

In this review:

- A. Recent articles – no abstract available
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A. Recent articles – no abstract available

Marshall, C.T. and Browman, H.I. **Disentangling the causes of maturation trends in exploited fish populations.** *Marine Ecology Progress Series* 335: 249-251, 2007.

B. Recent publications available online

Kiszka, J. and Muir, K. (eds.). 2007. **Incidental catch of non-targeted marine species in the western Indian Ocean: problems and mitigation measures.** Workshop proceeding. 13-15th November 2006, Mayotte, France. Western Indian Ocean Marine Science Association (WIOMSA). 111 pp.

Available at: <http://www.wiomsa.org/filearchive/1/1336/Workshop06-Mayotte%20Bycatch.pdf>

Notes: From 13 to 15 November 2006, representatives from Western Indian Ocean (WIO) countries and from other regions (USA, Australia, Sri Lanka) participated in a workshop to collate available information and assess the potential impact of bycatch on non-targeted marine species in the WIO, with a focus on marine mammals and turtles. This workshop was organized by the NGO Sea Sense, based in Tanzania, and by the University of La Rochelle, France and was funded by the Western Indian Ocean Marine Science Association. The aims of the workshop were to: 1- bring together relevant marine mammal and turtle scientists, fishery biologists, conservationists and managers in the region to share ideas and exchange information on bycatch of non-targeted marine species in the WIO; 2- review the level of threat from fisheries, both coastal and pelagic, in the WIO region; 3- discuss and resolve common issues relating to bycatch; 4- discuss and resolve common issues relating to data collection and analysis, survey techniques, and specific threats (other than by-catch) such as eco-tourism, pollution, habitat destruction/disturbance and boat collisions; and 5- produce recommendations for research and management, fund-raising and future regional and international collaboration. The workshop agreed that the coastal gillnet fishery poses a serious threat to turtles, dugongs and cetaceans in the WIO region. There are currently no measures to reduce bycatch in this fishery. Prawn trawling also poses a threat, particularly to turtles. It was acknowledged that while turtles, dugongs, cetaceans and sharks are all impacted by fishing activities in the WIO region, the highest priority is the dugong which is severely threatened from gillnetting and habitat disturbance. The establishment of a regional dugong research and conservation programme has been identified as a high priority. A rapid regional assessment of gillnet and prawn trawl fisheries was also considered a high priority to assess the level of threat from these gears on non-targeted marine species. Practical ways to reduce bycatch were identified, including convincing decision-makers of the importance of reducing bycatch due to the high tourism value placed on marine mammals and turtles.

C. Recent articles with abstracts

Harris, M.P., Beare, D., Toresen, R., Nottestad, L., Kloppmann, M., Dorner, H., Peach, K., Rushton, D.R.A., Foster-Smith, J., and Wanless, S. **A major increase in snake pipefish (*Entelurus aequoreus*) in northern European seas since 2003: potential implications for seabird breeding success.** *Marine Biology* 151(3): 973-983, 2007.

Notes: Since the early 2000s routine fish surveys have recorded increasing numbers of snake pipefish, *Entelurus aequoreus*, in the northeast Atlantic. Fishermen and divers have also commented on this increase and pipefish have started to appear in the diet of seabirds and other marine predators. This paper collates information from these diverse sources and assesses the current status of snake pipefish. We found compelling evidence of a dramatic increase in the abundance of snake pipefish starting around 2003 and continuing up to the present (2006) and a range expansion northwards to Spitzbergen and the Barents Sea. Since 2004 snake pipefish have been increasingly recorded in the diet of many species of seabird breeding in colonies around the coast of the UK, and in Norway, Iceland and the Faeroe Islands. Information on the nutrient value of snake pipefish is currently lacking but their rigid, bony structure makes them difficult for young seabirds to swallow and there are numerous records of chicks choking to death. Thus, in the case of avian predators during the breeding season, it appears unlikely that increased abundance of snake pipefish will provide a useful alternative prey. The reason for the rapid and dramatic increase in numbers of snake pipefish is currently unclear but such events are characteristic of marine ecosystems and will almost certainly have an effect on food web dynamics.

Fraser, D.J., Jones, M.W., McParland, T.L., and Hutchings, J.A. **Loss of historical immigration and the unsuccessful rehabilitation of extirpated salmon populations.** *Conservation Genetics* 8(3): 527-546, 2007.

