SCIENCE ADVICE FOR MANAGING RISK AND UNCERTAINTY IN OPERATIONAL DECISIONS OF THE FISHERIES PROTECTION PROGRAM

Figure 1: Department of Fisheries and Oceans' (DFO) six administrative regions.

Context:

Canada's revised Fisheries Act (amended via Bill C-38, June 29, 2012) amends the fishery protection provisions to place emphasis on the "ongoing productivity of commercial, recreational and Aboriginal fisheries", the "fish that support such a fishery", and "the contribution of the relevant fish to the ongoing productivity of commercial, recreational or Aboriginal fisheries". With works, undertakings or activities in and around waters bearing commercial, recreational or Aboriginal fish, there will be some degree of uncertainty in the effects of these activities (potentially both negative and positive), and the risks that these effects may pose to these fisheries.

Departmental implementation under the revised Act emphasizes self-assessment of proposed developments by stakeholders to determine if proposed developments require DFO review. In instances where a self-assessment cannot be completed by the proponent, DFO or external experts can provide proponents with expert guidance via an assisted assessment. Finally, for projects requiring regulatory authorization under the Act, a more comprehensive assessment of effects on fisheries productivity will support decisions made by the Department.

DFO Policy Sector requested scientific advice regarding the assessment and management of risk and uncertainty with Fisheries Protection Program decisions. The assembled experts discussed biological and ecological components of risk, and provided guidance for operational practices and decision making. In addition, some important next steps were identified to address information gaps and provide tools to assist decision making.

This Science Advisory Report is from the National Peer Review meeting of September 30 to October 3, 2013 on Operational Advice for Fisheries Protection Program. Additional publications from this process will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- For most projects reviewed by the Fisheries Protection Program, the uncertainty largely lies in the nature and magnitude of the impacts of the project on fish and fish habitat (and fisheries productivity), and “risk” will refer to uncertainties about future events, not about whether or not a project will occur. Key sources of uncertainty in implementing the Fishery Protection Policies include:
    - Uncertainty about impact prediction
    - Uncertainty about the effectiveness of activities intended to mitigate or offset any negative project impacts
    - Uncertainty about future states of nature
- For self-assessment or assisted assessment a project can proceed only if there is a low likelihood and low uncertainty regarding both the death of fish and a net negative residual impact on habitat, prior to considerations of any offsetting activities. For proponent self-assessment to have such low uncertainty, the project will typically comprise routine activities with standard guidance on the best practices for performance of these activities.
- For assisted assessment, standardized guidance on routine operational practices for conduct of the project has not been provided, or the proponent cannot apply available guidance to the project. However, with expert assistance, project-specific approaches can be identified or developed that avoid or adequately mitigate death of fish and residual impacts on habitat, again, prior to consideration of any offsetting activities.
- Projects that are large, complex, or otherwise likely to potentially cause changes to fish habitat or death of fish that cannot be avoided or adequately mitigated with appropriate project design require substantial expert planning to identify appropriate measures for better avoidance, mitigation and offsetting of death of fish or residual harm to habitat, and to ensure the overall intent of the Fishery Protection Provisions is met.
- For self-assessment or assisted assessment, risk of failing to achieve the intent of the Fishery Protection Provisions would only be managed effectively if the same common, high standard of protection to fisheries productivity was met. The necessary low level of risk can only be achieved under two conditions:
    - The project had no residual effects on habitat nor death or fish
    - The project was designed so the combination of expected beneficial and detrimental effects resulted in no loss of local productivity, without any offsetting.
- A single project that presents a risk of a non-zero net loss of local productivity of a relevant fish population might not, by itself, directly cause a loss of productivity of a commercial, recreational or Aboriginal (CRA) fishery. However, a decision rule consistently allowing such projects to proceed would, over time, have high likelihood of resulting in such loss at the scale of CRA fisheries, and fail to provide for sustainability and ongoing productivity of fisheries.
- There are a number of methods that can be used to analyze equivalency, ranging from service-to-service methods to completely economic assessments, and properties of each method are considered. The calculation of equivalence within an offsetting program should acknowledge, assess, and as fully as possible manage all the sources of uncertainty: uncertainty about impact prediction, effectiveness of mitigation/offsetting, and future states of nature.

- Discounting is generally used when conducting analyses for offsetting to equate productivity losses resultant from residual effects of a project to potential gains expected from an offsetting program. Discounting is unlikely to be a consideration in self-assessment or assisted assessments, but needs to be considered in all projects requiring offsetting.
- Productivity may be measured in many ways and for the Fishery Protection Policies and Provisions should be done at appropriate geographic scales. When productivity is assessed, a suite of productivity indicators is usually more robust than a single indicator. Guidance is provided on considerations in choosing appropriate suites of criteria. Under the Fishery Protection Program, projects with small impacts are not generally expected to require project-specific indicators. However, indicators can be useful on a regional scale to ensure that the goals of the Fishery Protection Program are being met.
- The complexity of the tools and information, and involvement of DFO staff are expected to increase at each level of assessment. The possible tools for *self-assessment* will generally be designed for activities that are proposed frequently and for which there is extensive experience with both likely impacts and effective avoidance and mitigation actions for any impacts. *Assisted assessments* will require more case-specific support for a project to have a sufficiently low level of risk. Projects requiring *full* or *comprehensive assessments* will require more involved and sophisticated tools to determine if death of fish or residual impacts on habitats can be avoided, or if authorization should proceed and for developing offset programs. Useful tools for each type of assessment are tabulated.
- Cumulative effects need to be taken into account in Fishery Protection Program assessments. If the Fishery Protection Policy implementation framework increases the likelihood that a project will on average yield net benefits (and so outweigh potential negative outcomes) then there would be a great reduction in the risk that the intent of the Fishery Protection Provisions will not be achieved due to cumulative effects.

BACKGROUND

1.0 Assessment of Risk and Uncertainty for Decision-making under the FPP[1]

1.1 What is meant by “risk” in this framework

There are a variety of definitions of risk. This variety can lead to confusion regarding the selection of risk assessment approaches and the subsequent operational management of risk. The concept of decision-making in the face of future uncertainty is common to all these definitions. However, the definitions of risk often focus on different aspects, largely due to discipline-specific differences in nature of the risks.

Most definitions of risk fall into two general categories:

1. Definitions that involve probabilities and severity of consequences
2. Definitions based on uncertainties about future events.

[1] The abbreviation FPP could be interpreted as meaning any of three different things: the Fisheries Protection **Provisions** that appear in the amended *Fisheries Act*, the Fisheries Protection **Program** of DFO, which is accountable for the policies to implement the Fisheries Protection Provisions of the Act, and the Fisheries Protection **Policies** developed and adopted by the Program. Past SARs have used FPP to refer the **first** entity (the Provisions themselves) and to avoid contractions across SARs that practice will be maintained here. When either the DFO program or their Policies are intended, the second “P” will be written out as appropriate noun.

The first category of risk is commonly applied to stochastic events outside of management control that can have negative consequences, where the threat is a combination of the probability or likelihood of the event, and the nature and magnitude of the consequences of that event when it occurs. The category 2 risk definition is usually applied to the uncertainty of an outcome, for an event that could be a threat to something of value. This second type of definition is appropriate for events or actions that are likely to occur, or under strong management control, but for which the nature and magnitude of the consequence or impact are uncertain. Uncertainty in this case is not due to whether or not the event will occur but due to variation in the form and magnitude of the consequences plus the uncertainty in our ability to estimate the magnitude of the consequences. The category 2 definition of risk is the more appropriate for most projects being reviewed by the Fisheries Protection Program, as the uncertainty largely lies in the nature and magnitude of the impacts of the project on fish and fish habitat (and fisheries productivity).

