FATE OF FISH RELEASED FROM FISHERIES: ISSUES AND SOLUTIONS

Post-release mortality of juvenile Atlantic Bluefin Tuna (Thunnus thynnus) caught in the U.S. recreational troll fishery

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Atlantic Bluefin Tuna (ABFT) support valuable commercial and recreational fisheries in the United States. Each year large numbers of juvenile ABFT are released from the recreational fishery but the fate of these individuals is unknown. To investigate short-term mortality of ABFT released from the U.S. recreational fishery, twenty juveniles were tagged with pop-up satellite archival tags between 19 June 2012 and 22 September 2012 offshore of Point Pleasant, NJ and Chatham, MA. Fight times ranged from 4 to 11 min (7.5 +/- 1.9 min). One tag failed to report and four tags reported prematurely yielding 6, 7, 16, and 26 days of data, all other tags went to term (31 days). PSAT data indicate that none of the tagged fish died during the period the tags were attached, with the exception of one fish that exhibited normal behavior for 12 days before a predation event, which was not considered to be directly related to the capture and tagging events. Nineteen survivals and one non-reporting tag yield an estimated mortality rate of 0% with 95% confidence intervals between 0% and 10.5%, indicating that the catch and release portion of the recreational trolling fishery for ABFT has a minimal impact on the stock.

Delayed mortality of adult coho salmon bycatch in commercial seine fisheries in coastal waters of British Columbia

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Many commercial purse seine fisheries for Pacific salmon in British Columbia, Canada, are regulated based on mortality rates of released bycatch. Fishing mortality limits are therefore established within each management area but reliable or scientifically defensible assessments of mortality rates and stock compositions are rarely conducted. Interior Fraser River coho salmon are listed as endangered, but unfortunately a common bycatch species during pink salmon fisheries. If the current mortality rate for these coho is erroneously high, commercial fishers may be losing economic opportunities but if erroneously low, even stricter conservation measures may be required. A commercial purse seine vessel and crew were chartered to operate a simulated pink salmon fishery and all operational and handling practices were as in a real fishery. Telemetry, non-lethal biopsies and DNA sampling of coho bycatch to determine stock composition and mortality rates were combined with on-board holding studies to understand the short-term physiological processes associated with marine handling stressors and examine the consequential development of pathogens and disease. The results provide information directly applicable to management of commercial purse seine fisheries in British Columbia coastal waters while also elucidating potential mechanisms of mortality.

High temperature and fisheries capture and release: decreased survival and resiliency of adult coho salmon against microparasite infections

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Pacific salmon are highly susceptible to changes in environmental temperature. A climate-driven warming trend in the Fraser River has implications for decreased resilience of returning adult spawners to infectious disease. Compounding stress associated with fisheries capture likely exacerbates these effects. To increase our understanding of disease-related premature mortality of adults during freshwater spawning migration, we use high-throughput qPCR to assess multiple microparasite loads with host physiological impairment in response to chronic high water temperature exposure. Coho salmon (Oncorhynchus kisutch) were collected shortly after river entry and held in experimental tanks at optimal (10°C) or high temperature (15°C); a subset were treated via gill net entanglement. Survival was decreased at high temperature and further diminished among fish exposed to fisheries gear, suggestive of an interaction between these stressors. Survivors at optimal temperature showed no difference in microbe load from day 14 to day 24. However, high temperature survivors showed a general decrease in loads, indicative of a decreased threshold for high microparasite loads at elevated temperature and loss of heavily infected fish. These results suggest that high temperature contributes to premature mortality of adult salmon with heavy microparasite infections and an interaction between thermal- and capture-related stressors is associated with mortality.

