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Using a Regional Level, Risk-Based Framework to Cost Effectively Implement Ecosystem-Based Fisheries Management

W.J. Fletcher, D.J. Gaughan, S.J. Metcalf, and J. Shaw
Department of Fisheries, North Beach, Western Australia, Australia

Abstract

Risk-based frameworks to implement the "ecosystem approach" have been developed for a number of different industries in Australia. The framework for individual fisheries has been used for nearly a decade and while valuable it (i) does not address the cumulative effects of fishing, (ii) does not align with regional level planning undertaken by other government agencies, (iii) has not halted the increasingly negative community perceptions about fishing. To address these issues, use of a regional level approach, termed ecosystem-based fisheries management (EBFM), was proposed with the draft EBFM framework trialed for one bioregion in Western Australia (WA). Given the success of the trial, this paper outlines subsequent refinements to the methodology, the progress made in applying the framework in all bioregions of WA, and the broader adoption of these principles by the Department of Fisheries and other agencies.

Being a hierarchical, risk-based process, the EBFM framework avoids merely generating an impossibly complex set of regional level issues, uncertainties, and stakeholder expectations. In the initial case study over 600 ecological assets, social and economic outcomes, governance systems, and external drivers were identified by stakeholder workshops. The complexity was reduced by consolidating them into 60 regional level risks and a multi-criteria analysis was used to integrate related ecological, social, and economic values and risks into 24 "agency level" priorities. This framework has been applied to all six aquatic bioregions in WA with the resultant 88 agency priorities now used as the basis

for all annual budget-setting decisions made by the Department of Fisheries. To fully implement EBFM, WA is currently revising the fisheries legislation and governance arrangements to facilitate creation of regional level strategies to coordinate the management of all individual fisheries/activities and simplify the department's engagement in future multi-sector (EBM), regional planning processes.

Initiating implementation of EBFM did not require detailed data on ecosystems; it required only the holistic consideration of risk to each ecological asset and the associated stakeholder benefits to determine which assets have the greatest requirement for direct management. The cost effective steps for a regional level, ecosystem-based approach using only currently available data combined with expert opinion make implementation of this management planning framework viable in any location.

Introduction

Background

There has been considerable effort within Australia to translate the various ecosystem-based concepts into practical outcomes that are useful for management (Fletcher 2008). Risk-based frameworks are now available for a wide variety of industries including the management of individual fisheries (Fletcher et al. 2005, Fletcher 2010); aquaculture (Fletcher et al. 2004); agriculture (Chesson and Whitworth 2005); and irrigation usage (Camkin et al. 2007). From the application of these concepts across a variety of situations, we identified the four universal management "principles" that ensure a holistic ("ecosystem") approach is taken irrespective of the industry.

Four Universal Principles for Holistic Management

1. What impacts are the activities I control having on the **assets** that I manage?
2. What impacts are these activities having on the **assets** that someone else manages?
3. What economic/social benefits and costs are generated from these activities and the use of my **assets**?
4. What activities managed by others affect my **assets** and me?

(Modified from Fletcher and Chesson 2008.)

In applying these principles, the "my" can be an individual, a company, a fishery, a region, a department, a state, a country, or even an entire continent. So depending upon what the "my" represents, the

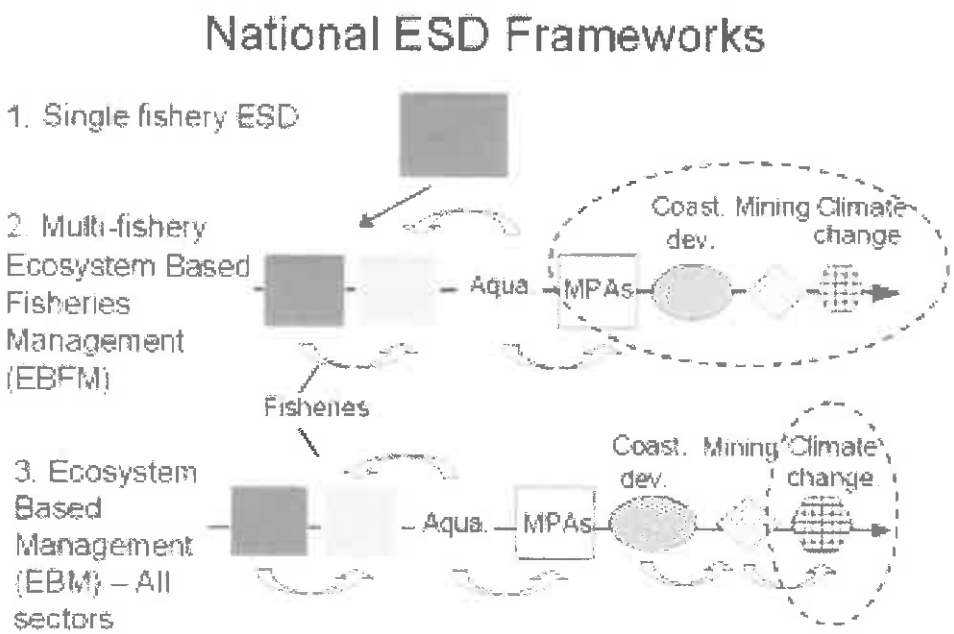

Figure 1. Relationship between the three ecosystem-based framework levels. In this instance single fishery ESD is equivalent to EAF. The elements included in the dashed ovals represent the difference in external drivers between EBFM compared to EBM. Abbreviations are used for aquaculture (Aqua.), marine protected areas (MPAs), and coastal development (Coast. dev.) Modified from Fletcher (2006), Fletcher et al. (2010).

scope and complexity covered by the management system can vary dramatically. For fisheries management, there are three common levels at which an ecosystem approach can be applied (Fletcher 2006): the individual fishery (EAF), multi-fishery level (EBFM), and multi-sector level (EBM) (see Fig. 1).

