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Marine Science Review – 253

Fish and fisheries

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In this review:

O/A denotes an open access article or journal

A. Recent articles with abstracts

Waller, R., Watling, L., Auster, P., and Shank, T. **Anthropogenic impacts on the corner rise seamounts, north-west Atlantic Ocean.** *Journal of the Marine Biological Association of the United Kingdom* 87(5): 1075-1076, 2007.

Notes: Here we report the first direct underwater observations of extensive human-caused impacts on two remote seamounts in the Corner Rise complex (north-western Atlantic). This note documents evidence of anthropogenic damage on the summits of Kukenthal peak (on Corner Seamount) and Yakutat Seamount, likely resulting from a limited Russian fishery from the mid-1970s to the mid-1990s, highlighting how bottom trawling can have long-term detrimental effects on deep-water benthic fauna.

Ciborowski, K.L., Consuegra, S., Garcia de Leaniz, C., Wang, J., Beaumont, M.A., and Jordan, W.C. **Stocking may increase mitochondrial DNA diversity but fails to halt the decline of endangered Atlantic salmon populations.** *Conservation Genetics* 8(6): 1355-1367, 2007.

Notes: Over the last 50 years, Spanish Atlantic salmon (*Salmo salar*) populations have been in decline. In order to bolster these populations, rivers were stocked with fish of northern European origin during the period 1974-1996, probably also introducing the furunculosis-inducing pathogen, *Aeromonas salmonicida*. Here we assess the relative importance of processes influencing mitochondrial (mt)DNA variability in these populations from 1948 to 2002. Genetic material collected over this period from four rivers in northern Spain (Cantabria) was used to detect variability at the mtDNA ND1 gene. Before stocking, a single haplotype was found at high frequency (0.980). Following stocking, haplotype diversity (*h*) increased in all rivers (mean *h* before stocking was 0.041, and 0.245 afterwards). These increases were due principally to the dramatic increase in frequency of a previously very low frequency haplotype, reported at higher frequencies in northern European populations proximate to those used to stock Cantabrian rivers. Genetic structuring increased after stocking: among-river differentiation was low before stocking (1950s/1960s π_{ST} = -0.00296-0.00284), increasing considerably at the height of stocking (1980s π_{ST} = 0.18932) and decreasing post-stocking (1990s/2002 π_{ST} = 0.04934-0.03852). Gene flow from stocked fish therefore seems to have had a substantial role in increasing mtDNA variability. Additionally, we found significant differentiation between individuals that had probably died from infectious disease and apparently healthy, angled fish, suggesting a possible role for pathogen-driven selection of mtDNA variation. Our results suggest that stocking with non-native fish may increase genetic diversity in the short term, but may not reverse population declines.

Good, T.P., Beechie, T.J., McElhany, P., McClure, M.M., and Ruckelshaus, M.H. **Recovery planning for Endangered Species Act-listed Pacific salmon: Using science to inform goals and strategies.** *Fisheries* 32(9): 426-440, 2007. O/A

Notes: Endangered and threatened populations of Pacific salmon (*Oncorhynchus* spp.) in the United States span major freshwater and marine ecosystems from Southern California to northern Washington. Their wide-ranging habits and

anadromous life history exposes them to a variety of risk factors and influences, including hydropower operations, ocean and freshwater harvest, habitat degradation, releases of hatchery-reared salmon, variable ocean productivity, toxic contaminants, density-dependent effects, and a suite of native and non-native predators and competitors. We review the range of analyses that form the scientific backbone of recovery plans being developed for Pacific salmon listed under the U.S. Endangered Species Act. This process involves: identifying the appropriate conservation units (demographically independent Evolutionarily Significant Units [ESUs] and their populations), developing viability criteria for Pacific salmon populations and overall ESUs, and using coarse-resolution habitat analyses and life-cycle modeling to identify likely consequences of alternative actions proposed to achieve recovery. Adopting this wide breadth of analyses represents a necessary strategy for recovering Pacific salmon and a model for conservation planning for other wide-ranging species.

Tourre, Y.M., Lluch-Cota, S.E., and White, W.B. **Global multi-decadal ocean climate and small-pelagic fish population.** *Environmental Research Letters* 2(3): art. 034005, 2007. **O/A**

Notes: Ocean climate, environmental and biological conditions vary on several spatio-temporal scales. Besides climate change associated with anthropogenic activity, there is growing evidence of a natural global multi-decadal climate signal in the ocean-atmosphere-biosphere climate system. The spatio-temporal evolution of this signal is thus analyzed during the 20th century and compared to the variability of small-pelagic fish landings. It is argued that the low-frequency global ocean environment and plankton ecosystems must be modified such that small-pelagic populations vary accordingly. A small-pelagic global index or fishing 'regime indicator series' (RIS) (i.e. a small-pelagic abundance indicator) is used. RIS is derived from fish landings data in the four main fishing areas in the Pacific and Atlantic oceans. Global RIS changes phase (from positive to negative values) when SST multi-decadal anomalies are out-of-phase between the eastern Pacific and southern Atlantic. RIS also displays maxima during the mid-30s to early-40s and the late-70s to early-80s when the multi-decadal signal was approximately changing phases (Tourre and White 2006 *Geophys. Res. Lett.* **33** L06716). It is recognized that other factors may modulate fish stocks, including anthropogenic predation. Nevertheless it is proposed that variable climate and environment, and the low-frequency 'global synchrony' of small-pelagic landings (Schwartzlose *et al* 1999 *S. Afr. J. Mar. Sci.* **21** 289-347), could be associated with the multi-decadal changes in global ocean climate conditions.

Heithaus, M.R., Burkholder, D., Hueter, R.E., Heitbaus, L.I., Pratt, H.L., and Carrier, J.C. **Spatial and temporal variation in shark communities of the lower Florida Keys and evidence for historical population declines.** *Canadian Journal of Fisheries and Aquatic Sciences* 64(10): 1302-1313, 2007.

