EBFM – What's it all about anyway?

R.C. Francis
School of Aquatic and Fishery Sciences
University of Washington, Seattle

Out of context, the best minds do the worst damage.
Wes Jackson (Berry 2005)

Ecosystem-Based Fishery Management (EBFM) seems to be one of those concepts, like motherhood or sustainability that is very hard to be against. In fact, it seems the less you know about it the better it sounds. EBFM is fast becoming the new mantra of the fishery science and management community. Questions that come to be connected with EBFM are deeply felt and very complex. As such, EBFM has become a buzzword. And so in this essay, I try to talk my way through the concept of EBFM, how to think straight about it and what its implications might be, both in general and at the fishing community scale.

Let me say at the outset that, for me, EBFM is an issue of context and not method. Allow me to quote from Wendell Berry (Renewing Husbandry, Orion Sept/Oct 2005) on context in modern agriculture.

> *It is no longer possible to deny that context exists and is an issue. If you can keep the context narrow enough (and the accounting period short enough), then the industrial criteria of labor saving and high productivity seem to work well. But the old rules of ecological coherence and of community life have remained in effect. The costs of ignoring them have accumulated, until now the boundaries of our reductive and mechanical explanations have collapsed.*

Walters and Kitchell (2001) point out that over the past half century, context has changed in marine fisheries as well. They argue that there have been three important steps in the evolution of the theory of fishing. The first two have focused on abundance of individual stocks and the direct effects of exploitation on (single species) stock productivity. The third step - that toward ecological interactions - has become necessary with recent severe stock depletions and their unexpected or unknown ecosystem consequences, rendering some single species techniques either unreliable or unsatisfactory when considered on their own (Longhurst 1998, Pauly et al. 1998, Myers and Worm 2003, Myers and Worm 2005, Jackson et al. 2001, Bundy 2001). As a result, fishery resource managers are confronted with increasingly complex issues – issues characteristically involving tradeoffs and interactions within and between nature and society.

With this in mind, I think Field and Francis (2005) provide a useful basis for understanding EBFM.

A common theme (of all definitions of EBFM) is that such an ecosystem approach involves a more holistic view of managing resources in the context of their environment than presently exists. For marine fisheries management, this must include taking 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. 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.

One challenge to EBFM is defining its place within the realm of sustainability science and management (Kates et al. 2001). Almost two decades ago, and based on the history of California fisheries (McEvoy 1986), the environmental historian Arthur McEvoy presented an innovative, broad and comprehensive context for marine fishery science and management, with a strong emphasis on direct interactions and relationships, of which those occurring within the ecosystem are just a part. Ten years later he built on this experience to define a sustainable fishery as follows (McEvoy 1996):

What a fishery is, descriptively, and what management ought to try to sustain, prescriptively, is an interaction between three variables: an ecosystem, a group of people working (economy), and the system of social control within which the work takes place (management).

McEvoy's key assertion is that management must equally weigh the many social and economic relationships within the fishery and how, in turn, they both influence and are influenced by marine ecosystem processes and dynamics. In fact it is human interrelationships that are of particular concern to decision makers. What McEvoy (1996) says is that a fishery is a classic example of a social-ecological system (Berkes 2004, Berkes et al. 2003): an integrated concept of humans in nature. And the essence of a sustainable fishery is the health of the interactions between the ecosystem, economy and management.

The science of both ecological and social systems has undergone a major conceptual change in the past few decades - the recognition that nature is seldom linear (the rules of organization can change) and predictable. Berkes et al (2003) discuss this in detail. More importantly they use **resilience** as an organizing concept and scoping devise for integrating ecosystem and social system complexity. This concept originated in ecology and has been applied and studied primarily in the context of ecosystems. However there have recently been a number of attempts to apply the concept in the broader context of social-ecological systems (Levin et al 1998, Berkes et al 2003). Taking the narrower line, focusing on the ecosystem, resilience is defined as

> *…. the extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping into alternate states.* (Hughes et al 2005)

And so any ecosystem has certain rules of organization or interaction which it is following at any time. These rules obey the laws of thermodynamics and, as such, can be represented mathematically. Sometimes this is described as an ecosystem state or domain of attraction. And the system has the capacity to be pushed and pulled and still maintain these rules of organization … that is, up to a certain point. And so what we call resilience refers to the capacity of an ecosystem to withstand perturbation without suddenly changing its rules of organization.

Of course, the same can be said for a social system. Now the $64K question is, what defines or controls fishery (ecosystem-economy-management) resilience and how can it be measured? Folke et al (2004) indicate that

> *The likelihood that an ecological system will remain within a desired state is related to slowly changing variables that determine the boundaries beyond which disturbance may push the system into another state.* (Folke et al 2004).

Clearly the same can be said for the other social components of a fishery.

And so what are the implications here? How do we begin to get a practical handle on this monster we call EBFM? I think there are several approaches we can take.

