A Framework for Environmental Risk Assessment and Decision-Making for Tidal Energy Development in Canada

FINAL REPORT – August 2012

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EXECUTIVE SUMMARY

In-stream tidal energy initiatives are rapidly developing in Nova Scotia, but there remains a high degree of uncertainty regarding the nature and extent (in space and time) of environmental implications of energy harvesting activities. This report outlines a science-based environmental risk assessment and decision-making framework for the developing in-stream tidal energy industry. It lays out a set of practical criteria and related risk indictors for consideration when planning and reviewing projects. This guidance document offers an approach that would help facilitate a consistent, objective and efficient environmental review, regulatory and follow-up process for the tidal energy industry in Canada.

The framework and guidance offered can also be used to inform tidal energy proponents of the minimum information that should be included in initial project descriptions or registration documents, and of the priorities for baseline studies and monitoring. In addition, the framework can help identify evaluation measures or trigger points for adaptive management actions of approved/ongoing projects such as: modification of project or mitigation measures; ceasing operations and/or removal of devices; or further detailed or formalized environmental assessment.

Section 1 provides some background on the in-stream tidal energy sector in Canada and Nova Scotia and the need for the development of an environmental risk assessment and decision-making framework that specifically addresses the unique aspects presented by this type of development. The current federal and provincial regulatory processes that relate to the developing tidal energy industry are briefly summarized in the Appendices.

Section 2 describes the guiding principles underlying the risk assessment and decision-making framework. These principles include:

- Appropriate consideration of ecosystem-scale and cumulative effects;
- Acknowledging natural changes;
- Use of precautionary and adaptive management approaches to deal with uncertainty;
- Early initiation of baseline studies;
- Consideration of site-specific and project-specific characteristics;
- Social values and concerns; and
- First Nations engagement.

Section 3 presents a regulatory decision-making framework and provides guidance for project proposals. The process involves seven main steps:

1. Define the scope of the review;
2. Evaluate the project site characteristics;
3. Evaluate the environmental risk of the project proposal based on a set of standard defined criteria and indicators;
4. Identify risks of interference with other human uses of the ecosystem (e.g. fisheries, recreation);
5. Categorize the overall risk of the proposed project and make a management decision;
6. Define supplementary mitigation measures to reduce the overall risk of the project, where applicable; and

7. For an approved project, prepare an environmental monitoring program that incorporates adaptive management principles.

Given that it is not possible to define universally applicable quantitative threshold values, the environmental risk assessment is based on a set of standard defined criteria and indicators that:

- Are relevant, flexible and can be consistently applied to projects of any type, size or location;
- Address directly or indirectly the major environmental concerns related to the operation of in-stream tidal devices;
- Relate to specific and characterizable attributes of a development project and the environment; and
- Are based on current scientific literature and expert judgment.

The report concludes with a set of recommendations, including the need for the development of protocols for environmental monitoring, data collection and dissemination, and stakeholder engagement. A focus on case study scenarios that address environmental risk assessment and monitoring needs for a range of site types / conditions and tidal energy development levels (demonstration to commercial arrays) is an important next step.

ABBREVIATIONS & ACRONYMS

CEAA – Canadian Environmental Assessment Act

COMFIT – Community Feed-in Tariff

COSEWIC – Committee on the Status of Endangered Wildlife in Canada

DFO – Fisheries and Oceans Canada

EA – Environmental Assessment

EMF – Electromagnetic Field

FIT – Feed-in Tariff

FORCE – Fundy Ocean Research Centre for Energy

HADD – Harmful Alteration, Disruption or Destruction

HCC – High Conservation Concern

IUCN – International Conservation Union

MRE – Marine Renewable Energy

OEER – Offshore Energy Environmental Research Association. Now called Offshore Energy Research Association (OERA) of Nova Scotia

