A Conversation about NMFS' Ecosystem-Based Fisheries Management Policy and Road Map

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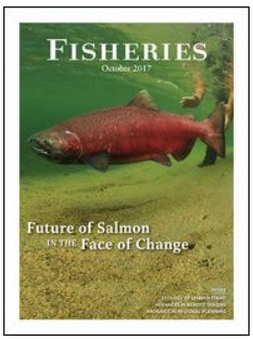

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COLUMN
GUEST

A Conversation about NMFS' Ecosystem-Based Fisheries Management Policy and Road Map

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How does one catch fish, preserve habitat, conserve other critters, and keep as many people as possible happy all at once? In many respects, that is another way of saying that we need to consider ecosystem-based fisheries management (EBFM).

In talking with my colleagues at AFS—Sarah Harrison (SH) and Tom Bigford (TB), and the science editor at *Fisherie*s, Jeff Schaeffer (JS) —about helping us at NMFS get the word out on our ecosystem-based fisheries management (EBFM) Policy Statement and associated Road Map[1], they suggested that instead of yet another dry, boring recapitulation of bureaucratic policy details we imagine any such presentation as if we were having a conversation around a picnic table at an AFS networking event (complete with appropriate beverages!). Thus, we invite you to take a seat with us and be a part of this "virtual conversation."

[JL] Thank you for agreeing to entertain this subject.

[JS] You bet. This conversation will be a great way to engage readers on an important topic.

[JL] First, let me tell you what we mean by EBFM. When we were trying to define EBFM for our Policy Statement and Road Map, we looked in the literature and found over 40 such definitions. So of course, we made a hybrid of them and came up with a 41st. Our definition of EBFM is

"a systematic approach to fisheries management in a geographically specified area that: contributes to the resilience and sustainability of the ecosystem; recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals."

In other words, EBFM addresses not only fish and fisheries dynamics themselves, not only the broader suite of factors that impact fisheries, but also the potential impacts of fisheries and fished stocks on other parts of the ecosystem.

[SH] OK, but why do we need yet another definition? Didn't you present one in *Fisheries* about 15 years ago (Link 2002a,b)? Aren't there plenty of them? Are our own definitions changing over time, as we learn more and gain experience?

[JL] Good point Sarah. We did define EBFM earlier. But the key elements this time were to explicitly delineate the legalities, benefits, rationale, and context for EBFM. In particular, we find a lot of linguistic uncertainty, so we have tried to make the distinctions among ecosystem approaches to fisheries management (EAFM) and EBFM and ecosystem-based management (EBM) to clarify that we're not trying to solve every ocean use issue (as in EBM) or trying to add temperature or predation for every single stock (as in EAFM), but focus on the system of fisheries (see Dolan et al. 2016, Link and Browman 2014). We're addressing a nuance that not all people will nor even should entirely grasp but it is crucial to moving beyond traditional management approaches.

[SH] Do you have a way to depict this so I can see it more clearly?

[JL] Yes. The paper by Dolan et al. (2016), reinforced by works I've done with Wes Patrick and Howard Browman (Patrick and Link 2015a, Link and Browman 2014) has what we call the blue infographic, updated and reproduced here (Figure 1). That infographic shows these distinctions. It's our best attempt at visually characterizing this.

[TB] OK. But haven't we already been thinking about this for 150 years or more? In many instances we seem to be moving beyond single-species management by managing multiple species caught in the same gear (like squid and butterfish in the mid-Atlantic or Pacific coast groundfish like rockfishes). We have been codifying essential fish habitat since 1996 to reflect sources of non-fishing mortality and chronic habitat degradation. Awareness of the need to consider ecosystem factors seems increasingly widespread. So what's new about the policy statement and road map?

[JL] Yes, in many ways, we have been. I often start out presentations with quotes from the leaders of our discipline from the mid to late 1800s, and they were definitely thinking about these things. In fact, that can be kinda depressing….