- Think more broadly about fishery resource biology issues. For example I think we should put as much emphasis on the preservation of biological structure as we do on the optimizing the magnitude of extraction.
- Fishery science needs to learn from emerging new interdisciplinary fields that deal with coupled systems of humans and nature, ultimately becoming a truly interdisciplinary conservation science.
- Adaptive capacity is the ability of a social-ecological system to cope with novel situations without losing options for the future, and resilience (the capacity to absorb shocks while maintaining function) is key to enhancing adaptive capacity (Folke et al 2002). Fishery resource scientists and managers need to begin to understand and measure resilience of specific fisheries.
- Fishery management institutions need to alter their formal structures so that EBFM can be discussed with the same intensity and rigor as current fishery management methods.

To recapitulate, in my view EBFM is all about context. And the context within which fishery management decisions are being made has changed.

> *History and the law of consequence have widened the context of the scene as circles widen on water around a stone throw.* (Berry 2005)

EBFM is not a dogma or a prescription but a way to think about the world.

> *The transition to sustainability derives from fundamental change in the way people think about complex systems upon which they depend.* (Folke et al 2002)

As such it forces fishery science smack dab into the realm of sustainability science – a science which seeks to understand the fundamental character of interactions between nature and society (Kates et al 2001).

EBFM at the Community Scale

What might all of this mean at the "community" scale? According to Levin (1992), the issue of scale is "the fundamental conceptual problem in ecology, if not in all of science." And certainly the issue of scale is central to the concept of EBFM. Most applications of EBFM occur at a fairly large scale - e.g. The Northern California Current (Field and Francis 2005), the Newfoundland Labrador shelf (Bundy 2001), Jamaican coastal coral reef ecosystem (Hughes et al 2003). These examples all occur at scales for which ecosystem modeling serves as a necessary scientific organizing tool. What particularly interests me is how the concept of EBFM might be applied on a relatively small scale, say in the instance of a local community and its adjacent nearshore ecosystem. My plan is to have a bit of a conversation with myself and see if I can develop some further bullets which might be useful to operationalizing EBFM on this smaller scale. I will use the "The Pt Orford Fishery" as my specific example.

Port Orford is a small community situated just south of Cape Blanco along the southern Oregon coast. 10-15% of the population relies on one or more of the fifty commercial fishing vessels which operate out of Pt Orford fishing for groundfish (live and dead groundfish, crab, salmon). Vessel size is limited to 40' due to the logistics of vessel launch and storage on the town pier. A substantial component of the "Port Orford Fishery" occurs in the nearshore marine environment adjacent to the town – called the Pt. Orford Reef. Because of large scale federal fishing regulations based on large scale stock assessments, fishing opportunities in the Pt Orford nearshore area have been sharply diminished in recent years. State and federal fishery managers, constrained by tight budgets and shrinking staffs, are forced to group together fisheries across large geographic scales when making management decisions. At the same time, many nearshore species in Oregon are not adequately surveyed, nor do many have quantitative stock assessments. And so the "Port Orford Fishery" is caught between a rock and a hard place. The local resource upon which it depends is poorly assessed and the fishery is constrained by coastwide trends which may or may not apply to the Port Orford Reef.

And so the question is, how does the concept of EBFM apply to a small scale coastal fishery like that found in Port Orford? Berkes (2004) and Lee (1993) give us some useful leads;

> *The issue of scale has implications for the match between institutions and ecosystems and for the perspectives that may be held by different agents. Take the question of match. Can a given conservation problem be managed by a centralized agency or are there more appropriate structures of governance in which the scale of management institution is matched to the scale of the ecosystem?*
>
> *When human responsibility does not match the spatial, temporal, or functional scale of natural phenomena, unsustainable use of resources is likely, and it will persist until the mismatch of scales is cured. Because the natural world is rich in patches, unsustainable use can continue for long enough for humans to assume it can be permanent.*

And thus appears my first bullet:

- **Determine the scale of the fishery as a social-ecological system – ecosystem, economy/community, management jurisdiction.**

This is certainly not a trivial matter. For example, with regard to Pt Orford, a number of questions come to mind:

1) What is the ecosystem? The Pt Orford reef? The nearshore region fished by Pt Orford vessels?
2) What is the economy? The Pt Orford fleet (salmon, live and dead groundfish, crab)? The Pt Orford fleet that fishes on the Pt Orford reef?
3) What is the scale of management? Nearshore area inside 3 miles (State of Oregon responsibility)? The area fished by the Pt Orford fleet (Oregon, PFMC, Klamath River salmon management authority)?

It seems that the only way to begin the answer these questions is to gather detailed information about harvest activities of the Pt Orford fleet and the scope of the resource that it harvests. Berkes (2004) approaches the how of this;

> *Hence, a new kind of approach to science and management must be created through a process by which researchers and stakeholders interact to define important questions, objectives of study, relevant evidence, and convincing forms of argument.*

Once we have the scale issue under control, then we need to think about the concept of resiliance; what is it, how to measure it, and how to incorporate it into management. Perhaps of utmost importance here is that it is the slowly changing variables that tend to determine resilience (Folke et al 2004). One innovative approach to monitoring slow variables is the Cascadia Scorecard (NEW 2004), an index of trends shaping the future of the Pacific Northwest. Without going into too much detail, this scorecard attempts to represent trajectories of variables whose "shifts are extreme over decades but almost imperceptible day to day." Now my second bullet:

- **For the local fishery. develop a Cascadia Scorecard whose variables have the following properties: reflect progress toward shared aspirations, complement one another and provide a good range of coverage of different aspects of social and ecological resilience, easy to understand, measurable on a regular basis.**

Now my thoughts turn to the linkages between science and management. In my view, Holling (1993) and Holling and Meffe (1997) relevantly come to grips with this issue as it applies to EBFM. Essentially they say that science and management are inextricably linked and that there are (at least) two forms or streams within which these linkages can take place.

