

Marine Science Review - 170

Fish and fisheries



In this review:

- A. Recent articles – no abstract available
- B. Recent articles with abstracts

A. Recent articles – no abstract available

Morgana, S.K. and Lourie, S.A. **Threatened fishes of the world: *Hippocampus comes* Cantor 1850 (Syngnathidae).** *Environmental Biology of Fishes* 75(3): 311-313, 2006.

Dybas, C.L. **Ode to a codfish.** *BioScience* 56(3): 184-191, 2006.

B. Recent articles with abstracts

Cooke, S.J. and Cowx, I.G. **Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments.** *Biological Conservation* 128(1): 93-108, 2006.

Notes: Commercial fishing has repeatedly been identified as a major causal factor for global declines in fish stocks. Recently, recreational fisheries have also been considered as having the potential to contribute to fisheries declines. Here, we take a global focus, contrasting the characteristics of commercial and recreational fisheries relevant to conservation and sustainability of exploited fishes in both marine and freshwater environments. We provide evidence to support our assertion that the same issues that have led to global fisheries concerns regarding commercial fishing can have equivalent, and in some cases, magnified effects in recreational fisheries. Contrasts revealed that the issues of bycatch and catch-and-release, fisheries-induced selection, trophic changes, habitat degradation, gear technology, fishing effort, and production regimes are remarkably similar among fishery sectors. In recognition of this conclusion, we present a new vision for recreational fishing that positions it on the same scale and urgency as commercial fisheries. Efforts to manage and conserve fisheries must recognise that issues and threats are similar in these fundamentally and philosophically different fisheries, as may be the solutions. Failure to recognise the similarities will further polarise these sectors and retard efforts to conserve aquatic resources. Fishing activity of any kind, whether commercial or recreational, has the potential to affect negatively fish and fisheries, as well as aquatic environments.

Huntingford, F.A., Adams, C., Braithwaite, V.A., Kadri, S., Pottinger, T.G., Sandoe, P., and Turnbull, J.F. **Current issues in fish welfare.** *Journal of Fish Biology* 68(2): 332-372, 2006.

Notes: Human beings may affect the welfare of fish through fisheries, aquaculture and a number of other activities. There is no agreement on just how to weigh the concern for welfare of fish against the human interests involved, but ethical frameworks exist that suggest how this might be approached. Different definitions of animal welfare focus on an animal's condition, on its subjective experience of that condition and/or on whether it can lead a natural life. These provide different, legitimate, perspectives, but the approach taken in this paper is to focus on welfare as the absence of suffering. An unresolved and controversial issue in discussions about animal welfare is whether non-human animals exposed to adverse experiences such as physical injury or confinement experience what humans would call suffering. The neocortex, which in humans is an important part of the neural mechanism that generates the subjective experience of suffering, is lacking in fish and non-mammalian animals, and it has been argued that its absence in fish indicates that fish cannot suffer. A strong alternative view,

however, is that complex animals with sophisticated behaviour, such as fish, probably have the capacity for suffering, though this may be different in degree and kind from the human experience of this state. Recent empirical studies support this view and show that painful stimuli are, at least, strongly aversive to fish. Consequently, injury or experience of other harmful conditions is a cause for concern in terms of welfare of individual fish. There is also growing evidence that fish can experience fear-like states and that they avoid situations in which they have experienced adverse conditions. Human activities that potentially compromise fish welfare include anthropogenic changes to the environment, commercial fisheries, recreational angling, aquaculture, ornamental fish keeping and scientific research. The resulting harm to fish welfare is a cost that must be minimized and weighed against the benefits of the activity concerned. Wild fish naturally experience a variety of adverse conditions, from attack by predators or conspecifics to starvation or exposure to poor environmental conditions. This does not make it acceptable for humans to impose such conditions on fish, but it does suggest that fish will have mechanisms to cope with these conditions and reminds us that pain responses are in some cases adaptive (for example, suppressing feeding when injured). In common with all vertebrates, fish respond to environmental challenges with a series of adaptive neuro-endocrine adjustments that are collectively termed the stress response. These in turn induce reversible metabolic and behavioural changes that make the fish better able to overcome or avoid the challenge and are undoubtedly beneficial, in the short-term at least. In contrast, prolonged activation of the stress response is damaging and leads to immuno-suppression, reduced growth and reproductive dysfunction. Indicators associated with the response to chronic stress (physiological endpoints, disease status and behaviour) provide a potential source of information on the welfare status of a fish. The most reliable assessment of well-being will be obtained by examining a range of informative measures and statistical techniques are available that enable several such measures to be combined objectively. A growing body of evidence tells us that many human activities can harm fish welfare, but that the effects depend on the species and life-history stage concerned and are also context-dependent. For example, in aquaculture, adverse effects related to stocking density may be eliminated if good water quality is maintained. At low densities, bad water quality may be less likely to arise whereas social interactions may cause greater welfare problems. A number of key differences between fish and birds and mammals have important implications for their welfare. Fish do not need to fuel a high body temperature, so the effects of food deprivation on welfare are not so marked. For species that live naturally in large shoals, low rather than high densities may be harmful. On the other hand, fish are in intimate contact with their environment through the huge surface area of their gills, so they are vulnerable to poor water quality and water borne pollutants. Extrapolation between taxa is dangerous and general frameworks for ensuring welfare in other vertebrate animals need to be modified before they can be usefully applied to fish. The scientific study of fish welfare is at an early stage compared with work on other vertebrates and a great deal of what we need to know is yet to be discovered. It is clearly the case that fish, though different from birds and mammals, however, are sophisticated animals, far removed from unfeeling creatures with a 15 s memory of popular misconception. A heightened appreciation of these points in those who exploit fish and in those who seek to protect them would go a long way towards improving fish welfare.

