Hidden in plain sight: Using optimum yield as a policy framework to operationalize ecosystem-based fisheries management

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Hidden in plain sight: Using optimum yield as a policy framework to operationalize ecosystem-based fisheries management

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ABSTRACT

An often-cited impediment to the operationalization of ecosystem-based fisheries management is the lack of a governance structure that explicitly provides the authority and framework for implementing this holistic approach to fisheries management. However within the United States and elsewhere in the world, the concept of optimum yield appears to be an explicit mandate and framework that can and should be used to operationalize ecosystem-based fisheries management. This optimum yield policy has been hidden in plain sight for close to 40 years, largely due to happenstance, as other factors facing society-at-large have masked the original intent behind this concept. This paper describes the similarities between optimum yield and ecosystem-based fisheries management, how it has been overlooked in the past, and how the concept can be used to operationalize ecosystem-based fisheries management.

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1. Introduction

The ability to operationalize ecosystem-based fisheries management (EBFM) remains a challenging process [21,89], even though the concept was first adopted by several nations as a more holistic approach to fisheries management over 20 years ago [2,33,44]. There have been several impediments to implementing EBFM [21,37,77], one of which is whether there is a governance structure that can effectively implement EBFM [6,18,43].

From an EBFM perspective, governance involves both the legal authority and the regulatory framework of how fisheries could be managed. In general, discussions over governance and EBFM usually include such things as:

- Whether existing mandates provide the legal authority to manage fisheries using an ecosystem approach to management (e.g., [77,56,71]).
- The stakeholder and jurisdictional challenges of managing within a large marine ecosystem (e.g., [77,3,21]).
- The ability to incorporate social and economic dimensions into the decision making process (e.g., [88,3]).
- The ability to identify long-term goals and prioritize among conflicting goals (e.g., [88,93,21]).

Although several authors have described how many of the past governance impediments to EBFM are no longer an issue (e.g., [77,71,21]), the debate on governance is far from over. This is especially true in the United States (U.S.), where many scientists and managers still regularly state they lack governance structures to implement EBFM because there are no explicit mandates or frameworks to operationalize the concept (e.g., [56,88,48,3]).

This paper describes why the U.S., and likely other countries, does have a clear mandate and robust framework to implement EBFM. In the U.S., this governance structure was developed by the Magnuson-Steven Fishery Conservation and Management Act (MSA) almost 40 years ago (16 USC 1801, etc.), which among other things mandated the use of optimum yield (OY). Below, the paper describes the similarities between OY and EBFM, why OY was possibly overlooked during the early implementation phases of EBFM, and how to use OY to implement EBFM.

2. Similarities between OY and EBFM

The concept of OY was formalized as a guiding principle in fisheries management in the U.S. and Canada in 1976 [47]. Although the U.S. and Canada define OY differently, in general the definitions imply that OY is an amount of fish that is derived from maximum sustainable yield and balances the ecological, economic, and social goals of the Nation [47]. Other countries that use similar concepts such as maximum economic yield and optimum sustainable yield [26,68,69,72], and face similar governance challenges would be able

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to use this framework to implement EBFM too. For example, countries like Australia, United Kingdom, New Zealand, and South Africa use or are exploring OY concepts and could benefit from this approach. In the U.S., the definition of OY has essentially been the same since 1976 (see the section below on overlooking OY), which is currently defined as:

> *the amount of fish which will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery* (16 United States Code (USC) §1802(33)).

In contrast with the fairly consistent North American definitions of OY, there are several derivatives of EBFM defined in the scientific literature (e.g., [55,1,59]). They have all mostly coalesced to substantively mean the same thing, just with different subtle points of emphasis. One of the more prominent definitions, produced by the Food and Agriculture Organization (FAO) – an intergovernmental organization with representatives from 194 nations, defines EBFM[1] as an approach to fisheries management that:

> *strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries* [33].

To compare the similarities between the OY and EBFM concepts, a matrix of the key phrases from each of the definitions was constructed (see Table 1). The degree of overlap was rated as high, moderate or low, based on expert opinion of the authors. Both concepts share the common objective of providing the greatest benefits to the Nation or Society. However, the OY definition is explicit in the types of objectives (e.g., food production, recreational opportunities, ecological factors, etc.) that are important to consider when determining the OY; whereas the EBFM definition is explicit about acknowledging the different components of the ecosystem (i.e., biotic, abiotic, and human dimensions), and the uncertainty surrounding these variables. The EBFM key phrase "strives to balance diverse societal objectives" aligns with several of the key phrases used in the OY definition, and the OY key phrases "particularly accounts for the protection of the marine ecosystem" and "based on relevant ecological factors" aligns with several of the keywords used in the EBFM definition (see Table 1).

