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President's Message

I am retiring on May 27 after 40 years in the Department of Fisheries and Oceans. I looked forward to coming to work every day of these 40 years. I plan to stay on as an Emeritus Scientist which means that I do not work as hard and I pay less attention to deadlines and no attention to some other things. There have been many discoveries in fisheries science over the past 40 years, but some fundamental processes remain to be discovered. In the North Pacific, we are getting historic high catches of Pacific salmon. I suspect that more records will be broken. However, after 100 years of research, we do not understand why the abundances are so high and increasing. It is amazing how much we found out about Pacific salmon in recent years, but this is also a positive way of saying how little we know about key processes that regulate abundances. I think that there are enough biologists around the Pacific, so the rate of discovery could be related to other issues. When our profession focuses on an issue such as an impact of a contaminant, we tend to find needed answers. Perhaps the answer for Pacific salmon is to find a way to focus a portion of the research that occurs in the United States, Canada, Russia, Japan and Korea. For the relatively small cost of organizing and coordinating the research effort, Governments would save money in the long term and win friends as each country publicized the collective discoveries. I suspect that this approach of coordinating teams of researchers would increase the rate of discovery in a number of areas across North America. I also suspect that teams of researchers, focused on key problems in fisheries science, would be good for moral among the team members and good for politicians as the public recognize their support.

The voting for President-elect closed on March 1. I am pleased to announce that Steve Cadrin, of the New England District, received 98% of the votes, and is now officially the President-elect. Steve has been a strong supporter of AIFRB and is organizing our next symposium in 2012.

We have some new initiatives that he will take over after our annual meeting in September. One event will be to begin to host major debates on key issues in fisheries science. Board members and Steve are anxious to include new members in our plans for AIFRB and this will be another major focus for Steve. Congratulations, Steve!

Dick Beamish February 2011

The Overfishing Metaphor

B. J. Rothschild

The term "overfishing"[1] seems to have first been used in 1854 at a meeting of the British Association for the Advancement of Science (Rozwadowski, 2002). The determination of whether or not a stock is overfished preoccupied fishery scientists for the next several decades. During this time no precise definition of overfishing could be developed, despite a prestigious inquiry by the International Council for Exploration of the Sea (ICES) (Petersen, 1903).

Progress seemed evident in the 1940s and 1950s with the development of quantitative theories of fishing. The theories created the belief that practical and concrete overfishing definitions could be developed from mathematical models linking fishing mortality and population abundance. These models could generate optimal values (maxima) of production, yield-per-recruit, and recruitment as functions of stock size or fishing mortality. Thus, if optimal values were exceeded—the stock size was too low, or fishing mortality was too high—the stock could be declared overfished.

However, the promise one-half century ago has dissipated. The connection between the theories and real fish populations has been disappointing for several reasons. The theoretical models:

1. do not in general correspond with real data;
2. do not exhibit well-defined optima or maxima for extensive portions of their parameter space (Rothschild *et al.*, 1997). As a consequence, generally arbitrary substitutes (so-called "proxies") are contrived to replace the optimization target;
3. are equivocal and generally not consistent with one another (e.g., growth overfishing and stock overfishing) (see Cushing, 1973);
4. focus on populations in equilibrium despite the fact that real populations are generally not in equilibrium (see, however, Rothschild and Jiao, 2009; Prager, 1994);

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5. ignore critical sources of variability in fish-stock population dynamics, such as interactions with associated species and effects of the ocean environment (Cushing, 1995).

Taken together, these deficiencies result in applications that do not describe the dynamics of fish populations. A consequence of this is that stock abundance and fishing mortality are not always tightly coupled, reflecting that the theories of fishing can only be considered to be metaphorical representations of the relationship between fishing mortality and fish population abundance and, as such, associated definitions of "overfished/overfishing" are also metaphorical. The fact that there is no unique definition of overfishing (except in the Schaefer model sense), and different overfishing standards are applied to different stocks, make it difficult to interpret overarching "mission accomplished" claims about the success or lack of success of fisheries management. Furthermore, the lack of environmental information in the overfishing calculus prevents any meaningful claim that overfished stocks will increase in abundance, if fishing mortality is reduced or terminated.