Unless explicitly stated otherwise, throughout this Science Advisory Report (SAR) the risk to be managed is the risk of failing to achieve the overall intent of the FPP, "to provide for the sustainability and ongoing productivity of commercial, recreation or Aboriginal (CRA) fisheries. The Department will manage the risk through implementation of the policies of the FP Program".

1.2 The sources of risk and uncertainty related to the FPP and its implementation

The risks posed by any development project stem from the uncertainties associated with conducting the activity itself, and uncertainties in the effectiveness of any mitigation or offsetting measures. These uncertainties can be considered in the context of the comprehensive proposed project (i.e. assessing both potential residual impacts and associated measures to mitigate and provide benefits). The meeting identified several general sources of uncertainties:

a) Uncertainty about impact prediction: how well does a proponent understand the nature and magnitude of all the ways the project might kill fish or result in permanent alterations or destruction of habitat?

For projects requiring mitigation or offsetting, and where any expected benefits will accrue over time:

b) Uncertainty about the effectiveness of activities intended to mitigate or offset any negative project impacts (see (a)). These uncertainties can be further separated into two sources:
    i) uncertainty about project design – the mitigation or offsetting measures might not be designed in ways that can provide enough benefits to mitigate or offset the full level of death of fish or impacts on habitat expected for the project;
    ii) uncertainty about project implementation – the mitigation or offsetting measures may have been appropriately designed to compensate for the expected death of fish or impacts on habitat, but their actual construction and operation is less effective than expected.

c) Uncertainty about future states of nature: The mitigation and offsetting components of a project may have been designed (b-i) and constructed and operated (b-ii) to adequately account for the expected death of fish or negative impacts on habitat (a). However, the net result is that the anticipated benefits of the activities do not occur due to environmental conditions which are different than expected when the design and construction parameters were set.

The uncertainties in (a) are related to how large the negative impacts of a project might actually be, whereas the uncertainties in (b) and (c) are related to how large the positive effects of the mitigation and offsetting measures actually might actually be. Generally, uncertainties in (a) will be smaller than uncertainties in (b) and (c). It is expected that a proponent should know a great deal about how the project might potentially directly affect existing habitat or kill fish. However, uncertainties about the consequences on fisheries productivity could vary, depending on the scale and nature of the project and the experience of the proponent. In contrast, the risk projections in (b) and (c) consider the consequences of development activities which may accrue benefit to fish survival or other components of productivity. The effectiveness of some types of mitigation or offsetting measures for some species and watersheds may be fairly well known, but that does not ensure they will be implemented effectively. Moreover, as scale and complexity of the mitigation, offsetting and other measures intended to benefit fisheries productivity increase, the uncertainty about the benefits that will be realized often increases rapidly. The potentially greater uncertainty in (b) and (c) has important implications for managing risks associated with any project. These implications are addressed Section 4.0.

One of the reasons to consider these sources of uncertainty separately in project design, evaluation and management is that each source of uncertainty can be managed independently, although often a particular activity may reduce uncertainty about more than one risk factor at the same time.

Finally, it is recognized that the management framework and decision-making process may also contribute uncertainty in several possible ways, including:

- lack of clear project / fisheries management objectives, or presence of multiple incompatible objectives,
- communication error (where it may be communication among any combinations of science-management-proponent-public),
- lack of coordination between management jurisdictions / authorities,
- enforceability, and;
- lack of monitoring and adaptive management (to reduce future uncertainty).

ASSESSMENT

2.0 The Operational Decision Process for Implementing the FP Program and its associated policies

The general process for determining whether a project requires an authorization starts with a proponent assessment of whether their project is likely to kill fish or permanently alter, or destroy, fish habitat. Several factors should be considered, including what constitutes “serious harm to fish” under relevant FP Policies, how the project might affect fish and fish habitat, what avoidance and mitigation measures are available to deal with any potential effects, and how to implement those measures. Many proponents, particularly for smaller projects, will not have the technical knowledge to actually assess all these factors. However, tools have, and continue to be, developed by the FP Program which will allow proponents to self-assess their projects and determine whether an authorization may be required. For projects not matching those covered by the self-assessment tools, assessments can be guided by an expert (third party consultant or possibly DFO staff), referred to subsequently in this advice as an “assisted assessment”.

At present, self-assessment tools include a list of generic best practices for avoiding harm, and types (and scales) of projects that, when following best practices, are unlikely to require authorization. Projects that have residual impacts that may result in death of fish or permanent alteration to, or destruction of, fish habitat may require case-specific review before a decision can be made about whether authorization is required. In such cases, the proponent would submit a project for review to DFO. For projects where death of fish or residual impacts on fish habitat are likely, the “self-assessment” may in practice be a simply decision by the proponent to approach DFO to commence the process for full project assessment.

2.1 Science Advice needed to inform the decision process

Given the interpretation of risk and sources of uncertainty described above, a decision framework related to the need for authorization can provide guidance for the management of the risks (see Figure 2). Science advice can inform each these decision points, taking into account the nature and magnitude of uncertainties for each decision. For successful implementation of the FPP, tools[2] to evaluate and inform operational management (See Section 7.0) in the context of risk assessment (see Section 1.0), should be widely available. The flow chart of steps and alternatives for decision-making within the FP Program is still evolving, but all recent variants of it contain several decision points where risk and risk tools may be relevant and beneficial to decision makers (Figure 2).

For the first two decision points, a project can proceed only if there is a low likelihood and low uncertainty regarding both the death of fish and a net negative residual impact on habitat harm. For the first decision (e.g. proponent self-assessment) to have such low uncertainty, the project will typically comprise routine activities covered by tools providing standard guidance on the best practices for performance of these activities. If the self-assessment tools are based on sound scientific information and consistent with the advice in this and the other SARs on the FPP, and if the proponent executes the project following this guidance, then a self-assessment is likely sufficient to manage the risk of failing to achieve the intent of the FPP.

For the second decision point, standardized guidance on operational practices for conduct of the project has not been provided or the proponent cannot apply available guidance to the project. Such projects have a higher initial level of uncertainty to the proponent and expert assistance can be employed. If, with expert assistant project-specific approaches can be identified that avoid or adequately mitigate death of fish and residual impacts on habitat then the assisted assessment is likely sufficient to manage the risk of failing to achieve the intent of the FPP.

If either the self-assessment or assisted assessment steps achieve low uncertainty that the standards described in Section 3.0 will be met, then risk can be managed without authorization, provided that it complies with the guidance provided. Failing to achieve low uncertainty about death of fish or residual impacts through self- or assisted assessment will likely require a full or more comprehensive assessment taking into account the considerations in the several past SARs on FPP implementation (DFO 2013;2014 a, b, c).

[2] References to “tools” throughout this SAR are to the types of tools envisioned as feasible and useful for implementation of the FPP. Development and testing of tools is an ongoing process and tools may be described that have not yet been developed. When a specific tool, existing or proposed, is intended, the reference will be specific and restrictive.