There are, however, several key phrases (or portions thereof) that do not directly align with the OY or EBFM definitions (see Table 1). In these cases, similarities are discussed elsewhere in the FAO guidelines for EBFM [33], MSA (16 USC Section 1801 etc.), or National Standard 1 (NS1) Guidelines [35]. For example, the EBFM definition does not include a reference to "an amount of fish" that is taken from the fishery. The FAO guidelines for EBFM do, however, recognize that quotas for target and bycatch species are needed to protect more vulnerable species and the marine ecosystem as a whole ([33], see Section 3.2.2.2). Another example is that the OY definition does not include a reference to "use ecologically meaningful boundaries." Within the U.S., boundary issues have largely been resolved by the MSA, which created eight Regional Fishery Management Councils that manage fisheries within their marine ecosystems [21,77]. The point being, the supporting context of each framework indeed often aligns with the main tenets of the other.

While this key phrase comparison is helpful, overarching questions remain. In the U.S., OY is commonly specified at the stock or stock complex level, whereas EBFM is performed at the fishery or ecosystem level (i.e., multiple stocks and/or fisheries). The MSA actually notes that OY should be specified for the fishery, and defines fishery as one or more stocks which can be treated as a unit for purposes of conservation and management (16 USC Section 1802(15) and (33)). To operationalize this concept for traditional single-species approaches to fisheries management, NOAA Fisheries has generally recommended that OY be specified at the stock or stock complex level [109]; however, fishery-wide OY can also be specified for mixed-stock fisheries [109]. Currently, only the Bering Sea/Aleutian Island and Gulf of Alaska groundfish fisheries specifies a fishery-wide OY [106]. The concept of specifying OY at the larger fishery or ecosystem level to prevent ecosystem level overfishing is also encouraged in the scientific literature (e.g., [76,58,17]), and by existing guidance for developing Fishery Ecosystem Plans (1999). Currently, 4 out of 8 U.S. Regional Fishery Management Councils have Fishery Ecosystem Plans for at least a portion of the regions over which they have responsibility [100,80].

Another overarching issue related to OY and EBFM is that OY is often considered a reference point or specified amount of catch, rather than an integrated approach (as described in the EBFM definition). However, the NS1 guidelines explicitly layout an integrated approach by which OY is assessed and specified. OY should be reduced from MSY based on tradeoffs that are of ecological, economic, or social importance to the fishery and the Nation [35]. The process is also adaptive, where OY is expected to change on a regular basis due to changing circumstances in the fishery. For example, profit margins on specific species may change due to increases in harvesting cost, the demographics of the fishing fleet and fishing communities could change over time, ocean productivity may alter the production potential of fish stocks, or technological advancements in gear could reduce bycatch and increase OY.

Overall, the comparison shows that OY and EBFM are essentially identical in concept: (1) each suggests there is an integrated process whereby (2) the ecological, economic, and social objectives of fisheries can be balanced to (3) provide the greatest benefit to the nation or society. The only difference between the two concepts is that the definitions emphasize different aspects, where OY emphasizes the type of objectives that should be considered while EBFM emphasizes the various components of an ecosystem. Where differences did occur from a definitional standpoint, supporting FAO and U.S. guidelines further elucidate their similarities.

3. Overlooking optimum yield

The history of U.S. fisheries management provides some clues as to why OY was not seen as an explicit framework whereby EBFM could be implemented. In the U.S., the definition of OY has essentially been the same since 1976 [73]; however, the manner in which it has been interpreted has changed dramatically over the last 38 years. The OY concept evolved over time as the MSA was revised and as NOAA Fisheries revised the NS1 guidelines pertaining to OY. The result was an OY that reflected the fisheries management concept du jour.

Prior to 1976, the prevailing fishery management concept was MSY, which attempted to maximize the yield of fisheries without considering other management objectives. Healey [47] notes that "by 1975 it had become abundantly clear that, in most cases, stock

[1] The FAO guidelines use the term ecosystem approaches to fisheries management (EAFM), which is sometimes used interchangeably with the term EBFM and appears to be the case here.