The spectacular collapse of the cod stock complex in the northwest Atlantic, which has been widely attributed to overfishing, is an interesting, somewhat typical case study (for reviews, see: Rothschild, 2007; Rice, 2002; Lilly *et al.*, 2008; Hilborn and Litzinger, 2009; Halliday and Pinhorn, 2009). The assertion that overfishing is the main cause of the collapse is not supported by the data. Five stanzas in the northwest Atlantic cod-population complex dynamics can be discerned (Figure 1). In the first stanza, the complex is stable despite increasing fishing mortality. In the second stanza, biomass decreases sharply under high fishing mortality. Note however that this major increase in fishing mortality occurs *after* the stock complex has declined in abundance. In the third stanza, the cod complex rebuilds at low fishing mortality. In the fourth stanza, the biomass declines sharply at low fishing mortality. In the fifth stanza, fishing mortality rises sharply *after* the complex has declined. In the second and most dramatic collapse from to 1984-1994 (stanzas 4 and 5), the cod complex begins to decline at relatively low levels of fishing mortality. Counter-indicating fishing intensity as a primary cause of the cod decline during this decade are observations that reflect a widespread deterioration of environmental productivity. These observations include: 1) a fishing moratorium imposed subsequent to the cod collapse did not result in a recovery; 2) the natural mortality rate (i.e., mortality independent of fishing) of cod increased by a factor of four; 3) cod growth rates declined substantially; 4) individual cod condition factors declined; 5) changes in the typical food of the cod were evident; 6) associated species exhibited declines in abundance, growth, and condition; and 7) abnormal quantities of cold, relatively fresh water were evident throughout the region. Altogether these observations point to a major environmental change as the primary cause generating and sustaining the 1984-1994 decline of the cod in the northwest Atlantic.

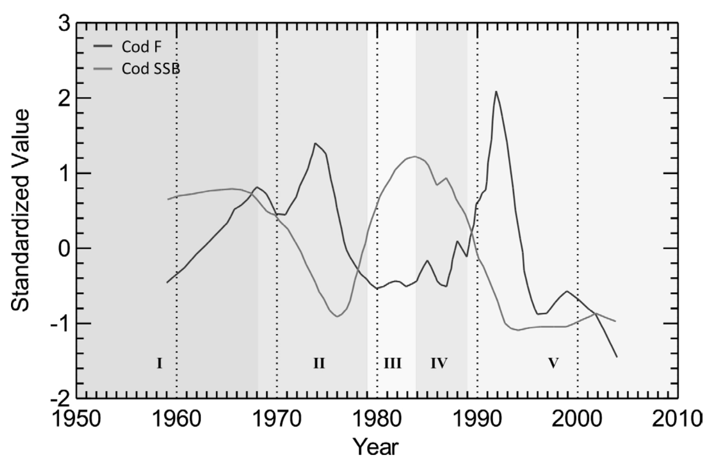

Figure 1. Trajectories of northwest Atlantic cod spawning stock biomass and fishing mortality for five stanzas of time. The data have been normalized in standard deviation units. The trajectories are smooth curves fitted through the data using the Loess smoother (tension = .35).

Two forms of decoupling are apparent. In the first, decoupling appears to be associated with a fish population reaching its "carrying capacity"—either because the size of the stock exceeded the capacity of the environment, or because the capacity of the environment deteriorated. This type of decoupling is evidenced by the not uncommon situation where a stock "crashes" at relatively low fishing mortality. The second form of decoupling relates to the unorthodox concept that *declines* in fish-stock abundance *cause* increases in fishing mortality, rather than the conventional view that increases in fishing mortality cause decreases in fish stock. This is easy to explain inasmuch as nominal fishing mortality (e.g., the number of fishing vessels) tends to decrease more slowly than the number of individuals in a rapidly declining population, generating a sharp post population-crash increase in fishing mortality.

A more plausible model is that fish stock abundance is often coupled with fishing intensity. However, exceptional abundance of a fish stock or decadal transients in ocean productivity (e.g., Steele, 2004) generate a decoupling between fishing intensity and stock abundance. In cases where the stock declines, the slower dynamics of fishing effort causes fishing mortality to increase rapidly, and it is reasonable to argue that this can impede the stock from recovering. Nevertheless, for recovery to take place, both a reduction of fishing mortality *and* a restoration of ecological productivity must take place.

An underlying theme to all of this is that we have been attempting to smash a 19th century concept into a 21st century mold, apparently forgetting basic scientific principles of constraining the complexity of theory by the information content of the data. It would be interesting to test the notion or hypothesis that it would be simpler and less expensive (particularly in multiple-species fisheries) to target on sustained yield rather than ephemeral maximum sustained yield by tracking catches and correcting nominal effort when catches exceeded or did not meet control bounds. This would obviate the need to define stocks as subject to overfishing or overfished while concentrating on obtaining a socio-economic acceptable sustained yield from either single stocks or from a mixture of stocks in a mixed species fishery.

D. H. Cushing, Population Production and Regulation in the Sea: *A Fisheries Perspective* (Cambridge University Press, 1995), xii, 354p.

D. H. Cushing, Dependence of recruitment on parent stock. *J. Fish. Res. Board Can.* **30**, 1965-1976 (1973).

R. B. Halliday, A. T. Pinhorn, The roles of fishing and environmental change in the decline of Northwest Atlantic groundfish populations in the early 1990s. *Fisheries Research* **97**, 163-182 (2009).