Notes: Sharks are top predators in many marine ecosystems. Despite recent concerns over declines in shark populations, studies of shark communities in coastal habitats are limited. We used drumlines and longlines to determine shark community composition and habitat affinities in the Florida Keys, USA. Community composition varied among habitats. Catch rates of smaller sharks were highest in protected shallow waters, while large sharks were more abundant in deep channels. Overall probabilities of catching large sharks on drumlines did not vary with water temperature, while catches of small sharks on longlines increased with increasing water temperature. Individual species differed in their responsiveness to variation in water temperatures and habitat. Bait type affected catch rates of some species, suggesting that fishing methods should be considered explicitly in studies describing shark communities or temporal trends in abundance. Catch rates of large-bodied sharks were higher in a remote and protected location compared with similar habitats near inhabited Keys. Also, historical accounts of a shark fishery in the study area during the 1920s suggest substantial declines in large shark abundance and shifts in community composition. By implication, ecosystem impacts of changes in the large shark community may be dramatic and likely occurred before adequate baselines were established.

Barrera-Oro, E.R. and Marschoff, E.R. **Information on the status of fjord *Notothenia rossii*, *Gobionotothen gibberifrons* and *Notothenia coriiceps* in the lower South Shetland Islands, derived from the 2000-2006 monitoring program at Potter Cove.** *CCAMLR Science* 14: 83-87, 2007. **O/A**

Notes: The long-term monitoring program of demersal fish at inshore sites of the South Shetland Islands has continued at Potter Cove from 2000 to 2006, extending a continuous sampling period of 24 years which began in 1983, and at Harmony Cove in the summers of 2001 to 2003. The decline in trammel net catches of fiord *Notothenia rossii* and *Gobionotothen gibberifrons*

in relation to the non-commercially fished *Notothenia coriiceps* is still evident. At Potter Cove, despite an overall increasing trend of *N. rossii* catches from 1991 to 2006, the actual levels are half of those found in the early 1980s, while those of *G. gibberifrons* have further declined and remain close to zero. At Harmony Cove, the relative abundance of *N. rossii* showed an increase in 2002 and 2003, whereas *G. gibberifrons* was absent in the catches. These trends are consistent with those observed in scientific cruises studying the offshore populations in a similar period. No recovery of the stocks of *N. rossii* and *G. gibberifrons* was observed, more than two decades after the end of the commercial fishery.

Rooker, J.R., Bremer, J.R.A., Block, B.A., Dewar, H., DeMetrio, G., Corriero, A., Kraus, R.T., Prince, E.D., Rodriguez-Marin, E., and Secor, D.H. **Life history and stock structure of Atlantic bluefin tuna (*Thunnus thynnus*).** *Reviews in Fisheries Science* 15(4): 265-310, 2007.

Notes: Our understanding of the biology of Atlantic bluefin tuna (*Thunnus thynnus*) has increased profoundly in the last decade, and the progress is attributed to the development and application of a variety of novel tools. Here we provide a comprehensive examination of available data on the life history and stock structure of *T. thynnus* by re-examining current databases and literature and highlighting findings from recent studies using approaches such as archival tags and natural markers (e.g., genetics, otolith chemistry). The present review provides a detailed synthesis on the reproductive biology, feeding ecology, growth, mortality, migration, and stock structure of *T. thynnus*. In addition to characterizing key life history attributes and discussing stock-specific (east versus west) differences, the implication of trans-Atlantic movement and mixing are addressed. We also identify significant data needs that still exist and must be addressed to promote effective management and rapid recovery of *T. thynnus* populations.

Golet, W.J., Cooper, A.B., Carnpbell, R., and Lutcavage, M. **Decline in condition of northern bluefin tuna (*Thunnus thynnus*) in the Gulf of Maine.** *Fishery Bulletin* 105(3): 390-395, 2007. O/A

Notes: The northern bluefin tuna (*Thunnus thynnus*) is a highly mobile apex predator in the Gulf of Maine. Despite current stock assessments that indicate historically high abundance of its main prey, Atlantic herring (*Clupea harengus*), commercial fishermen have observed declines in the somatic condition of northern bluefin tuna during the last decade. We examined this claim by reviewing detailed logbooks of northern bluefin tuna condition from a local fishermen's co-operative and applying multinomial regression, a robust tool for exploring how a categorical variable may be related to other variables of interest. The data set contained > 3082 observations of condition (fat and oil content and fish shape) from fish landed between 1991 and 2004. Energy from stored lipids is used for migration and reproduction; therefore a reduction in energy acquisition on bluefin tuna feeding grounds could diminish allocations to growth and gamete production and have detrimental consequences for rebuilding the western Atlantic population. A decline in northern bluefin tuna somatic condition could indicate substantial changes in the bottom-up transfer of energy in the Gulf of Maine, shifts in their reproductive or migratory patterns, impacts of fishing pressure, or synergistic effects from multiple causes.

Floeter, S.R., Rocha, L.A., Robertson, D.R., Joyeux, J.C., Smith-Vaniz, W.F., Wirtz, P., Edwards, A.J., Barreiros, J.P., Ferreira, C.E.L., Gasparini, J.L., Brito, A., Falcon, J.M., Bowen, B.W., and Bernardi, G. **Atlantic reef fish biogeography and evolution.** *Journal of Biogeography* 35(1): 22-47, 2008.