Table 1
The degree of overlap or similarities of key phrases used in the definitions of optimum yield and ecosystem-based fisheries management, based on qualitative analysis.

Optimum Yield Keywords	Ecosystem Based Fisheries Management Keywords					
	Strives to balance diverse societal objectives	Account for knowledge and uncertainty about biotic components of ecosystems	Account for knowledge and uncertainty about abiotic components of ecosystems	Account for knowledge and uncertainty about human components of ecosystems	Applying an integrated approach to fisheries	Ecologically meaningful boundaries*
Amount of fish*						
Provide the greatest overall benefit to the nation	High					
Food production	Moderate				Low	
Recreational opportunities	Moderate				Low	Low
Account for the protection of marine ecosystem	Moderate	High	High	High	Low	
Based on maximum sustainable yield		High			Moderate	
Relevent economic factor	Moderate			High	Moderate	
Relevant social factor	Moderate			High	Moderate	
Relevant ecological factor	Moderate	High			Moderate	
Provides for rebuilding	Moderate				Low	

Low or no overlap from a definitional standpoint, but discussed elsewhere in FAO or NS1 guidelines.

dynamics were neither well enough understood nor sufficiently deterministic to render MSY an achievable goal, that knowledge of stock dynamics alone was not sufficient for effective management, and that MSY was probably not an appropriate societal goal anyway." Similarly, Larkin [54] and others [27,103,110] also noted that MSY was no longer a viable goal in the 1970s because it increased the risk of recruitment failure, was unattainable in mixed-stock fisheries due to gear selectivity and trophic interactions, and that from an economics perspective fishing at MSY did not always create the most profitable or sustainable fishery. All of these experts noted than an obvious way out of this problem was not to target harvest levels equivalent to MSY, but rather set MSY as a limit to fishing effort, target some lower level of harvest to decrease risk and to consider much more sophisticated techniques that optimize yield within fisheries.

Aware of these potential consequences, the U.S. introduced OY in 1976, under the Fishery Conservation Management Act (later renamed the MSA), and defined OY as a level of catch that provides the greatest overall benefit to the Nation and is prescribed on the basis of MSY, as modified by any relevant economic, social or ecological factor (16 USC Section 1802(18), as written in 1976). In practice, however, the OY provision was not used by Councils to account for the scientific uncertainty in the estimate of MSY (i.e., an ecological factor), or other social and economic factors that were usually cited as incalculable [47]. Rather, it was generally understood that OY was used by the Councils to prevent foreign fishing, because the MSA only allowed foreign fishing to occur in the Exclusive Economic Zone (EEZ – 200 nm) if the capacity of the domestic fishing fleet was unable to achieve OY [73]. As a result, OY was usually defined as an average amount of catch historically landed by the domestic fishery or the level of catch landed pursuant to the management measures of the fishery management plan (i.e., whatever was caught by the domestic fishery is the OY). The use of OY largely as a foreign fishing deterrent continued on through the 1980s.

In the 1990s two major initiatives were making their way into fisheries management: (1) the use of the precautionary approach to fisheries management and (2) ecosystem-based management. The precautionary approach to fisheries management was an initiative to set limit and target reference points in fisheries to account for the scientific uncertainty in estimates of MSY. By the 1990s, this initiative was well vetted, as it had also been a key concept behind OY in the 1970s [47,54]. The concept was enshrined into international policy in 1995, when the FAO published its Code of Conduct for responsible fisheries management, which emphasized the importance of precautionary management [14,32]. Meanwhile, ecosystem-based management (EBM) was a burgeoning new field of study in the 1990s, especially in the field of fisheries management. When the MSA was reauthorized in 1996 and the NS1 guidelines on OY were published in 1998, the fisheries science and management community were still trying to define what exactly EBM was and how it applied to fisheries management [45,59].

Therefore, it is not surprising to see that when the MSA was reauthorized in 1996 by the Sustainable Fisheries Act (SFA) that these two concepts received different treatments. The precautionary approach was addressed through a modification to the OY definition, which required OY to be adjusted downward from MSY, no longer allowing fisheries to specify OY above MSY (16 USC Section 1802(33)). The EBFM concept appeared in two sections, the most prominent of which was the requirement to form an Ecosystem Principles Advisory Panel to further evaluate how EBFM could be promoted in fisheries management and provide a report within two years (16 USC Section 1882(a), [31]). Interestingly, the other location where EBFM was explicitly highlighted was within the OY definition (16 USC Section 1802(33)), which emphasized the importance of the marine ecosystem when considering benefits to the nation.