Estimating and reducing release mortality in red snapper fisheries

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The red snapper (Lutjanus campechanus) fishery is the most important finfish fishery in the Gulf of Mexico, but the species has been overfished since the 1980s. Management measures such as size limits require some fish to be released, but not all released fish survive. This talk summarizes 10 years of projects we have done to estimate the discard rate and release mortality of red snapper, to predict a fish's probability of mortality based on their condition at capture, and to reduce release mortality by venting and rapid recompression. Results show that regulations contribute to overfishing because of high mortality rates of released fish and that delayed mortality is significantly higher than immediate mortality. Fish condition is positively correlated with burst swimming speed and inversely correlated with the reaction distance of fish to a simulated predator. Red snapper in intermediate condition were most likely to be eaten by dolphins upon release rather than impaired or unimpaired fish. Rapid recompression via release hooks did not appear to significantly improve fish survival, and based on CT scans, the variability in venting results are likely due to ruptures in the swim bladder, which change the distribution of air inside the fish.

The degree and result of gillnet fishery interactions with juvenile white sharks in southern California assessed by fishery-independent and -dependent methods

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Juvenile white sharks have had historic interactions with gillnet fisheries in southern California, which continue to the present day. However, the extent of this has not been quantified using fishery-dependent and -independent methods. Using acoustic and satellite transmitters, we compared juvenile white shark movements to fisheries data to determine the degree and effect of white shark interactions with the gillnet fisheries in southern California. While set
and inshore drift gillnet effort were significantly and positively correlated with incidence of white shark capture and number of satellite detections, spatial and temporal overlap of fisheries and white sharks was limited. Of sharks captured by gillnets, more than half were retrieved alive and the post-survival of those tagged and released was high. While there was no difference in condition index, sharks were more often found live in gillnets when net soak times were low. Although juvenile white sharks were shown to overlap with gillnet fisheries in their vertical, horizontal and temporal distributions, the interaction potential was much lower than previously believed. Further research is needed to fully evaluate the potential benefit of reducing soak times as an option to improve incidental capture survival of juvenile white sharks.

Evaluating physiological stress of White Marlin Kajikia albida caught in the U.S. recreational fishery

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White Marlin Kajikia albida are a highly migratory species that occur throughout temperate and tropical Atlantic waters and are the basis of a large sport fishery along the U.S. Atlantic coast with the vast majority of fish released after capture. Previous research has demonstrated that circle hooks result in a significant decrease in post-release mortality of White Marlin but not much information is available regarding how physiological stress from angling may stimulate physiological change at the organismal level (impacting growth rates, reproductive output or investments, ability to evade predators, and disease resistance) or lead to post-release mortality. We examined post-release physiological stress by sampling blood and tissue from recreationally angled white marlin. A total of 68 fish were sampled for blood and tissue of which 22 were additionally tagged with pop-up satellite archival tags to follow survival. Physiological data analyzed to date suggests that plasma lactate, glucose, sodium, and cortisol increased significantly with fight time and plasma chloride increased significantly with fight time and water temperature. These data suggest that increased angling times and warmer water lead to physiological stress in White Marlin; the effects are generally sublethal, but may result in physiological change at the organismal level.

Capture-stress and post-release survival in coastal and pelagic sharks caught by commercial longline and purse seine

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During the last 2 decades worldwide assessments of some shark populations indicate an overall decline in stock size and, when viewed in the context of their reproductive biology, suggest that these fish are easily susceptible to being overfished. In response, the commercial fishing industry and fishery managers have implemented new strategies and management plans with the intention of increasing the number of incidentally captured sharks being released and returned to the ocean. A major assumption is that all (or most) released sharks survive, however, there is no evidence to support this. Longline and purse seine operations were conducted between 2010 and 2013 to capture and tag sharks, in order to assess 1) at-vessel mortality, 2) post-release survival, and 3) investigate the potential physiological consequences of the fishing event. Overall, the degree of stress associated with longline capture is highly species specific, with some species having an up to 90% mortality after 3-5hrs on the line while others being relatively unaffected by capture, even after 12hrs on the line. Post-release survival was directly affected by time on the line but was also species specific. Purse seine captured sharks showed up to 70% at vessel mortality with a 15% post-release survival. Our overall findings suggest that the degree of capture-stress and post-release survival is highly species- and gear-specific.
To many fishermen in the sea, are they a risk for endangered species?