The steps to apply the ecosystem approach to individual fisheries are based on the international standard for risk management (AS/NZS 4360 1999, AS/NZS 2009), reflecting that fisheries management is really just a specific form of risk management (Fletcher 2005; Fig. 2). These steps are routinely applied in Australia (Fletcher 2008) and have been adapted for use elsewhere (e.g., FAO 2005, Cochrane et al. 2008, Fletcher 2010) with a variety of tools available to undertake each step to suit different fishery and country situations (e.g., De Young et al. 2008; FAO www.fao.org/fishery/eaf-net/en).

A national workshop (see Millington and Fletcher 2008) concluded that while extremely valuable, applying an ecosystem approach at the fishery level did not address the cumulative effects of all fishing-related activities in a region or deal with the conflicting objectives and

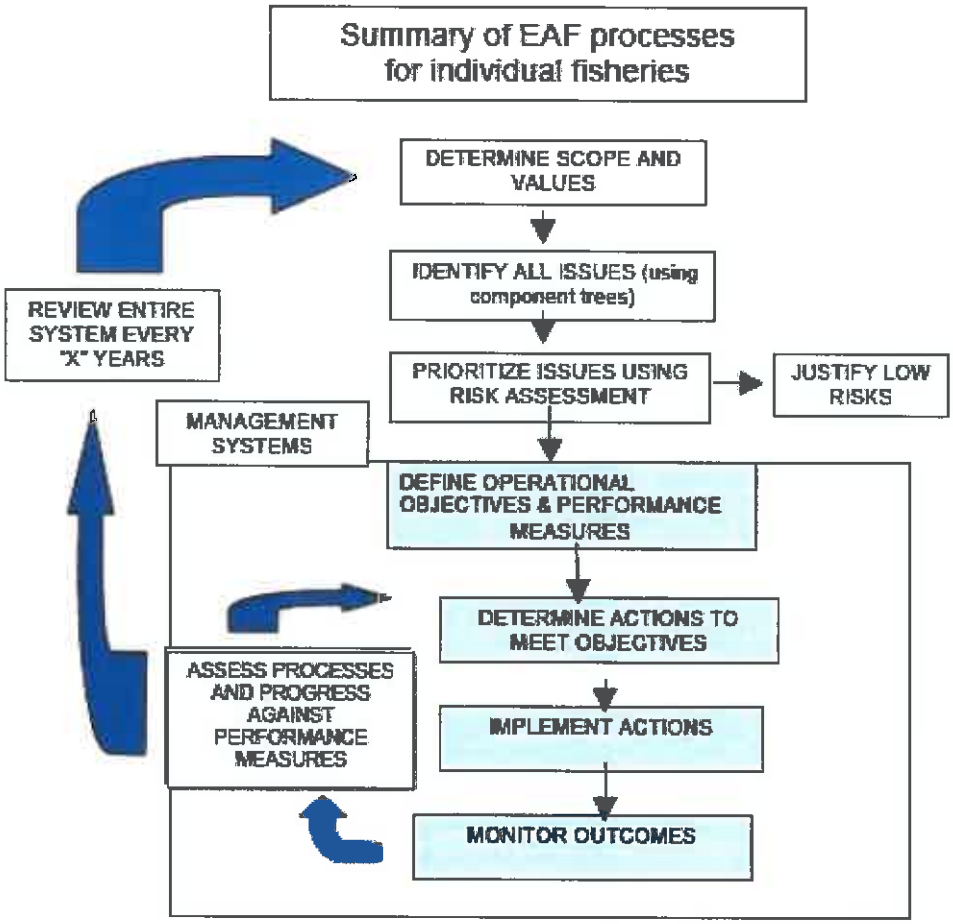

Figure 2. The EAF framework for individual fisheries. Adapted from the AS/NZS 4360 Risk Management framework, and modified from Fletcher (2008)

allocation issues between fisheries or sectors (e.g., commercial and recreational). Managing only at this level can hinder linkages to other government planning processes that operate at a regional level (e.g., establishment of marine parks) and it has not halted the increasing community perception that fishers (especially commercial fishers) no longer have an automatic "social license" to operate. The workshop proposed that taking a regional level (multi-fishery) ecosystem-based fishery management approach (EBFM, see Fig. 1.) would assist in dealing with many of these issues.

Potential and perceived problems

When developing the methods to apply EBFM in Western Australia (WA), a number of potential and perceived problems were identified. First, there was a tendency for many stakeholders to assume this must

involve the collection of more "ecosystem" information (Fletcher 2008). But, without increased resources, it was essential that EBFM could begin without increased information. Second, undertaking regional level assessments had to avoid merely generating an impossibly complex set of issues, systems, uncertainties, and expectations. Finally, the EBFM process had to complement, not duplicate, the activities already being progressed within fishery level management systems.