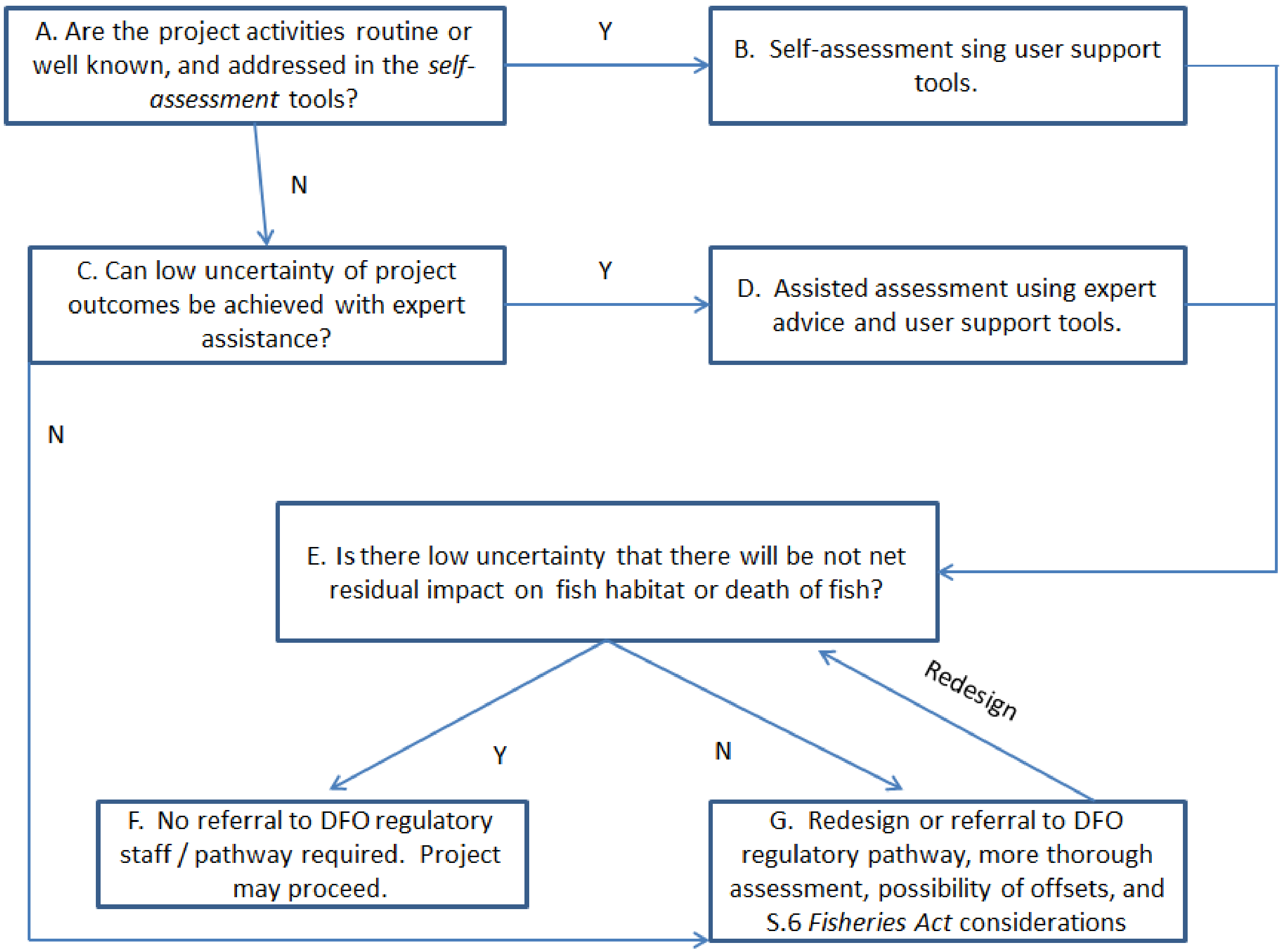

Figure 2: Schematic representing the points at which science advice can inform the risk-management decision making process. For further details, refer to Section 2.0 of this document.

The “assessment” is an evaluation of the potential effects of a proposed project on fish and fish habitat. This assessment may be undertaken via three potential means:

a) “Self-assessment”: refers to an assessment by a proponent of its potential effects, the effectiveness of any mitigation measures taken (if applicable).

b) “Assisted assessment”: as conducted by a qualified environmental professional experienced with such technical assessments, either working for the proponent or the government.

c) A “full” or “comprehensive” assessment conducted by the proponent or a contractor of the proponent and reviewed by DFO operational staff charged with such regulatory review. Part of the “full” assessment process may be suggestions for redesign of parts of the project that may avoid or fully mitigate death of fish and residual harm to habitat. Hence Figure 2 has an arrow back from Box G (referral to DFO) to the third decision-point (Box E).

3.0 Tools and Standards in the Operational Decision Process

The projects within the scope of Box C and subsequent boxes of Figure 2 are those that are large, complex, or otherwise likely to potentially cause changes to fish habitat or death of fish that cannot be avoided or adequately mitigated with appropriate project design. To ensure the overall intent of the FPP is met in those cases, substantial expert planning will be needed to identify appropriate measures for better avoidance and mitigation (of death of fish or residual harm to habitat), and for offsetting of any resultant serious harm that cannot be avoided or mitigated. Much of the previous DFO science advice on FPP implementation, including that related to productivity assessments, productivity-state (P-S) curves, and offsetting, is primarily intended for use in these cases. As Figure 3 (below) illustrates, the flow of activities available to apply the past advice in supporting planning and decision-making for such projects is actually a complex web of possible pathways. Both ecological and risk management factors (the top row of boxes) are a consideration in all decisions, even for small projects (Pathway a). As projects become more complex (Pathways b and c) details of each project will usually be case-specific and planning will usually have expert engagement (e.g. members of the proponent’s team, independent contractors and consultants, and/or DFO staff). The multiple potential pathways in Figure 3 make it inappropriate to recommend a single best way to include these tools in specific evaluations of projects in the lower boxes of Figure 2. However, any case-specific pathway is likely to require assessments using combinations of the various risk evaluation and management tools, and scientific advice in in this and the previous SARs and will depend on the nature and magnitude of the uncertainties described in Section 1.0 (vis-à-vis the potential death of fish and residual impacts of a project on fish habitat, the expected effectiveness of mitigation and offsetting options, and the quantity and quality of information available to reduce those uncertainties).

