Ecological Risk Assessments: A Roadmap for California Fisheries

Introduction

The California Ocean Science Trust examined risk assessment frameworks for understanding fishery vulnerabilities to various stressors, including fishing pressure and climate change. This project identified key aspects ecological risk assessments (ERAs), lessons learned from existing applications, and considerations for adopting such methods for California fisheries.

Our exploration included research of the scientific literature, case studies, and interviews with international fishery assessment experts. We drew upon our unique perspective and position as a boundary organization to bring together partners from academia, state government, and other non-governmental organizations in a workshop to collectively explore the potential for ERAs to support sustainable fisheries management in California. We have applied this research together with new thinking from the workshop participants to provide an analysis of the potential utility of ERAs in the context of State legislative, regulatory, and management frameworks. Our intention is to highlight the opportunities that ERAs present to state fisheries managers faced with competing priorities and multiple fisheries needing attention. The goal is not an in-depth comparison of ERA frameworks relative to other fisheries management tools, nor do we intend to suggest that ERAs are the single solution to every fisheries challenge. For situations where the State decides that a risk framework would advance its fisheries management efforts, we have included a roadmap to highlight steps that our research indicates are critical to successful implementation of an ERA framework.

Key Findings

Ecological risk assessments (ERAs) constitute a family of dynamic tools that have been deployed across the globe to assist decision-makers in designing fisheries policy, regulations and management structures. In contrast to traditional fisheries management, which focuses on population size and metrics like maximum sustainable yield (MSY), ERAs consider risks to populations due to a suite of vulnerabilities, including fishing pressure. Risk assessment frameworks can be structured to identify species vulnerable to impacts from fisheries in which they are not the target, as well as from other potential stressors aside from fishing activity such as climate change.

By considering fisheries targets in the context of other species and habitats, ERAs provide an opportunity to evaluate risks to ecosystem condition from fishing activities, thereby placing fisheries management within the broader context of ecosystem-based management frameworks.

ERA's present opportunities to realize efficiencies in fisheries management. For example, an ERA may reveal that low-risk fisheries are found to meet management goals without needing to invoke additional data collection or conduct other costly scientific assessments.

ERAs are not a drop-in replacement for traditional data-rich fisheries management. They are a way to evaluate a risk from a stressor (such as fishing activity) to a range of species and habitats on the same scale, using minimal data. This allows managers to make decisions about next steps for management action on fisheries alongside each other and prioritize allocation of limited resources. They can also provide information about potential concerns outside of direct effects of fishing on target stocks.

California has in place - through the Marine Life Management Act (MLMA) and associated policy documents (e.g., the MLMA Master Plan) – legislation that is grounded in ecosystem-based management principles and which allows flexibility in implementation to achieve core sustainability goals. Application of a risk assessment approach in California might be achieved within the framing and requirements of existing mandates and may present opportunities to meet existing mandates quickly and efficiently.

What are Fisheries Ecological Risk Assessments and What Can they Do?

ERAs for fisheries management are frameworks for assessing the likelihood of a fishery, species, or ecosystem facing significant impacts due to fishing activities, climate change, ocean acidification, impaired water quality, etc. They are one of the few tools that can be used to help a manager move away from single species or habitat management and towards ecosystem based management.

There is not a single Ecological Risk Assessment. The term refers to a class of frameworks, which in turn can address a range of goals. The particular framework chosen, adapted as needed, and implemented depends on the management situation it is designed to support. It is important to create or adapt an ERA for clearly defined applications and management goals. ERAs all have different components and inputs, carefully chosen and designed to address the specific management goals (e.g., maintain stock under fishing, minimize bycatch impacts, etc.). ERAs can support different types of managers' information needs, which, in turn, link to different types of management decisions.

Assessing Risk from Fishing Pressure

One of the early applications of ERAs for fisheries management is the Ecological Risk Assessment for the Effects of Fishing (ERAEF) developed by Hobday and Smith[1]. This seminal application was designed to meet a specific policy mandate in Australia: to manage fisheries using ecosystem based management practices, which encompasses much more than managing only target species. This raised the need to find a practical and defensible way to consider the range of impacts for target and non-target species and habitats, despite having different levels of information available about each.

ERAEF can help managers assess multiple species and habitats potentially impacted by fishing activities in the same framework based on commonly available information. In this way, managers are able to consider a suite of species and habitats at the same time and decide how to allocate management resources to achieve the best outcome for the ecosystem. In the Australian experience, ERAs were, and continue to be, a time and cost-effective step in the transition from species management to ecosystem based management, allowing science-informed management decisions without exhaustive data collection about every species of interest.