Given these issues, many sections of the department became skeptical that EBFM could be implemented cost effectively and without significant disruptions to services. There was a fear that the EBFM initiative would shift the focus off core activities and even potentially affect career development. Many were convinced that it was just an academically attractive but impractical concept that would not improve management outcomes.

It is against this background that we began to evaluate whether there was any real value to government from implementing EBFM. The rest of the paper outlines the set of activities developed to deal with the issues outlined above which resulted in this risk-based "EBFM framework" ultimately being adopted and implemented by the department in a cost effective, practical, and useful manner.

Materials and methods

Overview of the EBFM framework

To deal with the complexity of regional level issues generated by EBFM, the single fishery framework (EAF[1]) had to be modified into a hierarchical, regional level, risk based framework (Fig. 3). A description of each of the key steps in the EBFM framework, including some recent refinements, is presented below using specific examples from the West Coast Bioregion of WA (see Fletcher et al. 2010 for more details).

Commitment, capacity, and responsibility

The first and most important step in successfully implementing EBFM (or any management system) is having an appropriate level of political commitment and institutional capacity that will enable suitable management arrangements to be developed and enforced. The most common cause of fisheries management failure is the lack of good governance, not the lack of information (Kruse 2011). The lack of governance is often due to the lack of will to undertake what is known should be done.

Operating at the regional level can often require clarification of who has legislative responsibility for what assets and where. The one asset may "belong" to different jurisdictions, and conflict frequently arises

1 EAF is the term used by FAO; in Australia it is more generally known as ESD—Ecologically Sustainable Development.

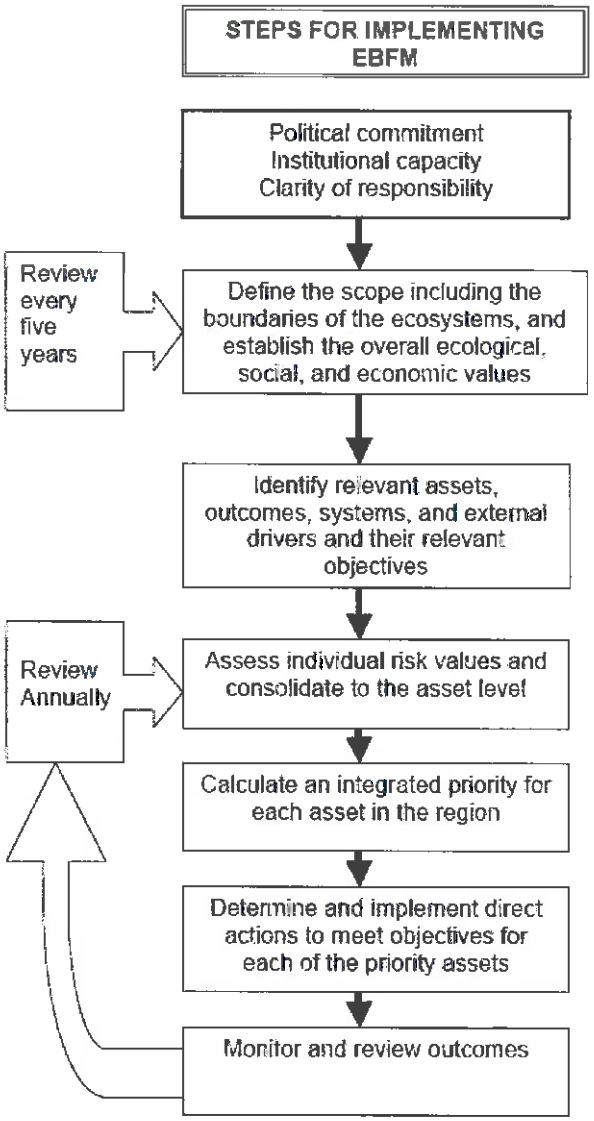

Figure 3. Outline of the planning steps used for the implementation of a regional level ecosystem approach—multi-fishery (EBFM) or multi-sector (EBM).

where more than one agency/group is trying to manage the one asset. This can occur between agencies of the one government, between state and federal governments, and frequently between countries. It is, therefore, essential to understand the limits of your legislative responsibility because this defines what you can directly manage, compared to what you can only influence or react to (see also Fletcher 2006). Depending upon the degree of overlap, it may be necessary for more than one agency (i.e., more than one legislative act) to be directly involved.

Table 1. The main values identified as relevant to EBFM in Western Australia. Note: this list of values does not include food security, which would be a key value in many developing countries

	Value	High level objective
1	Species sustainability	Keeping biomass levels above levels where recruitment could be affected
2	Ecosystem sustainability	Ensuring that any impacts on ecosystem structure and function are kept at acceptable levels
3	Economic outcomes	The economic benefits to the community are optimized
4	Social amenity	The social amenity (i.e., non-economic benefits) derived by the community is optimized
5	Social impacts	Social impacts and negative attitudes associated with management of these resources are minimized

Defining the scope

Based on the legislative arrangements of the agency(s) involved, the scope of what will be included in the EBFM assessment needs to be clearly described. This includes the geographic boundaries of the area that will be encompassed, and developing a very clear description of each of the relevant fisheries and other activities that are being managed in this region. For the WC example, the region encompassed for EBFM was a 1,000 km stretch of coastline in the southwest of WA from Kalbarri (27°S) in the mid-west, south to Augusta (115°30E), out to the 200 m depth contour, including all fishing related activities that occurred in those waters (Fletcher and Santoro 2010).