Notes: Comprehensive evaluations of multiple genetic factors are rarely undertaken in rehabilitation attempts of extirpated populations, despite a growing need to address why some rehabilitation projects succeed and others fail. Using temporally-spaced samples of microsatellite DNA, we tested several genetic hypotheses that might explain an unsuccessful attempt to re-establish Atlantic salmon populations (*Salmo salar*) in two rivers of the inner Bay of Fundy, Canada. Census sizes (N) in both populations plummeted to near zero from initial increases after reintroduction/human-mediated recolonization occurred. Over the same period (1974-1996), both populations were characterized by low or relatively low effective sizes (N_e) and temporally unstable genetic structuring, whereas neighbouring populations, known historically for their significant salmon production, were not. Despite evidence for genetic bottlenecking and continual linkage disequilibrium over time in both populations, neither exhibited detectable inbreeding or a significant loss of allelic diversity or heterozygosity relative to known donor/source populations. Ratios of N_e to N also increased with decreasing N in both populations, implying a buffering capacity against losses of genetic diversity at depressed abundances. Most significantly, multiple lines of evidence were consistent with the hypothesis that there has been substantial and recurrent asymmetric migration (migration rate, m) from neighbouring areas into both populations even after initial rehabilitation. This included migration from a historically productive population that became extirpated during the course of rehabilitation efforts, indicating that both populations might have naturally depended on immigration from neighbouring areas for persistence. Our results highlight the value of incorporating temporal genetic data beyond commonly used metrics of neutral genetic diversity (F_{ST} , allelic richness, heterozygosity) to evaluate rehabilitation successes or failures. They also illustrate how the joint evaluation of multiple genetic concerns in rehabilitation attempts, at spatial scales beyond donor and rehabilitated populations, is useful for focusing future rehabilitation efforts.

Magnussen, J.E., Pikitch, E.K., Clarke, S.C., Nicholson, C., Hoelzel, A.R., and Shivji, M.S. **Genetic tracking of basking shark products in international trade.** *Animal Conservation* 10(2): 199-207, 2007.

Notes: Mounting evidence that sharks are being over-fished to supply shark fin markets is causing widespread concern about the sustainability of these practices. The basking shark *Cetorhinus maximus*, whose fins command high market prices, has proven especially sensitive to exploitation. To prevent further population declines, this species is now protected in the territorial waters of several countries, and is listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) requiring monitoring of trade in its products by all parties to CITES. Tracking trade in basking shark products, however, is often hampered by difficulties in identifying shark products to species of origin. Here, we present the development

and application of a streamlined genetic forensics assay that does not require DNA sequencing to identify basking shark products. The dual-primer, species-specific polymerase chain reaction strategy provides diagnostic redundancy for robustness in legal venues. It is also effective for identifying basking shark products regardless of geographic origin, an important consideration, given the global distribution of the species and international sourcing of fins to the trade. Application of the assay confirmed the presence of basking shark fins in the Hong Kong and Japan markets, and indicated an apparent relationship between the Chinese fin trader category 'Nuo Wei Tian Jiu' and fins from basking sharks. The assay was also used in a law enforcement investigation to document illegal trade in basking shark fins in the United States where this species is prohibited from harvest and trade. These trade detections suggest that the high market value of basking shark fins is continuing to drive the exploitation, surreptitious and otherwise, of this highly threatened species, underscoring the need for improved trade monitoring. The streamlined assay developed here can assist in monitoring and conservation on a worldwide scale.

Hixon, M.A. and Tissot, B.N. **Comparison of trawled vs untrawled mud seafloor assemblages of fishes and macroinvertebrates at Coquille Bank, Oregon.** *Journal of Experimental Marine Biology and Ecology* 344(1): 23-34, 2007.

Notes: We report the first quantitative comparison of trawled vs untrawled mud seafloor communities off the west coast of North America. Using a manned submersible, we ran visual transects at Coquille Bank, 25 km off the central coast of Oregon, USA, including six half-hour (mean length 1184 m) transects over mud seafloors 183-361 m deep. The shallowest transects were untrawled, whereas deeper transects were heavily trawled, as evidenced by extensive trawl-door tracks. Differences between trawled and untrawled seafloor assemblages were striking. We observed 23% more fish over untrawled compared to trawled seafloors, and recorded 27 fish species on untrawled bottoms, but only 19 species on trawled seafloors. Regarding benthic invertebrates, density of individuals was 6 times greater on untrawled compared to trawled bottoms. Nonetheless, we observed 11 taxa on trawled seafloors and only 6 taxa on untrawled bottoms. Principal components analysis (PCA) defined the untrawled assemblage as characterized by sea pens, ratfish, sablefish, ronquill, slender sole, and poacher. PCA defined the trawled assemblage as characterized by seastars, hermit crabs, bigfin eelpout, Dover sole, hagfish, and shortspine thornyhead. In untrawled areas, there was no correlation between sea-pen density and total fish density, whereas in trawled areas, there was a marginally inverse correlation between the density of trawl-door tracks and total fish density. The dominant fishes and macro invertebrates on trawled seafloors are known mobile scavengers that may aggregate along trawl-door tracks. Sea pens that dominated untrawled bottoms are sessile, slow-growing, long-lived species that are likely to recover slowly from physical disturbance. We conclude that the observed differences between trawled and untrawled communities were the result of groundfishing activities rather than local environmental differences. Given that habitat considerations for groundfish management in this region focus exclusively on rocky seafloors, it seems prudent to consider the adverse effects of bottom trawling on mud seafloor ecosystems of the continental shelf and slope.

Powell, E.N. and Klinck, J.M. **Is oyster shell a sustainable estuarine resource?** *Journal of Shellfish Research* 26(1): 181-194, 2007.