But Bigford, let me tell you why this is different than the discussions we've been having since the late 1800s, and especially during the last 20 years or so. The discipline has been talking about this subject seemingly forever, but this is the first time any organization has gone on record as (1) saying they will commit to doing EBFM, (2) saying what they specifically think that looks like, and (3) creating a timeline with actionable steps to track our success.

[JS] I have to agree with Bigford; why now?

[JL] My former boss—Richard Merrick— the prior chief scientist of NMFS, was sitting in my office one day several years ago. He said, "We really need to have an EBFM road map to lay out how to implement this stuff."

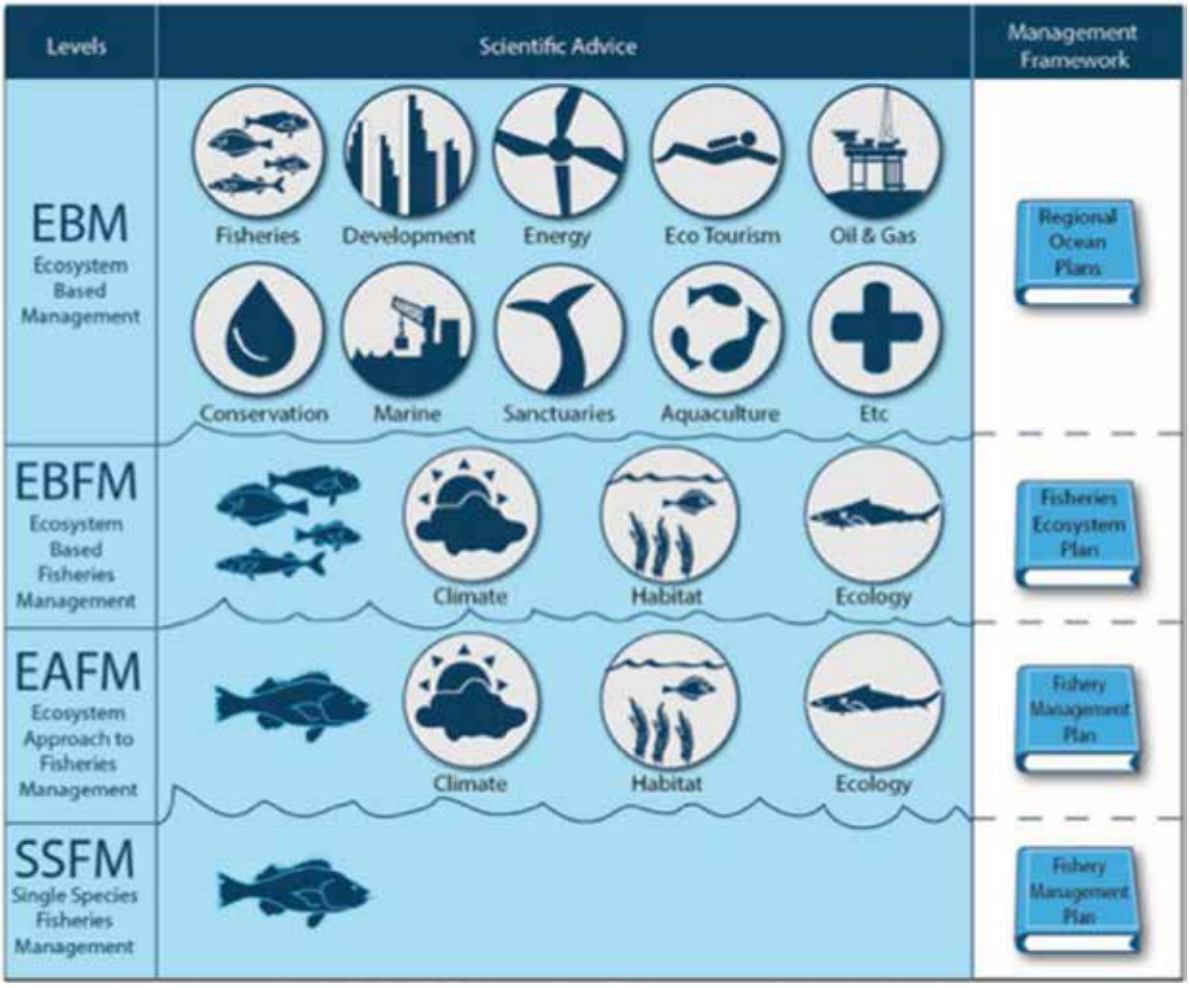

Figure 1. The paradigms of ecosystem management (EM), building upwards from single-species fisheries management (SSFM), to ecosystem-based management (EBM). Scientific advice and the sectors of management build with each level, as well as the management framework. Key differences between ecosystem approaches to fisheries management (EAFM) and ecosystem-based fisheries management (EBFM) is that the later considers the trade-offs of multiple species, as opposed to a stock within a fishery, and EBFM takes a more coordinated approach to management through the use of strategic planning documents like fishery ecosystem plans. The considerations broaden as one moves up the levels of EM, as depicted by the elements in each circle. The delivery of the advice at each level is delivered in different types of plans. The breaks between these levels are not sharp, and information can be used at multiple levels. Modified from Dolan et al. (2016) and discussions in Patrick and Link (2005a) and Link and Browman (2014).

I replied, "I agree."

Then he said, "And we need to make sure it is consistent with the EBFM policy statement."

I again replied, "I agree." Then we paused. After a few moments, I asked, "What policy statement?"

He replied, "Ummm, good question."

To make a long story short, that led to over a two-year effort to pull together both the EBFM policy statement and road map. There was an alignment of a lot of conditions, building on the excellent groundwork from prior colleagues and agency leaders (e.g., EPAP 1999; Murawski and Matlock 2006). But ultimately we were at the point where we recognized that we as an agency, we as a discipline, and the broader community of stakeholders, interested parties, and partners are all realizing that we need to better consider broader ecosystem factors—be they climate driven shifts in distribution, predation-caused mortality, habitat conditions, minimization of bycatch, whatever—that are affecting our nation's living marine resources, right now, and more so to figure out how to deal with them by laying out a plan to implement EBFM.