Notes: *Aim* To understand why and when areas of endemism (provinces) of the tropical Atlantic Ocean were formed, how they relate to each other, and what processes have contributed to faunal enrichment. *Location* Atlantic Ocean. *Methods* The distributions of 2605 species of reef fishes were compiled for 25 areas of the Atlantic and southern Africa. Maximum-parsimony and distance analyses were employed to investigate biogeographical relationships among those areas. A collection of 26 phylogenies of various Atlantic reef fish taxa was used to assess patterns of origin and diversification relative to evolutionary scenarios based on spatio-temporal sequences of species splitting produced by geological and palaeoceanographic events. We present data on faunal (species and genera) richness, endemism patterns, diversity buildup (i.e. speciation processes), and evaluate the operation of the main biogeographical barriers and/or filters. *Results* Phylogenetic (proportion of sister species) and distributional (number of shared species) patterns are generally concordant with recognized biogeographical provinces in the Atlantic. The highly uneven distribution of species in certain genera appears to be related to their origin, with highest species richness in areas with the greatest phylogenetic depth. Diversity buildup in Atlantic reef fishes involved (1)

diversification within each province, (2) isolation as a result of biogeographical barriers, and (3) stochastic accretion by means of dispersal between provinces. The timing of divergence events is not concordant among taxonomic groups. The three soft (non-terrestrial) inter-regional barriers (mid-Atlantic, Amazon, and Benguela) clearly act as 'filters' by restricting dispersal but at the same time allowing occasional crossings that apparently lead to the establishment of new populations and species. Fluctuations in the effectiveness of the filters, combined with ecological differences among provinces, apparently provide a mechanism for much of the recent diversification of reef fishes in the Atlantic. *Main conclusions* Our data set indicates that both historical events (e.g. Tethys closure) and relatively recent dispersal (with or without further speciation) have had a strong influence on Atlantic tropical marine biodiversity and have contributed to the biogeographical patterns we observe today; however, examples of the latter process outnumber those of the former.

Bonhommeau, S., Chassot, E., and Rivot, E. **Fluctuations in European eel (*Anguilla anguilla*) recruitment resulting from environmental changes in the Sargasso Sea.** *Fisheries Oceanography* 17(1): 32-44, 2008.

Notes: European eel decline is now widely observed and involves a large number of factors such as overfishing, pollution, habitat loss, dam construction, river obstruction, parasitism and environmental changes. In the present study, we analyzed the influence of environmental conditions in the Sargasso Sea and Atlantic Ocean circulation on European glass eel recruitment success. Over a recent 11-yr period, we showed a strong positive correlation between an original index of glass eel recruitment and primary production (PP) in eel spawning area. Moreover, PP was negatively correlated with temperature in the Sargasso Sea. Therefore, we used sea temperature as an inverse proxy of marine production. A close negative relationship has been found over the last four decades between long-term fluctuations in recruitment and in sea temperature. These findings were reinforced by the detection of a regime shift in sea temperature that preceded the start of the decline in glass eel recruitment in the early 1980s. By contrast, variations in integrative indices measuring ocean circulation, i.e. latitude and strength of the Gulf Stream, did not seem to explain variations in glass eel recruitment. Our results support the hypothesis of a strong bottom-up control of leptocephali survival and growth by PP in the Sargasso Sea on short and long time scales. We argue that sea warming in the eel spawning area since the early 1980s has modified marine production and eventually affected the survival rate of European eels at early life stages.

Sumaila, U.R., Khan, A., Watson, R., Munro, G., Zeller, D., Baron, N., and Pauly, D. **The World Trade Organization and global fisheries sustainability.** *Fisheries Research* 88(1-3): 1-4, 2007.

Notes: The World Trade Organization (WTO) is in a unique position to move global fisheries towards sustainability. The current Doha Trade Round of Negotiations offers an important opportunity to improve the future prospects of fish as a main source of animal protein for one-fifth of the world's population. Countries are wrestling with the issue of government fishing subsidies, which keep too many commercial fishing boats in operation and drive the unsustainable exploitation of the world's depleted fish populations. Removal of subsidies is challenging as it cannot be resolved without international cooperation because unilateral action has trade implications, and may not work because fish and fishing vessels do not respect national exclusive economic zones. This is why the WTO, which has in place mechanisms to enforce its agreements, is the only institution that can tackle the global problem of overfishing subsidies. We identify the opportunities and challenges that WTO members face, and provide suggestions on how to address these challenges.

Hamilton, S.L., Caselle, J.E., Standish, J.D., Schroeder, D.M., Love, M.S., Rosales-Casian, J.A., and Sosa-Nishizaki, O. **Size-selective harvesting alters life histories of a temperate sex-changing fish.** *Ecological Applications* 17(8): 2268-2280, 2007.

Notes: Selective mortality, whether caused naturally by predation or through the influence of harvest practices, initiates changes within populations when individuals possessing certain heritable traits have increased fitness. Theory predicts that increased mortality rates will select for changes in a number of different life history characteristics. For example, fishing often targets larger individuals and has been shown repeatedly to alter population size structure and growth rates, and the timing of maturation. For sex-changing species, selective fishing practices can affect additional traits such as the mature population sex ratio and the timing of sexual transformation. Using historical comparisons, we examined the effects of exploitation on life history characteristics of California sheephead, *Semicossyphus pulcher*, a temperate protogynous (female-male sex changer) labrid that inhabits nearshore rocky environments from central California, USA, to southern Baja California, Mexico. Recreational

fishing intensified and an unregulated commercial live-fishery developed rapidly in southern California between the historical and current studies. Collections of *S. pulcher* from three locations (Bahia Tortugas, Catalina Island, and San Nicolas Island) in 1998 were compared with data collected 20-30 years previously to ascertain fishery-induced changes in life history traits. At Bahia Tortugas, where fishing by the artisanal community remained light and annual survivorship stayed high, we observed no changes in size structure or shifts in the timing of maturation or the timing of sex change. In contrast, where recreational (Catalina) and commercial (San Nicolas)fishing intensified and annual survivorship correspondingly declined, males and females shifted significantly to smaller body sizes, females matured earlier and changed sex into males at both smaller sizes and younger ages and appeared to have a reduced maximum lifespan. Mature sex ratios (female : male) increased at San Nicolas, despite a twofold reduction in the mean time spent as a mature female. Proper fisheries management requires measures to prevent sex ratio skew, sperm limitation, and reproductive failure because populations of sequential hermaphrodites are more sensitive to size-selective harvest than separate-sex species. This is especially true for *S. pulcher*, where different segments of the fishery (commercial vs. recreational) selectively target distinct sizes and therefore sexes in different locations.

Cox, T.A., Lewison, R.L., Zydelis, R., Crowder, L.B., Safina, C., and Read, A.J. **Comparing effectiveness of experimental and implemented bycatch reduction measures: The ideal and the real.** *Conservation Biology* 21(5): 1155-1164, 2007.