The scoping process must also generate a shared understanding of the relevant social, economic, and ecological values desired by the various stakeholder groups. Essentially, what does the community want to achieve from undertaking management of the region's resources? The values (or high level objectives) can include ecological sustainability, food security, social amenity, and economic development. The combination and relative priority among these can vary dramatically among countries, among regions, and even between assets within the one region.

Understanding which of these values is the most important has major implications for what should be managed and how best to manage it. In the West Coast case study, the primary objective was ecological sustainability, with social and economic outcomes being secondary objectives; food security was not considered relevant in this situation.

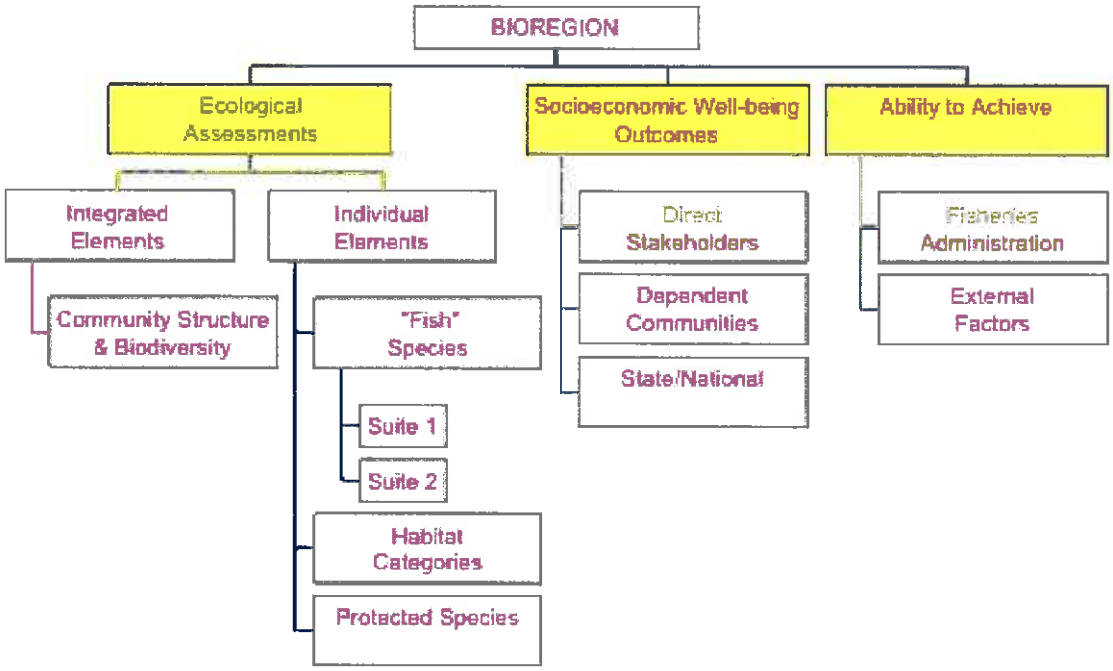

Figure 4. Key EBFM components. Each component expands into its own tree and branch structure, which are subsequently modified to suit the region being assessed.

Identification of EBFM assets, outcomes, and specific objectives.

Using the agreed scope and values, the next step is to identify all the relevant EBFM items (Fig. 4) and determine what specific objectives are to be achieved given any local, regional, or national requirements or global attitudes (see Table 1). The EBFM items were identified through a series of workshops with a diverse range of participants, including fishery managers, other government agencies, sector representatives, and other stakeholders. The items were structured into a hierarchy of related groups using a set of EBFM component trees with one tree for each for the ecological assets, social and economic outcomes, institutional governance system, and external drivers. Each of the EBFM trees was tailored by adding relevant items and deleting those considered irrelevant. For the West Coast case study, in excess of 600 items were identified across the spectrum of EBFM components with over 80 separate items identified just for the "fish species" asset tree (see Fig. 5 top). This number is clearly too large to be useful for agency planning; therefore, methods to reduce this complexity were applied.