Notes: The decline of the eastern oyster (*Crassostrea virginica*) as an estuarine resource is well documented for many estuaries on the United States east coast. This decline is often associated with a decline in the shell resource and ultimately the disappearance of the shell bed. We develop a model that expressly and conjointly evaluates oyster abundance and surficial shell quantity and examine whether stability in the stock and the habitat can be simultaneously achieved. Simulations suggest that a steady-state shell content exists for any set of recruitment and natural mortality rates and that the amount of shell present at steady state varies over a wide range as recruitment and natural mortality vary. Shell mass is maximized at a natural mortality rate near the rate observed in unfished populations unimpacted by disease. A species dependent on the maintenance of hard substrate for survival, as is the oyster, might have a life span adapted to maximize the accretion of carbonate; thereby sustaining the substrate on which it depends. Relatively small changes in the recruitment rate produce large changes in abundance and consequently shell mass and the scale of variation dwarfs that of natural mortality or fishing. Only variations in the rate of shell loss or the average size of animals at death produce equivalent excursions in shell mass. In comparison, the ambit of natural mortality imposed by the disease process fortuitously occurs in a range that restrains the change in carbonate mass, probably because increased mortality reduces abundance but also increases the death rate, thus adding more shell. Simulations covering a range of fishing rates indicate that no fishing rate exists that is likely to be sustainable of the shell resource over the long term. Fishing will always abet the taphonomic and depositional processes conspiring to debilitate the oyster bed. Successful management of the oyster shell resource is obstructed by the simple fact that no additional mortality,

whether imposed by disease or through fishing, can occur that will not result in habitat loss at some rate. The shell resource is maximized when the population is at predisease natural mortality rates and unfished. Thus, if fishing is to be permitted or if disease has increased persistently the natural mortality rate, the only recourse of the manager is the perpetual addition of shell in compensation to the loss or the acceptance of the degradation of the shell bed.

Beddington, J.R., Agnew, D.J., and Clark, C.W. **Current problems in the management of marine fisheries.** *Science* 316(5832): 1713-1716, 2007.

Notes: The public perception of fisheries is that they are in crisis and have been for some time. Numerous scientific and popular articles have pointed to the failures of fisheries management that have caused this crisis. These are widely accepted to be overcapacity in fishing fleets, a failure to take the ecosystem effects of fishing into account, and a failure to enforce unpalatable but necessary reductions in fishing effort on fishing fleets and communities. However, the claims of some analysts that there is an inevitable decline in the status of fisheries is, we believe, incorrect. There have been successes in fisheries management, and we argue that the tools for appropriate management exist. Unfortunately, they have not been implemented widely. Our analysis suggests that management authorities need to develop legally enforceable and tested harvest strategies, coupled with appropriate rights-based incentives to the fishing community, for the future of fisheries to be better than their past.

Arlinghaus, R., Cooke, S.J., Lyman, J., Policansky, D., Schwab, A., Suski, C., Sutton, S.G., and Thorstad, E.B. **Understanding the complexity of catch-and-release in recreational fishing: An integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives.** *Reviews in Fisheries Science* 15(1-2): 75-167, 2007.

Notes: Most research on catch-and-release (C&R) in recreational fishing has been conducted from a disciplinary angle focusing on the biological sciences and the study of hooking mortality after release. This hampers understanding of the complex and multifaceted nature of C&R. In the present synopsis, we develop an integrative perspective on C&R by drawing on historical, philosophical, socio-psychological, biological, and managerial insights and perspectives. Such a perspective is helpful for a variety of reasons, such as 1) improving the science supporting successful fisheries management and conservation, 2) facilitating dialogue between managers, anglers, and other stakeholders, 3) minimizing conflict potentials, and 4) paving the path toward sustainable recreational fisheries management. The present work highlights the array of cultural, institutional, psychological, and biological factors and dimensions involved in C&R. Progress toward successful treatment of C&R might be enhanced by acknowledging the complexity inherent in C&R recreational fishing.

Figueiredo, I., Moura, T., Bordalo-Machado, P., Neves, A., Rosa, C., and Gordo, L.S. **Evidence for temporal changes in ray and skate populations in the Portuguese coast (1998-2003) - its implications in the ecosystem.** *Aquatic Living Resources* 20(1): 85-93, 2007.

Notes: In mainland Portugal, rays constitute an important by-catch of multi-gear shelf fisheries. However and despite their economical importance, landing information discriminated by species is scarce. The relative stability in Portuguese annual landings of rays and skates can be misinterpreted as no evidence for species declines. The present concern on the overexploitation of individual species arises from both theoretical considerations about biological and ecological traits and for historical reasons. This work constitutes an approach for a retrospective analysis of ray landings in mainland Portugal. Data from research surveys carried along the Portuguese coast was used to infer possible changes in species composition on Portuguese landings. Clusters were determined based on data collected during surveys from species composition for three time-periods, 1989-1991, 1995-1997 and 2001-2003. The relative importance of the associate species within clusters was the input data to define discriminating rules posteriorly used to assign clusters to landings from each commercial vessel. The results show an increase of species relative importance and changes on species abundance: *Raja brachyura* and *Raja clavata* decreased, whilst *Leucoraja naevus*, increased. Furthermore, it was observed a decrease on the mean weight of the two first species and a relative stability in the last one. Such results reflect the importance of species life-history characteristics in particular, on the response to fishing impact.