However, when the NS1 guidelines were revised in 1998 to address the SFA amendments, they largely promoted the use of OY as a precautionary approach to preventing overfishing by accounting for scientific uncertainty in fishing mortality rates associated with MSY (F_{msy}). The NS1 guidelines [109], related NS1 technical guidelines [92], and a litany of other scientific articles (e.g., [78,22,65]) instructed Councils to develop a target and limit system that could account for the scientific uncertainty in calculating MSY reference points, through the use of OY control rules. Although a section on ecosystem considerations that could be considered by the Councils when specifying OY was added to the NS1 guidelines, Councils were not able to explicitly account for these ecosystem considerations or other social, ecological, and economic factors in their OY control rules due to a lack of information or methods to do so. Instead, most Councils ended up specifying a default OY control rule that was 75% of F_{msy}, based on the technical guidance of Restrepo et al. [92].

Further obfuscating OY were the 2007 revisions to the MSA (i.e., Magnuson Stevens Reauthorization Act – MSRA), which required Councils to specify annual catch limits (ACLs) for all managed stocks at a level not to exceed the acceptable biological catch (ABC) limit recommended by a Council's Scientific and Statistical Committee [73]. Although the definition of OY did not change, when NOAA Fisheries revised the National Standard 1 guidelines in 2009, the concept of OY control rules was supplanted with an ABC control rule. While the ABC control rule also emphasized the importance of accounting for scientific uncertainty in the estimate of F_{msy} and current biomass of the stock; it is not functionally the same because the ABC control rule no longer included considerations for other economic, ecological and social factors. In fact, the relationship between OY and the new ACL framework was never clarified in the 2009 NS1 guidelines, leaving many managers and stakeholders to wonder if OY was even a worthwhile concept anymore given that the ACL framework drives the specification of catch [36].

This look into the history of OY suggests that the similarities between OY and EBFM were overlooked due to happenstance, not intention. As noted above, the use of OY was primarily a reflection of mature management initiatives being proposed at the times when the MSA was revised. In 1996, when the MSA was being amended the precautionary approach to fisheries management was a well-established concept, even having roots to when OY was first being recommended in 1976 [47]. Whereas, EBFM was a relatively new concept[2], in the governance sense, being outlined by the United Nations Convention for the Law of the Sea in 1989 [96], formal implementation did not begin until 1993 when several U.S. agencies adopted an ecosystem approach to management [44,9], and international guidelines for implementing EBFM were not available until 2003 [33]. It was not until after the 2007 MSA, was there any need to reevaluate the purpose of OY and a look into history of OY revealed its similarities to the now well-defined EBFM concept.

This is not to say that the use of OY as a governance structure for implementing EBFM is a totally new idea. Several experts have noted that the MSA is one of many pieces of legislation that promote the use of EBFM and support this notion by pointing to the definition of OY [49,66,71]. Further discussions on how OY could be used to operationalize EBFM, however, have never been clarified. Thus, the next section describes how OY can be used to operationalize EBFM.

[2] Ecosystem considerations in a marine scientific and management context have been around for more than a century [59].

4. Using OY to operationalize EBFM

There are several ways in which OY could be used as a framework to operationalize EBFM, where OY can be specified at the stock, stock complex, fishery, or ecosystem level [31,35]. However, specifying OY at the ecosystem level seems to align the best with the intent behind EBFM for several reasons: (1) it places an ecologically meaningful boundary of management unit [19,33,96], (2) to provide the greatest benefit to the nation, all fisheries within an ecosystem should be evaluated against one another as opposed to evaluating stock or stock complexes within an individual fishery [33,35], (3) it provides a process to explore different formulations regarding tradeoffs across stocks and societal goals [53,59]; and (4) it addresses the issue of ecosystem overfishing [17,58,76], which lower levels of specification do not address.

There has been a long history of theoretical development underpinning this aggregate OY approach [38,41,70,8,90]. Several studies have shown that trying to achieve MSY for every stock does not consider the depletion of secondary production due to technical interactions, species interactions, or the export of biomass and energy through exploitation [39,62,75,8,90], and that an aggregate approach usually results in more precautionary reference points. More recent studies [104,107,39,63,79] confirm this and clearly demonstrate that analytical and data capacity exists to meet these conceptual requirements. It should be further noted, that the lower reference points typically lead to higher value in the fishery system [29,52]. Aggregating species within an entire ecosystem into aggregate groups provides reasonable equivalents to single species reference points [106,39,62,75,99]. In addition to the North Pacific (described further below), this approach has been considered elsewhere in the world (e.g. [62]), typically in places with limited species-specific data, high fish species diversity, or intense fishing pressure.