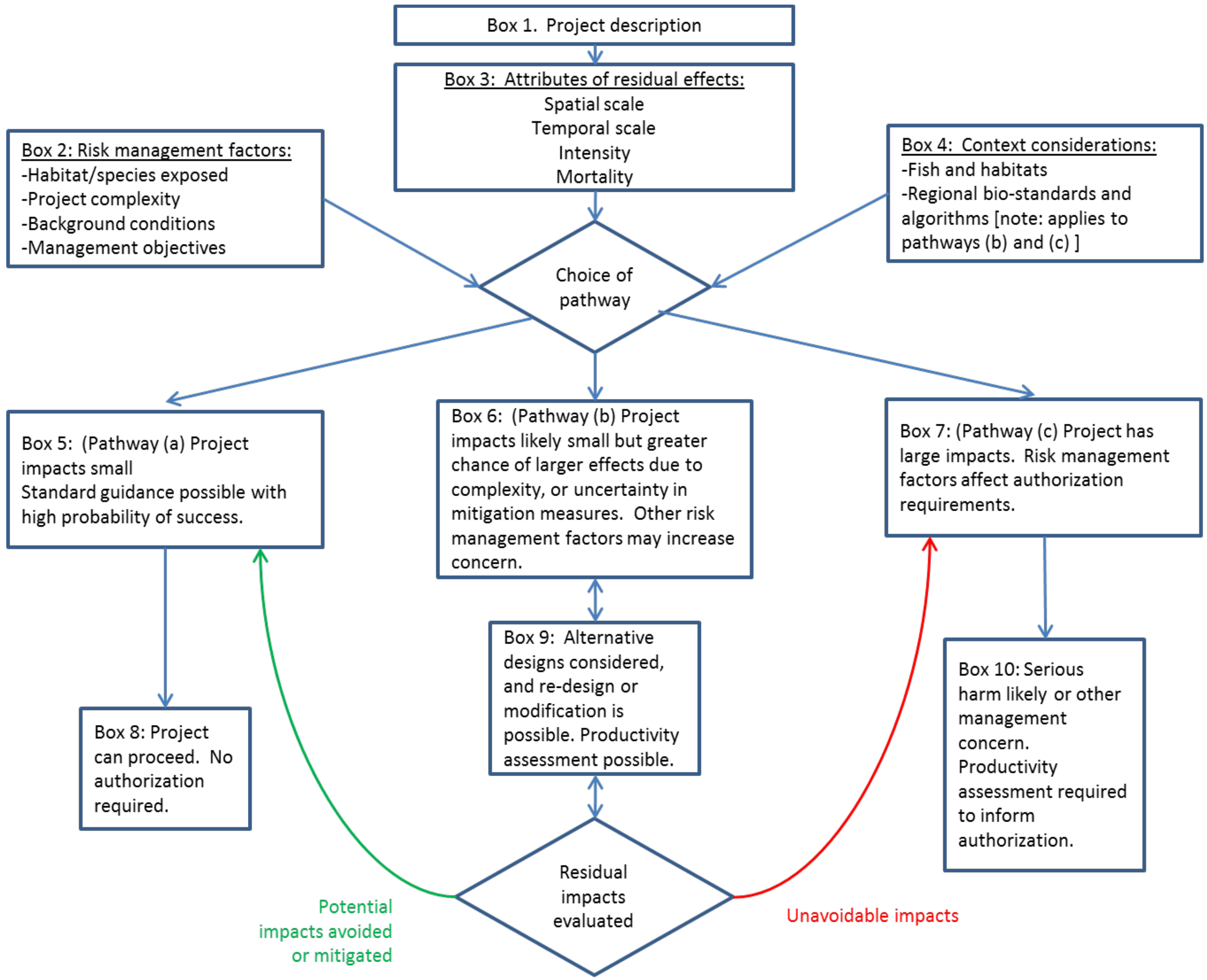

Figure 3: Schematic illustrating the factors and bio-physical considerations in decision making with implementing the FPP.

For some projects that have potential to cause death of fish or permanent alteration to, or destruction of, the habitat of fish that are part of CRA fisheries, or fish that support such fisheries, ways may be found to undertake the projects that either avoid or mitigate such impact. These cases are represented by the first two boxes in Figure 2, and Pathway (a) and the green arrow of Figure 3. For such cases the risk that the intent of the FPP will not be met can be managed effectively and the project can proceed without authorization, and without the more thorough review represented by the red arrow of Figure 3. However, all such cases require a decision that a project does indeed pose a sufficiently low risk to the intent of the FPP that it can proceed without the subsequent review steps and authorization.

The meeting considered in detail the way(s) that such decisions could be made systematically, applying a high and uniform standard of protection to fisheries productivity, without requiring significant engagement of experts or case-specific data. When a decision to proceed without contacting DFO is made by the proponent with or without expert assistance, risk of failing to achieve the intent of the FPP would only be managed effectively if a common, high standard of protection to fisheries productivity was met. After consideration of many possible approaches and standards, it was concluded that the necessary low level of risk can only be achieved under two conditions:

1. the project had no residual effects on habitat nor death or fish;
2. any effects of the project are not expected to extend beyond the vicinity of the activities, and the project was designed so the combination of expected beneficial and detrimental effects resulted in no loss of local productivity of fish that are part of a CRA fishery (or fish that support such fish).

A single project that presents a risk of a non-zero net loss of local productivity of a relevant fish population might not, by itself, directly cause a loss of productivity of a CRA fishery. However, a decision rule consistently allowing such projects to proceed would, over time, have high likelihood of resulting in such loss at the scale of CRA fisheries, and fail to provide for sustainability and ongoing productivity of fisheries. Thus, under current policies, such a decision rule would fail to manage the risk of not achieving the intent of the FPP (See discussion of Cumulative effects in Sources of Uncertainty);

There has been longstanding policy guidance that the preferred option is for a project to be conducted in ways and places that avoid all death of fish and residual impacts on fish habitat. Where this can be achieved, there is high likelihood that the necessary standard would be met. Several of the types of tools that may contribute to informing proponents how projects can be conducted in those ways and places are described in Section 7.0 of this SAR.

Many projects might include aspects that cannot be conducted with total avoidance of death of fish or residual impact on habitat, but the project design could also include other design components that would be likely to enhance survivorship or productivity of the same species[3]. Within the proposed evaluation framework, components of the project with both negative and positive effects on fisheries productivity would be considered as a package. For the risk of failing to achieve the intent of FPP to be managed effectively, such projects could proceed without further review, only if there was low uncertainty that the net effect of this combined package of activities on populations at the local scale would be zero or positive. However, the potential positive and negative aspects of the package would have to be activities inherent to the project itself, and not a project with clear net negative impacts that has some additional positive activities not necessary for the project itself. Those would be cases of potential

[3] For example, a footing for a dock might unavoidably cover a small amount of lake- or river- bottom, but could be designed so the footing and supports provided at least as much habitat for fish as was covered. Such designs might be part of the expert guidance provided to proponents.

offsetting and would not be appropriate for approval through self-assessment or assisted assessment.

For project designs that inherently have both potential positive and negative features, notwithstanding any incremental activities planned to mitigate or offset impacts of the project itself, the considerations in Section 1.0 apply. Uncertainty about the potential negative consequences of death of fish or residual impacts on habitat will often be less than uncertainty about potential future positive consequences of activities intended to improve productivity. Therefore, to have high confidence that the components expected to have positive consequences on productivity will meet or exceed the consequences of the expected death of fish or residual impacts on habitat, such projects will almost always be of small scale and the parts of the project intended to provide positive consequences must be well tested and easy to implement. As projects increase in scale, uncertainties increase rapidly. As specific mitigation or offsetting components become considered appropriate, case-specific analyses quickly become necessary to ensure the risk of losing productivity of fisheries is managed effectively. Similarly, if the project components intended to provide benefits to productivity are not well known and tested, uncertainties about their effectiveness will always be so high that it will not be possible to be confident the positive consequences of the project will meet or exceed the negative consequences, and a positive outcome of a self-assessment would be unlikely.