Hutchings, J.A., Swain, D.P., Rowe, S., Eddington, J.D., Puvanendran, V., and Brown, J.A. **Genetic variation in life-history reaction norms in a marine fish.** *Proceedings of the Royal Society of London [B]* 274(1619): 1693-1699, 2007.

Notes: Neither the scale of adaptive variation nor the genetic basis for differential population responses to the environment is known for broadcast-spawning marine fishes. Using a common-garden experimental protocol, we document how larval growth, survival and their norms of reaction differ genetically among four populations of Atlantic cod (*Gadus morhua*). These traits, and their plastic responses to food and temperature, differed across spatial scales at which microsatellite DNA failed to detect population structure. Divergent survival reaction norms indicate that warm-water populations are more sensitive to changes in food, whereas cold-water populations are more sensitive to changes in temperature. Our results suggest that neither the direction nor the magnitude of demographic responses to environmental change need be the same among populations. Adaptive phenotypic plasticity, previously undocumented in marine fishes, can significantly influence the probability of recovery and persistence of collapsed populations by affecting their ability to respond to natural and anthropogenic environmental change.

Vince, J. **Policy responses to IUU fishing in Northern Australian waters.** *Ocean and Coastal Management* 50(8): 683-698, 2007.

Notes: Illegal, unreported and unregulated (IUU) fishing activities continue to thrive in the northern region of Australia's Fishing Zone (AFZ). Indonesian fishermen involved in IUU fishing in this area target specific marine species such as shark, reef fish, sea cucumber and trochus that are destined for the Asian market. Many of these marine species' stocks are now at critical levels. Local communities based in Northern Australia, state and Federal governments are also concerned with issues of border security and quarantine measures that coincide with the IUU fishing activities. Whilst Australian and Indonesian governments continue to negotiate this pressing issue, international instruments, bilateral agreements and domestic policies are not deterring Indonesian fishermen from pursuing IUU fishing activities in the AFZ.

Carlson, J.K., Osborne, J., and Schmidt, T.W. **Monitoring the recovery of smalltooth sawfish, *Pristis pectinata*, using standardized relative indices of abundance.** *Biological Conservation* 136(2): 195-202, 2007.

Notes: The US population of smalltooth sawfish, *Pristis pectinata*, is currently listed as endangered under the Endangered Species Act. An important component of monitoring the recovery of this species is establishing long-term baseline trends in abundance. In the absence of scientific survey data, assessing and monitoring the status of some marine species has required the utilization of fishery-dependent data. Using voluntary dockside interviews of sport fishers collected in Everglades National Park, a standardized index of abundance was created for smalltooth sawfish using the delta method. The index was developed as the product of separate generalized linear models of the proportion of positive trips and the positive catch rates on successful trips. Development of the final model included testing factors that were expected to influence the catch of smalltooth sawfish. The final model assumed a binomial distribution for the proportion of positive trips and a lognormal distribution for positive catch rates. Year was significant as a main effect in the binomial model whereas year and skill level of the fishing party were significant in the lognormal model. The relative abundance index shows a small increase in abundance at an average rate of about 5% per year since 1989. These results indicate that the population of smalltooth sawfish in Everglades National Park has at least stabilized and may be increasing. However, additional data and analyses from multiple sources are required before definitive conclusions on the recovery of smalltooth sawfish can be established.

Savenkoff, C., Castonguay, M., Chabot, D., Hammill, M.O., Bourdages, H., and Morissette, L. **Changes in the northern Gulf of St. Lawrence ecosystem estimated by inverse modelling: Evidence of a fishery-induced regime shift?** *Estuarine, Coastal and Shelf Science* 73(3-4): 711-724, 2007.

Notes: Mass-balance models have been constructed using inverse methodology for the northern Gulf of St. Lawrence for the mid-1980s, the mid-1990s, and the early 2000s to describe ecosystem structure, trophic group interactions, and the effects of fishing and predation on the ecosystem for each time period. Our analyses indicate that the ecosystem structure shifted dramatically from one previously dominated by demersal (cod, redfish) and small-bodied forage (e.g., capelin, mackerel,

herring, shrimp) species to one now dominated by small-bodied forage species. Overfishing removed a functional group in the late 1980s, large piscivorous fish (primarily cod and redfish), which has not recovered 14 years after the cessation of heavy fishing. This has left only marine mammals as top predators during the mid-1990s, and marine mammals and small Greenland halibut during the early 2000s. Predation by marine mammals on fish increased from the mid-1980s to the early 2000s while predation by large fish on fish decreased. Capelin and shrimp, the main prey in each period, showed an increase in biomass over the three periods. A switch in the main predators of capelin from cod to marine mammals occurred, while Greenland halibut progressively replaced cod as shrimp predators. Overfishing influenced community structure directly through preferential removal of larger-bodied fishes and indirectly through predation release because larger-bodied fishes exerted top-down control upon other community species or competed with other species for the same prey. Our modelling estimates showed that a change in predation structure or flows at the top of the trophic system led to changes in predation at all lower trophic levels in the northern Gulf of St. Lawrence. These changes represent a case of fishery-induced regime shift.