	First Stream	**Second Stream**
Science	• System knowable and predictable • Science of parts and disciplines • Seek prediction	• Ecosystem evolving, has inherent unknowability and unpredictability • Science of integration • Seek understanding
	Command and Control	**Golden Rule**
Policy	• Problem perceived, bounded, solution for control developed • Objective: reduce variability and make system more predictable	• Retain and restore critical types and ranges of natural variations • Facilitate existing processes and variability

First stream science tends to be disciplinary, reductionist, and detached from people, policies and politics and tends to be linked to command and control management in which a problem is perceived and a solution for its control is developed and implemented. Second stream science is interdisciplinary, holistic and focuses on the relationships between nature and society which produce resilience, and tends to be linked with "Golden Rule" management which strives to facilitate existing processes and variabilities rather than changing or controlling them. This leads me to a third bullet:

- **EBFM should strive towards the second stream in both science and management.**

Finally, to be more specific about management (Folke et al 2002)

> *Centralized management is a poor fit for complex systems: it works neither at the level of the central government nor at the community – and it creates a mismatch in scale. If conservation issues are complex-systems problems, they have to be addressed simultaneously at various scales.*

It is a cross-scale approach which allows us to address both formal governance and the concept of "community" in dealing with localized EBFM issues. Three final bullets (Berkes 2004):

- **Cross-scale conservation requires linking institutions horizontally (across space) and vertically (across levels of organization). These kinds of linkages need to be facilitated by boundary organizations (e.g. PMCC).**
- **Even though linkages are key, the community level is still singularly important because long-term conservation objectives are easier to achieve with the cooperation of local people than without.**
- **The goal (of EBFM) should be as much local solution as possible and only so much government regulation as necessary.**

References:

Berkes, F. 2004. Rethinking community-based conservation. Cons. Biol. 18(3):621-630.

Berkes, F., J. Colding and C. Folke. Introduction. Pp 1-29 in F. Berkes, J. Colding and C. Folke (eds.) Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge Univ. Press.

Berry, W. 2005. Renewing husbandry. Orion Sept/Oct 2005

Bundy, A. 2001. Fishing on ecosystems: the interplay of fishing and predation in Newfoundland – Labrador. *CJFAS* 58:1153-1167.

Field, J.C. and R.C. Francis. 2005. Considering ecosystem-based fisheries management in the California Current. Mar. Pol. In press.

Folke, C. et al. 2002. Resilience and sustainable development: Building adaptive capacity in a world of transformation. Scientific background paper on resilience for the process of The World Summit on Sustainable Development.

Holling, C.S. 1993. Investing in research for sustainability. Ecol. Appl. 3(4):552-555.

Holling, C.S. and G.K. Meffe. 1996. Command and control and the pathology of natural resource management. Cons. Biol. 10(2):328-337.

Hughes, T.P. et al 2003. Climate change, human impacts, and the resilience of coral reefs. Science 301:929-933.

Hughes, T.P. et al. 2005. New paradigms for supporting the resilience of marine ecosystems. TREE 20(7):380-386.

Jackson, J.B.C. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293:629-638.

Kates, R.W. et al. 2001. Sustainability science. Science 292:641-642.

Lee, K.N. 1993. Greed, scale mismatch, and learning. Eol. Appl. 3(4):560-564.

Levin, S.A. 1992. The problem of pattern and scale in ecology. Ecology 73:1943-1967.

Levin, S.A. et al. 1998. Resilience in natural and socioeconomic systems. Env. And Dev. Econ. 3(2):221-262.

Longhurst, A. 1998. Cod: perhaps if we all stood back a bit? *Fish. Res.* 38:101-108.

McEvoy, A.F. 1986. The fisherman's problem: ecology and law in the California fisheries, 1850-1980. Cambridge Univ. Press, New York.

McEvoy, A.F. 1996. Historical interdependence between ecology, production, and management in California fisheries. pp 45-53 in D. Bottom, G. Reeves and M. Brookes (eds.) *Sustainability Issues for Resource Managers. USDA Forest Service Tech Rep. PNW-GTR-370.*

Myers, R.A. and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. Nature 423:280-283.

Myers, R. A. and B. Worm. 2005. Extinction, survival or recovery of large predatory fishes. Phil. Trans. R. Soc. Britain.

Northwest Environment Watch (NEW). 2004. Cascadia Scorecard. NEW, Seattle, WA

Walters, C. J. and J.F. Kitchell. 2001. Cultivation/depensation effects on juvenile survival and recruitment: implications for the theory of fishing. CJFAS 58:39-50.