

### In this review:

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## A. Recent publications available online

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Petersen, S.L., Nel, D.C. and Ouardien, A. (eds.) 2007. **Towards an Ecosystem Approach to Longline Fisheries in the Benguela: An Assessment of Impacts on Seabirds, Sea Turtles and Sharks.** WWF Report Series – 2007/Marine/001. 94pp.

**Available at:** [http://assets.panda.org/downloads/longline\\_fishing\\_africa.pdf](http://assets.panda.org/downloads/longline_fishing_africa.pdf)

**Notes:** This report assesses the scale and nature of the mortality of seabirds, sea turtles and sharks in longline fishing operations in the Benguela Current Large Marine Ecosystem. It concludes that approximately 6.6 million pelagic sharks, an estimated 4 200 sea turtles and some 33 850 seabirds are killed each year.

## B. Recent articles with abstracts

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Myers, R.A., Baum, J.K., Shepherd, T.D., Powers, S.P., and Peterson, C.H. **Cascading effects of the loss of apex predatory sharks from a coastal ocean.** *Science* 315(5820): 1846-1850, 2007.

**Notes:** Impacts of chronic overfishing are evident in population depletions worldwide, yet indirect ecosystem effects induced by predator removal from oceanic food webs remain unpredictable. As abundances of all 11 great sharks that consume other elasmobranchs (rays, skates, and small sharks) fell over the past 35 years, 12 of 14 of these prey species increased in coastal northwest Atlantic ecosystems. Effects of this community restructuring have cascaded downward from the cownose ray, whose enhanced predation on its bay scallop prey was sufficient to terminate a century-long scallop fishery. Analogous top-down effects may be a predictable consequence of eliminating entire functional groups of predators.

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Newton, K., Côté, I.M., Pilling, G.M., Jennings, S., and Dulvy, N.K. **Current and future sustainability of island coral reef fisheries.** *Current Biology* 17(7): 655-658, 2007.

**Notes:** Overexploitation is one of the principal threats to coral reef diversity, structure, function, and resilience. Although it is generally held that coral reef fisheries are unsustainable, little is known of the overall scale of exploitation or which reefs are overfished. Here, on the basis of ecological footprints and a review of exploitation status, we report widespread unsustainability of island coral reef fisheries. Over half (55%) of the 49 island countries considered are exploiting their coral reef fisheries in an unsustainable way. We estimate that total landings of coral reef fisheries are currently 64% higher than can be sustained. Consequently, the area of coral reef appropriated by fisheries exceeds the available effective area by ~75,000 km<sup>2</sup>, or 3.7 times the area of Australia's Great Barrier Reef, and an extra 196,000 km<sup>2</sup> of coral reef may be required by 2050 to support the anticipated growth in human populations. The large overall imbalance between current and sustainable catches implies that management methods to reduce social and economic dependence on reef fisheries are essential to prevent the collapse of coral reef ecosystems while sustaining the well-being of burgeoning coastal populations.

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Brown, J. and Macfadyen, G. **Ghost fishing in European waters: Impacts and management responses.** *Marine Policy* 31(4): 488-504, 2007.

**Notes:** In this paper we review levels of net loss, what happens to the gear once it has been lost, and the resulting levels of 'ghost catches' made in passive net fisheries in the EU. We also consider ghost catches resulting from lost gear in other types of fisheries, and the extent to which the value of ghost catches has been quantified. We consider why fishing gear is lost, and profile common management responses. We present a cost benefit model to assess the relative cost effectiveness of different management measures, and suggest that gear retrieval programmes may provide less value for money than other management responses.

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Hawkins, J.P., Roberts, C.M., Gell, F.R., and Dytham, C. **Effects of trap fishing on reef fish communities.** *Aquatic Conservation: Marine and Freshwater Ecosystems* 17(2): 111-132, 2007.

**Notes:** 1. Trap fishing is widespread on coral reefs but the sustainability of this practice is causing concern because it is efficient and unselective. The effects of trap fishing were investigated by comparing fish assemblages among six Caribbean islands subject to different trapping pressures. These ranged from none in Bonaire and Saba increasing through Puerto Rico, St Lucia, Dominica and Jamaica respectively. 2. Fish were censused at depths of 5 m and 15 m on fore-reef slopes by counting the numbers within replicate 10 m diameter areas for 15 min. Between 64 and 1375 counts were made in each country. 3. In St Lucia and Jamaica abundance of fish censused on the reef was compared to representation in traps which were visually sampled underwater in the area of fish counts. Twenty-three traps were sampled in Jamaica and 75 in St Lucia. For some comparisons between these islands, St Lucian sampling effort was reduced to that of Jamaica (23 traps and 112 counts) by randomly sub-sampling 10 times. 4. Traps contained 54 different species in St Lucia and 22 in Jamaica, while there were 90 and 57 respectively in counts. After reducing St Lucian sampling effort to Jamaican levels, an average of 35 species were found in traps and 70 seen in counts. Of these, 76% in St Lucia and 73% in Jamaica were relatively more abundant in traps than they were on the reef. 5. Species were considered to be highly susceptible to trapping if the ratio of their abundance in traps compared to that on the reef exceeded 3:1. Trapping pressure was approximately three and a half times greater in Jamaica than St Lucia. After equalizing sampling effort, there was an average of 16 highly trappable species in St Lucia compared to 13 in Jamaica. Species did not always appear highly trappable in both countries. Eleven of St Lucia's highly trappable species were absent from Jamaica (falling to 8.5 on average after equalizing sampling effort), but none vice versa, suggesting that trapping may have contributed to their absence or rarity on Jamaican reefs. 6. The Tetraodontiformes, which include many non-target species, were particularly susceptible to trapping in both countries. Their abundance in the six islands censused was inversely related to trap fishing pressure, as was that of two other non-target families, butterflyfish (Chaetodontidae) and angelfish (Pomacanthidae). 7. To determine whether fish that are common in traps in St Lucia are reaching sexual maturity before capture, size frequency data for 23 species from a sample of trap catches were gathered and examined for their state of maturity. In seven species, more than a third of 705 trapped fish were immature, indicating that trap fishing causes growth over-fishing (premature removal of fish), and calling into question the sustainability of yields for these species. 8. In conclusion, at the intensities seen in this study, trap fisheries cause serious over-fishing, reduce biodiversity, and alter ecosystem structure. While commonly perceived as low impact, coral reef trap fisheries in the Caribbean and further afield, need tighter regulation and control.