Mendiola, D., Ibaibarriaga, L., and Alvarez, P. **Thermal effects on growth and time to starvation during the yolk-sac larval period of Atlantic mackerel *Scomber scombrus* L.** *Journal of Fish Biology* 70(3): 895-910, 2007.

Notes: The effect of incubation temperature (8.6, 11.1, 13.2, 15.1 and 16.8°C) on north-east Atlantic mackerel *Scomber scombrus* development, growth and age at starvation during the yolk-sac larval period was investigated. Standard length at hatch was found to be inversely proportional to incubation temperatures within the natural thermal ranges of this species; it ranged from 3.76 mm at 11.1°C to 3.30 mm at 17.8°C. Following hatch, however, larval growth rate was positively related to temperature. Individual logistic models, as a function of temperature and age, were fitted to the development processes of gape, eye pigmentation, jaw mobility and yolk exhaustion. Thereafter, development was classified into different ordered stages and an extended continuation model was fitted to the multinomial ordered stage classification. In all cases, there was a difference of >23 h between the first and the last individual developing in certain stage. The probability of survival decreased with age and was inversely related to temperature. Yolk utilization varied from 4.5 to 8.6 days and individuals died between 7.9 and 12.2 days from 17.8 to 11.1°C. The study demonstrated the significant impact that temperature has on development, growth and survival rates, during the early life history.

Luiz, O.J., Joyeux, J.-C., and Gasparini, J.L. **Rediscovery of *Anthias salmopunctatus* Lubbock & Edwards, 1981, with comments on its natural history and conservation.** *Journal of Fish Biology* 70: 1283-1286, 2007.

Notes: After c. 30 years without sighting or capture, *Anthias salmopunctatus* was rediscovered at the type locality, St Peter and St Paul's Rocks, Mid-Atlantic Ridge. To date, the known distribution is restricted to depths varying from 35 to 55 m in vertical drop offs around the perimeter of the islands (c. 400 m). This may be the smallest geographic range known for a marine fish species.

Shertzer, K.W. and Prager, M.H. **Delay in fishery management: diminished yield, longer rebuilding, and increased probability of stock collapse.** *ICES Journal of Marine Science* 64(1): 149-159, 2007.

Notes: When a stock is depleted, catch reductions are in order, but typically they are implemented only after considerable delay. Delay occurs because fishery management is political, and stricter management, which involves short-term economic loss, is unpopular. Informed of stock decline, managers often hesitate, perhaps pondering the uncertainty of scientific advice, perhaps hoping that a good year class will render action moot. However, management delay itself can have significant costs, when it exacerbates stock decline. To examine the biological consequences of delay, we simulated a spectrum of fisheries under various degrees of delay in management. Increased delay required larger catch reductions, for more years, to recover benchmark stock status (here, spawning-stock biomass at maximum sustainable yield). Management delay caused stock collapse most often under two conditions: (1) when the stock-recruitment relationship was depensatory, or (2) when catchability, unknown to the assessment, was density-dependent and fishing took juveniles. In contrast, prompt management resulted in quicker recoveries and higher cumulative yields from simulated fisheries. Benefits to stock biomass and fishery yield can be high from implementing management promptly.

Marchal, P., Andersen, B., Caillart, B., Eigaard, O., Guyader, O., Hovgaard, H., Iriondo, A., Le Fur, F., Sacchi, J., and Santurtun, M. **Impact of technological creep on fishing effort and fishing mortality, for a selection of European fleets.** *ICES Journal of Marine Science* 64(1): 192-209, 2007.

Notes: Face-to-face interviews were conducted to identify the main changes in gear and vessel technology that may have improved the fishing efficiency of a number of French, Danish, and Basque fleets over the past few decades. Important changes include the gradual appearance of twin trawls (Danish and French trawlers) and trammel-nets (French gillnetters), and the increased polyvalence of Basque bottom trawlers. The results suggest that fishing effort descriptors that are not traditionally measured (gear type, groundrope type, length of net used per day, headline length, crew size, number of winch or net drums) may have a substantial impact on catch rates. Adjusting fishing effort using such descriptors may generally improve the relationship between fishing effort and fishing mortality.

Friedland, K.D., Miller, M.J., and Knights, B. **Oceanic changes in the Sargasso Sea and declines in recruitment of the European eel.** *ICES Journal of Marine Science* 64(3): 519-530, 2007.