PoE – Pathways of Effects

SARA – Species at Risk Act

SEA – Strategic Environmental Assessment

TISEC – Tidal In-stream Energy Conversion

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1.0. INTRODUCTION

1.1. CANADA'S MARINE RENEWABLE ENERGY OPPORTUNITY

Canada has significant potential for extracting marine renewable energy (MRE) from coastal environments, and appears intent on doing so in order to diminish reliance on fossil fuels, and to reduce greenhouse gas emissions. Interest in MRE development, particularly in relation to installation of tidal in-stream energy conversion (TISEC) technologies, has been growing rapidly. Extractable tidal energy is abundant in numerous, but localized areas of Canada's Pacific, Atlantic, and Arctic coasts, some of which represent substantial energy resources (Figure 1.0) in close proximity to areas of significant energy demand (Cornett 2006; EPRI 2006). Currently, the Bay of Fundy on the Atlantic coast is considered one of the most promising areas for tidal energy development.

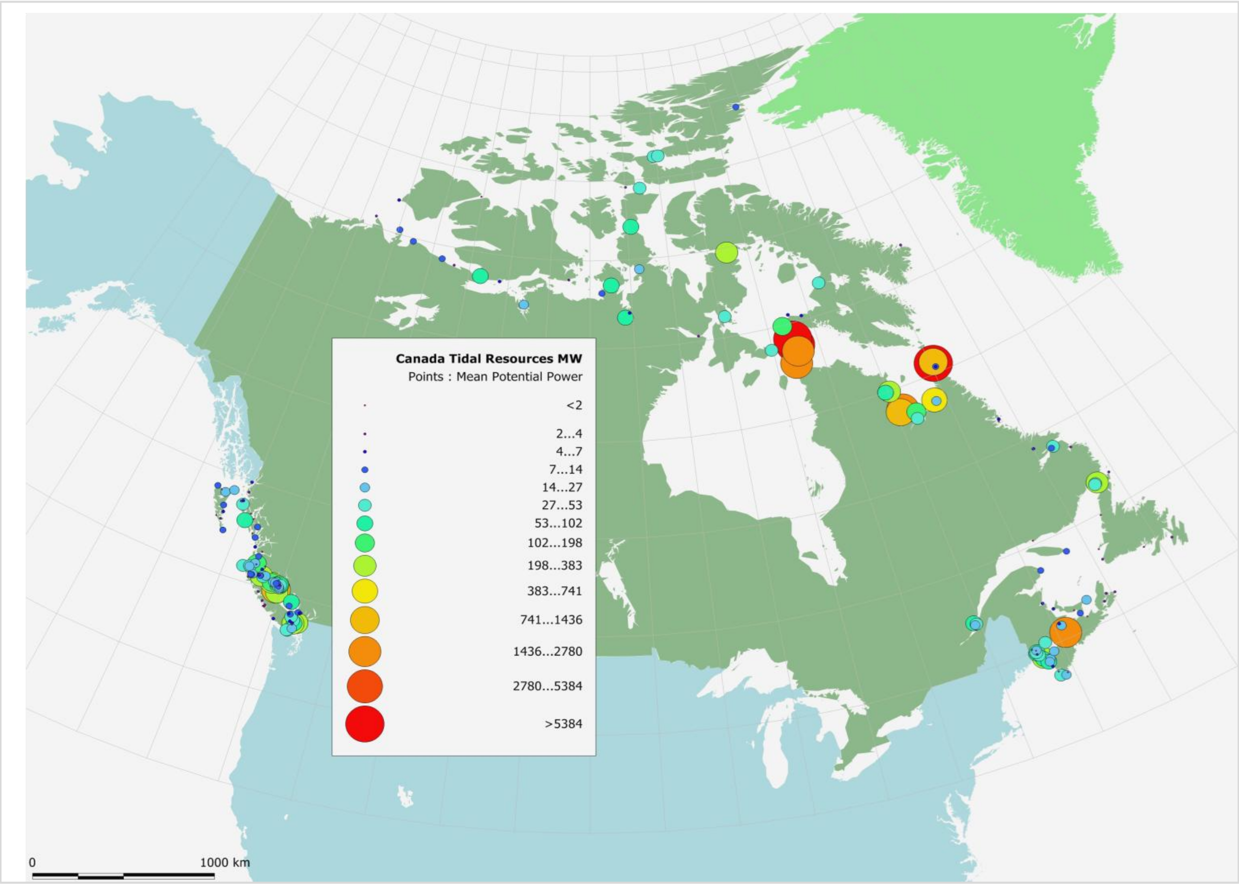

Figure 1.0. Potential Tidal Current Resource Sites in Canada, based on Mean Potential Power (Cornett 2006).