Sneddon, L.U. **Ethics and welfare: Pain perception in fish.** *Bulletin of the European Association of Fish Pathologists* 26(1): 6-10, 2006.

Notes: Fish welfare is currently a controversial subject with many scientific studies now demonstrating the possibility for fish to experience negative events such as pain, fear and stress. This has important implications in the treatment of fish during commercial and experimental procedures in terms of ethics and welfare. In this review, the evidence for pain perception in fish is considered and the repercussions for the use of fish as a research model as well as in aquaculture and large-scale fisheries. These issues are discussed briefly from a welfare and ethical perspective.

Lecchini, D., Polti, S., Nakamura, Y., Mosconi, P., Tsuchiya, M., Remoissenet, G., and Planes, S. **New perspectives on aquarium fish trade.** *Fisheries Science* 72(1): 40-47, 2006.

Notes: Since the 1990s, the international market for importing aquarium fish is suspicious of stock coming from South-East Asia. Fish catches are still executed with cyanide-based toxic products. In the present paper, the potential of the French Polynesian Islands to develop a marine aquarium fish business with a new approach is explored. Coral reef fish are captured at the larval stage with crest nets, then larvae are reared in aquaria before being put on the world ornamental fish market. This approach offers several advantages: (i) larvae are captured with a passive system placed on the reef crest (crest net) that does not destroy the environment and limits the stress on collected larvae; (ii) larvae are then put into farmed basins that allow them to be controlled sanitarilly; and (iii) larvae are weaned at the farm and fed rapidly with artificial food. This method increases survival rates as it eliminates the food acclimatization problem of fish captured at adult stage (main cause of fish mortality in

aquaria). Overall, reared larvae will constitute a new product in terms of species, sizes and quality of ornamental fish on the aquarium market.

Kaiser, M.J. and Edwards-Jones, G. **The role of ecolabeling in fisheries management and conservation.** *Conservation Biology* 20(2): 392-398, 2006.

Notes: The Marine Stewardship Council (MSC) regulates the ecolabeling of products from fisheries with the aim of promoting sustainable fishery practices. To date 11 fisheries have attained full certification and a further 7 are under review. Together these fisheries offer 220 ecolabeled marine products to consumers. Despite great potential to encourage sustainable fisheries, and thereby bring conservation benefits to marine systems, a range of issues may limit the wider uptake of MSC ecolabeled products. These include a general lack of consumer concern for marine fishes and sustainable fisheries, an absence of guaranteed continued financial benefits to participating fishers, and difficulties of quality assurance that are related to complexities of monitoring compliance of marine fisheries. In addition, it is apparent that property rights over the fishery seem to be an essential prerequisite for engagement in MSC, and this is one major impediment to wider uptake of the scheme in current marine fisheries, which tend to be open access. Some modifications to the current scheme may be needed if wider participation of marine fishers is to be achieved. These may include a tiered approach to certification, certification of fishers rather than fisheries, governmental facilitation to assist the latter, and greater engagement with retailers and buyers rather than individual consumers. None of these changes will occur without constructive engagement of government, retailers, and the fishing industry.

Grey, M., Blais, A.M., and Vincent, A.C.J. **Magnitude and trends of marine fish curio imports to the USA.** *Oryx* 39(4): 413-420, 2005.

Notes: The curio trade in marine fishes has not previously been quantitatively analysed. As a contribution towards understanding the scale and conservation impact of such trade we summarize import and export data from the United States Fish and Wildlife Service for 1997- 2001. At least 32 fish species were involved in the USA's international trade in curios, of which 24 were included on the 2004 IUCN Red List of Threatened Species, with categorizations ranging from Endangered to Data Deficient. The USA apparently imported an annual total of approximately one million fish and 360 tonnes of fish parts, worth more than USD 1.7 million, although total volume declined over the 5 years of data. Fish curios imported to the USA reportedly came primarily from Taiwan and the Philippines, with 95% of curios obtained from wild populations. The three marine fish groups most traded for curios were sharks, seahorses and porcupinefishes. The value per individual fish fluctuated across years, with a considerable increase in the value of dried seahorses from 1997 to 2001. The trade probably adds to conservation concerns for at least some species.

Clark, C.W. **Fisheries bioeconomics: why is it so widely misunderstood?** *Population Ecology* 48(2): 95-98, 2006.

Notes: Many fisheries management systems, even when based on apparently sound science, have failed to prevent severe overfishing. And even when successful in this sense, such systems have frequently resulted in a large degree of excess fishing capacity. The reason for these failures can often be found in a lack of consideration of the economic incentives affecting fishermen. Specifically, when forced to compete for a fixed total annual catch quota (TAC), fishermen are motivated to fish at high intensity, and to expand the fishing power of their vessels. Individual fishing quotas (IFQs) are being increasingly used as a method of altering economic incentives in a desirable way. IFQ systems, however, can also suffer severe shortcomings, unless substantial fees are extracted for the exclusive right to exploit a publicly owned resource. When combined with appropriate fees, or royalties, IFQs can indeed result in sustainable, profitable fisheries. There still remains the fundamental question of risk management, but this is also now beginning to be addressed. Thus there is now a strong hope for the future success of marine fisheries, at least within 200-mile coastal zones.