R. Hilborn, E. Litzinger, Causes of decline and potential for recovery of Atlantic cod populations. *The Open Fish Science Journal* **2**, 32-38 (2009).

G. R. Lilly, K. Wieland, B. J. Rothschild, S. Sundby, K. F. Drinkwater, K. Brander, G. Ottersen, J. E. Carscadden, G. B. Stenson, G. A. Chouinard, D. P. Swain, N. Daan, Decline and recovery of Atlantic cod (*Gadus morhua*) stocks throughout the North Atlantic. In Resiliency of Gadid Stocks to Fishing and Climate Change. Edited by G. H. Kruse, K. Drinkwater, J. N. Ianelli, J. S. Link, D. L. Stram, V. Wespestad, and D. Woodby. Alaska Sea Grant College Program, AK-SG-08-01, Fairbanks, Alaska. pp. 39-66 (2008).

C. G. J. Petersen, What is overfishing? *Journal of Marine Biology Association (UK)* **6**, 587-594 (1903).

M. H. Prager, A suite of extensions to a non-equilibrium surplus production model. *U.S. Fishery Bulletin*. **92**, 374-389 (1994).

J. Rice, Changes to the large marine ecosystem of the Newfoundland–Labrador Shelf. Pages 51–104 in K. Sherman and H. R. Skjoldal, editors. Large marine ecosystems of the North Atlantic: changing states and sustainability. Elsevier, Amsterdam (2002).

B. J. Rothschild, A. F. Sharov, M. Lambert, Single-species and multispecies management. In Northwest Atlantic Groundfish: Prospectives on a Fishery Collapse. Edited by J. Boreman, B. S. Nakashima, J. A. Wilson and R. L. Kendall. American Fisheries Society, Bethesda, MD. 141-152 (1997).

B. J. Rothschild, Coherence of Atlantic cod stock dynamics in the northwest Atlantic Ocean. *Trans. Am. Fish. Soc.* **136**, 858-874 (2007).

B. J. Rothschild, Y. Jiao, The structure of complex biological reference points and the theory of replacement. *Trans. Am. Fish. Soc.* **138**, 949-965 (2009).

H. M. Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science under ICES* (ICES in Association with Univ. of Washington Press, 2002) pp. 448.

J. H. Steele, Regime shifts in the ocean: reconciling observations and theory. *Progress in Oceanography* **60**, 135-141 (2004).

Ice Fishing Anyone?

VANCOUVER - University of British Columbia researchers say that Canada, the U.S., and Russia have not been accurately reporting fisheries catches in the Arctic. In a study published this week in the journal Polar Biology, they estimate that fisheries catches in the Arctic totaled 950,000 tonnes from 1950 to 2006, almost 75 times the amount reported to the United Nations Food and Agriculture Organization (FAO) during this period. “Ineffective reporting, due to governance issues and a lack of credible data on small-scale fisheries, has given us a false sense of comfort that the Arctic is still a pristine frontier when it comes to fisheries,” lead author Dirk Zeller, a senior research fellow at UBC’s Fisheries Centre, said in a statement. “We now offer a more accurate baseline against which we can monitor changes in fish catches and to inform policy and conservation efforts.”

Researchers from UBC’s Fisheries Centre and department of earth and ccean sciences reconstructed fisheries catch data from various sources, including limited governmental reports and anthropological records of indigenous people, for FAO’s Area 18, covering Arctic coastal areas in northern Siberia (Russia), Arctic Alaska, and the Canadian Arctic. Official FAO data on fish catches in the Arctic area studied from 1950 to 2006 were based solely on statistics supplied by Russia and amounted to 12,700 tonnes.

The UBC study found that while the U.S. National Marine Fisheries Service’s Alaska branch currently reports zero catches to FAO for the Arctic area, the Alaska Department of Fish and Game has collected commercial data and undertaken studies on 15 coastal communities in the Alaskan Arctic that rely on fisheries for subsistence. The estimated fish catch during this period in Alaska alone totaled 89,000 tonnes.

While no catches were reported to FAO by Canada, the research team shows commercial and small-scale fisheries actually amounted to 94,000 tonnes in catches in the same time span. Meanwhile, Russia’s total catch was actually 770,000 tonnes from 1950 to 2006, or nearly 12,000 tonnes per year. “Our work shows a lack of care by the Canadian, U.S. and Russian governments in trying to understand the food needs and fish catches of northern communities,” said Daniel Pauly, whose Sea Around Us Project at UBC has shown a trend of fish stocks moving towards polar regions due to the effects of climate change.

By Larry Pynn, Vancouver Sun February 4, 2011