Canada is competing internationally in this promising field; in order to capitalize on economic opportunities, it is essential that technical or environmental uncertainties do not prevent progress in assessing the acceptability and durability of nascent MRE technologies. A clear and coherent regulatory landscape will enable this potential new energy sector to evolve in a responsible manner.

Management of Canadian marine environments involves a number of federal and provincial agencies, each of which has specific regulatory responsibilities. All MRE projects have the potential to interact with fish, fish habitat, fisheries, and other marine users and for this reason Fisheries and Oceans Canada (DFO) has a direct interest in any MRE development. Provinces also have a regulatory stake in MRE, in terms of allocation of submerged crown lands, economic development, energy and environmental management.

Nova Scotia is currently focused on the opportunities for in-stream tidal energy development in the Bay of Fundy. The province is developing policies and legislation specifically addressing marine renewable energy, and regulatory agencies are in the process of designing the best approach to assess and manage environmental risks. Initial steps have included the following: a Strategic Environmental Assessment (SEA) of the Bay of Fundy area (completed); a SEA for coastal Cape Breton and the Bras D'Or lakes region (initiated in spring 2012); a test facility for commercial scale devices in Minas Passage (FORCE) together with an Environmental Assessment (EA); background research and environmental monitoring projects for Minas Passage and other high priority sites in the Bay of Fundy; a public consultation process to advise on legislative and regulatory options available to the provincial government (the Fournier Report); and a programme of Feed-In Tariffs (COMFIT and FIT) aimed at supporting both small and large scale tidal energy developments in the province.

1.2. NOVA SCOTIA MARINE RENEWABLE ENERGY STRATEGY (2012)

In 2010, a public consultation process was commissioned by the Nova Scotia government for use in developing its recently released Marine Renewable Energy Strategy. The process culminated in a report entitled "*Marine Renewable Energy Legislation: A Consultative Process*" (Fournier 2011). The Strategy forms part of the Nova Scotia Cleaner Energy Framework, and describes broad policy and economic and legal conditions for the development of marine renewable energy to help meet the province's 2020 renewable energy target of 40% of the province's electricity demand. The Strategy rests upon three plans:

- A long term, integrated <u>Research Plan</u> based upon partnerships that are involved in coordinated, multi-disciplinary research to address existing knowledge gaps. The document identifies numerous non-government organizations currently engaged in research on tidal energy, including FORCE, the Fundy Energy Research Network, the Offshore Energy Research Association of Nova Scotia, and several Nova Scotia universities. Coordination will be encouraged through the formation of a Tidal Energy Research Forum.
- A <u>Development Plan</u> to encourage development of tidal energy extraction that is environmentally sustainable, cost-effective, and maximizes benefits to Nova Scotia. This will be achieved through active partnerships involving FORCE, technology developers, power companies and investors. The plan will address both large scale and small scale energy development projects by providing incentives (e.g. FIT and COMFIT), and envisages the creation of a tidal energy industry in Nova Scotia.
- A <u>Regulatory Plan</u> to ensure that development proceeds with appropriate licensing, environmental protection, community benefits and provincial revenue. It proposes to create two new types of licenses for TISEC projects: 1. a Technology Development License

permitting testing and demonstration phases of development, and 2. a Power Development License for projects aimed at large scale, commercial power production. A third license will be developed for Tidal Range (i.e. tidal barrage or lagoon-based) projects if needed. The Regulatory process will also incorporate engagement of all major stakeholders through a Tidal Energy Stakeholder Forum.