The North Pacific Fishery Management Council specifies OY in a similar fashion, in its Bering Sea/Aleutian Islands (BSAI) groundfish fishery [106]. The OY cap for the BSIA groundfish fishery is 2.0 million mt, which was based on 85% of the historical estimate of the MSY range [84]. However, the 2.0 million mt OY cap aligns well with subsequent aggregate surplus production models (i.e., 2.5 million mt) conducted by Mueter and Megrey [75]. Not surprisingly then, the sum of individual MSY estimates of stocks in this fishery exceeds the OY cap (i.e., 2.0 million mt OY cap). As a result, the Council conducts a qualitative tradeoff analysis to optimize catches among the various stocks and fishing fleets managed in the Bering Sea/Aleutian Islands groundfish fishery management plan.

With over 30 years of experience, the North Pacific process of specifying OY provides an excellent example of how a system level OY cap can be used to operationalize EBFM. Although the BSAI specifies a fishery level OY, it is essentially a system level OY in that the BSAI fishery accounts for 79% of the landings within Alaska [81]. The BSAI tradeoff analysis is also a more in-depth and holistic approach to management that explicitly balances the ecological, economic, and social goals of the fishery to provide the greatest benefit to the Nation. Building off of the BSAI example, this paper outlines the general steps to optimize yield. This represents a modified approach of starting with the productivity of the system [105,16,87,94] to specifically focus on the tradeoff analysis. Lastly, it is important to note that there are no regulatory constraints preventing a Council from specifying a system level OY and managing individual fisheries within that system to that level. Actually, existing guidelines encourage the use of system level OY caps (see [31]).

4.1. Step 1 – set an OY cap for the ecosystem

The first step to using OY to operationalize EBFM is identifying a cap on removals from the ecosystem that would increase the systems' resiliency to ecosystem overfishing [17,31,58,76]. This calculation essentially starts with measures of system level productivity minus any "set-asides" for protected, threatened or sensitive (e.g. forage) species. Generally, such exercises result in an OY that is approximately 75% of the sum of MSY [39]. Although this may seem like a drastic reduction in landings from MSY, U.S. fisheries already operate below some level of MSY ranging from ~75% (i.e., data-limited stocks) to ~95% (i.e., data rich stocks) of MSY [15,4,64,92]. Also, as stated previously, the economic value is typically equal or higher at this level of landings [29,52]. The use of a Fishery Ecosystem Plan [31], could serve as the strategic planning document that summarizes how the system-level cap on removals was calculated and how the individual fishery management plans within that system would regulate catches cognizant of that level.

Although such a system-level cap is potentially objectionable, it merits noting that the North Pacific groundfish fishery is the largest in the country, has been stable for multiple decades, and is widely regarded as being well managed [106,107,20,5].

4.2. Step 2 – conduct a trade-off analysis to determine the greatest benefit to society

The North Pacific Council uses a process whereby its Advisory Panel obtains recommendations from its fishing industry, non-governmental organizations, and other related stakeholder representatives on how to allocate catch below the groundfish fishery OY cap [106,82]. This considers the ecological and economic trade-offs across species while simultaneously accounting for the social aspects of sustaining various fishing communities that may be dependent on certain types of species for revenue (e.g., particular types of processing plants and fishing vessels). The full Council then deliberates on these recommendations. Only during years of extremely high estimates of Pollock ABC (*Theragra chalcogramma*, which generally make up ~65% of landings in the groundfish fishery) do results from qualitative tradeoff analysis become contentious. Although the North Pacific Council has been successful at resolving these issues through formal discussions, the use of more quantitative tradeoff analysis like management strategy evaluations (MSEs) could also be used to address these allocation issues.

Management strategy evaluations are based on the Adaptive Management Concept [102], and formalized by the work of Smith et al. [98]. Today MSEs are widely used for classical single-species, multiple species, and multiple sector ecosystem applications (e.g., [24,13,12,95,25,11,67,23,91]). The objective of MSEs is to examine the tradeoffs in performance of alternative management strategies across a range of management objectives, and in so doing, provide stakeholders and managers a greater certainty and basis for selecting an optimal management strategy [59,91]. For instance, in the Great Barrier Reef, the choice was made to minimize fishing effort for the "line" fishery through area closures to simultaneously meet several fishery, economic and conservation objectives identified by stakeholders [67].