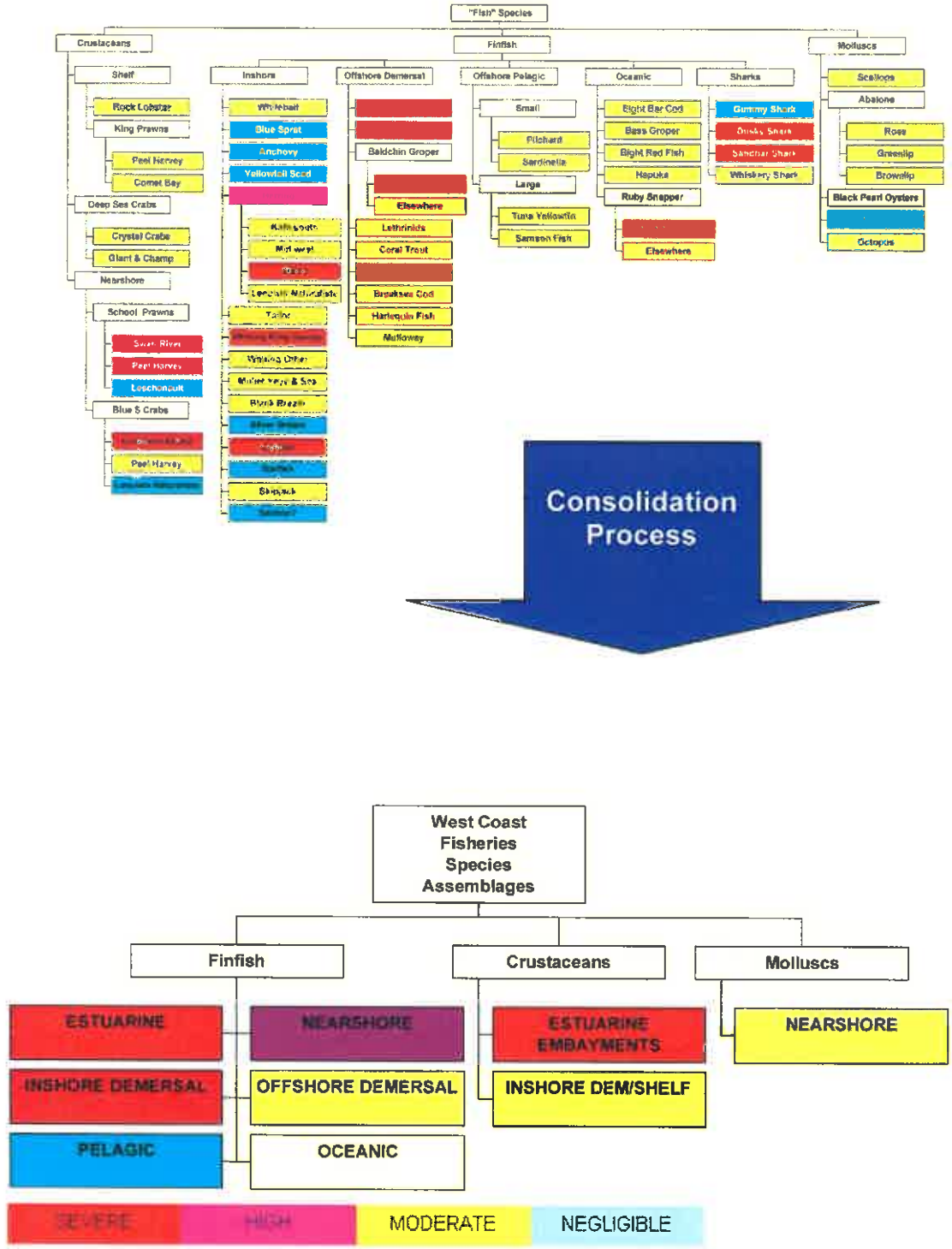

Figure 5. Above: individual "Fish" stock/species risks; and below: consolidated risks of species suites (assets) from the West Coast Bioregion of Western Australia. Colors represent (top) the risk status of the species and (bottom) the entire suite. Modified from Fletcher et al. (2010)

Table 2. Examples from the multi-criteria assessment for the West Coast region showing individual risk and value scores.

Asset	Ecological risk	GVP level	Econonomic risk	Social amenity	Social risk	External impacts (other agencies manage)	Current Dept. of Fisheries score and priority (EBFM)	Whole of govt. score and priority (EBM)	Departmental resources applied
WC crustacean (lobsters)	3	5	5	4	3	0	111 Urgent	111 Urgent	Very high
WC pelagic finfish	2	1	1	1	1	0	4 Very low	4 Very low	Very low
WC estuarine ecosystems	5	3	3	4	4	4	25 Low/mod	125 Urgent	Low
WC governance, external linkages	2	5	4	5	4	0	92 Urgent	92 Urgent	High
WC pests and diseases	3	3	1	3	4	0	45 Medium	45 Medium	Very low

All risk and value levels are scaled from 0 to 5, with 5 the highest value and risk.

GVP = gross value of production; social amenity includes use and non-use values. The values are the relative "weights" used for these criteria.

The EBM formula includes all WA legislation and hence does not include "other agency discounting."

Assessing individual risk values and consolidating to asset level.

The risk levels associated with each of the identified items were assessed using standard risk assessment techniques (e.g., Fletcher 2005, 2010; IEC 2009). While this reduces complexity by showing which items have only low or negligible risks, the number of moderate or higher risk values generated can still be large. Furthermore, many individual risks will already be subject to specific management and planning processes at the fishery level. Therefore, to ensure that the EBFM process recognized and added value to existing fishery level management, these were combined into regional level assets (Fig. 5).

The process of consolidation into broader asset categories utilizes the branch structure of the component trees. Each of the branches represented groups of "like risks" that can/should be managed collec-

tively. For example, the West Coast "fish species" tree had 80 individual species/stock risks, which were consolidated down to just nine species suites (Fig. 5 bottom). Using the risk status for the entire species suite (e.g., inshore demersal finfish) is very efficient for management planning which can be evaluated using the status of one or more indicator species representative of the entire suite. For the case study, this approach enabled the consolidation of the 600 EBFM items down to 60 regional level risks (see Fletcher et al. 2010 for details).