[JS] OK, so how about a quick summary of what you came up with?

[JL] In essence, we developed six guiding principles (Figure 2) in the policy statement that we then unpacked further in the road map.

[TB] OK, that's intriguing. But also seems somewhat familiar as it has elements common to most adaptive resource management protocols. What's different? Particularly, how do you take these

guiding principles and turn them into actionable steps? What makes this more than just a paperwork exercise?

[JL] It should be similar because we recognized that such an approach of generic, adaptive management cycles is time-tested and worth doing. Here we're primarily relying on the process described in our Integrated Ecosystem Assessment[2] effort. What's different is that we use the six guiding principles as an organizing thematic, highlight two to three main elements in each, and then identify two to four action items for each one of those. And building on the theme of familiarity, we capitalize on the fact that in many of our regions, we are doing or beginning to do a lot of this work already.

[SH] Are you working with different sectors or disciplines to address some of the broader issues that are implied?

[JL] Yes. Those Integrated Ecosystem Assessment efforts are very interdisciplinary, particularly bringing together teams of ecologists and biologists with experts in the social sciences.

[JS] This is all fine, but it seems pretty esoteric. Why bother doing it?

[JL] I get that a lot. The rationale for considering EBFM has a strong basis; let me quote directly from our policy statement:

"…These benefits are realized across its multiple federal mandates by considering salient environmental and ecological factors that affect trust resources and by identifying trade-offs among its trust resources, including fisheries, protected species, and their habitats. Through EBFM, NOAA Fisheries and its partners can have a better understanding of the cumulative impact of a management action beyond just a single species. Additionally, EBFM can help communicate risks, uncertainties, and implications of management decisions across marine fisheries and a range of affected species. Better understanding, articulation, and consideration of the risks, benefits and effectiveness of management alternatives, as well as the interconnectedness and trade-offs between and among management objectives, will ensure more Fisheries transparent decision processes, outcomes, and more efficient resource use by NOAA Fisheries and partners.