Notes: Fishers, scientists, and resource managers have made substantial progress in reducing bycatch of sea turtles, seabirds, and marine mammals through physical modifications to fishing gear. Many bycatch-avoidance measures have been developed and tested successfully in controlled experiments, which have led to regulated implementation of modified or new fishing gear. Nevertheless, successful bycatch experiments may not translate to effective mitigation in commercial fisheries because experimental conditions are relaxed in commercial fishing operations. Such a difference between experimental results and real-world results with fishing fleets may have serious consequences for management and conservation of protected species taken as bycatch. We evaluated preimplementation experimental measures and postimplementation efficacy from primary and gray literature for three case studies: acoustic pingers that warn marine mammals of the presence of gill nets, turtle excluder devices that reduce bycatch of turtles in trawls, and various measures to reduce seabird bycatch in longlines. Three common themes to successful implementation of bycatch reduction measures are long-standing collaborations among the fishing industry, scientists, and resource managers; pre- and postimplementation monitoring, and compliance via enforcement and incentives.

Kuparinen, A. and Merila, J. **Detecting and managing fisheries-induced evolution.** *Trends in Ecology and Evolution* 22(12): 652-659, 2007.

Notes: Exploitation of fish populations can induce evolutionary responses in life histories. For example, fisheries targeting large individuals are expected to select for early maturation at smaller sizes, leading to reduced fecundity and thus also reduced fisheries yield. These predicted phenotypic shifts have been observed in several fish stocks, but disentangling the environmental and genetic causes behind them has proved difficult. Here, we review recent studies investigating phenotypic shifts in exploited populations and strategies for minimizing fisheries-induced evolution. Responses to selective harvesting will depend on species-specific life-history traits, and on community-level and environmental processes. Therefore, the detection of fisheries-induced evolution and successful fish stock management requires routine population monitoring, and a good understanding of genetics, relevant ecological processes and changing environmental conditions.

Fergusson, I.K., Graham, K.J., and Compagno, L.J.V. **Distribution, abundance and biology of the smalltooth sandtiger shark *Odontaspis ferox* (Risso, 1810) (Lamniformes: Odontaspididae).** *Environmental Biology of Fishes* 81(2): 207-228, 2008.

Notes: The smalltooth sandtiger shark, *Odontaspis ferox*, has a cosmopolitan distribution across warm temperate and tropical waters, and although essentially demersal, it has also been captured pelagically in mid-ocean. The species often occurs inshore at steeply shelving coastal and insular locations, and has now been identified by divers at eight widely separated shallow water sites. In the Southern Hemisphere, most *O. ferox* were caught by trawl on the continental slope, where its bathic range was extended to at least 880 m. Large specimens (> 200 cm TL) were found across the whole depth range, but almost all juveniles were caught between 200 and 600 m. The largest recorded male was 344 cm TL, and female 450 cm TL. The few biological data suggest that size at maturity for males is around 200-250 cm TL, and for females 300-350 cm. No pregnant females were

recorded but size at birth is probably about 100 cm TL. Nowhere has the species been found in large numbers. Survey and commercial catch data from south-east Australian trawl grounds suggest that numbers of *O. ferox* there have declined since the advent of deepwater commercial trawling in the 1970s. In areas of steep untrawlable terrain, increased gill-netting and longlining are likely to impact on local populations, with mature individuals being particularly vulnerable. Although *O. ferox* is not specifically targeted by commercial fishing activities, its likely very low fecundity make it susceptible to local extirpation, even at seemingly small capture rates. This species is protected off New South Wales and is considered "vulnerable" globally, by the World Conservation Union (IUCN).

August, S.M. and Hicks, B.J. **Water temperature and upstream migration of glass eels in New Zealand: implications of climate change.** *Environmental Biology of Fishes* 81(2): 195-205, 2008.

Notes: Glass eels migrating upstream in a New Zealand river showed a clear preference for water temperatures between 12 and 20ºC, with an optimum of 16.5ºC. Water temperatures < 12ºC and > 22ºC almost completely inhibited migration, which implies that warmer temperatures associated with global climate change might have a detrimental impact on glass eel recruitment in their current ranges. We established this by trapping glass eels of shortfin, *Anguilla australis*, and longfin, *A. dieffenbachii*, eels nightly from September to November. Eels caught in 2001 (50,287) outnumbered those caught in 2002 (19,954); shortfin glass eels dominated catches in both years, comprising 91-93% of the catch. Longfins were larger than shortfins, and size and pigmentation in both species increased as the seasons progressed. Temperatures within the migratory season in 2001 showed ~14-day intervals between maxima that appeared to be associated with the new and full moons.

Waples, R.S., Zabel, R.W., Scheuerell, M.D., and Sanderson, B.L. **Evolutionary responses by native species to major anthropogenic changes to their ecosystems: Pacific salmon in the Columbia River hydropower system.** *Molecular Ecology* 17(1): 84-96, 2008.

Notes: The human footprint is now large in all the Earth's ecosystems, and construction of large dams in major river basins is among the anthropogenic changes that have had the most profound ecological consequences, particularly for migratory fishes. In the Columbia River basin of the western USA, considerable effort has been directed toward evaluating demographic effects of dams, yet little attention has been paid to evolutionary responses of migratory salmon to altered selective regimes. Here we make a first attempt to address this information gap. Transformation of the free-flowing Columbia River into a series of slack-water reservoirs has relaxed selection for adults capable of migrating long distances upstream against strong flows; conditions now favour fish capable of migrating through lakes and finding and navigating fish ladders. Juveniles must now be capable of surviving passage through multiple dams or collection and transportation around the dams. River flow patterns deliver some groups of juvenile salmon to the estuary later than is optimal for ocean survival, but countervailing selective pressures might constrain an evolutionary response toward earlier migration timing. Dams have increased the cost of migration, which reduces energy available for sexual selection and favours a nonmigratory life history. Reservoirs are a benign environment for many non-native species that are competitors with or predators on salmon, and evolutionary responses are likely (but undocumented). More research is needed to tease apart the relative importance of evolutionary vs. plastic responses of salmon to these environmental changes; this research is logistically challenging for species with life histories like Pacific salmon, but results should substantially improve our understanding of key processes. If the Columbia River is ever returned to a quasinatural, free-flowing state, remaining populations might face a Darwinian debt (and temporarily reduced fitness) as they struggle to re-evolve historical adaptations.