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Considering Risks from Climate Change

ERAs have also more recently been used to evaluate vulnerability to stressors beyond fishing, such as climate change. For example, the NOAA Climate Vulnerability Assessment[2] provides fisheries managers a succinct evaluation of the impacts their managed species might experience due to climate change, the mechanisms underpinning those impacts, and any management actions available to mitigate those impacts. It is possible to envision similar ERAs designed to evaluate the risk due to ocean acidification or impaired water quality.

Designing an ERA to Support Diverse Management Goals

The variety of potential uses of ERAs is reflected in the variety of ways that such frameworks have been applied to support fisheries management across the globe. ERAs can be applied to a staggering combination of species (fished, target, threatened and endangered, bycatch, emerging fisheries), recreational and commercial fisheries, gear types, and even habitat and ecological communities. Similarly ERAs can be designed to provide a variety of different types of information including:

- comparable risk categorizations across both

data poor and data rich species, fisheries, and habitats,

- assessment of when, and if, fisheries management intervention will have a meaningful impact, or be swamped by other stressors,
- identification of fishery impacts to ecosystems, and reciprocal ecosystem impacts on fisheries, and
- insight into cumulative impacts (e.g., from multiple fisheries affecting the same target) or multiple stressors.

Outputs of a risk assessment can inform a range of fishery management decisions. At the policy level, ERA relative risk scores can underpin prioritization of fisheries for more expensive and time intensive management consideration. For fisheries managers, an ERA can then also identify potential management approaches. For example, a low risk species or fishery may operate under a less costly management scenario utilizing landings data while a more risky fishery might be chosen to undergo a more rigorous traditional or data poor stock assessment along with Management Strategy Evaluation (MSE).

ERAs are precautionary in the absence of information. Therefore, they provide insight as to when more data could decrease a perceived risk. For instance, several data-poor species might be evaluated as at high risk. By analyzing the results of an ERA, it might be possible to separate high risk factors that merely indicate lack of information from those that result from known risks to the species. In one case, additional information may reduce the perceived risk, while in the case where the risk is due to known factors (e.g., long time to reproductive age), additional information is unlikely to change the level of concern. This can help to prioritize scarce data collection efforts towards those fisheries where additional information can provide more nuanced understanding.

It is important to note that ERAs do not evaluate the magnitude of effects of fishing activities or assess the status of a stock. Rather they provide insight into the likelihood that negative impacts may occur. The value of ERAs is the ability to make like comparisons of risk due to fishing activities for data poor and data rich species and habitats. They provide a basis for next steps, which might include more traditional scientific assessments, such as stock assessments.

Ecological Risk Assessment in the Context of Legislation, Policy, and Management

ERAs must be rooted in legal or policy goals that specify what is considered a "risk." This definition needs to be clearly articulated before an ERA is developed or applied to a particular management situation. The very notion of risk needs to be laid out such that it aligns with policy and management goals. In other words, high risk means strong likelihood of a goal *not being met* with respect to a particular fishery or ecosystem. By the same token, management goals and information needs must be clearly defined. Whether it is concern about the direct effects of fishing or indirect effects of climate

Legislation: *In some cases legislation has explicitly set up the framework for utilizing ERAs, in other cases existing legislation was interpreted to make use of the next generation of management tools.*

Policy: *With the concept of ERAs in mind, policy can be set to take action utilizing this tool.*

Regulation and Management: *With policy in place, managers can act and use the tools and its output to set priorities and management targets.*

change, the target of analysis and the risk factor should be identified and specified.

In most cases, ERAs are an initial step for prioritizing and identifying possible management interventions. By assessing the relative vulnerabilities (e.g., to different species, or from different gear types, or in different locations), they help prioritize which components of which fisheries are most vulnerable to the assessed stressor (e.g., fishing pressure, climate change, etc.). This prioritization can assist fisheries managers with identifying where to invest limited resources.

ERAs help provide a pathway for identifying next management steps in a scientifically defensible manner. A primary value of ERA comes from the framework's ability to place fisheries on a common, quantitative scale that allows comparisons and prioritization between different fisheries units. Managing marine resources requires managers to make tradeoffs, both between different stressors (e.g., fishing pressure, climate change, or impaired water quality) as well as between levels of risk that are acceptable. Within this context, ERAs can provide transparent and quantifiable means to compare some of these risks.