As with the preferred option of avoidance of negative effects, past experience with habitat protection should make it possible to develop user-support tools which provide the necessary standards for mitigation of impacts from certain types of projects in specific areas. Risk can be managed without requiring that parts of the project with positive effects need to be exact mirror images of the specific potential impacts of the activities with potential negative consequences; for example residual impacts on habitat would not have to be paired with incremental improvements to identical habitat features. From the perspective of managing risk to fisheries productivity, what matters is that the project is designed and conducted so the negative and positive effects of the project accrue together, both are inherent design features necessary to achieve the proponent’s goals of the project, and there is high confidence the positive effects meet or exceed the negative ones.

The above arguments provide the rationale that if the self-assessment or assisted assessment approaches are to offer sufficient protection to fisheries productivity without extensive case-specific analysis of potential death of fish or impacts on habitat, the positive effects of a project on fisheries productivity must meet or exceed the negative effects. This can only be achieved if the user-support tools are themselves strongly rooted in sound science, taking the uncertainties about negative and positive effects of various aspects of various types of projects into account. In developing the user tools and guidance for such projects the concept of *equivalency* (Section 4.0) may be helpful in establishing that the scale of assessment, particularly if the net effect on fisheries productivity is expressed at different stages of a species’ life history (see DFO 2014b). Users of the decision-support tools would not be expected to conduct such computations on a project-by-project basis; but to use the more generic guidance that has been based on such computations conducted by experts.

The guidance in the user-support tools needs to be founded on scientific evaluations of potential impacts of various types of activities, including potential mitigation measures, on fish and fish habitats. The evaluations need to be based on applying consistent standards of risk management across species, habitats and regions of Canada. These evaluations should take into account regional ecological variation; as the same degree of perturbation of a specific habitat feature might have different ecological consequences in different parts of Canada. Where different jurisdictions have adopted different explicit fisheries management objectives, recovery objectives for species at risk, and other objectives relative to aquatic habitats and communities, it is a policy decision what status these objectives have in FPP implementation.

However, if they have status, then the biological aspects of these objectives may be relevant considerations in the evaluations. Where the user support tools include guidance on acceptable spatial or temporal scales of activities, those scales may differ regionally and across different habitat types within regions (see DFO 2013 for further discussion of these stratification issues). Nevertheless, the support tools should be designed to maintain a consistent standard of risk management nationally. DFO has significant experience in incorporating ecological and regional policy differences in developing nationally consistent programs, and that experience needs to be applied in developing the user-support tools.

Operational decisions should make use of the tools described in Section 7.0, as well as the more intensive case-specific analyses described in the opening of this section. All operational decisions should take into account, as needed, considerations like adult equivalence, uncertainties, and areas of special ecological or policy significance. In some cases these risk considerations are expected to operate similarly in the support tools for self-assessment or assisted-assessment projects and in the projects undergoing full case-specific evaluation. However, the potential impacts of projects appropriate for self-assessment or assisted-assessment will be local enough in space and time that there is no ecological justification for applying discounting considerations. Nevertheless, such risk considerations should be taken into account in the design of the tools themselves, and thus not have to necessarily be quantified in each application of the tools. These issues are explored further in the sections below.

4.0 Equivalency and Discounting

Equivalency is the term commonly used in the offsetting literature when using a common metric, where impacts of a project are compared to the benefits of an offsetting activity. There are a number of methods that can be used to analyze equivalency, ranging from service-to-service methods to completely economic assessments. The term service refers to ecosystem services that natural resources provide to humans. In the case of the FPP and its policies, “services” mainly refers to the functions that habitat plays in fisheries productivity.

‘Service-to-service’ equivalency is developed on the basis of replacing damaged ecosystem or habitat function(s) with an amount of new or altered fish habitat that can deliver the lost functions (e. g. spawning, nursery, habitat area etc.) at a rate that means there is no loss of services enjoyed by humans.

Resource-to-resource analysis uses metrics such as fish numbers, biomass or productivity to define equivalency rather than the ecosystem services provided by habitats. Offsets attempt to replace the loss in abundance or productivity, and can use a suite of techniques that could focus on fish habitats or life stages other than the ones assessed as damaged or lost assessment.

Economic techniques are used to scale damages and their offsets using an economic analysis of their value in trade or cost of replacement. This method is not commonly used because of the complexities of valuation of ecosystem services, but may be necessary when the offsets involve species or ecosystems other than those being damaged, or if the offsets are non-ecological in form, such as economic, educational or social instruments.

The calculation of equivalence within an offsetting program should acknowledge, assess, and as fully as possible manage all the sources of uncertainty summarized in Section 1.0 – uncertainty about impact prediction, effectiveness of mitigation/offsetting, and future states of nature.

The most common way of incorporating uncertainty into the equivalency analysis is through the use of multipliers or offset ratios. The differing offset methods themselves will have differing levels of uncertainty with respect to efficacy, and previous advice has been provided on this aspect (see DFO 2014b - Offsetting). Evidence from technical literature suggests that the general uncertainty associated with working in natural environments is addressed by using an offset ratio of 2:1. The uncertainty associated with project failure has been estimated to require offset ratios ranging from 4:1 to 8:1, with this ratio generally considered to take “general uncertainty” into account as well. There are a number of project-specific attributes that will modify the required ratios to achieve equivalency. In general larger offset projects tend to be more uncertain in their outcome. When habitat creation/restoration is used as the offset, projects that can build in protection of the offset habitat from environmental variability (i.e. wave action, hydrologic events etc.) tend to require lower offset ratios. There are also management options that can be used to reduce some uncertainties related to risk of project failure (e.g. bonds, fines, audits, etc.). These considerations should be taken into account when determining an offset ratio.

Discounting is a process used in equivalency analysis to help account for time lags associated with the fact that impacts from residual project effects and offsets often occur on differing time scales. The discount rate standardizes the unit of measurement through time as equivalency analyses require a common metric. Whenever time lags in receiving benefits from offsetting are expected, more total units of offsets whose benefits accrue in the future would be needed to meet an offset requirement of a given amount than if offsetting is conducted such that benefits begin to be realized at the time of impact.

Discounting is generally used when conducting analyses for offsetting to equate productivity losses resultant from residual effects of a project to potential gains expected from an offsetting program. When standard or prescribed mitigation measures are expected to balance any potential residual effects in smaller scale projects (i.e., self-assessment or assisted assessment), discounting is not necessary. In these situations, the beneficial components of the project are inherent in the project’s construction, so that temporal differences between any residual effects and the benefits of the mitigation are expected to be very small.

The discount rate is derived from economic theory, where it is viewed as reflecting societal values for a desired rate of productivity return over a given period. A review of the scientific literature and guidance from countries in North America and Europe indicates the use of discount rates for habitat compensation ranging from 2-4%. The most commonly used rate in the literature is 3%. Discounting can be viewed as a simplification of the long-term value of habitat or fish as it does not explicitly address population dynamic aspects of habitat loss or fish mortality. Using population models or analysis would provide more biologically correct estimates of the short- and long-term implications of the effects of project impacts, but further investigation is needed to determine whether a fuller analysis will result in significant differences in the overall comparisons of impacts of differing durations for the decision framework being developed.