Zeller, D., Booth, S., Craig, P., and Pauly, D. **Reconstruction of coral reef fisheries catches in American Samoa, 1950-2002.** *Coral Reefs* 25(1): 144-152, 2006.

Notes: Fisheries catches from Pacific Island coral reefs are rarely recorded in official statistics. Reconstruction of catch estimates with limited hard data requires interpolation and assumptions, justifiable only by the unsatisfactory alternative of continued substitution of zero catches, a common policy interpretation for 'no data'. Uncertainties associated with reconstructions are high, requiring conservative estimation. American Samoan domestic fisheries consist of an artisanal, small-boat sector, whose commercial catches are reported, and a shore-based subsistence sector, with no regular reporting. Our catch reconstruction (with large pelagic species removed) suggested a 79% decrease in catches between 1950 (752 t) and 2002 (155 t). Accounting for rapid human population growth on the main island, the per capita catch rate may have declined from 36.3 kg · person⁽⁻¹⁾ year⁽⁻¹⁾ in 1950 to 1.3 kg · person⁽⁻¹⁾ year⁽⁻¹⁾ by 2002, while the catch rate for the inhabited outer islands has been independently reported as 58.6 kg · person⁽⁻¹⁾ year⁽⁻¹⁾. Catch per area of coral reef (to 50-m depth) may have declined from 5.5 to 0.7 t km⁽⁻²⁾ year⁽⁻¹⁾ for the main island, and from 9.1 to 4.9 t km⁽⁻²⁾ year⁽⁻¹⁾ for the outer islands, for 1950 and 2002, respectively. Summed for 1950 - 2002, our reconstruction suggested a 17-fold difference between reconstructed estimates and reported statistics.

Berkes, F., Hughes, T.P., Steneck, R.S., Wilson, J.A., Bellwood, D.R., Crona, B., Folke, C., Gunderson, L.H., Leslie, H.M., Norberg, J., Nystrom, M., Olsson, P., Osterblom, H., Scheffer, M., and Worm, B. **Globalization, roving bandits, and marine resources.** *Science* 311(5767): 1557-1558, 2006.

Notes: Marine resource exploitation can deplete stocks faster than regulatory agencies can respond. Institutions with broad authority and a global perspective are needed to create a system with incentives for conservation.

Henry, L.A., Kenchington, E.L.R., Kenchington, T.J., MacIsaac, K.G., Bourbonnais-Boyce, C., and Gordon, D.C. **Impacts of otter trawling on colonial epifaunal assemblages on a cobble bottom ecosystem on Western Bank (Northwest Atlantic).** *Marine Ecology Progress Series* 306: 63-78, 2006.

Notes: Colonial epifauna are an important component of benthic communities, providing structural complexity at scales of millimetres to metres. Many are sessile, emergent and fragile - characteristics which render them vulnerable to disturbances associated with bottom fishing. Many also have impressive abilities to rapidly regenerate both sexually and asexually and, consequently, the ultimate results of impacts of physical disturbance are difficult to predict. We analysed the effects of 3 yr of pulsed experimental otter trawling, following an asymmetrical before-after-control-impact design, on grab-sampled colonial epifauna. Our study site was on a cobble seabed on the Scotian Shelf in a formerly important fishing ground which had seen no disturbance by mobile fishing gears for 10 yr. The number of taxa, total biomass, the biomass of component major taxa (hydroids, bryozoans, sponges, tunicates, soft corals) and the community composition were analysed for single-year and cumulative effects. The study site had a rich colonial fauna containing at least 53 taxa, the majority of which were hydroids. The small vase sponge *Scypha ciliata*, the leafy bryozoans *Dendrobeania* spp. and the hydroids *Symplectoscyphus* spp. were the most frequent, occurring in > 70% of the samples. Significant inter-annual differences at control sites were observed. The number of taxa, total biomass and hydroid biomass increased over the study period, with associated changes in community composition. Short-term effects of trawling were detected as decreases in the number of taxa per sample, total biomass and total hydroid biomass across the trawling events, although these trends were non-significant after Bonferroni adjustment. No cumulative effects from the pulsed trawling were detected, and colonial species assemblages on control and impacted lines were similar at the end of the experiment. While some of the tests for trawling effects were statistically weak, it is certain that any effects were small relative to natural inter-annual change.

Romanuk, T.N. and Levings, C.D. **Relationships between fish and supralittoral vegetation in nearshore marine habitats.** *Aquatic Conservation: Marine and Freshwater Ecosystems* 16(2): 115-132, 2006.