As noted, ERAs can be designed to assess single or multiple stressors such as fishing pressure, habitat degradation, water quality, climate change, and ocean acidification. With the proper policy and management framework in place to utilize results, managers and decision-makers can chose to implement multiple ERAs or a single ERA designed to assess multiple stressors. Additional information beyond risk of impacts due to fishing activity can help managers determine which actions may be the most impactful or mitigate the most risk. For example, a fishery determined to be at greater risk from habitat degradation than from fishing pressure could provide an opportunity to engage with other management entities also charged with maintaining ecosystems and better understand the impact of different management actions. At the present time, ERAs are not capable of incorporating risks that cascade through food webs, though this may become an option with future research.

ERA frameworks can, with varying levels of time and effort, help identify a range of risks to a fishery or ecosystem posed by a stressor. Policy structures must exist to incorporate the information they reveal in order to realize the full value of these tools. ERAs are not a cheaper replacement for stock assessments and other traditional management methodologies that can feed into the same management processes. They are a way of helping evaluate whether, and under what circumstances, those time intensive and often more costly fisheries tools are necessary to evaluate and manage risks to target populations. ERAs enable managers to carefully select the most efficient and effective management strategies for each fishery. For species determined to be at high risk of negative impacts due to fishing, the next step is often to conduct a traditional stock assessment, allowing fisheries managers to carefully calibrate regulations so as to avoid that possible fate. In cases deemed at low risk of negative impacts due to fishing, these more precise assessment and management tools may simply be an unnecessary use of resources.

Another benefit of implementing an ERA is the identification of risks that may require management action but that are not addressed under current policy with traditional tools focused solely on preventing negative outcomes from overfishing.

For instance, climate change impacts are not well understood from a fisheries perspective and are therefore not well incorporated into fisheries management. Climate change may have significant impacts on certain species, and identifying those vulnerable fisheries can alert fisheries managers to prepare to monitor and manage for these additional impacts.

Fundamental Lessons Learned from Applications of Ecological Risk Assessments

While ecological risk assessments are a relatively new development in fisheries management, over the past decade they have been deployed in numerous situations around the world. Ocean Science Trust's work drew from key case studies across the globe (see Box 1). In our workshop, we were able to delve into specific details of ERA implementation.

These examples demonstrate different models, ranging from a more general approach, utilizing only a few characteristic parameters, to more complex ones that attempt to incorporate the cumulative effects of multiple fishing strategies. They provide substantial intellectual resources to draw upon in the creation or adaptation of an ERA specific to the needs of California. One of the lessons learned through this project is that the mechanics of conducting actual risk assessments is the easy part of the effort. As discussed in more detail below, the harder part is creating and implementing an ERA development process that truly engages and gets buy-in from government and stakeholders at each step of ERA development. Previous efforts provide suggestions for creating an environment where the results of ERA can be accepted as a valuable component of fisheries management.

Although many different ERAs have been deployed, no off-the-shelf framework can be directly applied to address every ecological and policy need. Each fishery, ecosystem, management structure, and fishing community will have particular nuances that need to be considered from the early stages of scoping an ERA framework.

Two key lessons we heard in our interviews and workshop from those who have created or implemented ERAs were the need for clear upfront management goals and for well-considered processes for involving stakeholders. Workshop participants highlighted the importance of transparency throughout ERA scoping, creation, and implementation.

While acknowledging that this process can be time consuming, this up-front effort pays dividends in the form of buy-in from fishermen and other stakeholders in the outcomes and process.

Our workshop participants pointed out that they also realized additional benefits of external participation: these groups were a valuable source of data that

enhanced the rigor of the ERA results. Fishermen, scientists, and other stakeholders familiar with species and habitats of interest can provide key insight and information otherwise not accessible. The structured participation of stakeholder groups providing input into the model makes for a more informative product, and also one that aligns with the understanding of those who are most familiar with conditions on the water. The scoping of an ERA process should include identifying key participants who should be involved at each stage. An ERA process may need to include different participants: government entities (state, federal, and tribal), fishing communities, citizens with local or traditional ecological knowledge (LEK or TEK), scientists, and non-governmental organizations (NGOs) depending on the goals and information needed at each step.