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Hiddink, J.G., Jennings, S., and Kaiser, M.J. **Assessing and predicting the relative ecological impacts of disturbance on habitats with different sensitivities.** *Journal of Applied Ecology* 44(2): 405-413, 2007.

**Notes:** Methods for assessing habitat sensitivity to human impacts are needed to gauge the sustainability of existing impacts, develop spatial management plans and support meaningful environmental impact assessments. These methods should be quantitative, validated, repeatable and applicable at the scales of impact and management. Existing methods for assessing the sensitivity of marine habitats to human impacts have tended to rely on expert judgement and/or scoring systems. They are neither validated, quantitative nor repeatable. We have developed a method that meets the criteria for assessing the sensitivity of seabed habitats to physical disturbance, and delineating and mapping habitat sensitivity at large spatial scales (> 10<sup>5</sup> km<sup>2</sup>). The method assumes that sensitivity is related to the recovery time of production or biomass, as predicted using a size-based

model that takes account of the effects of natural disturbance. As trawling disturbance is a major and widespread direct human impact on shelf seas, this was used as an example of anthropogenic physical disturbance. We mapped habitat sensitivity to trawling in 9-km<sup>2</sup> boxes across an area of 125 000 km<sup>2</sup> in the North Sea. Habitat sensitivities varied widely, and a trawling frequency of 5 year<sup>-1</sup> in the least-sensitive habitat had the same ecological effect as a trawling frequency of 0.3 year<sup>-1</sup> in the most-sensitive habitat (based on production). When trawling effort was held constant but redirected to the least-sensitive habitats, the existing impacts on production and biomass were reduced by 36% and 25%, respectively. *Synthesis and applications.* The method described in this paper enables managers to predict the implications of changing patterns of human impact on seabed habitats when establishing spatial management plans. In the context of fisheries management, this will support the identification and selection of fishing grounds that minimize the adverse ecological effects of fishing; the selection of closed areas (both representative and highly sensitive); the comparison of management options that might reduce the overall environmental impacts of fishing; and any future steps towards the application of environmental impact assessment in advance of fishery development.

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Rulifson, R.A. **Spiny dogfish mortality induced by gill-net and trawl capture and tag and release.** *North American Journal of Fisheries Management* 27(1): 279-285, 2007.

**Notes:** The spiny dogfish *Squalus acanthias* was once classified as an underutilized species along the U.S. east coast, but it constituted a lucrative fishery in the 1990s until recruitment overfishing caused stock collapse. Coastwide restrictions currently apply; federal stock assessment models use bycatch mortality estimates of 50% for trawling, 75% for gill netting, and 100% for hook-and-line fishing. This study examined mortality at the southern end of commercial fishing operations caused by trawling for 30- and 90-min periods and by gill nets of various mesh sizes set for 19- to 24-h periods. Both experiments used tagged and untagged fish placed in rectangular cages anchored to the seafloor for 48 h. Tags were the Floy SS-94 single-barb nylon dart with a stainless steel wire insert. A total of 635 spiny dogfish were captured by trawl and all were alive, for a 0% initial mortality rate. A total of 2,284 spiny dogfish were collected by gill net for an initial mortality rate of 17.5%. There was no additional mortality in the 480 trawl-caught fish held for 48 h, but there was 33.3% mortality among the 480 gill-net-caught fish held under the same conditions, for an overall gill-net mortality rate of 55.0%. Examination of subsampled catches indicated that 88.6% of gill-net-caught fish had gill-net marks on the head and 41.2% had gill-net marks on the girth but, interestingly, 26.1% of trawl-caught fish had the same markings, indicating prior gill-net capture and release. Female spiny dogfish caught by gill net had a 3.6% abortion rate, compared with zero incidences of those caught by trawl. There was no significant difference in mortality between tagged and untagged fish caught by trawl or by gill net. Tag loss after 48 h was less than 1%.

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Kaplan, I.C., Cox, S.P., and Kitchell, J.F. **Circle hooks for Pacific longliners: Not a panacea for marlin and shark bycatch, but part of the solution.** *Transactions of the American Fisheries Society* 136(2): 392-401, 2007.