Hutchings, J.A. and Fraser, D.J. **The nature of fisheries- and farming-induced evolution.** *Molecular Ecology* 17(1): 294-313, 2008.

Notes: Humans have a penchant for unintentionally selecting against that which they desire most. In fishes, unprecedented reductions in abundance have been associated with unprecedented changes in harvesting and aquaculture technologies. Fishing, the predominant cause of fish-population collapses, is increasingly believed to generate evolutionary changes to characters of import to individual fitness, population persistence and levels of sustainable yield. Human-induced genetic change to wild populations can also result from interactions with their domesticated counterparts. Our examination of fisheries- and farming-induced evolution includes factors that may influence the magnitude, rate and reversibility of genetic

responses, the potential for shifts in reaction norms and reduced plasticity, loss of genetic variability, outbreeding depression and their demographic consequences to wild fishes. We also suggest management initiatives to mitigate the effects of fisheries- and farming-induced evolution. Ultimately, the question of whether fishing or fish farming can cause evolutionary change is moot. The key issue is whether such change is likely to have negative conservation or socio-economic consequences. Although the study of human-induced evolution on fishes should continue to include estimates of the magnitude and rate of selection, there is a critical need for research that addresses short- and long-term demographic consequences to population persistence, plasticity, recovery and productivity.

Temming, A., Floeter, J., and Ehrich, S. **Predation hot spots: Large scale impact of local aggregations.** *Ecosystems* 10(6): 865-876, 2007.

Notes: Broad scale survey distributions of fish are dominated by some extremely high catches. With a novel survey design we resolved the small-scale fish distribution in the spatio-temporal vicinity of these extreme hauls and showed that in the North Sea they generally do not occur in isolation. An additional case study where stomach contents of fish predators were analyzed revealed that they actually indicate aggregations of piscivorous fish predators on prey aggregations. We show that the predation impact can reach immense dimensions, an aggregation of more than 50 million juvenile cod (*Gadus morhua*) was entirely wiped out in 5 days by predatory whiting (*Merlangius merlangus*), aggregating on these juveniles in an area of approximately 18 km^2. The consumption of only 32 hot spots of similar magnitude as observed in our study adds up to the average size of an incoming North Sea cod year class. These findings support the hypothesis of predation as the major source of mortality in young-of-the-year demersal fish species and questions the generality of fish aggregation as an effective anti-predator strategy. This study highlights the system-wide structuring force of small-scale predation hot spots and further points to the importance of a more realistic implementation of local high-intensity predation events in food web models.

Hilborn, R. **Reinterpreting the state of fisheries and their management.** *Ecosystems* 10(8): 1362-1369, 2007.

Notes: A series of recent high-profile papers in *Science* and *Nature* have led readers to believe that most fisheries worldwide are overexploited and that current fisheries management practices have universally failed. In reality, current fisheries management is working well to achieve the legislated objective of MSY in some countries but is failing in others. Here, I present three interpretations about the status of fisheries management that are widely accepted and for each consider an alternative interpretation of the data. I propose that, rather than abandoning current approaches to fisheries management, we should expand the use of the management tools used in fisheries that currently achieve biological and economic sustainability.

García, V.B., Lucifora, L.O., and Myers, R.A. **The importance of habitat and life history to extinction risk in sharks, skates, rays and chimaeras.** *Proceedings of the Royal Society of London [B]* 275(1630): 83-89, 2008.

Notes: We compared life-history traits and extinction risk of chondrichthyans (sharks, rays and chimaeras), a group of high conservation concern, from the three major marine habitats (continental shelves, open ocean and deep sea), controlling for phylogenetic correlation. Deep-water chondrichthyans had a higher age at maturity and longevity, and a lower growth completion rate than shallow-water species. The average fishing mortality needed to drive a deep-water chondrichthyan species to extinction ($F_{extinct}$) was 38-58% of that estimated for oceanic and continental shelf species, respectively. Mean values of $F_{extinct}$ were 0.149, 0.250 and 0.368 for deep-water, oceanic and continental shelf species, respectively. Reproductive mode was an important determinant of extinction risk, while body size had a weak effect on extinction risk. As extinction risk was highly correlated with phylogeny, the loss of species will be accompanied by a loss of phylogenetic diversity. Conservation priority should not be restricted to large species, as is usually suggested, since many small species, like those inhabiting the deep ocean, are also highly vulnerable to extinction. Fishing mortality of deep-water chondrichthyans already exploited should be minimized, and new deep-water fisheries affecting chondrichthyans should be prevented.

Mora, C., Tittensor, D.P., and Myers, R.A. **The completeness of taxonomic inventories for describing the global diversity and distribution of marine fishes.** *Proceedings of the Royal Society of London [B]* 275(1631): 149-155, 2008.

Notes: Taxonomic inventories (or species censuses) are the most elementary data in biogeography, macroecology and conservation biology. They play fundamental roles in the construction of species richness patterns, delineation of species ranges, quantification of extinction risk and prioritization of conservation efforts in hot spot areas. Given their importance, any issue related to the completeness of taxonomic inventories can have far-reaching consequences. Here, we used the largest publicly available database of georeferenced marine fish records to determine its usefulness in depicting the diversity and distribution of this taxonomic group. All records were grouped at multiple spatial resolutions to generate accumulation curves, from which the expected number of species were extrapolated using a variety of nonlinear models. Comparison of the inventoried number of species with that expected from the models was used to calculate the completeness of the taxonomic inventory at each resolution. In terms of the global number of fish species, we found that approximately 21% of the species remain to be described. In terms of spatial distribution, we found that the completeness of taxonomic data was highly scale dependent, with completeness being lower at finer spatial resolutions. At a 3° (approx. 350 km^2) spatial resolution, less than 1.8% of the world's oceans have above 80% of their fish fauna currently described. Censuses of species were particularly incomplete in tropical areas and across the entire range of countries' gross domestic product (GDP), although the few censuses nearing completion were all along the coasts of a few developed countries or territories. Our findings highlight that failure to quantify the completeness of taxonomic inventories can introduce substantial flaws in the description of diversity patterns, and raise concerns over the effectiveness of conservation strategies based upon data that remain largely precarious.