We also heard the clear message that successful implementation of an ERA into management action is significantly enhanced with a priori setting of future management actions. This is also a time intensive, potentially controversial process, yet according to those who have implemented such frameworks, this advance work provides substantial benefits down the road. Stakeholders who have helped craft management options and scope the framework feel stronger ownership of the outputs that emerge from the ERA. Additionally, through the process of incorporating stakeholder input, creative management options may emerge that might not have been otherwise discovered or agreed upon outside of this process. A well-designed process for implementing an ERA framework provides a venue for a collaborative effort towards sustainable fisheries management.

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Considerations and Opportunities for Implementing an ERA Specific to California

Drawing on these lessons learned, we highlight some key considerations and opportunities for ecological risk assessments to inform California fisheries management. While this is not an exhaustive list of considerations, it is intended to help evaluate whether the time and circumstances are right for ERA application in the state.

These new tools must be employed while continuing to maintain the highest standards of scientific rigor and meeting the legislative mandates of the Marine Life Management Act (MLMA). Current legislative mandates and agency policy have been met using Fisheries Management Plans (FMPs) based on traditional stock assessments. The intensive time and resources required to complete and implement these plans means that it is not viable to complete an FMP for every fishery under state management. Emerging fisheries, in particular, are generally too data poor for an FMP, but the state still has a need to ensure that these stocks are not at risk from new fishing pressures. ERAs could serve as a mechanism to identify fisheries that are not at risk from these pressures and to document that they are meeting the legal mandates of the MLMA. In this way, ERAs may be a part of the answer to ensuring all state-managed species are meeting the requirements of the MLMA using more efficient and less costly methodologies.

Some of the potential uses of ERAs and their outcomes might require policy changes, yet ERAs could still offer substantial benefits to current management practices. For example, current FMPs must include an assessment of the ecosystem impacts of the fishery, which are notoriously hard to generate. Similarly, information about bycatch and impacts of a fishery on non-target species can be hard to ascertain. Both of these are areas where ERAs may provide useful information to demonstrate

Box 1. Application of Ecological Risk Assessment Frameworks

Below are a selection of ecological risk assessments applied around the globe. Without intending to create an exhaustive list, we have included these as examples that could serve as starting points for California based on their diversity and applicability to California's fisheries.

Ecological Risk Assessment for the Effects of Fishing (ERAEF)

ERAEF[1] is the seminal fisheries application of ERA. It is a precautionary, three tiered approach to assess risks due to the effects of fishing. It can be deployed to understand the potential for risks to any species (target, bycatch, threatened and endangered, etc.), habitat, or community due to fishing activities. One of the potential strengths of this tool is its ability to analyze multiple fisheries components alongside each other, identifying the features (e.g., gear types) that render stocks most vulnerable to overfishing. ERAEF can be an effective way for managers to prioritize fisheries and resources for varying levels of management action. Modified components of ERAEF have been applied to fisheries in the UK[3], as well as customized by NOAA to assess the vulnerability of U.S. fish stocks[4] with an emphasis on assessing data-poor stocks.

Ecological Risk Assessment Framework (ERAF)

This ERA[5] was developed to support Ecosystem-Based Management (EBM) efforts in Canada's North Coast Integrated Management Area, an area of high ecological, social and economic importance. This framework builds upon methodologies from existing ecological risk assessment frameworks and processes, including the Australian ERAEF. The result is creation of an ecological risk assessment framework (ERAF) more specifically tailored to the goals and purposes of EBM in the Pacific Region. The ERAF provides methods for calculating risk of harm to an ecosystem from both single and multiple stressors, and describes the steps necessary to provide transparent and defensible science-based advice on anthropogenic impacts for ecosystem-based management.

Risk-Based Framework for Assessing the Cumulative Impact of Multiple Fisheries

Productivity Susceptibility Analysis (PSA) was amended to incorporate multiple fisheries by proposing a new index for cumulative risk assessment: Aggregated Susceptibility[6] (AS) This extended PSA was applied to 81 species caught in 5 small-scale fisheries along the coast of Baja California, Mexico. This analysis provides the opportunity to assess cumulative impacts of multiple co-occurring fisheries identifies relative risk imposed by multiple fisheries, and provides a tool for a preliminary evaluation of the possible outcomes of management alternatives for the conservation of coastal marine ecosystems.