Individual stock or stock complex estimates of MSY and ABC are still needed in the process, even if via less sophisticated models (see [111]). It is likely that some stocks will have ACLs specified up to their full ABCs, while others will have a smaller percentage of their ABCs allocated as the ACLs. From a short-term economic perspective one would expect managers to fully allocate catch for the most profitable species, while less profitable would not be fully allocated. This, however, may not be operationally feasible due to bycatch issues. For example, highly profitable species may not be able to be fully exploited because more vulnerable non-target species caps overall effort in the fishery [86,28,85]. Furthermore, long term food web impacts may suggest that fully utilizing some species while underutilizing other species could result in ecosystem overfishing [17,58,76] or may be unobtainable due to limited production pathways. Thus, some measure of ecological feasibility and tradeoffs also need to be factored in. Measures of individual stock or stock complexes can help in the tradeoff analysis and also provides protection against a stock becoming overly depleted [107,39]. Tradeoff analysis can also provide context to determine which single species assessment should be given higher priority, over less vulnerable stocks (sensu [86]).

4.3. Step 3 – strategic planning and performance management

There are several reasons why OY should be reduced from MSY, such as bycatch, market conditions, ecosystem resiliency measures (e.g., forage fish, habitat protection, etc.), or scientific and management uncertainty, all of which could be addressed through strategic planning. Evaluating these OY modifications in the context of MSEs seems highly warranted [11,91]. Adopting a strategic view will help Councils identify the major risks, and strategies to address them, for all the fisheries in their ecosystems [42]. Possibly within overarching Fishery Ecosystem Plans, a description of control rules and actions they will take in the future can be provided to improve future yield of fisheries and associated business planning.

Ideally, Councils should regularly evaluate the performance of their Fishery Management Plans as they relate to system-level OY and other system-level reference points. Performance management has always been an important feature of fisheries management (e.g., status of the stock report to Congress, [83]); however, it has expanded greatly over the years, especially in regards to ecolabeling [46,50,51], and ecosystem-based fisheries management (e.g., [10,57,97,112]). It is entirely feasible to measure the performance of all fisheries in a given ecosystem, as a system. This implies no data or analytical requirements beyond what is typically done, rather a novel perspective of those data from a systemic or aggregative approach. Several instances of ecosystem status reports or ecosystem chapters [108,30] are beginning to report on aggregative fisheries performance in the US.

The approach proposed here is generic enough to accommodate the nuances and major distinctions for any given regional ecosystem and affiliated set of fisheries. Yet it provides an overarching approach that provides a standardized means to operationalize EBFM. Certainly there are many caveats, nuances and implications to be addressed in particular applications, yet this general approach has been suggested as a way to meet both OY and EBFM objectives [59]. As such, it warrants further exploration beyond the North Pacific example [60].

5. Conclusions

Given the mandate to achieve OY and the framework described above, the objections to implementing EBFM are becoming less valid. The obvious link between OY and EBFM objectives should alleviate concerns in the U.S. regarding the lack of governance structures for EBFM, and could be applied elsewhere in the world where similar OY policies exists (e.g., Australia, European Union, New Zealand, South Africa, etc.). Furthermore, the conceptual basis for OY clearly includes ecosystem considerations. Although OY was initially overlooked as a governance mechanism to implement EBFM, it was not an intentional rejection of EBFM but rather reflective of other factors facing society-at-large and the applied science-management discipline as a whole at particular points in time.

The need for EBFM remains ever strong [37,61,89], and the time is ripe to begin implementing it. The proposed approach uses the existing OY policy framework, adapts it to a system perspective, and provides a means to pragmatically consider co-located fisheries as the inter-connected system that they truly are. Using the OY framework to implement EBFM holds a lot of promise, there are no technical reasons not to do it, and the benefits of doing so are much higher than maintaining the status quo (e.g., [55,40,7,59]).

Hopefully, the proposed approach discussed here will at the very least expose something that was never truly hidden. Moreover, the proposal provides yet further confirmation that implementing EBFM is well within our reach and serves as a way forward to continue to reach both OY and EBFM objectives.

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