Notes: 1. This study was conducted to determine whether there were significant differences in the species richness and community composition of fish assemblages in coastal nearshore habitats with differing compositions of supralittoral vegetation. 2. We sampled fish assemblages and conducted supralittoral vegetation surveys at 27 beaches on the west coast of

Vancouver Island, British Columbia. Thirteen of the beaches had supralittoral vegetation characteristic of old-growth coastal forests and 14 had been previously subjected to logging or other disturbances. 3. Physical features (e.g. substrate, salinity, etc.) were recorded at each beach to determine whether there were significant associations between supralittoral vegetation and beach characteristics as well as between beach characteristics and fish assemblages. 4. Across all 27 beaches, 1832 individuals of 31 species of nearshore fish were collected, primarily juvenile cottids and salmonids. Mean species richness did not differ between beaches with old-growth versus secondary-growth supralittoral vegetation; however, a higher cumulative number of species was found at beaches with old-growth supralittoral vegetation. 5. Canonical Correspondence Analysis (CCA) showed that beach characteristics and supralittoral vegetation were not significantly associated. Separate CCA for fish associations with beach characteristics and fish associations with supralittoral vegetation explained similar to 55% of the variance in fish assemblage composition, suggesting that fish assemblage composition is significantly affected by substrate, submerged vegetation, and physico-chemical conditions as well as by the community composition of vegetation in adjacent supralittoral habitats. 6. Specifically, we found associations between supralittoral vegetation and penpoint gunnels (*Apodichthys flavidus* Girard), tidepool sculpins (*Oligocottus maculosus* Girard), Pacific staghorn sculpins (*Leptocottus armatus* Girard), arrow gobies (*Clevelandia ios* Jordan and Gilbert), shiner perch (*Cymatogaster aggregata* Gibbons) and kelp perch (*Brachyistius frenatus* Gill). Juvenile chum (*Oncorhynchus keta* Walbaum) and coho (*Oncorhynchus kisutch* Walbaum) salmon were strongly associated with supralittoral vegetation characteristic of mature coastal forests such as mosses and western red cedar (*Thuja plicata*) suggesting that some nearshore fish species may be affected by processes originating in terrestrial ecosystems. 7. Our results suggest that some nearshore fish species may be affected by removal of supralittoral vegetation.

Albert, V., Jonsson, B., and Bernatchez, L. **Natural hybrids in Atlantic eels (*Anguilla anguilla*, *A. rostrata*): evidence for successful reproduction and fluctuating abundance in space and time.** *Molecular Ecology* 15(7): 1903-1916, 2006.

Notes: The outcome of natural hybridization is highly variable and depends on the nonexclusive effects of both pre- and post-mating reproductive barriers. The objective of this study was to address three specific questions regarding the dynamics of hybridization between the American and European eels (*Anguilla rostrata* and *Anguilla anguilla*). Using 373 AFLP loci, 1127 eels were genotyped, representing different life stages from both continents, as well as multiple Icelandic locations. We first evaluated the extent of hybridization and tested for the occurrence of hybrids beyond the first generation. Second, we tested whether hybrids were randomly distributed across continents and among Icelandic sampling sites. Third, we tested for a difference in the proportion of hybrids between glass eel and yellow eel stages in Iceland. Our results provided evidence for (i) an overall hybrid proportion of 15.5% in Iceland, with values ranging from 6.7% to 100% depending on life stages and locations; (ii) the existence of hybrids beyond the first generation; (iii) a nonrandom geographic distribution of hybrids in the North Atlantic; and (iv) a higher proportion of first and later generation hybrids in yellow eels compared to glass eels, as well as a significant latitudinal gradient in the proportion of hybrids in Icelandic freshwater. We propose that the combined effect of both differential survival of hybrids and variation in hybridization rate through time best explain these patterns. We discuss the possibility that climate change, which is impacting many environmental features in the North Atlantic, may have a determinant effect on the outcome of natural hybridization in Atlantic eels.

Rindorf, A. and Lewy, P. **Warm, windy winters drive cod north and homing of spawners keeps them there.** *Journal of Applied Ecology* 43(3): 445-453, 2006.

Notes: 1. Climatic and anthropogenic effects often interact leading to unexpected results. For example, climate may lead to a change in the spatial distribution of a fish stock and thereby its vulnerability to exploitation. The North Sea cod stock is currently under pressure from both environmental change and human exploitation. This stock has experienced a series of poor recruitments since the late 1990s and, concomitant with the decrease in abundance, the distribution of cod has changed. While it has been suggested that the change in distribution can be linked to increasing temperatures and fishing pressure, there is little evidence for this hypothesis. 2. Using winter and summer survey catches, we investigated whether a directional shift in the distribution of cod has taken place over the years 1983-2003. We then examined whether the change could be linked to climatic conditions, fishing mortality, stock size or limited directional movement of cod. Using the derived models, we investigated whether fishing has increased the sensitivity of the cod population to climate-induced distribution changes. 3. A series of winters characterized by high temperatures and southerly winds during the egg and larval phases of cod led to a northward shift in the distribution of juvenile North Sea cod the following year. A concomitant northern shift of mature fish around the time of spawning was linked directly to a tendency for northerly distributed juveniles to remain northerly throughout their life. This shift of the spawners further augmented that of the new recruits. 4. Although fishing mortality on a

North Sea scale was not directly correlated with the displacement of any of the age groups, fishing has severely decreased the number of fish in older age groups. This increased the sensitivity of the distribution of the cod stock to climatic changes. 5. *Synthesis and applications.* The centre of gravity of North Sea cod has moved north as a result of the effect of a series of warm, windy winters on the distribution of recently settled cod. The shift was followed by a northwards shift in the distribution of older age groups. Unless a series of cold and calm years combined with a reduced mortality in the southern areas allows a southern spawning population to rebuild, the cod stock is unlikely to return to its previous area of distribution. Furthermore, protecting adult cod mainly in northern areas is unlikely to result in improved recruitment to the southern North Sea.