Management advice from EBFM will be more comprehensive and accurate, and will likely help reduce uncertainty by taking into consideration interacting elements in the ecosystem. EBFM can maintain ecosystem function and fishery sustainability, which support economic and social stability and fishing community well-being. EBFM applies the best available scientific information to improve decision-making via consideration of the holistic impact of management decisions. EBFM can also use forecasts of future ecosystem conditions and services, incorporating natural variability, anthropogenic forcing, and change in climate and ocean conditions to predict and evaluate outcomes from a range of alternative management strategies. Combined, stability and efficiency outcomes for business and regulatory planning result from adopting EBFM."

[JS] It still seems pretty esoteric, or high level. Can you give us some examples?

[JL] OK. Let's take forage fish as an example.

Regardless of the debate about how much should or should not be left in an ecosystem—and there are increasingly savvy estimates of this from many methods around the nation—it is generally recognized that forage species such as sardines, anchovies, herrings, mackerels, squids, krill and the like face distinct pressures. Not only are they targeted for direct harvest, they indirectly support other species as food for fish higher up the food chain that are also harvested (and which feed on them). Additionally, they serve as important food for a host of marine mammals and seabirds, some of which have some form of protected status. And they also serve as a critical link from lower trophic level production as translated into fish biomass that is more broadly available to other parts of the ecosystem. Furthermore, often these stocks have very variable population dynamics and can be highly susceptible to environmental conditions or human activities in nearshore waters where their habitats may be degraded. So they warrant a closer look for a few reasons.

Given that context, the Pacific Fishery Management Council set up a forage threshold, such that if the collective forage fishes biomass falls below it, fishing is suspended until the forage biomass grows back above it. That to me is a practical example of EBFM. And sure seems like a straightforward way to meet multiple management objectives at once.

[JS] That's fine, but forage issues have been controversial lately. Are there other examples?

[JL] OK, how about the Alaskan situation? The North Pacific Fishery Management Council has a total allowable catch limit of 2 million metric tons for groundfish (i.e., demersal fishes such as flounders, cods, and pollock) in the Bering Sea. That overall cap has led to heightened stability in that fishery for many decades and provides "trade-space" to ensure no one stock is overfished and that allocations to meet the cap drive discussions of what the fleet will ultimately capture. It provides a practical way to address the fact that we can't simultaneously optimize all species due to carrying capacity and productivity considerations in any given ecosystem. That to me is an excellent example of EBFM in practice.

[TB] That raises a question: Is EBFM less quantifiable than traditional fisheries management techniques where maximum or optimum yields were our primary goals?

[JL] They may be hard to estimate, like much of what we try to measure in this business, but these approaches use the same concepts of maximum or optimum yields, just applied to an aggregate group of fishes instead of individual stocks.

[TB] I'm curious. Are these real limits in the Alaskan example?

[JL] Yes. It's really Ecology 101, an application of the 2nd law of thermodynamics.

[TB] OK, I really do see the logic in this. It is Ecology 101 but sometimes it seems like not everyone read the book. This is really evident when we're trying to restore stocks in an ecosystem like Georges Bank when much of the fish biomass that used to be in demersal fishes has shifted towards more pelagic fishes. It's very difficult to manage an ecosystem with historical objectives when an ecosystem has been changed fundamentally by overfishing, climate change, or other disruptions. But I'm still curious. Has this approach been applied elsewhere?

[JL] Yes. There are comparable calculations in most of our large

Figure 2. Depiction of the interconnected and interdependent nature of the major EBFM guiding principles. The salient points are that we need science as the foundation of what we do, we need to start with the end in mind of that science, and we need to consider how best to achieve those stated goals as we conduction our science and management efforts.

marine ecosystems. The particular aggregate cap approach is being considered in a couple of regions. It is actually also quite well worked-out in the Antarctic region, with a variant of some adjustments to total yield, for some of the krill fisheries under CCAMLR. Antarctic resource managers recognize that there is a limitation to the productivity of the ecosystem, and that similar to the forage example, maintaining some krill as food for other species in the ecosystem is wise given the explicit acknowledgment of those limits.