5.0 Regional Productivity

To be applied consistently in all areas across Canada, a risk management decision framework for the FP Program must account for differences in regional productivity for all parts the framework (self-assessment, assisted assessment, and particularly the authorization process that may involve offsetting). In this context, a ‘region’ is defined broadly as a geographic area with similar fish assemblages, climate and water chemistry (e.g., a watershed, a collection of adjacent watersheds, salmon fishing areas, or coastal management areas). Information at a regional scale is needed to provide a reference benchmark(s) for the assessment of impact to productivity at the localized project scale. Although spatial variability in natural productivity is very high, implicit in the delineation of regions is that variability in productivity within regions is less than the variability among regions.

The geographic scale (and location) of regions with different productivity across Canada has not yet been decided. Existing classification schemes such as eco-regions, fish faunal zones, areas of high and low biodiversity and productivity, may be useful. Explicit fisheries management plans will also likely inform the delineation of regions. When developing decision support tools or making decisions within this operational framework, to manage the risk of failing to achieve the intent of the FPP, the default should be to assume productivity typical of 'healthy' habitat of each type within the region. These defaults provide a benchmark for assessing the habitat of the project area for the *self-assessment* and *assisted assessment* steps, and a starting point for more complete productivity assessments, although in such assessments more site-specific information may be provided by or required of the proponent.

Productivity may be measured in many ways (see Section 6.0). The determination of regional productivity zones would facilitate timely implementation of the productivity-state response curve framework (i.e., conceptually, regional benchmarks of productivity can be viewed as the upper plateau on productivity-state response curves).

6.0 Metrics of Productivity

The productivity-state response curve approach provides a conceptual link from impacts on aquatic habitat to effects at the scale of a fishery (see DFO 2013). "Indicators" are defined as metrics that measure local changes in fish and fish populations some of which may result in changes in CRA fisheries productivity (e.g. components of productivity). Indicators may to be used both to inform decision-making, and in monitoring of the state of fish and fish habitat (i.e. quantifying, for example, major stressors and productivity response). Ideally, indicators should be based on sound ecological theory, conservative under uncertain conditions, simple to understand and explain to proponents, and estimated with data that are feasible to collect and analyze.

Many metrics at the fish and fish population level can provide a link to fisheries productivity given a proper set of assumptions and a suitable ecological endpoint (e.g. intrinsic rate of population growth). However, some will exhibit more responsive linkages than others, in part due to the influence of confounding ecological factors (e.g. density dependence, life history evolution, fisheries exploitation and animal movement). Therefore, regardless of the indicator chosen, the interpretation of changes in the indicator must consider the influence of relevant confounding factors. Idealized and precautionary relationships between indicator change and confounding factors can be estimated from species specific life history and reproductive strategies. However, a set of conceptual relationships depicted in a similar manner to the Productivity-State curves would be particularly useful for consistent indicator interpretation. An inherently high variability within metrics/indicators can lead to a low statistical ability to detect change. This means habitat-fisheries monitoring programs should span a long time period (e.g. 10-30 years for many indicators). Accordingly, standardized survey methodologies (i.e. among sites, among projects) should be used to reduce variation, and when possible, units and estimates of indicator variation should be reported. Sources of error must be known, even if not estimated. Reference sites as well as regionalization of trends in the data collected (i.e. bio-regional benchmarks) can also improve the statistical power of the metrics, although here too environmental variation is expected to be high and should be documented. Further, in almost all reported cases, a suite of indicators has been more robust than a "one-size-fits-all" indicator. Greater value has been realized when the indicators within the suite are 1) complementary to each other such that change in one is informative about potential change in another, and 2) not redundant. There is added value when the suite can address different scales of ecosystem organization (e.g. community and trophic, population and individual level indicators) or animal life history (e.g. life stages, reproductive strategies). However, if suites of indicators are used in decision-making clear decision rules are needed such that the interpretation of positive change in one indicator and simultaneous negative change in another does not create an impasse in management actions.

Body-size- and number-based metrics are generally valuable indicators because they are statistically robust, and it is relatively easy to interpret qualitative and quantitative changes in value. Further, many regional benchmarks exist in public and private databases for most North American fish species. Three tiers of indicators may be useful for the FP Program (NB: within each category, the order of bullets does not represent a preferred sequence of indicators):

Primary indicators:

- Body size (e.g., max length)
- Total biomass (all species)
- Abundance of CRA species (including juveniles)

Secondary indicators:

- Relative abundance of sentinel species (Index of Biotic Integrity approach).
- Size of maturity for CRA species

Tertiary indicators:

- Pathology/Stress
- Growth Rate (from time series)
- Juvenile Mortality (from time series)
- Fecundity
- Regional Fishing Effort
- Benthic Invertebrate Abundance
- Movement / Migration

The number of indicators selected from this list will often be project specific, and should be prioritized within Primary, Secondary and Tertiary levels depending on what will work best operationally. Generally larger projects are likely to require more indicators, because of the wider range of impacts that may result from the project. All the Primary Indicators should be included as often as possible, because they can be measured directly and as a suite they reflect major ways that fish populations and communities may be impacted by projects. Additional Indicators within the Primary, Secondary and Tertiary levels may be suggested by proponents on a project-specific basis. Additional indicators should be evaluated for sensitivity to the expected environmental change and statistical power under environmental variability, relative to the existing Indicators on the list. Direction on other indicators that follow the Pathway of Effects progression under the FPP implementation framework can be found in the supporting Metrics of Productivity research document (de Kerckhove[4]).

These indicators are not considered alternatives to using the "equivalency" of adult fish as a common ecological currency as described in Clarke and Bradford[5] and Bradford et al.[6]. Rather,

[4] De Kerckhove, D. (2014) A review of promising indicators of fisheries productivity for the Fisheries Protection Program Assessment Framework. Unpublished Manuscript, Fisheries and Oceans Canada.

[5] Clarke, K. D. and Bradford, M. J. (2014) A Review of Equivalency in Offsetting Policies. Unpublished Manuscript, Fisheries and Oceans Canada.

in many cases (mainly the Primary and Secondary Indicators) the indicators provide information that can be converted into estimates of "adult equivalency".

Under the FPP, even when many individual projects do not require project-specific indicators, indicators can be useful on a regional scale to ensure that the goals of the FP Program are being met. Regular environmental audits of indicator values at regional scales could provide valuable insight into the success of the program, as well as allow managers to select the most appropriate indicator(s) for tracking progress against the management objective(s). Such a program would further reduce uncertainty because indicators are often most robust when aggregated across regional spatial zones (i.e. watersheds) than across the larger ecosystems (see Section 5.0 - Regional Productivity).

Indicators used for offsetting plans should be generally the same as the indicators used for more *comprehensive assessments* to ensure that changes in population productivity are equivalent within projects.

7.0 Fisheries Protection Program Decision Support Toolkit

Science advice and information (data, documents, and tools) are needed to support the risk management framework for the FP Program. Management and implementation of the projects will be subjected to varying levels of assessment (self, assisted and full/comprehensive) (see Figure 2). The level of assessment will depend on how much is known about the risk of death of fish or residual impacts on habitat, and that knowledge, depends in turn on the scale, location, and complexity of the proposed work, including size (footprint and area of impact) and timing of the proposed work, duration of the project impact, and location restrictions based on habitat/species sensitivity. These features of the work will be considered at each stage of the assessment process. Data, documents, and tools are needed for each stage to ensure that decisions are scientifically defensible, that risk is managed in a consistent manner, and that the goals of the FP Program are met.