**Notes:** Blue marlin *Makaira nigricans*, striped marlin *Tetrapturus audax*, and pelagic sharks (e.g., blue shark *Prionace glauca*) are commonly caught as bycatch by longline fisheries in the central North Pacific Ocean. Recently, concern has increased about depletion of these species. Modifications in longline gear may offer one solution. Here, we test the use of circle hooks, rather than the conventional tuna-style hooks, on longlines using an ecosystem model of the central North Pacific Ocean. The simulations considered span a range of reasonable circle hook catchability and survival rates for released fish. The results suggest that if circle hooks have higher catchability than the currently used tuna-style hooks, switching to circle hooks depletes marlin biomass by 25-40% and shark biomass by 15-35% over 30 years. However, these depletions do not occur if circle hook catchability is equal to or lower than that of tuna-style hooks. When the effects of catch-and-release requirements for marlins and sharks were also considered, we found that regardless of assumptions about circle hook catchability and survival rates, a combined policy of using circle hooks and releasing sharks and marlins leads to net increases in marlin and shark abundance. The simulations show a trade-off between the abundance of marlins and sharks and their prey items, yellowfin tuna *Thunnus albacares* and small blue sharks. There is also evidence of trophic trade-offs between yellowfin tuna and small blue sharks and their prey, small scombrids (*Auxis* spp.) and mahi mahi *Coryphaena hippurus*. The results illustrate the importance of understanding catchability and survival rates for circle hooks compared with those for tuna-style hooks and encourage further research in this area.

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Read, A.J. **Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments.** *Biological Conservation* 135(2): 155-169, 2007.

**Notes:** Circle hooks have been proposed as a means of reducing the by-catch mortality of sea turtles in pelagic longline fisheries to sustainable levels. I examine the efficacy of circle hooks as a sea turtle conservation measure by examining the results of field trials conducted in the western North Atlantic, the Azores, the Gulf of Mexico, and Ecuador. These experiments employed more than a million and a half hooks between 2000 and 2004 and, in general, were well designed, conducted and analyzed. Four of five experiments demonstrated a significant reduction in capture rate and/or hooking location, indicating that circle hooks would reduce overall mortality. In one trial, however, circle hooks reduced catches of target species to such a degree that their use was impractical. I conclude, therefore, that circle hooks have the potential to reduce the mortality of sea turtles captured in many (but not all) pelagic longline fisheries, but that they should be field tested in a rigorous experiment before they are required in any fishery. Circle hooks will not reduce mortality rates of sea turtles in every pelagic longline fishery; each case needs to be tested before this measure is adopted. Circle hooks reduce turtle mortality because of their shape and size and the ways that these parameters interact with the size of turtles interacting with the fishery. Circle hooks may cause a reduction in turtle mortality by decreasing the incidence of hook ingestion as well as reducing capture rate, particularly for loggerhead sea turtles.

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Garcia de Leaniz, C., Fleming, I.A., Einum, S., Verspoor, E., Jordan, W.C., Consuegra, S., Aubin-Horth, N., Lajus, D., Letcher, B.H., Youngson, A.F., Webb, J.H., Vollestad, L.A., Villanueva, B., Ferguson, A., and Quinn, T.P. **A critical review of adaptive genetic variation in Atlantic salmon: implications for conservation.** *Biological Reviews* 82(2): 173-211, 2007.

**Notes:** Here we critically review the scale and extent of adaptive genetic variation in Atlantic salmon (*Salmo salar* L.), an important model system in evolutionary and conservation biology that provides fundamental insights into population persistence, adaptive response and the effects of anthropogenic change. We consider the process of adaptation as the end product of natural selection, one that can best be viewed as the degree of matching between phenotype and environment. We recognise three potential sources of adaptive variation: heritable variation in phenotypic traits related to fitness, variation at the molecular level in genes influenced by selection, and variation in the way genes interact with the environment to produce phenotypes of varying plasticity. Of all phenotypic traits examined, variation in body size (or in correlated characters such as growth rates, age of seaward migration or age at sexual maturity) generally shows the highest heritability, as well as a strong effect on fitness. Thus, body size in Atlantic salmon tends to be positively correlated with freshwater and marine survival, as well as with fecundity, egg size, reproductive success, and offspring survival. By contrast, the fitness implications of variation in behavioural traits such as aggression, sheltering behaviour, or timing of migration are largely unknown. The adaptive significance of molecular variation in salmonids is also scant and largely circumstantial, despite extensive molecular screening on these species. Adaptive variation can result in local adaptations (LA) when, among other necessary conditions, populations live in patchy environments, exchange few or no migrants, and are subjected to differential selective pressures. Evidence for LA in Atlantic salmon is indirect and comes mostly from ecological correlates in fitness-related traits, the failure of many translocations, the poor performance of domesticated stocks, results of a few common-garden experiments (where different populations were raised in a common environment in an attempt to dissociate heritable from environmentally induced phenotypic variation), and the pattern of inherited resistance to some parasites and diseases. Genotype x environment interactions occur for many fitness traits, suggesting that LA might be important. However, the scale and extent of adaptive variation remains poorly understood and probably varies, depending on habitat heterogeneity, environmental stability and the relative roles of selection and drift. As maladaptation often results from phenotype-environment mismatch, we argue that acting as if populations are not locally adapted carries a much greater risk of mismanagement than acting under the assumption for local adaptations when there are none. As such, an evolutionary approach to salmon conservation is required, aimed at maintaining the conditions necessary for natural selection to operate most efficiently and unhindered. This may require minimising alterations to native genotypes and habitats to which populations have likely become adapted, but also allowing for population size to reach or extend beyond carrying capacity to encourage competition and other sources of natural mortality.