Comprehensive Assessment of Risk to Ecosystems (CARE) and CARE Lite

The CARE model (W. Battista and R. Fujita, in prep) has been developed primarily to address the needs of data poor fisheries in developing regions. CARE calculates risk from all threats facing a system, quantifies the interactions between threats, assesses the risk to the entire ecosystem with a comprehensive suite of attributes that characterize system productivity and functioning, and quantifies risk to the differential production of ecosystem services. CARE can be used to prioritize critical threats and greatest ecosystem services to allocate limited management resources. CARE relies largely on expert and local knowledge and requires minimal background research, but does require extensive time to complete. CARE Lite is streamlined version of the full CARE model which can be completed rapidly using only local knowledge.

Risk-Based Framework, Marine Stewardship Council (MSC)

The Risk Based Framework[7] (RBF) is a component of the MSC certification scheme that can be used where there is not enough data available about a fishery to follow the regular, data intensive standard assessment methodology. In the absence of sufficient quantitative data, MSC certifiers can use the structured RBF to assess the risk that a fishery is operating unsustainably with regard to target, bycatch and retained species, and habitats and ecosystems. The Framework is a direct adaptation of ERAEF. It is two tiered; ,a qualitative, stakeholder-driven process gathers expert opinion is gathered, followed, if necessary, by a semi-quantitative assessment based on the productivity of the species concerned and their susceptibility to fishing gear.

Fish Stock Climate Vulnerability Assessment, NOAA

NOAA Fisheries, in collaboration with the NOAA Office of Oceanic and Atmospheric Research, is finalizing a methodology (W. Morrison and M. Nelson, personal communication) to rapidly assess the vulnerability of U.S. marine stocks to climate change[2]. The methodology uses existing information on climate and ocean conditions, species distributions, and species life history characteristics. These data, combined with expert judgement are used to estimate the relative vulnerability of fish stocks to potential changes in climate. The results provide fishery managers with information on likely impacts, and mechanisms underpinning those impacts as well as management options available to mitigate those impacts.

that policy requirements are being met.

California has invested substantial resources in creating and monitoring a network of marine protected areas (MPAs). This MPA network has many goals, including helping decrease risks of overfishing. Despite this goal, fisheries managers are challenged to quantify any such reduction in risk. ERAs provide an excellent opportunity for California to incorporate MPAs directly into fisheries management. ERAs can explicitly utilize MPAs as a factor which diminishes risk due to fishing pressure; as such, they can provide justification for fisheries 'credit' for parts of species' ranges set aside in MPAs.

In addition to looking at risks from fishing, the ability of ERAs to consider risks due to environmental change provides California a powerful tool to ensure sustainable marine ecosystems. Existing ERAs, such as NOAAs Fish Stock Climate Vulnerability Assessment[2] can help managers understand where climate change impacts, including ocean acidification, may show up. Coupling these risk assessments with other tools such as Management Strategy Evaluation can help identify the conditions under which management actions can diminish risk. The NOAA climate vulnerability model is well developed and has been deployed in federal fisheries management. A federal and state partnership could greatly reduce the effort required to implement this assessment within the California Current ecosystem.

Roadmap for developing and applying ecological risk assessments in California

The previous sections have highlighted the potential utility of applying ERAs to California fisheries. The following roadmap is designed to lay out the mechanics of implementing such a framework were the state to decide this is a desirable addition to its fisheries management tool box. Should California decide to implement an ERA to advance fisheries management, it would not have to (and should not seek to) start from scratch. The wealth of ERAs in existence provides the basis to create a targeted ERA tool in a very effective and efficient manner. This roadmap highlights key steps towards scoping, developing, and implementing an ERA for California to help in this evaluation process (Figure 1).

Prior to Beginning an ERA Process

Any ERA should begin with the overt interest and thorough participation from state and tribal government partners including California Department of Fish and Wildlife, the Fish and Game Commission, the Ocean Protection Council, and tribal government representatives. This first step is critical because the scoping of the ERA is based, in large part, on expressed management priorities.

Once representatives have been identified, they need to engage in a discussion of the capacity of ERAs. This collective learning opportunity will help managers and decision makers to understand what an ERA is and what it can and cannot do in support of fisheries management. This knowledge will also enable government partners to begin to lay proper institutional foundations necessary to take up the results of an ERA.

Stakeholder engagement processes should also begin in advance of implementing an ERA. These should include identifying and engaging stakeholders such as commercial and recreational fishermen, NGOs, and communities with demonstrated interest. Again, this begins with an education step, communicating what an ERA is and what it does. It is helpful to clearly identify when and where in the process stakeholders will be asked to engage. Their participation throughout an ERA is critical to the success both in terms of buy-in of the results but also for the information they can provide into the ERA itself.