Notes: Anguillid eel recruitment in the North Atlantic has declined in recent decades, raising concerns that climatic changes in the Sargasso Sea may be influencing oceanic reproduction and larval survival. There is a significant negative correlation between the North Atlantic Oscillation and long-term variations in catches of glass eel stages of the European eel *Anguilla anguilla* recorded by the fishery independent Den Oever recruitment index (DOI) in the Netherlands, lagged by one year. Ocean-atmospheric changes in the Sargasso Sea may affect the location of spawning areas by silver eels and the survival of leptocephali during the key period when they are transported towards the Gulf Stream. A northward shift in a key isotherm (22.5°C), defining the northern boundary of the spawning area, a declining trend in winds and transport conditions in larval transport areas, and a shallowing of the mixed layer depth could affect primary productivity in areas where leptocephali feed. The relationships between these ocean parameters and the DOI suggest that these changing ocean conditions could be contributing to declining recruitment of the European eel and probably also of the American eel (*A. rostrata*), but anthropogenic factors during their continental life stage must also be considered.

Arnason, R. **Climate change and fisheries: Assessing the economic impact in Iceland and Greenland.** *Natural Resource Modeling* 20(2): 163-197, 2007.

Notes: Climate changes in the 21st century are expected to significantly increase ocean temperatures and modify other oceanographic conditions in the North Atlantic. Marine biological research suggests that the impacts on the commercially most important fish stocks in the Icelandic-Greenland ecosystem may well be quite substantial. This will obviously lead to a corresponding impact on the economics of these two countries. However, the timing, extent and biological impact of global warming is quite uncertain. As a result the economic impact is similarly uncertain. This paper attempts to provide estimates of the impact of altered fish stocks due to global warming on the Icelandic and Greenland economies. The approach is one of stochastic simulations. This involves essentially three steps. The first is to obtain predictions of the impact of global warming on fish stocks and the associated probability distribution. For this we rely on recent marine biological predictions. The second step is to estimate the role of the fisheries sector in the two economies. This is done with the help of modern econometric techniques based on economic growth theory and historical data. Obviously these estimates are also subject to stochastic errors and uncertainty. The third step is to carry out Monte Carlo simulations on the basis of the above model and the associated uncertainties. The result of the Monte Carlo simulations consists of a set of dynamic paths for GDP over time within expected value and a probability distribution for each future year. On this basis it is possible to calculate confidence intervals for the most likely path of GDP over time. The results indicate that the fisheries impact of global warming on the Icelandic GDP is more likely to be positive than negative but unlikely to be of significant magnitude compared to historical economic growth rates and fluctuations. The uncertainty of this prediction, however, is large. For Greenland, the impact on fish stocks and the GDP is highly likely to be positive and quite substantial relative to the current GDP. Due to less knowledge of the relationship between the fisheries sector and the Greenland economy, however, the confidence interval of this prediction is even wider than in the case of Iceland.

Eide, A. **Economic impacts of global warming: The case of the Barents Sea fisheries.** *Natural Resource Modeling* 20(2): 199-221, 2007.

Notes: Regional analyses of possible physical and biological effects of global warming in the Barents Sea area have been carried out recently. Based on such studies possible economic impacts of global warming on the Barents Sea fisheries have been quantified, assuming different types of management regimes. The EconSimp000 model, consisting of the Ecosystem model AggMult and the fleet model EconMult have been parameterized based on fleet and catch records from the Norwegian Barents Sea fisheries. The model has been used to study biological and economic impacts of different environmental scenarios representing possible consequences of global warming. The current environmental situation, including normal seasonal and other variations, has been used as a reference scenario. Several biological and economic indicators have been defined in order to evaluate the simulation results of different environmental scenarios and different types of management regimes. The findings support earlier studies where biological and economic impacts of changes in management regime is found to be more pronounced than impacts caused by effects of global warming.

Rockmann, C., Schneider, U.A., St. John, M.A., and Tol, R.S.J. **Rebuilding the Eastern Baltic cod stock under environmental change - A preliminary approach using stock, environmental, and management constraints.** *Natural Resource Modeling* 20(2): 223-262, 2007.

Notes: The population dynamics of the Eastern Baltic cod (*Gadus morhua callarias* L.), unlike many other stocks, shows a strong dependency on environmental conditions. To test the implications of different management policies on the stock and the fishery in a system of global environmental change, we apply a spatially disaggregated, discrete time, age-structured model of the Eastern Baltic cod stock in 50 year simulation analyses. The simulation provides an analysis of stock, yield, and revenue development under various management policies and environmental scenarios. The policy analysis, focusing on different regulations of fishing mortality, is embedded into three environmental scenarios, assuming low, medium, or high climate and environmental change. The environmental assumptions are based on simulation results from a coupled atmosphere-ocean regional climate model, which project salinity in the Baltic Sea to decrease by 7-47% in the period 2071-2100 relative to the reference period 1961-1990. Our simulation results show that a significant reduction in fishing mortality is necessary for achieving high long-term economic yields. Moreover, under the environmental scenarios presented, a stock collapse cannot be prevented. It can, however, be postponed by the establishment of a marine reserve in ICES subdivision 25.

Hannesson, R. **Global warming and fish migrations.** *Natural Resource Modeling* 20(2): 301-319, 2007.