[JS] Alright. But how do managers set their priorities in such situations? Say among the different species they manage, or across a range of ecosystem considerations.

[JL] As of right now, over two-thirds of our nation's Fishery Management Councils are either developing or updating what we call Fishery Ecosystem Plans. This is for a good number of the approximately 12 large marine ecosystems within which we manage fisheries. These documents generally lay out the high-level emphases and priorities for a given region and some even itemize key considerations they'd like to see addressed in a region. So to me that is truly a pragmatic, real-world example of EBFM being implemented, and as those documents continue to evolve, clearer means for addressing such tradeoffs will likely continue to emerge.

[JS] What would a situation look like before and after an EBFM approach? Take for example snappers or groupers in the Gulf of Mexico. How would an EBFM approach contrast with that situation using a classical approach?

[JL] Alright, let's look at that. Our analysts in the region have been doing assessments on several species, any number of which I could discuss. Let's take gag grouper. The assessments for that stock weren't always exhibiting the most robust model diagnostics. Then it came to our attention there were several fish kills of gag grouper. After further exploration, such fish kills seemed to coincide with red tides (aka harmful algal blooms, HABs). To make a long, really cool detective story short, when our analysts included HABs in the assessment models, the model behavior improved and the estimates actually resulted in slightly better stock status. From that, fishery managers in the region realized that this additional source of mortality would be prudent to consider when setting management measures.

Now, before I get totally skewered by my colleagues in that region, there are the usual caveats to this situation, chief of which is we still have to monitor the situation to ensure the mechanisms are understood and the functional relationships don't break down. But the point is, by taking into account facets of an ecosystem approach for this taxa helped our understanding and may have led to a better evaluation of the stock available for fishing.

We've been repeating this effort regarding environmental effects on sablefish in the Pacific northwest, sea-ice and "fat" copepods considerations for walleye pollock in Alaskan waters, thermal conditions for sardines in the California Current, predation for menhaden in the Atlantic, and predation again for mackerel, herring, or squid in the northeast. We're even considering thermal conditions as they impact stock distribution and spawning location in highly migratory species that traverse large portions of entire ocean basins in the Atlantic and Pacific. And so on. Any of these examples are helping to provide better information to manage these resources.

And I haven't even gotten into habitat-related examples, or climate-driven considerations, or bycatch mitigation measures,

spatial aspects of fisheries, and so on. The point being, there are many instances where we are doing bits and pieces of EBFM already.

[TB] You're mainly focused on marine fisheries. Does EBFM apply to freshwater fisheries? There seems to be less information and fewer examples available about freshwater applications.

[JL] Absolutely. In fact, I think often of the Laurentian Great Lakes and my colleagues with a limnological emphasis in their work. The principles and approaches are similar enough, the issues facing inland fisheries managers are common enough, the challenge of dealing with all these legislative, economic, ecological, and social tradeoffs are routine enough that implementing EBFM is applicable in such circumstances.

[TB] As you know, I am big on habitat issues. Do habitat protection and restoration fit in with EBFM and, if so, how? With many of our marine commercial and recreational species being dependent at some stage of their lives on nearshore waters, it would seem that habitat is a major factor.

[JL] Yes, it certainly does. In the road map we explicitly call out some action items that are focused specifically on habitat issues. There is one action item that particularly calls for a systematic and cumulative look at risk to habitat.

I might also add that EBFM is meant to be comprehensive, covering not only basic fishery biology and catch, but issues of ecology, climate, habitat, sociology, economics, and so on, almost an umbrella to a lot of our ongoing strategic efforts and work.

[SH] So I see that it can be quite expansive. Wes Patrick and you noted in *Fisheries* (Patrick and Link 2015a) a couple years ago that we do have enough data to do EBFM. But if it is so expansive and comprehensive, it seems like it will never have enough data. How do you reconcile those perceptions?