Calculate an integrated priority for each asset in the region

As many of these regional level risks are interrelated, an integrated set of holistic, departmental level priorities can be generated by recognizing that we manage ecological assets to generate economic and social benefits for the community. Each consolidated ecological asset therefore becomes the primary unit to integrate its associated ecological, social, and economic risks and values using a simple multi-criteria function (see Table 2 and Fletcher et al. 2010 for details). Using this approach, the complexity from the >600 West Coast items initially identified was reduced to just 24 agency level priorities.

Agency Priority = ("Stock" Risk – External Impact) × [(Economic Risk × GVP) + (Social Risk × Social Amenity)]

The highest agency priority scores will be calculated when there are risks to the ecological sustainability of the asset, and the asset is valuable economically and/or socially. Within the West Coast case study, the highest departmental score was for the WC crustacean suite, which is dominated by rock lobsters, the largest and most valuable fishery in the state (Table 2). The high priority score reflects the significant issues that were facing the fishery (Fletcher and Santoro 2010), including a series of low recruitment years that required major reductions in the allowable catch to ensure breeding stock levels were not depleted. The economic performance was also being affected by relatively low prices due to overseas market conditions and high exchange rates, which were exacerbating the impacts of increased costs associated with fuel and labor.

One of the lowest Agency Priority scores was for the West Coast pelagic finfish suite (Table 2). This suite of fish currently has only very minor levels of fishing due to poor markets combined with variable and low stock availability in the region (Gaughan et al. 2008), resulting in difficulties maintaining catches at economically viable rates. Consequently, the risks to the stocks are currently low to negligible and there are no additional risks being generated that affect other trophic levels, or social and economic outcomes.

The multi-criteria analysis for EBFM recognizes that if a stock or ecological risk is mostly being generated by human factors external to the fisheries management (legislative) control (e.g., pollution, coastal development), the overall priority for direct departmental activity is likely to be reduced accordingly. These external risks were taken into account in the agency level priorities through use of a "discounting term." For example, the agency level priority for the West Coast estuarine ecosystems was not as high as would be expected given the severe ecological risk level, because the majority of the ecological risks are generated by coastal development and agricultural runoff resulting in sedimentation/loss of habitat, which are managed by other agencies—overall responsibility is under the Swan River Trust. This generates a heavy discount from the agency level priority score for the Department of Fisheries. The department can directly ban only the capture of stocks most at risk (i.e., treat the symptom) and try to influence the other agencies involved to improve water quality (the cause).

In contrast to the formula for EBFM, the "whole of government" formula that would be used for an EBM assessment does not include any "discounting term" because all management agencies and their legislative controls are included. Consequently the EBM priority score for the West Coast estuarine ecosystems is extremely high (Table 2), reflecting increasing community concern about the Swan River Trust's inability to "halt the decline of this most valuable of Perth's natural assets" (*The West Australian*, Oct 12, 2010).

Determine and implement direct actions to meet objectives for each priority asset

The multi-criteria analysis provided a high degree of discrimination in priority among assets for urgency of action and relative use of agency resources. For the 24 regional level assets in the West Coast, there were five urgent priorities, two high priorities, and six moderate, low, and very low priorities. While we have found there was a reasonable degree of concordance between priority levels and levels of departmental funding/activity directed at each asset, suggesting that the previous implicit processes were not completely wrong (see Table 2), for some assets the current activities (and resourcing) were well below and well above that expected (e.g., Table 2). In one case it highlighted the unacceptable risks associated with an asset only recently added to our legislative responsibilities (introduced pests and diseases). To deal with this appropriately, additional resources will be required either directly from government or possibly indirectly from the shipping industry (the main source of the risks), on a cost recovery basis.

In situations where an asset has an unacceptably high sustainability risk (score >3) but low commercial and social value, and therefore

a relatively low priority score, this does not mean that the ecological risks are not addressed. If the ecological risk of any asset increases to >3 additional management actions must be generated to reduce the risk level[2], but for those with low social and economic value the actions are more likely to be relatively simple and cost effective.

Monitoring and review

Reflecting the full adoption of the EBFM framework as the basis for management of WA's aquatic resources, the annual monitoring and reporting to the WA Parliament by the department has been amended and renamed the *State of the Fisheries and Aquatic Resources Report* (Fletcher and Santoro 2010). This report now includes bioregional overviews outlining each of the key ecological resources (assets) for the region and summarizes their current cumulative risk status. Furthermore, each of the individual fishery reports has been refocused to become more resource-based rather than activity (sector)-based.

Discussion

Real adoption of the EBFM framework

Merely stepping through any new process, such as the EBFM framework, does not by itself guarantee that the outputs will be used by the agency, or that the process will continue to be used. To ensure effective and ongoing implementation of EBFM, the framework has to become an integral part of the agency's governance system. This is being achieved by changing both the Department of Fisheries' project management system and the budgeting/planning processes.