The complexity of the tools and information, and involvement of DFO staff, is expected to increase at each level of assessment. The possible tools for *self-assessment*, described in Table 1, will generally be designed for activities that are proposed frequently and for which there is extensive experience with both likely impacts and effective avoidance and mitigation actions for any impacts.

Assisted assessments will require more case-specific support in order for a project to have a sufficiently low level of risk. Projects requiring a *full* or *more comprehensive assessment* will require more involved and sophisticated tools to determine if death of fish or residual impacts on habitats can be avoided, or if authorization should proceed and for developing offset programs.

Because the FP Program and policies are based on new legislation and provide a new operational framework for its implementation, auditing the program's effectiveness at maintaining or enhancing the fisheries productivity for each assessment stage will be necessary to ensure the intent of the FPP is being achieved, and that FP policies are being implemented effectively. Therefore the support tools should be designed to acquire and accommodate new information. This new information and experience should allow regular improvements to the tools. For authorized projects, the acquisition of information should be built into monitoring programs. Acquisition of information will be most challenging for projects that only underwent *self-assessment*, because in such cases proponents will not interact with DFO staff. However,

[6] Bradford, M., Koops, M. and Randall, R. (2014) Science advice on a decision framework for managing residual impacts to fish and fish habitat. Unpublished Manuscript, Fisheries and Oceans Canada.

more information could be captured if on-line tools were developed to provide coarse spatial and temporal information that, when combined with information from local land use agencies, could be used to identify regions where specific forms of works are increasing and some follow-up in the area may be warranted. Depending on the follow-up, the *self-assessment* tools might be adjusted to ensure the risk of failing to achieve the intent of the FPP is managed effectively.

Information and tools that could be used to provide robust, science-based support (in both the short and medium term) are identified in Table 1. The examples provided are illustrative (not comprehensive) and will require further evaluation guided by operational implementation of the FP Policies. A comprehensive list of the science support required should be informed by both the scientific literature and from policy guidance provided by the FP Program.

Table 1: Illustrative list of possible data, document and tools that could be used by the Fisheries Protection Program in evaluation of projects in the risk-based decision framework. All require contributions from science, operational, and policy staff. In general tools designed for one type of assessment will continue to be relevant for more complex assessments, but will typically need to be augmented with additional tools such as those in each cell of the table.

Self Assessment	• Guidance documents and tools on fish and habitat, incorporating results of generic analyses, possibly using equivalency metrics and calculations (e.g. habitat quality/quantity, adult equivalents). However the tools themselves would not require case-specific calculations. • Interactive questionnaire and list of approved activities (i.e. those that match cases included in the user-support tools). • Interactive maps with species, fisheries, species at risk , habitat and other location specific information • Guidance documents on activities and required avoidance and mitigation measures • Pathways of Effects (POEs) for proposed development activities • Best management practices and examples[7] • Links to the *Fisheries Act*, the Fisheries Protection Policy Statement, Decision Framework
Assisted Assessment	• On-line Tool for submission of project descriptions and evaluation. Risk matrix for project evaluation. • Guidance documents and tools on fish and habitat, incorporating results of generic analyses, possibly using equivalency metrics and calculations (e.g. habitat quality/quantity, adult equivalents). However the tools themselves would not require case-specific calculations. • Best management practices and examples for additional avoidance and mitigation measures by activity type [7] • Pathway-of-Effects diagrams and documents. • Standards and guidelines by activity type to ensure avoidance / mitigation is effective [7]
Full or Comprehensive Assessments (evaluations of projects, including fisheries productivity)	• List of information requirements for productivity assessments, candidate metrics/indices to be used and data collection methods. • Productivity assessment framework and models for proponents and regulators to determine impacts and offset needs that can be customised. • Pre- and post-assessment monitoring requirements (habitat, productivity and indices) [8] • Offsetting assessment methods based on activity types, time & spatial scale, intensity & location. • Decision tools to help guide and justify decisions to authorize or not and documentation of productivity assessment results. • Fishery Management plans (developed or revised if needed with specific objectives)

[7] For activities for which best practices have not yet been identified, several years of experiments, monitoring, and evaluation may be needed to identify best practices.

[8] Monitoring needs may persist indefinitely for some types of projects or mitigation and offsetting measures.

Sources of Uncertainty

Although much of this SAR deals with risk and uncertainty, two particular sources of uncertainty in fishery productivity are discussed in greater detail below. These provide context for parts of the preceding advice and should be considered in applying the advice.

Consideration of cumulative effects

Cumulative effects are defined under the Canadian Environmental Assessment Act (CEAA) as "changes to the environment that are caused by an action in combination with past, present and future human actions". This definition generally includes (i) the additive effects of a repeated type of action over time, and (ii) the synergistic effects of either a repeated type of action over time or a wider range of multiple stressors. There is scientific evidence for both of these types of cumulative effects in Canada such that the combined effect of multiple stressors is leading to a background rate of habitat deterioration in many geographical areas. However, although cumulative effects are often negative, there is potential to impart positive change in aquatic habitats if proponent or management actions associated with a particular type of development typically result in a net benefit and if these actions are undertaken consistently. If the objective of managing cumulative effects within the FPP framework involves increasing the likelihood that a project will on average yield net benefits then the risk that the intent of the FPP will not be achieved is greatly reduced.

Additive cumulative effects are those where the overall impact of a type of development increases linearly with the number of individual and separate projects within the same environment. This type of cumulative effect is a concern if the methods employed to avoid impacts are less than fully effective. In these situations the initially small changes to fisheries productivity accumulate over time as the number of similar projects in the environment increases. If the productivity-state curve (P-S) between the impact and fisheries productivity is non-linear, at some point cumulative effects can lead to larger and unexpected changes following the addition of relatively few projects. Therefore under the FP Program it will be important to understand the potential for variability in mitigation success at different points along the productivity-state response curves. In the P-S curve framework, fish productivity changes the most at points along the P-S curve where the slopes are the steepest. Therefore, the risk of negative residual effects that can accumulate is greatly reduced if 1) management actions are tailored to this part of the curve, 2) the types of mitigation used by proponents have a relatively high certainty of success, and 3) net benefits are the goal of avoidance, mitigation and offsetting actions (e.g. offset ratios as described in Section 4.0). This type of approach should be valid across the implementation framework. However for larger projects there is an opportunity to further safeguard against negative residual effects by implementing site-specific mitigation and offsetting plans that have a very low risk of failing to adequately mitigate or offset the possible negative effects.

For some types of activities repeated addition of similar projects within an environment may have effects completely separate from the type of effects that required mitigation at the project-specific level. This type of "cumulative effect" has not been considered in this or previous advisory meetings, and is not addressed in the current advice.

The synergistic interactions of multiple diverse stressors are a commonly assessed cumulative effect under CEAA, and have been examined in aquatic habitats across many types of environmental scenarios including acid rain, pollutants and industrial development. The spatial scale of effects of multiple stressors is usually large and so is often examined at the scale of tertiary watersheds, or summarized for larger areas at coarser scales (e.g. across the Exclusive Economic Zone on BC's coast in 1 km^2 grids). While predicting the magnitude of synergistic multiple effects is extremely difficult, geographic areas that contain many stressors can be identified and proactively managed for high variability in fisheries productivity or increased vulnerability of fish stocks.