Kaiser, M.J. and Hiddink, J.G. **Food subsidies from fisheries to continental shelf benthic scavengers.** *Marine Ecology Progress Series* 350: 267-276, 2007. **O/A**

Notes: Fisheries generate carrion as a result of material discarded at sea from fishing boats, and as a result of the direct mortality of organisms on the seabed that is caused by the bottom trawling gears. It is unclear whether the increases in the population sizes in scavenging seabirds that have been partially attributed to discarding practices might be mirrored in populations of benthic scavengers. We used a previously published and field-validated, size-based model to calculate the effects of bottom fishing on benthic invertebrate production and production of invertebrate carrion at the seabed in the North Sea. This estimate was combined with previously published estimates of discarded fish carrion that reaches the seabed. Fishing decreases benthic biomass; this means that benthic production is also reduced. In this process, fishing increases production in the short term (2 to 3 d) by generating carrion. However, the production of carrion only compensates for 22% of the reduction in production. Calculations of ash free dry weight of carrion produced per unit area were similar to other previous estimates for the North Sea, which indicated that fisheries-generated carrion was sufficient to sustain benthic carnivores for only approximately 3 d yr^{-1}.

Mollet, F.M., Kraak, S.B.M., and Rijnsdorp, A.D. **Fisheries-induced evolutionary changes in maturation reaction norms in North Sea sole *Solea solea*.** *Marine Ecology Progress Series* 351: 189-199, 2007.

Notes: Age and size at maturation decreased in several commercially exploited fish stocks, which, according to life history theory, may be due to fisheries-induced evolutionary change. However, the observed changes may also represent a plastic response to environmental variability. To disentangle phenotypic plasticity from evolutionary change, the probabilistic reaction norm approach was applied to 43 cohorts (1960 to 2002) of female sole *Solea solea* from market samples. The reaction norm for age and size at first maturation has significantly shifted towards younger age and smaller size. Size at 50% probability of maturation at Age 3 decreased from 28.6 cm (251 g) to 24.6 cm (128 g). This change was even stronger when condition was included as a third dimension in the reaction norm estimation. The influence of alternative factors was tested on the population level by regression of reaction norm midpoints on annual estimates of condition, temperature and competitive biomass. Although effects of temperature and competitive biomass were significant, the variation in the midpoints was best explained by the decreasing time trend. Therefore, the results provide strong evidence for a fisheries-induced evolutionary change in the onset of sexual maturity.

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de Mutsert, K., Cowan, J.H., Essington, T.E., and Hilborn, R. **Reanalyses of Gulf of Mexico fisheries data: Landings can be misleading in assessments of fisheries and fisheries ecosystems.** *Proceedings of the National Academy of Sciences [USA]* 105(7): 2740-2744, 2008.

Notes: We used two high profile articles as cases to demonstrate that use of fishery landings data can lead to faulty interpretations about the condition of fishery ecosystems. One case uses the mean trophic level index and its changes, and the other uses estimates of fishery collapses. In earlier analyses by other authors, marine ecosystems in the Gulf of Mexico (GOM) and U.S. Atlantic Ocean south of Chesapeake Bay were deemed to be severely overfished and the food webs badly deteriorated using these criteria. In our reanalyses, the low mean trophic level index for the GOM actually resulted from large catches of two groups of low trophic level species, menhaden and shrimp, and the mean trophic level was slowly increasing rather than decreasing. Commercial targeting and high landings of shrimps and menhaden, especially in the GOM, drove the index as previously calculated. Reanalyses of fishery collapses incorporating criteria that included targeting, variability in fishing effort, and market forces discovered many false cases of collapse based simply upon a decline of catches to 10% of previous maximum levels. Consequently, we suggest that the low mean trophic level index calculated in the earlier article for the GOM did not reflect the overall condition of the fishery ecosystem, and that the 10% rule for collapse should not be interpreted out of context in the GOM or elsewhere. In both cases, problems lay in the assumption that commercial landings data alone adequately reflect the fish populations and communities.

Biro, P.A. and Post, J.R. **Rapid depletion of genotypes with fast growth and bold personality traits from harvested fish populations.** *Proceedings of the National Academy of Sciences [USA]* 105(8): 2919-2922, 2008.

Notes: The possibility for fishery-induced evolution of life history traits is an important but unresolved issue for exploited fish populations. Because fisheries tend to select and remove the largest individuals, there is the evolutionary potential for lasting effects on fish production and productivity. Size selection represents an indirect mechanism of selection against rapid growth rate, because individual fish may be large because of rapid growth or because of slow growth but old age. The possibility for direct selection on growth rate, whereby fast-growing genotypes are more vulnerable to fishing irrespective of their size, is unexplored. In this scenario, faster-growing genotypes may be more vulnerable to fishing because of greater appetite and correspondingly greater feeding-related activity rates and boldness that could increase encounter with fishing gear and vulnerability to it. In a realistic whole-lake experiment, we show that fast-growing fish genotypes are harvested at three times the rate of the slow-growing genotypes within two replicate lake populations. Overall, 50% of fast-growing individuals were harvested compared with 30% of slow-growing individuals, independent of body size. Greater harvest of fast-growing genotypes was attributable to their greater behavioral vulnerability, being more active and bold. Given that growth is heritable in fishes, we speculate that evolution of slower growth rates attributable to behavioral vulnerability may be widespread in harvested fish populations. Our results indicate that commonly used minimum size-limits will not prevent overexploitation of fast-growing genotypes and individuals because of size-independent growth-rate selection by fishing.

Gilman, E. *et al.* **Shark interactions in pelagic longline fisheries.** *Marine Policy* 32(1): 1-18, 2008.