Notes: Ocean temperatures are expected to rise over the next decades. This is likely to affect the distribution of fish stocks between the exclusive economic zones (EEZs) of different countries. Such changes are likely to be triggered as temperatures rise beyond certain threshold levels, and they are likely to be irregular because temperatures are likely to vary around a rising trend. The paper looks at the case where temperature changes would displace a fish stock out of the EEZ of one country and into the EEZ of another, with a transition period in which the stock is shared. It is examined how this might affect the risk of extinction and degree of overfishing, under different cost scenarios and different assumptions about how countries react to observed changes in the distribution of the stock between their economic zones.

Kaje, J.H. and Huppert, D.D. **The value of short-run climate forecasts in managing the coastal coho salmon (*Oncorhynchus kisutch*) fishery in Washington State.** *Natural Resource Modeling* 20(2): 321-349, 2007.

Notes: In recent years our understanding of the intricate connections between climate variability, marine and freshwater environmental conditions and the responses of fish stocks has improved considerably with predictable relationships between the environment and stock abundance, fishery managers should be able to forecast variation in stock survival and recruitment. Such forecasts present an opportunity for increasing the economic value of fisheries and for achieving other management objectives, such as stock conservation and maintenance of population diversity. After describing a 4-step framework for addressing the question 'What is a forecast worth?' in a fishery decision-making context, we introduce the management system for Washington's coastal coho salmon (*Oncorhynchus kisutch*) fishery. Then we apply the 4-step framework to estimate the value of improved run size forecasts in the annual harvest management of coho salmon in Washington State. Our principal

analytical tool is a stochastic simulation model that incorporates the main characteristics of the fishery. The paper concludes with a discussion of opportunities and constraints to the use of climate-based forecasts in fishery management on various spatial and temporal scales, and we consider the challenges associated with forecasting variations in fish stock size caused by shifts in climate and related ocean conditions.

deJuan, S., Thrush, S.F., and Demestre, M. **Functional changes as indicators of trawling disturbance on a benthic community located in a fishing ground (NW Mediterranean Sea).** *Marine Ecology Progress Series* 334: 117-129, 2007.

Notes: Trawling disturbs benthic communities, eliminating the most vulnerable organisms and modifying habitat structure. While the cumulative effects of disturbance resulting from commercial trawling activities are poorly understood, several studies suggest that chronically disturbed communities are dominated by opportunistic organisms. This study focuses on changes in functional components of the benthic community occurring in muddy sediments in a NW Mediterranean trawling ground, including an area that has not been fished for 20 yr. In both disturbed and undisturbed areas, the overall benthic community from the fishing ground was dominated by burrowing epifaunal deposit feeders and predators, and deep burrowing infaunal deposit feeders. The fished area had a higher abundance of burrowing epifaunal scavengers and motile burrowing infauna, while the undisturbed area was characterised by higher abundance of surface infauna, epifaunal suspension feeders and predatory fish. This study clearly demonstrates that changes in the functional components of a benthic community can result from fishing in areas dominated by organisms not considered especially vulnerable to trawling activities. Thus, fisheries managers aiming to reduce ecosystem disturbance must consider the implications of trawling on the structure and functioning of all types of benthic communities.

Law, R. **Fisheries-induced evolution: present status and future directions.** *Marine Ecology Progress Series* 335: 271-277, 2007.

Notes: This essay comments on recent research on Darwinian fisheries science and on the future development of this field. From a practical point of view, the key question is: how fast are evolutionary changes caused by fishing happening? To answer this question, there is a need to understand intensities of selection generated by fishing, heritabilities and genetic correlations of the traits under selection, and whether the rates of change in traits predicted from this information are consistent with the changes observed. Although there is little doubt about the existence of phenotypic change in life-history traits of exploited fish stocks, there are few direct estimates of selection differentials caused by fishing. Results that are available, together with the relatively low heritabilities of life-history traits, suggest that the evolution caused by fishing occurs at a modest rate, and is likely to need a decadal time scale to be clearly observable. Given the pressing need for attention to fisheries in the short term, measures to control the longer-term evolutionary impact of fishing are most likely to be adopted if they also help to meet short-term objectives of management. With this in mind, the essay mounts a defence of large, old fish, the presence of which would be beneficial to stocks in the short term, and the conservation of which would set in motion selection for improved growth in the longer term.

Kraak, S.B.M. **Does the probabilistic maturation reaction norm approach disentangle phenotypic plasticity from genetic change?** *Marine Ecology Progress Series* 335: 295-300, 2007.

Notes: Two-dimensional probabilistic maturation reaction norms (PMRNs) define the probability that individuals mature as a function of age and size. PMRNs have recently been used to derive empirical support for the hypothesis that high fishing mortality has induced genetic change towards earlier maturation in exploited populations. However, the 2-dimensional PMRN method does not, strictly speaking, disentangle phenotypic plasticity from genetic change in maturation. Instead, it disentangles the contribution of variation in growth and mortality from other sources of variation contributing to changes in maturation. After removing the contribution of variation in growth and mortality, any remaining change is not necessarily purely genetic. Environmental factors may exist that directly affect the propensity to mature at a certain size and age. An observed trend in the size-age PMRN may therefore be partly or fully explained by a co-incident trend in an (environmental) factor. As pointed out by Grift et al. (2007; *Mar Ecol Prog Ser* 334:213-224), such co-dependence is captured conceptually by multi-dimensional PMRNs, as opposed to 2-dimensional (size-age) PMRNs, where the higher dimensions represent the relevant variables. Dimensions that may partly or fully explain the observed trends in size-age PMRNs, other than evolution, include

temperature, polluting endocrine-disrupting chemicals, the social structure of the population, and body condition; changes in the last two may be fisheries-induced. To illustrate these views, I re-analysed data on North Sea plaice, and demonstrated that temperature explains part of the shift in the size-age PMRN but that a residual shift remains. The latter finding supports the hypothesis of genetic change.