Polacheck, T. **Tuna longline catch rates in the Indian Ocean: Did industrial fishing result in a 90% rapid decline in the abundance of large predatory species?** *Marine Policy* 30(5): 470-482, 2006.

Notes: Myers and Worm claim that their analyses of catch rates following the commencement of industrial longline fishing for tuna and billfishes show that these longline fisheries rapidly depleted the abundance of these large oceanic predators by 90% (Myers RA, Worm B. Rapid worldwide depletion of predatory fish communities. *Nature* 2003;423:280-3). Their analyses were published in a high profile science journal along with an accompanying press release, which then attracted substantial international media focus and public attention. This media focus in turn has been used as a base for advocating major marine policy changes for pelagic tuna fisheries (e.g. a minimum of a 50% reduction in catches and establishment of extensive marine reserves). However, among numerous scientific experts involved in tuna and pelagic fishery research substantial concerns exist that Myers and Worm's analyses provide a misleading picture of the status of large predatory pelagic fishes. These concerns are reviewed using data from the Indian Ocean for illustrative purposes and indicate that the initial longline catches were not responsible for a rapid depletion of the main tuna and billfish stocks nor were they threatening the overall sustainability of these stocks. However, the status of a number of these stocks is of concern as a result of large increases in catches in more recent years. The debate sparked by Myers and Worm's paper should not distract from the critical problem of developing and implementing effective international management policies. In addition to implications for fishery management, the publication, peer-review, scientific response and publicity process associated with the publication of Myers and Worm's paper are discussed. Concerns are raised that if these become standard practices for articles in high profile science journals that this would undermine the trust placed in such journal to provide an accurate and well-balanced representation of the most important new scientific findings and in their role to inform policy decisions based on these findings.

Field, J.C. and Francis, R.C. **Considering ecosystem-based fisheries management in the California Current.** *Marine Policy* 30(5): 552-569, 2006.

Notes: Recognizing that all management decisions have impacts on the ecosystem being exploited, an ecosystem-based approach to management seeks to better inform these decisions with knowledge of ecosystem structure, processes and functions. For marine fisheries in the California Current, along the West Coast of North America, such an approach must take into greater consideration the constantly changing climate-driven physical and biological interactions in the ecosystem, the trophic relationships between fished and unfished elements of the food web, the adaptation potential of life history diversity, and the role of humans as both predators and competitors. This paper reviews fisheries-based ecosystem tools, insights, and management concepts, and presents a transitional means of implementing an ecosystem-based approach to managing US fisheries in the California Current based on current scientific knowledge and interpretation of existing law.

Priede, I.G., Froese, R., Bailey, D.M., Bergstad, O.A., Collins, M.A., Dyb, J.E., Henriques, C., Jones, E.G., and King, N. **The absence of sharks from abyssal regions of the world's oceans.** *Proceedings of the Royal Society B* 273(1592): 1435-1441, 2006.

Notes: The oceanic abyss (depths greater than 3000m), one of the largest environments on the planet, is characterized by absence of solar light, high pressures and remoteness from surface food supply necessitating special molecular, physiological, behavioural and ecological adaptations of organisms that live there. Sampling by trawl, baited hooks and cameras we show that the Chondrichthyes (sharks, rays and chimaeras) are absent from, or very rare in this region. Analysis of a global data set shows a trend of rapid disappearance of chondrichthyan species with depth when compared with bony fishes. Sharks, apparently well adapted to life at high pressures are conspicuous on slopes down to 2000m including scavenging at food falls such as dead whales. We propose that they are excluded from the abyss by high-energy demand, including an oil-rich liver for

buoyancy, which cannot be sustained in extreme oligotrophic conditions. Sharks are apparently confined to *ca* 30% of the total ocean and distribution of many species is fragmented around sea mounts, ocean ridges and ocean margins. All populations are therefore within reach of human fisheries, and there is no hidden reserve of chondrichthyan biomass or biodiversity in the deep sea. Sharks may be more vulnerable to over-exploitation than previously thought.

Ruzzante, D.E. and et al. **Biocomplexity in a highly migratory pelagic marine fish, Atlantic herring.** *Proceedings of the Royal Society B* 273(1593): 1459-1464, 2006.

Notes: The existence of biologically differentiated populations has been credited with a major role in conferring sustainability and in buffering overall productivity of anadromous fish population complexes where evidence for spatial structure is uncontroversial. Here, we describe evidence of correlated genetic and life history (spawning season linked to spawning location) differentiation in an abundant and highly migratory pelagic fish, Atlantic herring, *Clupea harengus*, in the North Sea (NS) and adjacent areas. The existence of genetically and phenotypically diverse stocks in this region despite intense seasonal mixing strongly implicates natal homing in this species. Based on information from genetic markers and otolith morphology, we estimate the proportional contribution by NS, Skagerrak (SKG) and Kattegat and western Baltic (WBS) fish to mixed aggregations targeted by the NS fishery. We use these estimates to identify spatial and temporal differences in life history (migratory behaviour) and habitat use among genetically differentiated migratory populations that mix seasonally. Our study suggests the existence of more complex patterns of intraspecific diversity than was previously recognized. Sustainability may be compromised if such complex patterns are reduced through generalized management (e.g. area closures) that overlooks population differences in spatial use throughout the life cycle.