Notes: Substantial ecological, economic and social problems result from shark interactions in pelagic longline fisheries. Improved understanding of industry attitudes and practices towards shark interactions assists with managing these problems. Information on fisher knowledge and new strategies for shark avoidance may benefit sharks and fishers. A study of 12 pelagic longline fisheries from eight countries shows that incentives to avoid sharks vary along a continuum, based on whether sharks represent an economic disadvantage or advantage. Shark avoidance practices are limited, including avoiding certain areas, moving when shark interaction rates are high, using fish instead of squid for bait and deeper setting. Some conventionally employed fishing gear and methods used to target non-shark species contribute to shark avoidance. Shark repellents hold promise; more research and development is needed. Development of specifically designed equipment to discard sharks could improve shark post release survival prospects, reduce gear loss and improve crew safety. With expanding exploitation of sharks for fins and meat, improved data collection, monitoring and precautionary shark management measures are needed to ensure that shark fishing mortality levels are sustainable.

Morishita, J. **What is the ecosystem approach for fisheries management.** *Marine Policy* 32(1): 19-26, 2008.

Notes: The ecosystem approach for fisheries management is a widely accepted concept and various international instruments require its application. However, there are various interpretations of the ecosystem approach and its application almost always brings about confrontations and resistance among managers, proponents, and stakeholders. This paper categorizes the ecosystem approach into four distinguishable types: bycatch mitigation, multi-species management, protection of vulnerable ecosystems, and integrated approach. Furthermore, the lack of identification and understanding of specific management goals is hampering the application of the ecosystem approach. Unless the stakeholders understand and accept the goals, the ecosystem approach will not succeed.

Branch, T.A. **Not all fisheries will be collapsed in 2048.** *Marine Policy* 32(1): 38-39, 2008.

Notes: In a recently published paper, Worm *et al.* [Impacts of biodiversity loss on ocean ecosystem services. *Science* 2006; 314: 787-90.] project "the global collapse of all taxa currently fished" by 2048. Using their criteria and data, this paper shows that the number of not-collapsed fisheries actually increased over time to a plateau of about 5600 in 1985-2003. Furthermore, if trends are projected into the future, more than half of the world's fisheries would always be in a recovered state.

Hilborn, R. **Managing fisheries is managing people: what has been learned?** *Fish and Fisheries* 8(4): 285-296, 2007.

Notes: Understanding the behaviour of fishermen is a key ingredient to successful fisheries management. The aggregate behaviour of fishing fleets can be predicted and managed with appropriate incentives. To determine appropriate incentives, we should look to successes to learn what works and what does not. In different fisheries incentive systems have been found to reduce the race-for-fish and make fisheries profitable, to stimulate stock rebuilding, to reduce bycatch, and to provide for reductions in illegal fishing. Yet, success can be evaluated in many dimensions, but is, in fact, rarely done - per cent overfished seems to be the dominant measure of performance. I evaluate the yield lost due to overfishing in several ecosystems and contrast the situation of North Atlantic cod where considerable yield is lost, to fisheries in New Zealand and the west coast of the USA where lost yield due to overfishing is very small. Much more systematic evaluation of the other aspects of fisheries performance is greatly needed. From examples explored in this paper I conclude that prevention of overfishing can be achieved with strong central governments enforcing conservative catch regulations, but economic success appears to require an appropriate incentive structure.

Hill, S.L., Watters, G.M., Punt, A.E., McAllister, M.K., LeQuere, C., and Turner, J. **Model uncertainty in the ecosystem approach to fisheries.** *Fish and Fisheries* 8(4): 315-336, 2007.

Notes: Fisheries scientists habitually consider uncertainty in parameter values, but often neglect uncertainty about model structure, an issue of increasing importance as ecosystem models are devised to support the move to an ecosystem approach to fisheries (EAF). This paper sets out pragmatic approaches with which to account for uncertainties in model structure and we review current ways of dealing with this issue in fisheries and other disciplines. All involve considering a set of alternative models representing different structural assumptions, but differ in how those models are used. The models can be asked to identify bounds on possible outcomes, find management actions that will perform adequately irrespective of the true model, find management actions that best achieve one or more objectives given weights assigned to each model, or formalize hypotheses for evaluation through experimentation. Data availability is likely to limit the use of approaches that involve weighting alternative models in an ecosystem setting, and the cost of experimentation is likely to limit its use. Practical implementation of an EAF should therefore be based on management approaches that acknowledge the uncertainty inherent in model predictions and are robust to it. Model results must be presented in ways that represent the risks and trade-offs associated with alternative actions and the degree of uncertainty in predictions. This presentation should not disguise the fact that, in many cases, estimates of model uncertainty may be based on subjective criteria. The problem of model uncertainty is far from unique to fisheries, and a dialogue among fisheries modellers and modellers from other scientific communities will therefore be helpful.

Okey, T.A., Wright, B.A., and Brubaker, M.Y. **Salmon shark connections: North Pacific climate change, indirect fisheries effects, or just variability?** *Fish and Fisheries* 8(4): 359-366, 2007.

Notes: A variety of changes are occurring in the ecosystems of the North Pacific Ocean and Bering Sea, but information about the mechanisms of change has been relatively limited, due in part to the region's remoteness and subarctic conditions. Any number of ecosystem components or indicators could be used to exemplify this dilemma, but here we point to the salmon shark (*Lamna ditropis*, Lamnidae) as an example of a species that can potentially mediate considerable ecosystem change due to its high trophic level, but for which some basic information is lacking despite attracting some interesting research and widespread rumours and anecdotal evidence of increased abundance. Increases in the abundance of sharks such as salmon sharks in this region during the 1990s, if true, may help explain other observed changes such as declines in ocean survival rates of Pacific salmon (*Oncorhynchus* spp., Salmonidae) in the region and declines in some wild salmon stocks. Mechanisms that could cause salmon shark increases in Alaskan coastal waters include: (i) increases in sea temperature since the 1970s allowing distributional shifts of this species and changes in the abundance or distribution of their prey; (ii) the 1992 banning of high seas drift gillnets; and (iii) indirect fisheries effects such as competitive release of salmon sharks in the North Pacific transition region and towards the more southern geographic extent of their annual migration as the result of fishery-related reductions in blue sharks (*Prionace glauca*, Carcharhinidae) and other pelagic predators. The relative plausibility of these alternative explanations can be evaluated using combinations of existing ecosystem models and empirical research and monitoring programmes including local and indigenous observations.