Given that stakeholder engagement, especially from fishermen is key to the success of an ERA, a well-thought out plan and process for thoroughly engaging this community must be developed in advance. This process should be developed with sensitivity to the organizational structures that exist within the fishing communities.

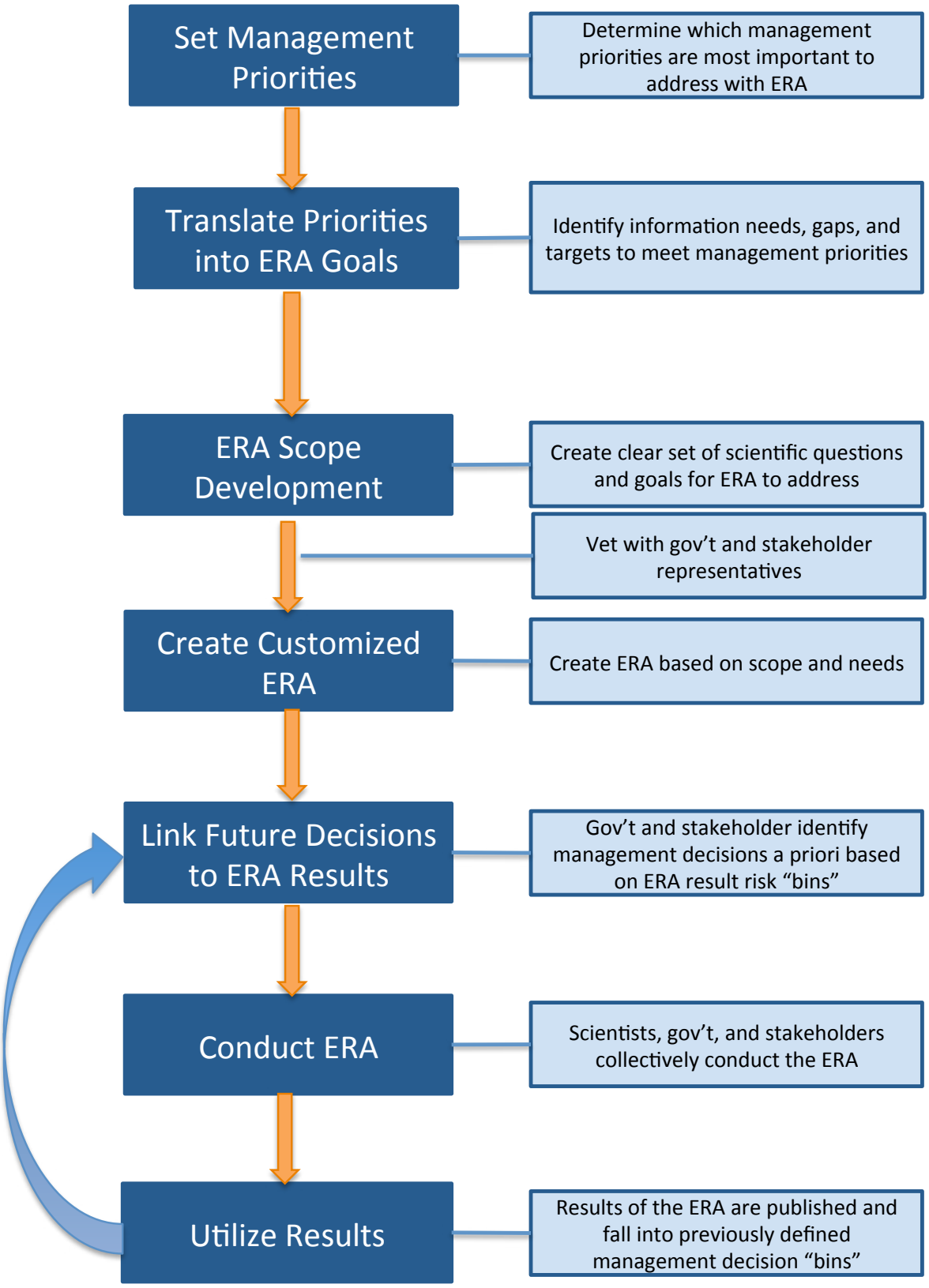

Figure 1. This roadmap highlights key steps towards scoping, developing, and implementing an ERA for California to help in this evaluation process. Should California decide to implement an ERA to advance fisheries management, it would not have to start from scratch.

