Framework Directive (MSFD). Results showed that shipping activity produced noise between 120-140 dB for the channel at Tarbert. Additionally, Biospheric Engineering made short duration noise measurements at two further locations in the estuary and found the mean of mean noise levels was 103 dB re 1 µPa. Dolphins were recorded at the Tarbert site on 53% of days monitored. In order to effectively monitor Annex II species, it is imperative that the effect of ocean noise on dolphin distribution and behaviour is explored through seasonal, diel and tidal patterns.

Contamination status of polychlorinated biphenyls (PCBs) and their hydroxylated metabolites (OH-PCBs) in the brain of finless porpoises (*Neophocaena phocaenoides*)