Maes, G.E. and Volckaert, F.A.M. **Challenges for genetic research in European eel management.** *ICES Journal of Marine Science* 64(7): 1463-1471, 2007.

Notes: Marine organisms experience a broad range of intrinsic and extrinsic influences during their lives, which impact their population dynamics and genetic structure. Subtle interpopulation differences reflect the continuity of the marine environment, but also pose challenges to those wishing to define management units. The catadromous European eel (*Anguilla anguilla*) is no exception. Its spawning habitat in the Sargasso Sea and long migration across the North Atlantic qualify it as marine. However, the synergy between hydro-graphic variability, changing climate, and the impacts of habitat degradation and overfishing in continental waters has negatively affected stock sizes. Its protracted spawning period, variance in age-at-maturity, parental contribution and reproductive success, and the difficulty in sampling the spawning region together may mask a weak geographical genetic differentiation. Recent molecular data report evidence for spatial as well as temporal differences between populations, with the temporal heterogeneity between intraannual recruitment and annual cohorts exceeding the spatial differences. Despite its common name of "fresh-water eel", the European eel should really be managed on a North Atlantic scale. The fishery may have to be curtailed, migration routes kept open and water quality restored if it is to survive. Eel aquaculture has to focus on efficient rearing in the short term and controlled breeding in the long term. Future research on eel genetics should focus on (i) sampling and analysing spawning populations and recruitment waves to detect spatio-temporally discrete groups, and establishing a biological baseline from pre-decline historical collections for critical long-term monitoring and modelling of its genetic composition; (ii) the analysis of adaptive genetic polymorphism (genes under selection) to detect adaptive divergence between populations, perhaps requiring separate management strategies; and (iii) improving artificial reproduction to protect natural stocks from heavy exploitation, especially now the species has been categorized as endangered.

Astrom, M. and Dekker, W. **When will the eel recover? A full life-cycle model.** *ICES Journal of Marine Science* 64(7): 1491-1498, 2007.

Notes: The European eel population has declined over the past decades in most of its distribution area, and the stock is outside safe biological limits. The EU has taken up the challenge to design a management system that ensures the escapement of 40% of spawning-stock biomass, relative to unexploited, unpolluted circumstances in unobstructed rivers. This ultimately aims to restore the spawning stock to a level at which glass eel production is not impaired, i.e. to restore to full historical glass eel recruitment. To explore the trajectory from the current depleted state to full recruitment recovery, we developed a simple model of stock dynamics, based on a simplified stock-recruitment relationship and the conventional dynamic pool assumptions. Recruitment trajectories under different future fishery regimes are explored, for the medium (one generation time) and long time-span (until full recruitment recovery). Reducing fisheries to zero, recovery is expected within ~ 80 years,

whereas under an ultimately sustainable fishing regime of just 10% of the current rate of fishing mortality, recovery may take more than 200 years. Moreover, management regimes, apparently leading to slight recovery of the stock in the coming 5-15 years, might still be unsustainable in the long run.

Belpaire, C. and Goemans, G. **Eels: contaminant cocktails pinpointing environmental contamination.** *ICES Journal of Marine Science* 64(7): 1423-1436, 2007.

Notes: There is growing concern that insufficient somatic and health conditions of silver European eels (*Anguilla anguilla*) emigrating from European waters to oceanic spawning areas might be a key causative factor in the decline of the stock. One factor that could contribute to deterioration in the status of eels is high contaminant accumulation in their body. Contaminants may affect lipid metabolism and result in lower energy stores. A high body burden of contaminants and low energy stores might be responsible for failure of migration and/or impairment of successful reproduction. During a 12-year study on a relatively small area within the 2 river basins of Ijzer, Scheldt, and Meuse (ca. 13 500 km^2), 2613 eels were sampled covering a dense monitoring network of 357 stations. Eels were analysed for ca. 100 chemicals. These included PCBs, organochlorine pesticides, heavy metals, brominated flame retardants, volatile organic pollutants (VOCs), endocrine disruptors, dioxins, perfluorooctane sulphonic acids (PFOSs), metallothioneins, and polycyclic aromatic compounds. This series represents only a very small fraction (<0.5%) of the >30 000 chemicals currently marketed and used in Europe. The biomonitoring value of eels as a tool for monitoring environmental contamination is illustrated. Two major conclusions were drawn: (i) the eel is a highly suitable biomonitor for environmental contaminants, for both local and international purposes, e.g. to evaluate the chemical status for the Water Framework Directive, and (ii) dependent on the degree of pollution in their habitat, the levels of certain contaminants reported in yellow eels can be high, and might affect their potential for reproduction.

Jennings, S. and Revill, A.S. **The role of gear technologists in supporting an ecosystem approach to fisheries.** *ICES Journal of Marine Science* 64(8): 1525-1534, 2007.

Notes: Central to an ecosystem approach to fisheries (EAF) is reconciling the short-term need for catches with the long-term need for sustainability of target species and other ecosystem components. We assess the role of gear technology in supporting the objectives and implementation of EAF and identify the circumstances in which investment in the environmental performance of fishing gear provides the greatest benefits. The greatest benefits are usually achieved when gear technologists embed the new technology in the management system and when there are clear incentives to use it. We propose a framework for comparing combinations of management measures that might support EAF, based on knowledge of the environmental impacts of different gears in different areas and management systems. This framework helps us assess when fishing effects "matter" and when gear technologists should contribute to mitigating unwanted effects. Incentives and effective enforcement will be key to introducing gears with lower environmental impact. We expect that future emphasis on marine spatial planning, the use of environmental impact assessment and strategic environmental assessment for fisheries, more equitable treatment of fisheries and other marine sectors, and rising oil prices will lead to greater pressure on gear technologists to support EAF.