The risk of not achieving the goals of the FP Program will increase if the potential effects of multiple stressors are not considered in the individual assessments. For *self-assessments* and *assisted assessments*, robust decision-support tools need to take into account other major stressors in the watersheds (e.g., by incorporating information from other watershed stressors into operational tools).

Minimizing the cumulative risk to fisheries productivity from both types of synergistic cumulative effects would be greatly aided by tracking of the frequency of projects within a region. The tracking methods do not need to include a detailed account of every project's site-specific impacts nor their exact location because the spatial scale of cumulative impacts is generally coarse, and so what is most useful is a complete inventory of small and large project types within a region. Although not explicitly designed for this purpose, appropriate cumulative effects tracking information has been collected within the Program Activity Tracking for Habitat ("PATH") database that could provide the FP Program with an historical reference. The use of PATH combined with tracking the future number of aquatic developments within a region could provide a simple method to gauge the potential risk of multiple stressors on aquatic systems, and could be implemented at all steps under the FP Program practices (e.g., additions could be made to the web-based user tools for projects in the first steps of the FP Program decision framework that would track project and general location). Many types of impacts that cause effects on aquatic ecosystems are not managed by the FP Program (e.g., land use and some water use; pollutant and nutrient loading, etc.) but nonetheless should be considered in a true cumulative effects assessment.

Non-stationarity

Non-stationarity refers to temporal changes in features of the environment or a population. Examples of such changes include climate change, acid rain, the cumulative effects of multiple stressors, etc.. Within an ecological context this can refer to environmental changes that, over time, will change the growth, reproduction, or survival schedule of individuals within a population. Within a population context, this can refer to changing abundances or age distributions.

Environmental non-stationarity drives changes over time and directly affects the ability of habitats to produce fish. The changes can include inter-annual fluctuations as well as trends over time. This environmental non-stationarity can result in changes in the relationship between fish and habitat. Environmental non-stationarity can mean that average conditions during a short time series may not be reflective of the conditions producing fish. Environmental non-stationarity has implications for the estimation of habitat offsets.

When a population is fluctuating among states that include growth or decline, use of a non-representative age distribution would mean that calculations of adult equivalents could be biased. Population non-stationarity can mean that the current ratio of young to adult fish may not be reflective of the conditions that would sustain on-going productivity. When there is non-stationarity, the possible changes in age distribution of potentially impacted populations needs to be taken into account in the assessments. Population non-stationarity may or may not be synchronised with environmental non-stationarity.

For projects with short-term impacts, assuming stationarity is not expected to introduce bias, therefore the design and application of tools to support decisions for such project does not need to address non-stationarity. However, any benchmarks or reference levels used in these decision support tools will need to be periodically updated to ensure that biases are not introduced due to non-stationarity. For projects with long-term impacts, non-stationarity is a potential complication that can introduce bias into the calculation of adult equivalents. An assessment of such projects should take into consideration the possible existence of non-stationarity and its effects on both the ecological impacts and the offsetting benefits expected from the project.

OTHER CONSIDERATIONS

8.0 Ecologically and biologically significant areas and other regulatory requirements

Other regulatory requirements outside the purview of the FPP may sometimes be relevant to decision-making. For example, "significant areas" (particularly in the marine environment) will need a Departmental assessment regardless if a project is able to avoid, mitigate or offset serious harm to fish and fish habitat. Two examples of particular relevance to FPP implementation are the habitat provisions of the *Species at Risk Act* (SARA) and the need for defining Ecologically and Biologically Significant Areas (EBSA), Species and Community Properties (ESSCP) under the *Oceans Act*.

In the case of the *Species at Risk Act* prohibitions, a project may be prohibited to proceed as planned because of the presence of a species that is listed as endangered or threatened. The Species at Risk Act prohibits activities that may kill, harm or harass such species as well as damage or destroy their residence or critical habitat. Under the *Oceans Act*, a similar situation may arise under marine protected area regulatory prohibitions which would prohibit a project that may disturb, damage or destroy any living marine organism or any part of its habitat. Under these two Acts, a permit may be issued to allow the project to proceed under additional and more stringent measures than the ones initially proposed to avoid, mitigate or offset serious harm under the *Fisheries Act*.

Ecologically and Biologically Significant Areas (EBSA), Species and Community Properties (ESSCP): As part of integrated management initiatives under the *Oceans Act*, ecologically and biologically significant areas have been identified for most marine eco-regions of Canada as well as ecologically significant species. These were established under national guidance to call attention to areas and species of particularly high ecological or biological significance and to facilitate the provision of a "greater-than-usual degree of risk aversion" in the management of activities. Based on ecological criteria, "significance" implies that if such area or species were perturbed severely, the ecological consequences would be greater than an equal perturbation of most other areas or species within the same ecological boundaries. It should be noted that "significance" is based on ecological criteria and does not consider special utility or importance of a species, habitat feature or area that are valued by humans.

A subsequent review of the EBSA and ESSCP criteria provided additional guidance as to their use in other aquatic environments such as coastal zones, estuaries and freshwater systems. The review also indicated that these criteria can be used as part of a systematic process to establish the ecosystem basis for management ensuring consistency and efficiency in the development of management measures. Their use in management and regulatory contexts also reduces Departmental liabilities that could result from inconsistent use or interpretation of scientific advice in policy and regulatory decision-making and, as such, are recommended for use in policy and management across sectors, to ensure consistency and credibility of practice.

In FPP, EBSA's and ESSCP's provide a consistent approach for the identifications of areas that would require a higher level of consideration by proponents in the development of their project proposal. It would also provide the same basis for the development of guidelines and standards in support of prescribed works or class authorizations as well as the identification of prescribed waters. Even though some areas may not have the proper specificity or granularity of scale, EBSA's could also provide the scientific underpinning and knowledge base for the development of "Ecologically Significant Areas" regulations as offered by the new provisions of the proposed *Fisheries Act*. In this latter case, it should be noted, however, that such regulation would require Departmental review of any project proposal.

CONCLUSIONS AND ADVICE

The main conclusions are all included in the Summary section. The advice is contained in all sections of this SAR, organized by type of consideration.

SOURCES OF INFORMATION

This Science Advisory Report is from the National Peer Review meeting of September 30 to October 3, 2013 on Operational Advice for Fisheries Protection Program. Additional publications from this process will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

DFO. 2013. Science Advice to Support Development of a Fisheries Protection Policy For Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/063.

DFO. 2014a. A science-based framework for assessing changes in productivity, within the context of the amended *Fisheries Act*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/071.

DFO. 2014b. Science Advice on Offsetting Techniques for Managing Productivity of Freshwater Fisheries. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/074.

DFO. 2014. A Science-Based Framework for Assessing the Response of Fisheries Productivity to State of Species or Habitats. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/067.

APPENDIX 1: DEFINITIONS

"*Assisted assessment*": as conducted by a qualified environmental professional experience with such technical assessments, either working for the proponent or the government.

CRA fisheries: commercial, recreational and Aboriginal fisheries.

Equivalency: a term commonly used in the offsetting literature when using a common metric, in which the impacts of a project are compared to the benefits of an offsetting activity.

"*Full*" or "*comprehensive" assessment*: by DFO operational staff charged with such regulatory review.

"*Self-assessment*": refers to an assessment by a proponent of its potential effects, the effectiveness of any mitigation measures taken (if applicable).

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