[JL] First, while true that we're not ever going to have enough data to know every mechanism about every stock and every process in the ocean, the simple fact is we don't need to. Additionally, systems theory and hierarchy theory as seen practically in things like the portfolio effect (Schindler et al. 2015) mean that we can take advantage of many emergent properties of marine ecosystems to capture key dynamics, perhaps even more efficiently than we do now, without having to have copious detail on every part of the ecosystem. The Alaskan 2 million metric ton cap is an example of this portfolio approach. And finally, there are a lot of data routinely collected and there are a lot of observation systems that are available. We just don't often think of those data as they can be atypical in a fisheries context, but in fact can be quite informative. This pertains to a lot of the physical data, but also a lot of socio-economic data as well.

[SH] OK. How do you respond to those that who say that the many complexities of marine ecosystems make them essentially impossible for full understanding of all the processes and mechanisms that can affect fish?

[JL] For me it is an issue of applying mechanistic knowledge, analytical rigor, and detailed effort at the right scale. That's effectively what hierarchy theory espouses from the ecological literature. For example, I understand the general principles of combustion engines, but I don't worry about the many particular, mechanistic details of how my vehicle utilized them on my drive into work this morning. Rather, I track the main indicators of vehicle performance and maintenance (e.g., rate of speed, mileage, gas tank fullness, oil pressure) along with the ambient conditions (other traffic, road conditions, weather, etc.) and only worry about particular mechanisms of indicated parts if parts of or the entire system of my vehicle start to malfunction. I think that analogy helps with a need to shift some of our focus in complex, marine ecosystems to perhaps more aggregate views, again as in the Alaskan 2 million metric ton cap example we discussed earlier.

[SH] Seems like there is a tension between reductionism and holism in how science is being approached here. How do you reconcile a historically species- or stock-oriented approach in our discipline with a more aggregate or systems approach?

[JL] Both are needed. We will always need to track stocks. But using a financial stock market analogy, I know of no one who manages their retirement account based entirely on a stock-by-stock basis. Rather, they manage for a portfolio of stocks and related financial products towards a more comprehensive goal. I think the same could be true for fisheries systems (Schindler et al. 2015).

[TB] So you're saying there are facets of both, but we need to be more systematic in our approach, correct?

[JL] Yes. And doing so can produce some real benefits.

[SH] OK, like what? What are some of the benefits of EBFM? Some of the things you noted above?

[JL] Yes. I think the better understanding is part of it, but I also think economic and regulatory stability have high promise from this approach.

[JS] Why bother with EBFM in situations where fisheries are managed well?

[JL] Even if they are managed well, the ocean is dynamic. It is not static or in equilibrium, as a lot of our approaches have historically assumed. More so, even in well managed and relatively stable oceanic situations, we're still confronted with tradeoffs—tradeoffs among targeted species, tradeoffs between targeted and protected species, tradeoffs among fleet allocations, and so on. There are always going to be tradeoffs that we'll miss if we don't consider the broader system. And further, by not considering EBFM, we're missing out on a lot of efficiencies and opportunities that such an approach can provide.

[TB] Sometimes the objection I hear about EBFM is that we are not compelled or even allowed to do it. Yet you and Wes Patrick noted in *Fisheries* (and elsewhere; 2015a,b) a couple years ago that in fact we are. How do you address that concern?

[JL] It's not that we're not allowed to do it, we are. It's just that it's not always clear. In our EBFM *Policy* we explicitly note specific instances in major U.S. fisheries and living marine resource legislation that call for key facets of EBFM. We also realize that to fulfill all these mandates simultaneously, we need to do EBFM—again, back to the potential tradeoffs.

[TB] OK, so how do we implement EBFM given the usual budget and resource limitations?