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The vaquita *Phocoena sinus* is the world’s smallest cetacean; it is endemic to the Upper Gulf of California and has the most restricted distribution rank of all mammals in México. This species is under grave risk of extinction due to its low numbers and restricted habitat in an important fishing zone. Several actions have taken place in Mexico to avoid extinction of the vaquita. The most recent was implementation in late 2005 of a refuge against vaquita fisheries by-catch in an area of 1,263.85 km². Fishery in this area has an income of $US 12,660,374, and three fishing communities fish within this marine protected areas all over the year. Reduction 15% of the artisanal fleet could help to the recovery of the vaquita population and giving those fishermen a derogation of $US 1,899,056 year for no fish again. This is important to considered, because 30% of the fishermen would continue fishing despite a commercial embargo or a fishing prohibition in the region. Our calculations could serve as a basis to implement an economic compensation for artisanal fishers in a buy-out scheme. This is a common fisheries management policy which might prove the only long-term effective conservation tool for the vaquita.

Shrimp-bycatch spatial variation and dominant fish size structure in the shrimp fishery of the Gulf of Tehuantepec

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Shrimp trawling is considered as one of the most important human activities affecting benthic marine ecosystems. We analyze the variation of spatial shrimp-bycatch rate and the dominant fish size structure during the period April-August 2003-2005 in the Gulf of Tehuantepec. 298 hauls were done during eleven cruises conducted onboard of shrimp trawlers in a 10-60 m depth range. A total biomass of 4,720 kg/ha of bycatch and 158 kg/ha of shrimp were registered. Average shrimp-bycatch rate was 1:33. Catch biomass was analyzed based on defined fishing areas of the Gulf of Tehuantepec and with respect to depth. Biomass catch per subarea presented a decreasing pattern from north to south. In addition, biomass catch showed a decreasing trend from shallow to deeper strata. 230 species of fish were identified, 16 of them were considered as dominant. Fish mean size was 105 mm standard length (SL). At least 12 dominant fish species caught as bycatch have not reached sexual maturity. This indicates that fishing effort in the Gulf of Tehuantepec is targeting greatly on fish juveniles.
Out of sight, out of mind? Bycatch and discarding issues in global and Mexican fisheries

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Bycatch, to varying degrees, is an accepted and often unavoidable consequence of wild capture fisheries. This may entail catch of other species, whether or not they are formally assessed as threatened, or of individuals of the target species at an unwanted age, size, or reproductive stage. This talk provides an introduction to these issues from a global perspective, and addresses why and when bycatch becomes a pertinent issue for resource policy. Mexican fisheries are used as a more focused case study, with estimates of the magnitude of bycatch and the type and fate of discards from key fisheries. These two issues have been extensively researched, and there are many successful and ongoing technical developments to curtail bycatch and increase post-release survival for a range of fishing gears and environments. Yet, the current social and economic incentive structures of fishers require further attention, as they can help explain why bycatch-reducing strategies are often not fully implemented. Moving forward, an integration of social and economic aspects of fishing strategy, together with technical developments, will hopefully improve and increase acceptance of sustainable fishing policies.

Influence of water temperature and net tending frequency on the condition of fish bycatch in a small-scale inland commercial fyke net fishery