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Cooke, S.J. and Schramm, H.L. **Catch-and-release science and its application to conservation and management of recreational fisheries.** *Fisheries Management and Ecology* 14(2): 73-79, 2007.

**Notes:** Catch-and-release angling is a well-established practice in recreational angler behaviour and fisheries management. Accompanying this is a growing body of catch-and-release research that can be applied to reduce injury, mortality and

sublethal alterations in behaviour and physiology. Here, the status of catch-and-release research from a symposium on the topic is summarised. Several general themes emerged including the need to: (1) better connect sublethal assessments to population-level processes; (2) enhance understanding of the variation in fish, fishing practices and gear and their role in catch and release; (3) better understand animal welfare issues related to catch and release; (4) increase the exchange of information on fishing-induced stress, injury and mortality between the recreational and commercial fishing sectors; and (5) improve procedures for measuring and understanding the effect of catch-and-release angling. Through design of better catch-and-release studies, strategies could be developed to further minimise stress, injury and mortality arising from catch-and-release angling. These strategies, when integrated with other fish population and fishery characteristics, can be used by anglers and managers to sustain or enhance recreational fishing resources.

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Sterner, T. **Unobserved diversity, depletion and irreversibility - The importance of subpopulations for management of cod stocks.** *Ecological Economics* 61(2-3): 566-574, 2007.

**Notes:** Diversity is often associated with resilience but in this model, *unobserved* genetic or behavioral diversity can explain the collapse of supposedly regulated fish stocks such as cod. Recent studies have shown the existence of separate sub stocks of cod even at a very fine geographical scale. We show that modeling a group of distinct stocks as if it were one large stock will tend to overestimate the growth and harvest potential. If quotas are based on such over-estimates, the unobserved stock diversity can explain sudden stock collapses and unexpectedly slow recovery as observed for Canadian cod. It is a lack of information concerning diversity that leads to irreversibility. The differences between the various stocks may be behavioral or genetic but cannot be observed by the fishermen or regulators who believe that there is a gradual decline in one big stock while in fact they are witnessing the successive disappearance of a series of sub stocks.

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Dingsor, G.E., Ciannelli, L., Chan, K.S., Ottersen, G., and Stenseth, N.C. **Density dependence and density independence during the early life stages of four marine fish stocks.** *Ecology* 88(3): 625-634, 2007.

**Notes:** Recruitment variability caused by density-dependent and density-independent processes is an important area within the study of fish dynamics. These processes can exhibit nonlinearities and nonadditive properties that may have profound dynamic effects. We investigate the importance of population density (i.e., density dependence) and environmental forcing (i.e., density independence) on the age-0 and age-1 abundance of capelin (*Mallotus villosus*), northeast Arctic cod (*Gadus morhua*), northeast Arctic haddock (*Melanogrammus aeglefinus*), and Norwegian spring spawning herring (*Clupea harengus*) in the Barents Sea. We use statistical methods that explicitly account for nonlinearities and nonadditive interactions between internal and external variables in the abundance of these two pre-recruitment stages. Our results indicate that, during their first five months of life, cod, haddock, and herring experience higher density-dependent survival than capelin. The abundance of age-0 cod depends on the mean age and biomass of the spawning stock, a result which has implications for the management of the entire cod stock. Temperature is another important factor influencing the abundance at age-0 and age-1 of all four species, except herring at age-1. Between age-0 and age-1, there is an attenuation of density-dependent survival for cod and herring, while haddock and capelin experience density dependence at high and low temperatures, respectively. Predation by subadult cod is important for both capelin and cod at age-1. We found strong indications for interactions among the studied species, pointing to the importance of viewing the problem of species recruitment variability as a community, rather than as a population phenomenon.

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Ciannelli, L., Dingsor, G.E., Bogstad, B., Ottersen, G., Chan, K.S., Gjosaeter, H., Stiansen, J.E., and Stenseth, N.C. **Spatial anatomy of species survival: Effects of predation and climate-driven environmental variability.** *Ecology* 88(3): 635-646, 2007.

**Notes:** The majority of survival analyses focus on temporal scales. Consequently, there is a limited understanding of how species survival varies over space and, ultimately, how spatial variability in the environment affects the temporal dynamics of species abundance. Using data from the Barents Sea, we study the spatiotemporal variability of the juvenile Atlantic cod (*Gadus morhua*) survival. We develop an index of spatial survival based on changes of juvenile cod distribution through their first winter of life (from age-0 to age-1) and study its variability in relation to biotic and abiotic factors. Over the 25 years analyzed (1980-2004), we found that, once the effect of passive drift due to dominant currents is accounted for, the area where age-0

cod survival was lowest coincided with the area of highest abundance of older cod. Within this critical region, the survival of age-0 cod was negatively affected by its own abundance, by that of older cod, and by bottom depth. Furthermore, during cold years, age-0 cod survival increased in the eastern and coldest portion of the examined area, which was typically avoided by older conspecifics. Based on these results we propose that within the examined area top-down mechanisms and predation-driven density dependence can strongly affect the spatial pattern of age-0 cod survival. Climate-related variables can also influence the spatial survival of age-0 cod by affecting their distribution and that of their predators. Results from these and similar studies, focusing on the spatial variability of survival rates, can be used to characterize species habitat quality of marine renewable resources.