[JL] That's a challenge we all face almost every day, Bigford. All of us in this business are wrestling with it, but I take comfort in the knowledge that in many ways, we always have. This EBFM approach may not be as radical as some fear. We've already recognized the need to prioritize our stock assessments, our protected species emphasis, our habitat areas of focus, and so forth. We have to given the limitations you note, as well as the differing degrees of risk they experience and the differing degrees of value they provide. This overarching EBFM effort is highly coordinated with those efforts. The short version is that a key part of implementing EBFM is done by various forms of risk assessment and vulnerability analysis. If we make some short-term, upfront investments in those efforts, we can triage where we need to emphasize more detailed, stock- or habitat-specific, mechanistic efforts and then utilize the efficiencies gained from the portfolio effect and other systems-level aggregate measures where there is lower specific risk.

[TB] We at AFS are convinced this is important. Such that we've been working closely with you and NMFS to carry the EBFM message, via congressional briefings, several of my policy columns, and in others of our publications. But how do you respond to those who categorically deny the need to do EBFM?

[JL] I totally recognize that some in our field will simply oppose this no matter what arguments we make, what evidence we provide, what benefits we repeatedly demonstrate. But I tend to think that most in our profession are pretty rational and open-minded. In a way, skepticism is a healthy part of the scientific debate and there needs to be rigor before considering a new approach. I also recognize that on the surface this can be a threat to various schools of thought and ways of doing things. I appreciate that change is inevitably uncomfortable. But at the same time, I point out that in many instances, we are already doing key parts of this. So we're not starting from scratch. And in some cases, the need to do this simply outweighs the need to continue with business as usual. We can't keep doing this business without taking into account broader considerations, otherwise we're going to miss some significant phenomena and the ramifications will not be good. And in some cases, doing EBFM actually accrues greater benefits. Not has the potential to, but does and has. So hopefully that leads towards a discussion consistent with how we've seen shifts in other scientific approaches over time.

More so, I look to those in graduate school now. I am encouraged by the breadth and comprehensiveness of many of the graduate theses and dissertations, not to mention the robust and wide-ranging skill sets, of the next generation of fisheries scientists I see entering our profession. So in many ways, Bigford, I see hope for and openness to EBFM in your and my replacements who are entering our field now.

[JS] So what conversation should we be having in 10 to 15 years? What do you hope to see that will be different?

[JL] Well, first, that all of our retirement accounts are doing well and that the Cubs and Red Sox are still winning restorative World Series titles…

But regarding EBFM, I'd love to see us not still talking about why we need it and what it is. I'd also love to see us well beyond talking about how to do it. Rather, I'd love to have discussions about what has and has not worked after we'd tried implementing it. I'd love to see books and tomes and compendia describing all the practical lessons learned from EBFM implementation. I'd love to see us talking about how we can incorporate next generation sampling into EBFM implementation. I'd be really excited to discuss and see what analytical tools and modeling approaches we'll be using to do EBFM in a decade plus. And I'd love to see us talking about what great shape all our living marine resources are in from having tried EBFM, even more so than the improvements we've seen over the past 10 to 15 years.

[SH] I hope so…

[TB] Me, too.

[JL] Before we conclude, can you let me thank a bunch of people both in NMFS and among our full array of partners who helped us pull together all these EBFM thoughts. It truly was a group effort and represents the contributions of a lot of talented, thoughtful and dedicated individuals. I'm proud to have worked with them on this stuff.

[TB] Sure. And thank you. For those interested in more details about the policy statement and road map, you can find them at the following webpages:

Synopsis: https://www.st.nmfs.noaa.gov/ecosystems/ebfm/creating-an-ebfm-management-policy
Policy: http://www.nmfs.noaa.gov/op/pds/documents/01/01-120.pdf
Road Map: http://www.nmfs.noaa.gov/op/pds/documents/01/120/01-120-01.pdf

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NOTES

[1] Policy: http://www.nmfs.noaa.gov/op/pds/documents/01/01-120.pdf; Road Map: http://www.nmfs.noaa.gov/op/pds/documents/01/120/01-120-01.pdf

[2] https://www.integratedecosystemassessment.noaa.gov// AFS