Purcell, J.F.H., Cowen, R.K., Hughes, C.R., and Williams, D.A. **Weak genetic structure indicates strong dispersal limits: a tale of two coral reef fish.** *Proceedings of the Royal Society B* 273(1593): 1483-1490, 2006.

Notes: The extent of dispersal by pelagic larvae in marine environments, including coral reefs, is central for understanding local population dynamics and designing sustainable marine reserves. We present here the first example of a clear stepping-stone genetic structure throughout the Caribbean basin for a common coral reef species, the French grunt (*Haemulon flavolineatum*). Analysis of microsatellite DNA markers indicated that French grunt population structure may be characterized by overlapping populations throughout the Caribbean, influenced by independent population dynamics but with no fixed geographical boundaries. In addition, different spatial genetic patterns were found in different oceanographic regions. A second species, the bluehead wrasse (*Thalassoma bifasciatum*), has a much longer pelagic larval duration than French grunts and showed no explicit spatial pattern of genetic variation. This finding is concordant with the hypothesis of a positive relationship between larval dispersal and duration in the plankton. While the magnitude of the genetic signal of population structure in French grunts was very low ($F_{ST}0.003$), the pattern of isolation-by-distance throughout the Caribbean indicated considerable population structure with important ecological and conservation significance.

Shivji, M.S., Chapman, D.D., Pikitch, E.K., and Raymond, P.W. **Genetic profiling reveals illegal international trade in fins of the great white shark, *Carcharodon carcharias*.** *Conservation Genetics* 6(6): 1035-1039, 2005.

Notes: Great white sharks are protected by national legislation in several countries, making this species the most widely protected elasmobranch in the world. Although the market demand for shark fins in general has continued to grow, the value and extent of utilization of white shark fins in trade has been controversial. We combine law enforcement with genetic profiling to demonstrate that illegal trade in fins of this species is occurring in the contemporary international market. Furthermore, we document the presence of fins from very young white sharks in the trade, suggesting a multiple-use market (food to trophies) exists for fins of this species. The presence of small fins in the trade contradicts the view that white shark fins have market value only as large display trophies, and not as food. Our findings indicate that effective conservation of protected shark species will require international management regimes that include monitoring of the shark fishery and trade on a species-specific basis.

Small, M.P., Frye, A.E., VonBargen, J.F., and Young, S.F. **Genetic structure of chum salmon (*Oncorhynchus keta*) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations?** *Conservation Genetics* 7(1): 65-78, 2006.

Notes: The lower Columbia River drainage once supported a run of over a million chum salmon. By the late 1950s, the run had decreased to often a few hundred fish. With the exception of Grays River near the coast and an aggregation of chum salmon spawning in creeks and the main stem near Bonneville Dam in the Columbia Gorge, most populations were thought to be extinct. However, chum salmon consistently return in low numbers to tributaries originating in the Cascade Range: the Cowlitz, Lewis, and Washougal rivers. To assess whether Cascade spawners were strays or remnants of former populations, chum salmon from the Coastal, Cascade and Gorge ecoregional zones were characterized at 17 microsatellite loci. Significant heterogeneity in genotype distributions was detected between zones and collections formed regional groups in a neighbor-joining tree. Cascade collections had higher allelic richness and private alleles, and the Cowlitz River supported genetically divergent fall and summer runs, the only summer chum salmon run extant in the Columbia River drainage. We propose that chum salmon in the Cascade zone are remnants of original populations. We attribute the divergence between zonal groups to diverse ecological conditions in each zone, which promoted regional genetic adaptation, and to genetic drift experienced in small populations.

Lage, C. and Kornfield, I. **Reduced genetic diversity and effective population size in an endangered Atlantic salmon (*Salmo salar*) population from Maine, USA.** *Conservation Genetics* 7(1): 91-104, 2006.

Notes: Atlantic salmon (*Salmo salar*) populations in Maine, USA, are listed as a Distinct Population Segment under the U.S. Endangered Species Act due to reduced spawning runs and juvenile densities. Whenever possible, optimal conservation strategies for endangered populations should incorporate both present and historical knowledge of genetic variation. We assayed genetic diversity at seven microsatellite loci and at the mitochondrial ND1 gene in an endangered wild population of Atlantic salmon captured from the Dennys River from 1963 to 2001 using DNA's extracted from archival scale and tissue samples. We examined temporal trends of genetic diversity, population structure, and effective population size (N_e). Overall temporal trends of diversity and N_e show significant reductions from 1963 to 2001 raising the possibility that current restoration efforts may be impacted by historical loss of diversity potentially critical to adaptation. Although our results suggest genetic stability in this population from 1963 to 1981, significant differentiation was observed for both the 1995 and 2001 samples compared with all other temporal samples. The presence of an ND1 mtDNA haplotype in this population, historically observed only in European and Newfoundland stocks, may represent previously unrecognized local wild diversity or, alternatively, may represent introgression from non-native fish.