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Burnett, K.M., Reeves, G.H., Miller, D.J., Clarke, S., Vance-Borland, K., and Christiansen, K. **Distribution of salmon-habitat potential relative to landscape characteristics and implications for conservation.** *Ecological Applications* 17(1): 66-80, 2007.

**Notes:** The geographic distribution of stream reaches with potential to support high-quality habitat for salmonids has bearing on the actual status of habitats and populations over broad spatial extents. As part of the Coastal Landscape Analysis and Modeling Study (CLAMS), we examined how salmon-habitat potential was distributed relative to current and future (+100 years) landscape characteristics in the Coastal Province of Oregon, USA. The intrinsic potential to provide high-quality rearing habitat was modeled for juvenile coho salmon (*Oncorhynchus kisutch*) and juvenile steelhead (*O. mykiss*) based on stream flow, valley constraint, and stream gradient. Land ownership, use, and cover were summarized for 100-m analysis buffers on either side of stream reaches with high intrinsic potential and in the overall area encompassing the buffers. Past management seems to have concentrated nonindustrial private ownership, agriculture, and developed uses adjacent to reaches with high intrinsic potential for coho salmon. Thus, of the area in coho salmon buffers, 45% is either non-forested or recently logged, but only 10% is in larger-diameter forests. For the area in steelhead buffers, 21% is either non-forested or recently logged while 20% is in larger-diameter forests. Older forests are most extensive on federal lands but are rare on private lands, highlighting the critical role for public lands in near-term salmon conservation. Agriculture and development are projected to remain focused near high-intrinsic-potential reaches for coho salmon, increasing the importance of effectively addressing nonpoint source pollution from these uses. Percentages of larger-diameter forests are expected to increase throughout the province, but the increase will be only half as much in coho salmon buffers as in steelhead buffers. Most of the increase is projected for public lands, where policies emphasize biodiversity protection. Results suggest that widespread recovery of coho salmon is unlikely unless habitat can be improved in high-intrinsic-potential reaches on private lands. Knowing where high-intrinsic-potential stream reaches occur relative to landscape characteristics can help in evaluating the current and future condition of freshwater habitat, explaining differences between species in population status and risk, and assessing the need for and feasibility of restoration.

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Wright, B.E., Riemer, S.D., Brown, R.F., Ougzin, A.M., and Bucklin, K.A. **Assessment of harbor seal predation on adult salmonids in a Pacific Northwest estuary.** *Ecological Applications* 17(2): 338-351, 2007.

**Notes:** The populations of many native species have increased or expanded in distribution in recent decades, sometimes with negative consequences to sympatric native species that are rarer or less adaptable to anthropogenic changes to the environment. An example of this phenomenon from the Pacific Northwest is predation by locally abundant pinnipeds (seals and sea lions) on threatened, endangered, or otherwise depleted salmonid (*Oncorhynchus* spp.) populations. We used survey sampling methodology, acoustic telemetry, and molecular genetics to quantify the amount of harbor seal (*Phoca vitulina*) predation on a depressed run of coho salmon (*O. kisutch*) and to determine whether some seals consumed a disproportionately higher number of salmonids than others. Based on a probability sample totaling 759.5 h of observation, we estimated that seals consumed 1161 adult salmonids (95% CI = 503 - 1818 salmonids) during daylight hours over an 18.9-km estuarine study area in Oregon during an 84-d period in fall 2002. Simultaneous tracking of 56 seals via an acoustic telemetry array indicated that a small proportion of marked seals (12.5%) exhibited behavior that was consistent with specialization on salmonids. These seals spent the majority of their time in the riverine portion of the study area and did so disproportionately more at night than day. Genetic analysis of 116 salmonid structures recovered from 11 seal fecal samples suggested that coho salmon accounted for approximately one-half of total salmonid consumption. Though subject to considerable uncertainty, the combined results lead us to infer that seals consumed 21% (range 3 - 63%) of the estimated prespawning population of coho salmon. We speculate that the majority of the predation occurred upriver, at night, and was done by a relatively small proportion of the local seal population. Understanding the extent and nature of pinniped predation can provide important inputs into risk assessments

and other modeling efforts designed to aid the conservation and recovery of salmonids in the Pacific Northwest. Such understanding may also help inform management actions designed to reduce the impact of pinniped predation on salmonids, which potentially range from short-term lethal removal programs to long-term ecosystem restoration and protection efforts.

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Cassoff, R.M., Campana, S.E., and Myklevoll, S. **Changes in baseline growth and maturation parameters of Northwest Atlantic porbeagle, *Lamna nasus*, following heavy exploitation.** *Canadian Journal of Fisheries and Aquatic Sciences* 64(1): 19-29, 2007.

**Notes:** We tested for density-dependent changes in growth and maturation of Northwest Atlantic porbeagle (*Lamna nasus*) after the population declined by 75%-80% from fishing. Vertebrae and reproductive data collected from the virgin (1961-1966) and exploited (1993-2004) populations were analysed to test for differences in growth rate and age and length at maturity between the time periods. We detected significant differences between reparameterized von Bertalanffy growth models for each period, using likelihood ratio tests. Beyond an age of 7 years, mean length at age was greater during 1993-2004 than during 1961-1966. Between 1961-1963 and 1999-2001, length at maturity decreased in males (from 179 to 174 cm curved fork length (CFL)) and was invariant in females (216 cm CFL), whereas age at maturity declined in both males (from 8 to 7 years) and females (from 19 to 14 years). An analysis of porbeagle temperature associations indicated that sharks occupied comparable temperature conditions during the mid-1960s and 1990s, ruling out the possibility of temperature-induced growth changes. The observed increase in growth rate and decrease in age at maturity following exploitation support the hypothesis of a compensatory density-dependent growth response.