The department has adopted a full risk-based management system, which requires all activities undertaken by staff to be explicitly assigned to assist the management of risks associated with one or more ecological or organizational assets (see Fig. 6). Having a direct association between activities and assets clearly illustrates to staff and stakeholders that the purpose of a natural resource management agency is to effectively manage the risks (ecological, social, and economic) to the community's assets and outcomes. The differing priority levels for assets will also clearly indicate to stakeholders why some issues will receive greater (or quicker) attention than others.

The annual budget planning cycle for the department has been updated so that the first step in this process is a review of the risk and value scores for each asset. Changes in these values affect the priority scores, which will potentially result in a shift in the level of resources directed to individual assets and regions.

2 Except where the risk is being generated by external factors.

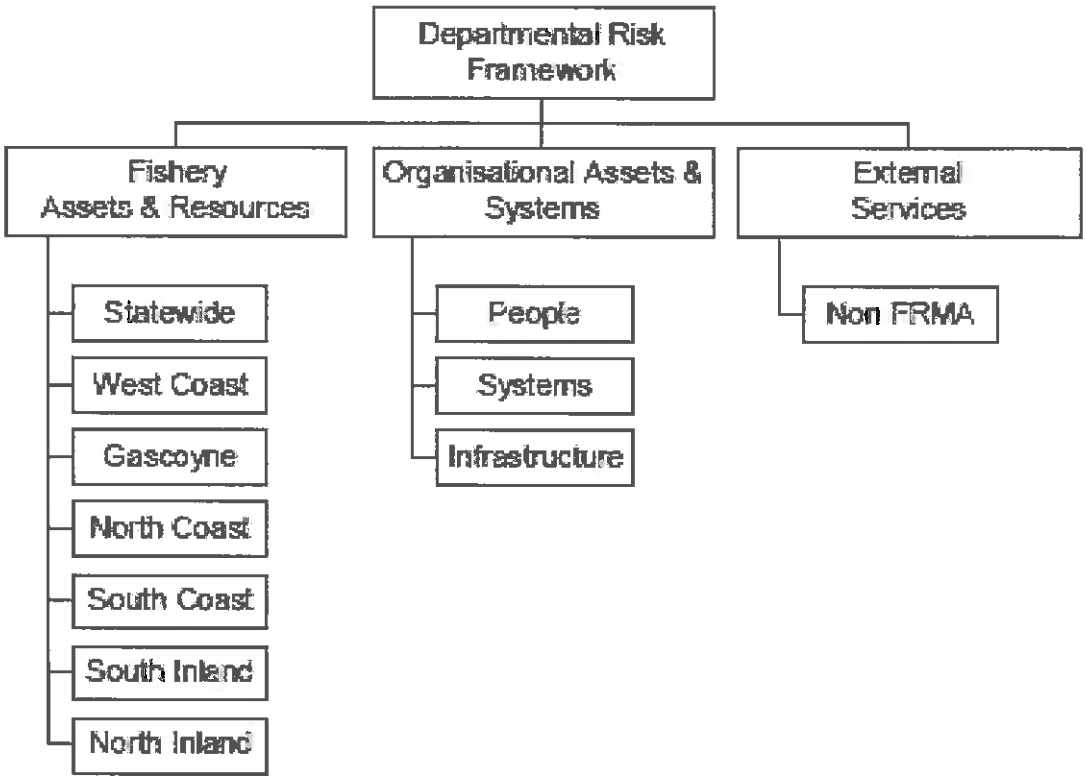

Figure 6. Framework for the Department of Fisheries risk register. Each of these components expands into its own set of branches and assets.

Regional level strategy plans

The next phase in implementing EBFM within WA is to update the Fish Resources Management Act (WA Govt. 1994) to better enable regional level management. The current act only provides a framework to establish management arrangements for individual commercial fisheries and to a lesser extent establish regulations for the management of recreational fishing. There are no "head powers" (legal structures) to manage across multiple sectors, allocate among sectors, or deal with cross government integration (DoF 2010). Consequently the department is in the process of amending the act to require the establishment of a hierarchy of management strategies (Fig. 7). A series of Aquatic Resource Management Strategies (ARMS) will set, at the regional level, overall objectives for management and the parameters for overall resource use and allocation of access. From this overarching plan, the various sectoral harvest use and protection plans can be generated that will outline the specific objectives for each sector in a coordinated manner. This will enable individual fishery issues and actions to be mapped into regional level plans.