A scientific advisory committee (SAC) should be set up to help guide the development of the ERA. Other scientific experts may be asked to participate in the ERA itself, but the SAC will be the lead body guiding the interpretation of management goals into ERA scientific terms, reviewing the ERA once complete, and helping participants interpret the results. The SAC engagement is useful throughout the process including identifying follow up tools and analyses that will be necessary to implement effective management action.

Developing and implementing an ERA requires an array of skills, including navigating management structures, scientific knowledge, and stakeholder engagement. It is useful to identify various actors, such as boundary organizations, consulting firms, and NGOs with specialized expertise to help state and tribal managers effectively engage these diverse needs.

Implementing an ERA

Set Management Priorities

Government bodies must determine which management priorities they wish to address using ERAs. Each agency has many mandates and priorities and they must decide which one or ones are most critical and appropriate to address using ERA. For example is it ecosystem based management, climate change, or impacts to threatened and endangered species for which you wish to apply an ERA?

Translate Priorities into ERA Goals

Once governing bodies have internally decided upon priorities, a key step is to translate these into scientific questions and information needs that an ERA can be designed to answer. Clearly defined questions and goals are keys to success for ERAs, just like any other scientific model. Failure to be clear at this step may result in an ERA which assesses risks that are not aligned with management priorities.

One effective technique to aid this translation process is a Science Needs Assessment (SNA), a series of structured interviews with key government actors. This can elucidate key information needs and gaps as well as fisheries and fishery components that are most important for an ERA to address. More importantly, a SNA can identify the framing of those needs, linkages between various management entities, and the opportunities for management processes to address them in the future. This analysis should be presented to and vetted with both government and stakeholder groups for feedback as well as to build a shared understanding of what an ERA seeks to address for California.

ERA Scope Development

Once the goals of the ERA are clearly articulated, the specific implementation process can be developed to address them. As noted, a SAC has a role to play steering the development process. The SAC will work with the vetted list of key goals and information needs and translate them into key scientific questions and goals for the development of the ERA tool itself. The SAC will make critical decisions about the feasibility of ERA addressing all of the management goals.

Create Customized ERA and Process

The process by which the ERA will be implemented needs to be articulated to all parties in advance to enhance transparency. Done well, engagement and clear avenues of communication between parties sets the ERA up for success later on. A boundary organization may be an important partner, steering the coordination between government representatives, stakeholder groups, and the SAC. These groups need trust and a collaborative relationship since each brings a needed perspective and role for successful ERA implementation.

Link Future Decisions to ERA Results

Once the ERA is developed, there will be distinct types of results or scores identified. The SAC should help government and stakeholder group to understand what these different result “bins” (e.g., high vs low risk) mean. Mangers and stakeholders should work together to identify agreed upon managed actions

for each result bin. For example, species with the lowest scores may be determined to meet the requirements of the MLMA under current strategies and may not need further management action other than ongoing monitoring of risk factors. At the other end, species determined to be at high risk may either undergo more thorough assessments such as traditional stock assessment or MSE's.

Essentially, all participants are asked to identify and agree upon management actions before they know which fisheries fall into a particular category. This a priori decision tree is important to ensure that the ERA is not only linked with management actions, but that managers have the buy-in and policy in place to enable them to act upon ERA results.

Develop and Conduct ERA

With an implementation process in place, scientists, government, and stakeholder representatives work alongside each other to create the actual framework appropriate to the situation. Through workshops, participants draw from previous framework examples to scope the input parameters for the model. In further workshops, participants apply data from a range of sources to actually assess risk of target species. Once this is completed, the results are analyzed and interpreted for report out, first to the SAC for review, then to the government and stakeholder participants and other interested representatives.

Utilize Results

The fisheries and fisheries components analyzed as part of the ERA have been placed into different risk bins as a result of the ERA scores. These various risk bins have also had management actions assigned a priori. The SAC can work with managers and stakeholders to help them understand why a particular species or habitat had a particular score (e.g., was it because of a susceptibility to a particular gear, life history bottlenecks, or a lack of data). This interpretation will help in the decision of picking which previously agreed upon management action is best suited for a particular species or fishery (e.g., a low risk bin may have options identified such as gather more information or manage with landings data using current management methodologies). With this information in hand, managers can quickly and confidently take action based on ERA results.

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