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To date, most studies of commercial fisheries bycatch have focused on mortality at time of capture as an endpoint. However, sub-lethal indicators of organismal condition have the potential to reveal mechanisms associated with mortality (both at time of capture and post-release) and opportunities for improving fish welfare. In this study, we simulated commercial fishing efforts in inland lakes with fyke nets during a typical fishing season (early April to late June) in southeastern Ontario, Canada, where bycatch of non-target fish species had previously been documented. Using non-target gamefish (i.e., largemouth bass [Micropterus salmoides, Lacépède], northern pike [Esox Lucius, L.]), as well as a target species (i.e., bluegill [Lepomis macrochirus, Rafinesque]), we examined the sub-lethal consequences of capture (e.g., blood physiology, reflex impairment, and injury) and compared the effects of being retained in the net for two different durations (i.e., two or six days) over a range of water temperatures (i.e., 3–28 °C). Sublethal physiological disturbances (i.e., blood glucose and lactate) in largemouth bass and bluegill tended to be greater at higher water temperatures. However, fish retained for six days generally did not exhibit greater stress than those retained for two days, with the exception of plasma glucose in largemouth bass. Reflex impairment was similar among temperature and retention periods. Fish retained in nets experienced a range of injuries (including fin frays, scale loss, and mouth damage) that had the potential to facilitate the development of opportunistic pathogenic infections. Greater incidences of injury on fish bycatch tended to be associated with higher temperatures and longer retention. To reduce physiological disturbances and injury that could lead to delayed mortality, we suggest that regulations for inland commercial fishers require them to check their nets more frequently as water temperatures increase. We suggest that future studies of bycatch incorporate sub-lethal endpoints given that they serve as an objective measure of fish welfare and can provide quantitative mechanistic information to support management actions.
Is the sardine of the Gulf of California a sustainable fishery?

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A biological and socio-economic analysis was carried-on. The main stock is the California pilchard (Sardinops sagax), whilst other seven species caught are by catch. The highest landing was 600,000 mt, in 2009, followed by an abrupt decline in 2012. Other species represent up to 30%. Fishing intensity was stable until 1996 with 50,000 fishing days, but the number of boats rised five times, and six times the number of fishing days, declining to previous figures the last three seasons. Fishing intensity was stable until 1996 with 50,000 days, but the number of vessels increased five times and nearly six times the number of fishing days, declining to the previous figures during the last three seasons. Until 1990, the fishing intensity was nearly 40 trips per season, followed by an increase up to 80 during the last five seasons. It is a profitable activity, with profits up to 220 M USD in 2009, but ranging between 50 and 100 M USD. Climate induces ups and downs in the stock biomass, and a high correlation between catch and the Decadal Oscillation Index was found. However, to ensure a sustainable activity, fishing effort should be kept between 4,000 and 6,000 fishing days

Size structure and some reproductive aspect of Haemulopsis leuciscus in the southeastern Gulf of California

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Haemulidae family species are important as a part of the shrimp bycatch on the Mexican Pacific, tropical and subtropical American Pacific. The importance is particularity in the magnitude of the catch (abundance) and generating a source of monetary income to the crew of the fishing fleet. Size structure analysis indicated at least seven size groups, where the 210 mm group is best represented, the smallest size was 170 mm, and it observed adults organisms. The multinomial distributions analysis provides an initial biomass closely of 18 t and 155,000 organisms before the open fishing season. Sex ratio indicate a statistically significant difference from a 1:1 (X2=20.87, P<0.05). The sexual maturity variations by moths indicated two abundance picks of mature stage, the maximum between May-June and minimum on August. The goal of this study is the generation of fishery-biological indicators which could be used to establish the condition of the population, and kwon the role in the biological community.

Catch efficiency of prototype trawl nets for blue shrimp commercial fishing in the upper Gulf of California

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Blue shrimp, Litopenaeus stilyrostris, is a valuable fishery resource, caught with drift gill nets in the northern Gulf of California. Interactions between coastal shrimp fisheries and the vaquita, Phocoena sinus, an endemic porpoise, have resulted in a high extinction risk due to incidental mortality in those nets. Therefore, it is necessary to avoid
completely the risk of vaquita bycatch throughout the region, replacing gillnets with other, alternative fishing gears. The objective of this research was to analyze the catch efficiency of prototype trawl nets, designed by Mexico’s National Fisheries Institute, for commercial fishing of blue shrimp in areas near San Felipe, B.C. 854 trawl sets, made by commercial fishermen in small vessels, were analyzed. Statistical analysis were performed using generalized linear models (GLM). The mean shrimp catch per unit effort (CPUE) was 6.66 kg/hr (95% CI 6.13-7.24). The mean proportion of shrimp in the total catch was 30% (95% CI 29-31%). No vaquita was caught in any trawl set. From the point of view of catch efficiency of blue shrimp, trawling represents a viable alternative to replace gill nets in the upper Gulf of California.