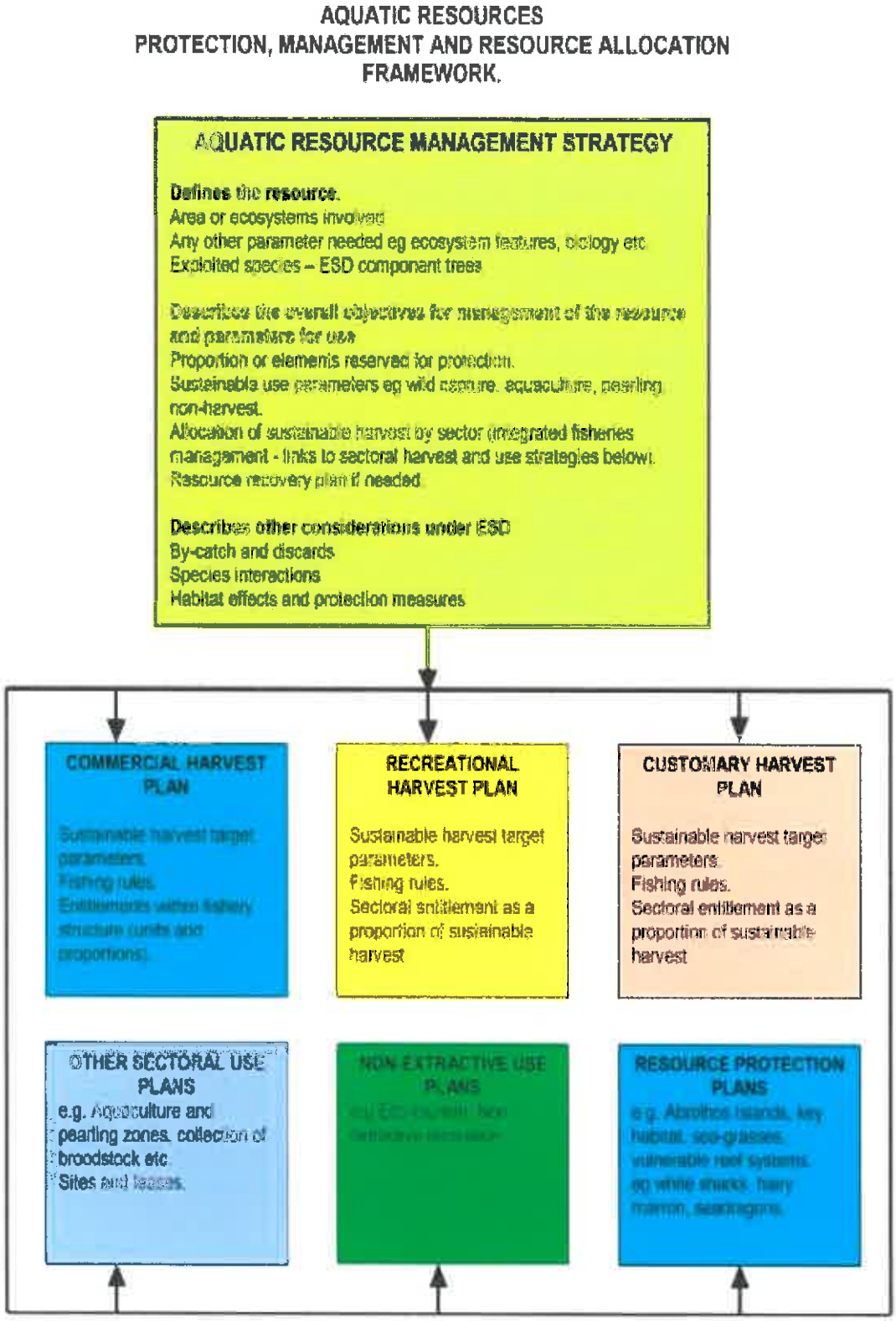

Figure 7. Proposed regional resource planning and management framework for Western Australia (from DoF 2010).

An additional benefit of ARMS is that they can be used as key inputs into any future multi-sector regional planning processes. Without defined regional level strategies, these processes require separate inputs for each fishery and sector, which is highly inefficient, generating a high workload for those involved and often leading to a lack of effective engagement. Everybody involved was very busy attending multiple meetings that resulted in numerous submissions, but the outcomes were mostly superficial or unpopular. The development and use of the ARMS should therefore reduce this level of cross agency inefficiency.

The linking of EBFM with multi-sector (EBM) processes has already begun with the establishment of a national committee that includes representatives of environment and fisheries agencies from both state and federal levels of government in Australia. This group recently agreed that the set of steps to implement multi-sector EBM would be essentially identical to those outlined here for EBFM (MACC 2010). Having a consistent set of steps should increase the likelihood that the outputs from these processes will complement each other and therefore generate improved outcomes for the community, not just activities and reports.

Conclusions

We have found that adopting an "ecosystem approach" at a regional level did not require a detailed understanding of all the relevant ecosystems. Instead, it required the efficient consideration of each ecological asset in the region and its associated stakeholder outcomes, to identify ecological assets that **most** require direct management to deliver the "best" outcomes for the community. The critical step in beginning to adopt EBFM is being able to clearly identify, in a pragmatic and consistent manner, the set of ecological assets to be managed and linking these to social and economic outcomes that they may generate.

The simple set of steps we developed for the EBFM framework has enabled adoption of a fully regional, "ecosystem-based" approach in WA without material increases in funding. It has successfully replaced the previous, disjointed planning systems with a single, coordinated risk-based system that is already generating efficiencies for the use of departmental (government) resources. Having a cost effective process means that it can be applied in all circumstances, not just in regions of the world where a large amount of resources and scientific data are available.

The adoption of risk-based approaches at a regional level as the overarching basis for fisheries management planning, combined with the wider adoption of similar steps to implement EBM, should facilitate more efficient linkages and harmonization with other government policies and processes. Consequently, we have found that there are clear and positive benefits from the implementation of this "ecosystem

approach" to assist with fisheries management planning and decision-making. These benefits are much more tangible than merely meeting some long-forgotten global political commitment.

Acknowledgments

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