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Bucklin, K.A., Banks, M.A., and Hedgecock, D. **Assessing genetic diversity of protected coho salmon (*Oncorhynchus kisutch*) populations in California.** *Canadian Journal of Fisheries and Aquatic Sciences* 64(1): 30-42, 2007.

**Notes:** California coho salmon (*Oncorhynchus kisutch*) are under legal protection owing to significant declines in abundance over the last decades. Previously, California coho salmon were characterized as having low genetic diversity and weak population subdivision, attributable potentially to homogenization by out-of-basin hatchery releases. Here, diversity at seven highly polymorphic microsatellite DNA markers is assessed within and among 32 collections of coho salmon from 16 California watersheds. In 71% of local populations, genotypic composition deviates significantly from that expected under the assumption of random mating. We develop and apply methods to adjust for two potential causes of deviation from random mating expectations: (i) Wahlund effects, owing to heterogeneous collections of individuals, and (ii) the "Allendorf-Phelps effect", owing to closely related juveniles in samples. Such population-level "adjustments" reduce within-region and increase among-region variance; after adjustment, we find strong concordance of genetic and geographic distances. We conclude that stock transfers have had minimal impact on population structure and that California coho salmon populations likely comprise small numbers of endemic breeders, potentially experiencing high levels of genetic drift and inbreeding.

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Scales, H., Balmford, A., and Manica, A. **Impacts of the live reef fish trade on populations of coral reef fish off northern Borneo.** *Proceedings of the Royal Society B* 274(1612): 989-994, 2007.

**Notes:** The live reef fish trade (LRFT) is one of the greatest but least-quantified sources of fishing pressure for several species of large coral reef fish across the Indo-Pacific. For the first time we quantify the localized impact of the LRFT. We collected data from three LRFT traders in northern Borneo, which yielded information on daily fishing effort and the species and mass of all fishes sold every day by individual fishers or vessels over 2, 3 and 8 years. Total monthly catch and relative abundance (catch-per-unit-effort) declined significantly in several species, including the most valuable species the Napoleon wrasse (*Cheilinus undulatus*, estimated changes of -98 and -78% over 8 years in catch and relative abundance, respectively) and lower-value bluelined groupers (*Plectropomus oligocanthus*: -99 and -81%) and *Epinephelus* groupers (-89 and -32%). These severe declines were rapid, species-specific and occurred in the first 2-4 years of the dataset and are, we believe, directly attributable to the LRFT. This has crucial implications for future data collection and monitoring if population collapses in other parts of the LRFT and similar wildlife trades are to be successfully detected.

Swain, D.P., Sinclair, A.F., and Hanson, J.M. **Evolutionary response to size-selective mortality in an exploited fish population.** *Proceedings of the Royal Society B* 274(1613): 1015-1022, 2007.

**Notes:** Many collapsed fish populations have failed to recover after a decade or more with little fishing. This may reflect evolutionary change in response to the highly selective mortality imposed by fisheries. Recent experimental work has demonstrated a rapid genetic change in growth rate in response to size-selective harvesting of laboratory fish populations. Here, we use a 30-year time-series of back-calculated lengths-at-age to test for a genetic response to size-selective mortality in the wild in a heavily exploited population of Atlantic cod (*Gadus morhua*). Controlling for the effects of density- and temperature-dependent growth, the change in mean length of 4-year-old cod between offspring and their parental cohorts was positively correlated with the estimated selection differential experienced by the parental cohorts between this age and spawning. This result supports the hypothesis that there have been genetic changes in growth in this population in response to size-selective fishing. Such changes may account for the continued small size-at-age in this population despite good conditions for growth and little fishing for over a decade. This study highlights the need for management regimes that take into account the evolutionary consequences of fishing.

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Aguilar-Perera, A. **Disappearance of a Nassau grouper spawning aggregation off the southern Mexican Caribbean coast.** *Marine Ecology Progress Series* 327: 289-296, 2006.

**Notes:** A Nassau grouper spawning aggregation formed in large numbers (e.g. 1000 to 15000 ind.) for more than 50 yr at the traditional aggregation site off Mahahual, Quintana Roo, Mexico (eastern Yucatan Peninsula). However, in the early 1990s the aggregation ceased forming at the site, and only small aggregations were found south of the site (1 to 2 km) moving northward along the fore reef. The spawning aggregation progressively disappeared, and in 1996 no aggregation formed even in areas adjacent to the site. Changes in grouper mean total length, size-frequency distribution and sex ratios analyzed from the commercial catch (taken from the migrating aggregation), showed that mean body size fluctuated and that the sex ratio was female-biased. The grouper aggregation showed evidence of overexploitation in terms of disappearance, reduction in number and fluctuations in size; however, the latter may be a recruitment effect. Fishery management and conservation alternatives, through the implementation of a network of no-take marine reserves and a total fishing ban, are necessary for protecting the Nassau grouper and other aggregating reef fishes, not only in the Mexican Caribbean Sea but also along the Mesoamerican Barrier Reef System.