Marshall, C.T. and McAdam, B.J. **Integrated perspectives on genetic and environmental effects on maturation can reduce potential for errors of inference.** *Marine Ecology Progress Series* 335: 301-310, 2007.

Notes: In exploited fish stocks, long-term trends towards earlier maturation have been interpreted as an evolutionary response to sustained, high fishing mortality. The evidence used to support this diagnosis consists of directional shifts in probabilistic maturation reaction norms (PMRNs) that are consistent with the expectation that high fishing mortality favours the genotype for early maturation. Most PMRNs describe the probability of becoming mature solely as a function of age and length. Because they do not fully account for several physiological aspects of maturation (including growth effects on maturation, critical time windows for maturation decisions and developmental thresholds for maturation), it is possible that the observed shifts in PMRNs that are currently being attributed to changes in genotype actually reflect environmental effects on maturation. In this study, a comparative approach was used to interrogate the historical database for Northeast Arctic cod *Gadus morhua* in relation to 2 contrasting but not mutually exclusive hypotheses: (1) that there is a significant effect of food availability on the probability of being mature, using condition as a proxy for food availability; and (2) that there has been a long-term shift in the PMRN for maturation in a direction that is consistent with a diagnosis of fisheries-induced evolution. The results show that the maturation trends in Northeast Arctic cod could be variously interpreted as showing a strong environmental effect, no genetic effect, or a strong genetic effect. If the scope of the analysis had been restricted to testing a single hypothesis related to either an environmental effect or a genetic effect, then the study could very easily have made a Type I error of inference. A more integrated view of maturation, incorporating key aspects of the physiological processes that culminate in maturation, is therefore required to avoid incorrect inferences about the underlying causes of earlier maturation.

Dieckmann, U. and Heino, M. **Probabilistic maturation reaction norms: their history, strengths, and limitations.** *Marine Ecology Progress Series* 335: 253-269, 2007.

Notes: Probabilistic maturation reaction norms (PMRNs) are emerging as a flexible and general tool for characterizing phenotypic plasticity in maturation schedules. Describing an organism's probability of maturing as a function of its age and size, PMRNs offer several beneficial features: (1) PMRNs overcome systematic biases that previously marred the estimation of deterministic maturation reaction norms for populations with probabilistic growth and maturation; (2) PMRNs remove the effects of varying mortality rates and average juvenile somatic growth rates from descriptions of maturation schedules; (3) PMRNs are defined at the level of individuals and can thus be treated as phenotypes when applying methods of quantitative genetics; (4) PMRNs serve as indispensable ingredients in process-based dynamical models of a population's age and size structure; and (5) PMRNs are readily extended to include effects on maturation of individual or environmental factors other than age and size. Owing to this combination of features, PMRNs allow many effects of phenotypic plasticity to be stripped away from the description of maturation schedules, so that residual trends are suggestive of genetic adaptation in maturation schedules. Here we review the historical developments that led to the introduction of PMRNs and address frequently asked questions about their interpretation, utility, and application.

Shackell, N.L. and Frank, K.T. **Compensation in exploited marine fish communities on the Scotian Shelf, Canada.** *Marine Ecology Progress Series* 336: 235-247, 2007.

Notes: We evaluated the temporal dynamics of the aggregate groundfish community, further decomposed into functional groups, individual species abundances, and health indicators, from adjacent management units on the Scotian Shelf. On the colder, eastern half of the shelf, several species collapsed in the early 1990s, while, on the western half, no such collapses were evident despite similar exploitation regimes. The decline in the eastern aggregate biomass was influenced by a decline in average body size, which was interpreted as a past integrator of temperature and size-selective fishing. Biomass of 3 out of 4 functional groups declined in the east; 3 out of 4 groups increased in the west. Some species from the east appear to be slowly compensating, but not enough to counter the decline in aggregate biomass. Species inhabiting the warmer western region

show strong evidence of compensation. In effect, warmer waters allow potential compensating species to increase at a faster rate. Quantitative measures of functional group temporal stability revealed no differences between areas; therefore, neither area can be considered stable. Physiological condition declined in many species in both regions. Species that increased in the west, or had slower rates of decline, had higher levels of condition than eastern populations. With the exception of cod in the western region, species growth rates declined in both areas. Although the west appears more stable, it is following a similar, but protracted trajectory, to that found in the east. The protracted response in the west may be due to higher demographic rates in warmer waters. To foster resilience in the western area, we should address the rapid pace of new fisheries, effects of size-selective mortality, and the diminishing number of natural refugia.