Grafton, R.Q., Arnason, R., Bjorndal, T., Campbell, D., Campbell, H.F., Clark, C.W., Connor, R., Dupont, D.P., Hannesson, R., Hilborn, R., Kirkley, J.E., Kompas, T., Lane, D.E., Munro, G.R., Pascoe, S., Squires, D., Steinshamn, S.I., Turriss, B.R., and Weninger, Q. **Incentive-based approaches to sustainable fisheries.** *Canadian Journal of Fisheries and Aquatic Sciences* 63(3): 699-710, 2006.

Notes: The failures of traditional target-species management have led many to propose an ecosystem approach to fisheries to promote sustainability. The ecosystem approach is necessary, especially to account for fishery-ecosystem interactions, but by itself is not sufficient to address two important factors contributing to unsustainable fisheries: inappropriate incentives bearing on fishers and the ineffective governance that frequently exists in commercial, developed fisheries managed primarily by total-harvest limits and input controls. We contend that much greater emphasis must be placed on fisher motivation when managing fisheries. Using evidence from more than a dozen natural experiments in commercial fisheries, we argue that incentive-based approaches that better specify community and individual harvest or territorial rights and price ecosystem services and that are coupled with public research, monitoring, and effective oversight promote sustainable fisheries.

Hiddink, J.G., Jennings, S., Kaiser, M.J., Queiros, A.M., Duplisea, D.E., and Piet, G.J. **Cumulative impacts of seabed trawl disturbance on benthic biomass, production, and species richness in different habitats.** *Canadian Journal of Fisheries and Aquatic Sciences* 63(4): 721-736, 2006.

Notes: Bottom trawling causes widespread disturbance of sediments in shelf seas and can have a negative impact on benthic fauna. We conducted a large-scale assessment of bottom trawl fishing of benthic fauna in different habitats, using a theoretical, size-based model that included habitat features. Species richness was estimated based on a generalized body mass versus species richness relationship. The model was validated by sampling 33 stations subject to a range of trawling intensities in four shallow, soft sediment areas in the North Sea. Both the model and the field data demonstrated that trawling reduced biomass, production, and species richness. The impacts of trawling were greatest in areas with low levels of natural disturbance, while the impact of trawling was small in areas with high rates of natural disturbance. For the North Sea, the model showed that the bottom trawl fleet reduced benthic biomass and production by 56% and 21%, respectively, compared with an unfished situation. Because of the many simplifications and assumptions required to synthesize these data, additional work is required to refine the model and evaluate applicability in other geographic areas. Our model enables managers to understand the consequences of altering the distribution of fishing activities on benthic production and hence on food web processes.

Duplisea, D.E. and Castonguay, M. **Comparison and utility of different size-based metrics of fish communities for detecting fishery impacts.** *Canadian Journal of Fisheries and Aquatic Sciences* 63(4): 810-820, 2006.

Notes: The use of fish community indicators based on size spectra has become popular in the development of an ecosystem approach to fisheries. Size spectrum theory arose from basic ecological work on energy flow, predator-prey interactions, and biomass standing stock and was later applied to fish communities as length-frequency analysis. A multitude of size spectrum indicators have resulted, but it is not clear if they all present similar information. Here we develop a simple framework describing what four size spectra indicators suggest about fish communities, their likely response to fisheries exploitation, their ecological interpretation, and some of their biases. We examined indicators for scientific survey data from six exploited North Atlantic fish communities for the information that they reveal about each community. Each indicator revealed different information and had different biases. Combining indicators for the most impacted system (owing to fisheries and environmental change), the eastern Scotian Shelf, revealed a pattern analogous to Holling's ecological cycle of exploitation, conservation, release, and reorganisation. If this analogy is generally valid, then it suggests that collapsed fish communities are more susceptible to chance events, and recovery is not directly reversible and may not be recoverable (to previous known state) at all if the system moves to an alternative cycle.

Tamini, L.L., Chiaraimonte, G.E., Perez, J.E., and Cappozzo, H.L. **Batoids in a coastal trawl fishery of Argentina.** *Fisheries Research* 77(3): 326-332, 2006.

Notes: Elasmobranchs have become an important element of the bycatch in the fisheries worldwide and an important resource for most of Argentine trawl fisheries. This work is the first analysis of the diversity of batoid fishes in the bycatch of the Argentine coastal fisheries. Between July 1998 and June 2000, an outboard observer program was carried out and 89 tows were monitored. A total of 1354 batoid specimens were obtained from the bycatch and 11 different species were identified: *Atlantoraja castelnani*, *A. cyclophora*, *Dasyatis pastinaca*, *Dipturus chilensis*, *Discopyge tschudii*, *Myliobatis goodei*, *Psammobatis bergi*, *P. extenta*, *Rioraja agassizii*, *Sympterygia bonapartii* and *Zapteryx brevirostris*. The electric ray *D. tschudii* and the sand skate *P. extenta* were the most abundant species and were always discarded. The commercial capture of batoids was estimated at 33.6 kg h⁻¹ and showed no clear pattern of temporal variation.

Stobutzki, I.C., Silvestre, G.T., and Garces, L.R. **Key issues in coastal fisheries in South and Southeast Asia, outcomes of a regional initiative.** *Fisheries Research* 78(2-3): 109-118, 2006.