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Cheung, W.W.L., Watson, R., Morato, T., Pitcher, T.J., and Pauly, D. **Intrinsic vulnerability in the global fish catch.** *Marine Ecology Progress Series* 333: 1-12, 2007.

**Notes:** We have identified the marine fish taxa that are most vulnerable to exploitation, by compiling an index of intrinsic vulnerability based on life history traits. Since 1950, the global fish catch has been increasingly dominated by species with low intrinsic vulnerability, indicated by a decline in mean vulnerability of the taxa in the catches. This decline is strongest in catches of coral reef fishes, probably as a result of overexploitation of the more vulnerable species. The change is less apparent in estuaries, where fish communities are more transient. The opposite is observed at seamounts, where more vulnerable species have become exploited and serially depleted in recent years. Rates of change in the mean vulnerability index in the catches from different areas are negatively correlated with the number of threatened fishes on the IUCN Red List. Particularly, catches from the Indo-Pacific and Caribbean regions are characterized by a high abundance of threatened fishes and by strong declines in the mean vulnerability index. Our findings suggest that fishing largely alters the community structure of coral reef fishes, which may detrimentally affect the ecosystem. Attention should also be given to deep water demersal and benthopelagic fish assemblages, especially those around seamounts, which are intrinsically vulnerable to fishing. The index of intrinsic vulnerability thus provides a novel tool for fisheries management and conservation.

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Stevens, J.D. **Whale shark (*Rhincodon typus*) biology and ecology: A review of the primary literature.** *Fisheries Research* 84(1): 4-9, 2007.

**Notes:** In the 160 years since Andrew Smith described the whale shark in 1828, two people devoted much of their scientific lives to whale sharks. This period of research mainly comprised documenting the known sightings, captures and strandings of

this species. Dr Eugene Gudger collected reports of whale sharks from all over the world and published 47 papers on these sharks in 40 years. Dr Fay Wolfson also documented whale shark records from all over the world and published a bibliography on the species as well as a paper summarising all the known (320) occurrences from published records and verified reports up to 1985. However, life history information during this period was scant. In the succeeding 20 years from 1986, there has been a huge increase in recreational diving and boating activity around the world that has led to discoveries of whale shark aggregations in various places. Together with increased demand and prices for whale shark products this has led to considerable conservation and marine ecotourism interest in the species that has provided the impetus for a number of studies. However, while some further understanding of whale shark reproduction and age and growth has resulted, our knowledge of the species biology and ecology is still poor. Over the last 10 years several tagging and tracking studies have been initiated on whale sharks in various parts of the world. Despite the relatively recent increases in demand for whale shark meat driven by the Taiwan market, there are still few good data in the primary literature from existing fisheries.

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Rowat, D. **Occurrence of whale shark (*Rhincodon typus*) in the Indian Ocean: A case for regional conservation.** *Fisheries Research* 84(1): 96-101, 2007.

**Notes:** From the first whale shark (*Rhincodon typus*) described in 1828 from the Indian Ocean, the region continues to be one of the most important areas for whale shark sightings. However, the species has been the subject of several targeted fisheries and thus sustained massive, rapid declines in population numbers. The known range of occurrence and targeted fisheries for whale sharks in the Indian Ocean are discussed, along with stated national conservation measures in the range states. The results of a preliminary survey of 16 regional cooperative partners from 11 of the Indian Ocean range states are presented for whale shark occurrence, monitoring, perceived threats and realized conservation measures. These data are already proving valuable by facilitating cooperation between organisations regionally. The current international conservation framework is briefly described and suggestions made as to possible linked regional conservation initiatives, such as under the auspices of the Convention on Migratory Species.

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Heales, D.S., Brewer, D.T., Kuhnert, P.M., and Jones, P.N. **Detecting declines in catch rates of diverse trawl bycatch species, and implications for monitoring.** *Fisheries Research* 84(2): 153-161, 2007.

**Notes:** Trawl fisheries around the world are being pressured to demonstrate that their impacts on both the target and bycatch species are sustainable in the long-term. However, the effectiveness of sampling catches to assess the viability of populations of non-targeted species is rarely examined. We estimated the levels of fishery-dependent sampling effort required to detect declines in catch rates of prawn trawl bycatch from 95 commercial trawls in two regions of Australia's Northern Prawn Fishery. We explore a range of possible monitoring options including combining different sampling intensities, time-frames and levels of statistical power. Poisson and negative binomial models were used to determine the number of trawls required to detect a range of declines. We found that between 15,536 and 24,933 trawls, depending on the region, would be required to detect a 20% decline in catch rates of the rarest taxa (< 0.1 individuals h<sup>-1</sup>), assuming a power of 90% and a level of significance of 5%. Assuming a lower detection power (70%), trawl numbers would drop to 9126 and 14,646, respectively. Using a model of a constant decline in relative abundance (over 5 years), data accumulated from modest-sized annual surveys (52 and 43 trawls in two regions) would provide increasing power to detect changes in catch rates. After 3 years, surveys of this size (and power of 70%), could detect declines of 99.9% in 72-81% of taxa, declines of 50% in 34-43% of taxa, and declines of 20% in 20-34% of taxa, depending on the region. After 5 years, the power to detect declines of 50% had increased to cover 43-72% of taxa, and declines of 20% in 34-43% of taxa. Our results indicate that the power to detect even quite large declines in catch rates of rarely caught species would only be possible after some years of modest-sized annual surveys.