Notes: Asia is an important region in terms of fish trade supplying nearly 60% of global fish production. The region's coastal fisheries play a critical role in ensuring food security and providing livelihoods, particularly for poorer sections of the community. This paper introduces a regional initiative in which eight Asian countries (Bangladesh, India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand and Vietnam) undertook simultaneous, multi-disciplinary assessments of their coastal fisheries. The outputs of this initiative are presented in the next four papers of this volume of Fisheries Research. The assessments have highlighted two disturbing regional trends: coastal fisheries resources are severely depleted, and biological and economic overfishing is occurring throughout the region. These are symptoms of the lack of effective management of fishing capacity in the region. This overview paper highlights the urgent need to reduce fishing capacity in the region. Only

through such capacity reduction strategies can fish stocks be rebuilt to more productive and sustainable levels so that potential economic and social benefits from fisheries can be realized. Strategies need to be country- and fishery-specific and should focus on the development of effective access and property-rights regimes. For instance, countries need to explicitly allocate rights between small-scale and industrial fisheries, where resources are shared. This will require an understanding of the overlap between the sectors in terms of resource use and also the relative economic and social benefits from each sector.

Stobutzki, I.C., Silvestre, G.T., Abu Talib, A., Krongprom, A., Supongpan, M., Khemakorn, P., Armada, N., and Garces, L.R. **Decline of demersal coastal fisheries resources in three developing Asian countries.** *Fisheries Research* 78(2-3): 130-142, 2006.

Notes: Worldwide, there is serious concern about the state of fisheries; yet for Asia, which accounts for half of the global fisheries production, information on the state of fisheries in order to guide management is sparse. In this paper we review the results of a regional study that examined the state of demersal fisheries resources in the coastal areas of Malaysia, the Philippines and Thailand. In each country time series of scientific trawl survey data (spanning 12-49 years, depending on the area) were used to assess changes in the total biomass of demersal species over time. All countries showed substantial declines in the total biomass. In Malaysia, the declines were greatest in the shallow depths (< 50 m) where the biomass declined to 4-20% of the original estimates. In the Gulf of Thailand, by 1995 the total biomass estimates had declined to less than 8% of the 1965 estimates. In the Philippines, changes in the biomass were examined in different bays and fishing areas and the recent estimates of the biomass were 12-64% of the original estimates. These severe declines in the total biomass are thought to be due to over-fishing, compounded by environmental degradation. While over-fishing has been previously documented for selected species or fisheries in these countries, the fishery-independent data analysed here provide the first multi-country evidence of the widespread degradation of demersal coastal resources. Exploitation ratios (fishing mortality:total mortality), calculated from length frequency data, were on average > 0.5, suggesting over-fishing. In Thailand a time series of exploitation ratios for 17 species showed increasing fishing pressure over time. Environmental degradation, in terms of changes in water quality and habitat modification and loss, has been documented in all countries and this is likely to be a contributing factor for the declines. The serious declines observed in these three countries are illustrative of a regional trend and highlight the urgent need for countries to reduce and manage their fishing capacity. This regional study also identified a requirement for key interventions, such as strengthening licensing systems, limiting entry to fisheries and increasing gear selectivity. It also highlighted the fact that the strategies developed must take into account the context of the developing countries and the broader socioeconomic role of fisheries.

Zeeberg, J., Corten, A., and DeGraaf, E. **Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa.** *Fisheries Research* 78(2-3): 186-195, 2006.

Notes: The accidental capture of large animals such as sharks, manta rays, sea turtles, and dolphins in pelagic trawler fisheries remains controversial because it threatens biological diversity in many biogeographical regions, including the subtropical eastern North Atlantic. Bycatch rates observed during more than 1400 trawl sets off Mauritania, Northwest Africa, are shown to have been considerable during the past 4 years, with high animal abundance in summer when the Northwest African shelf is occupied by subtropical water. We demonstrate the urgency for bycatch reduction and evaluate the use of species-selective gear, a conservation method immediately available and immediately effective in waters fished through international access agreements. A modification tested in commercial trawls during the observer program guides pelagic megafauna deflected by a filter to an escape tunnel along the bottom of the trawl. This "excluder" reduces bycatch mortality of the most vulnerable megafauna species by at least 40-100%.

Fare, R., Kirkley, J.E., and Walden, J.B. **Adjusting technical efficiency to reflect discarding: The case of the US Georges Bank multi-species otter trawl fishery.** *Fisheries Research* 78(2-3): 257-265, 2006.

Notes: Discarding undesirable catch is recognized as a major problem confronting fishery managers. It is widely perceived by managers, however, that reductions in discards can only be accomplished via reductions in good or desirable outputs and technical efficiency. Yet there appear to be few studies which actually examine the relationship between discard reduction and technical efficiency. In this paper, we present an alternative concept of technical efficiency, which explicitly recognizes that

measures of technical efficiency should be adjusted for discard levels. This is because traditional measures of efficiency do not consider the resources used in order to discard. We also offer a framework based on data envelopment analysis for assessing efficiency in the presence of undesirable outputs. We examine the relationship between vessel efficiency and regulatory discards in the U.S. Georges Bank multi- species otter trawl fishery on a tow-level basis. We then examine differences between efficient and inefficient tows, and extend our results to the trip level. Further examination of trip-level results then yield insights into the potential impact of trip-limit regulations. Results show that in order to reduce discards, vessels are limited in the amount they can increase their total output, and that trip-limit regulations may have unintended consequences.