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Sanchirico, J.N. and Wilen, J.E. **Global marine fisheries resources: status and prospects.** *International Journal of Global Environmental Issues* 7(2/3): 106-118, 2007.

**Notes:** This paper discusses the current status of the world's fisheries and their prospects for the future, from the perspective of the economics discipline. We focus on governance institutions within which fisheries are conducted, discussing their evolution during the post WW II period with particular emphasis on the jurisdiction extension codified by the Law of the Sea Convention in 1982. We discuss the stages through which governance institutions in fisheries seem to be moving, culminating

with a discussion of recent experiences with rights-based systems. Of particular importance is the manner in which behavioural incentives are framed by governance institutions. We discuss evidence about how rights-based systems fundamentally alter incentives in comparison with systems that retain vestiges of open access incentives. Promoting sustainable use of the world's fisheries is critically dependent upon the alignment of economic incentives with conservation objectives, a prospect that appears possible only when rights-based management is adopted.

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Kirkley, J.E., Walden, J., and Ward, J.M. **The status of USA's commercial fisheries and management and crystal-balling the future.** *International Journal of Global Environmental Issues* 7(2/3): 119-136, 2007.

**Notes:** Despite the enormity of the commercial fishing industry of the USA, the structure of the industry and various interactions are not known on a national basis. The US public wants seafood, but current domestic production capabilities appear to be inadequate to support the growing demand for seafood. Imports, particularly aquacultured products, are increasing and expected to further increase in the future. Many of the major species have been identified as being overfished or experiencing overfishing. Federal management is moving from single-species to multispecies to ecosystem-based fisheries management. In this paper, we present economic performance trends of US fisheries. We note a trend of declining landings and ex-vessel values between periods reflecting two major management regimes. We also provide an overview of the potential changes in the management regimes or recognition of a very slow adoption of market-based solutions and movements away from command-and-control regulations.

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Pascoe, S. and Burnett, A. **Recovering from overexploitation: the European fisheries of the North Sea.** *International Journal of Global Environmental Issues* 7(2/3): 158-173, 2007.

**Notes:** In the last two decades, the fisheries of the North Sea have experienced substantial declines in the population of a number of commercially harvested species. The fisheries have also experienced the development of considerable overcapacity as a result of ineffective management and subsidies. Management of the fishery is complicated by the existence not only of multiple species and gears, but also multiple countries. Concerns about regional employment have also influenced management decisions to the detriment of the resource and industry. In this paper, the underlying factors that have shaped the current situation in the North Sea fisheries are discussed and potential solutions are explored.

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Rice, J. **An ecologist's view of economic instruments and incentives.** *International Journal of Global Environmental Issues* 7(2/3): 191-204, 2007.

**Notes:** Advice by fisheries scientists to reduce catches or effort is often not fully implemented and efforts to increase impact of advice have often failed. Fisheries scientists rarely discuss the potential contribution of economic instruments to improving the impact of science advice. This paper rejects several possible justifications for the absence of discussion on economic instruments in fisheries science advice. It then highlights how two types of economic instruments, allocation of property rights and eco-certification, may promote the same changes in fisheries exploitation rates and ecosystem impacts that science advisors recommend on biological grounds. It concludes with a consideration of how science advice could include a discussion of such instruments without having the advice from fisheries scientists and ecologists affect social and economic policy any more than advice on tools like marine protected areas or quota reductions do at present.

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Wilson, J.R. **Challenges and opportunities for fisheries managers in developing countries: a case for economic eclecticism.** *International Journal of Global Environmental Issues* 7(2/3): 205-220, 2007.

**Notes:** Fisheries managers and advisors in developing countries face challenges that may be difficult to overcome, because they use doctrines, principles and models of management and economics that do not adequately explain the problems that need to be solved. This may perpetuate non-sustainable policies, because broader issues important to fisheries sustainability are not accounted for more eclectic studies of the economic behaviour of humans within the context of their respective societies may be useful. Advice and policy based upon a more varied knowledge of different branches of economics provides insights

into how managers might deal with the more difficult problems they confront. The author motivates these ideas by discussing new international trade theory and fisheries agreements, New Institutional Economics (NIE) applied to public management of fisheries conflicts and applications of Public Choice (PC) theory to the economics of corruption. These theoretical ideas are discussed with references to observations in the field.

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Holland, D.S. **Managing environmental impacts of fishing: input controls versus outcome-oriented approaches.**  
*International Journal of Global Environmental Issues* 7(2/3): 255-272, 2007.

**Notes:** Fishery management has focused primarily on limiting the total catch of key target species to sustainable levels, but fishery managers and the public are becoming increasingly concerned with environmental impacts of fishing such as damage to habitat and bycatch of non-target species, particularly marine mammals and seabirds. There are two main approaches to managing environmental impacts of fishing. The first is to prohibit or prescribe use of particular fishing gears and methods in particular areas either year-round or at specific times. The primary alternative is an outcome-oriented approach under which the environmental impacts are regulated directly, either by setting and monitoring limits on impacts by individuals or groups or by taxing impacts. This paper explores the factors that determine relative effectiveness and efficiency of input versus outcome-oriented approaches to managing environmental impacts of fishing. This paper highlights the role of technology in determining the preferable regulatory methods.

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