Timelines in the MRE Strategy document suggest that development of arrays of tidal devices should be expected between 2014 and 2020.

1.3. UNCERTAIN ENVIRONMENTAL RISKS OF TISEC DEVELOPMENTS

TISEC technologies are diverse and continue to evolve, with most still at the testing phase. As a result, there is currently insufficient information to assess the environmental risks of TISEC developments, largely because:

- few full size devices have been deployed in natural environments for prolonged periods of time;
- environmental effects are likely to be technology-, scale-, and site-specific;
- the most favoured locations for deployment exhibit challenging physical conditions – consequently data collection and effects monitoring are difficult and sometimes limited by the availability of suitable monitoring and mooring technologies;
- there have been insufficient monitoring results to confirm predictions of environmental assessments; and
- many of the sites with high MRE potential are insufficiently studied for the environmental implications to be assessed with confidence.

Because of these varied uncertainties, development of the tidal energy sector in Canada should proceed using an adaptive management approach, by both federal and provincial levels of government.

1.4. AIMS OF THE DECISION-MAKING FRAMEWORK AND GUIDANCE REPORT

This report presents guidance to developers and regulators on the development of best practices in environmental risk assessment and decision-making in relation to in-stream tidal energy development proposals and projects. It applies to all development scales and sites and uses an adaptive management approach. The framework proposed here aims to inform appropriate regulatory and approval decisions and to assist industry in the planning of their projects, such as helping to refine location, selection of technologies, environmental assessment, mitigation and monitoring requirements.

It is intended that this framework be used to assist the development of a Statement of Best Practice for the management of in-stream tidal energy development proposals and projects, and serve as guidance for regulatory and licensing authorities to ensure the tidal energy industry in Nova Scotia (and elsewhere in Canada) develops in an environmentally safe and sustainable manner.

2.0. GUIDING PATHWAYS AND PRINCIPLES FOR IN-STREAM TIDAL ENERGY ENVIRONMENTAL RISK ASSESSMENT AND DECISION-MAKING

Both regulators and developers currently lack sufficient knowledge or experience to be able to assert, with an appropriate degree of confidence, whether a project is likely to cause adverse environmental effects. Moreover, they are currently lacking practical and consistent guidelines upon which to base project planning and environmental review. To facilitate a consistent, objective and efficient environmental review, and regulatory and follow-up process for the in-stream tidal energy industry, a science-based environmental risk assessment and decision-making guidance document has been developed to address the unique aspects presented by this type of development. It serves as:

1. A guidance tool for regulators and developers in the assessment of environmental risk for in-stream tidal energy development proposals and projects; and
2. A procedure upon which regulators can base their regulatory decision-making for project proposal reviews and approvals.

The evaluation criteria included in the guidance framework can also be used to inform regulators and proponents of the minimum information (type and scale) that should be included in initial project descriptions or registration documents and priorities for baseline studies and monitoring. As well, these criteria can help identify evaluation measures or trigger points for adaptive management actions of approved/ongoing projects, such as: modification of project or mitigation measures; ceasing operations and/or removal of devices; or further detailed or formalized environmental assessment.

The framework and guidance provided in this report supports the review and adaptive management of in-stream tidal energy proposals, including sector-specific assessment criteria, based on the best available scientific knowledge, expert advice and best practices for environmental risk and impact assessment.

2.1. PATHWAYS OF EFFECTS

In 2011, DFO obtained funding support under Natural Resources Canada's Clean Energy Fund for *"Supporting an Efficient Regulatory Framework for Ocean Renewable and Clean Energy Initiatives"*. The ultimate aim of the project was to develop a strategic research plan to ensure that marine renewable energy developments are effectively reviewed and located in such a manner as to minimize adverse environmental and socio-economic impacts. As part of this overall objective, a series of Pathways of Effects (PoE) logic models were developed for the major forms of marine renewable energy: in-stream tidal, in-river hydrokinetic, wave and offshore wind (Isaacman and Daborn 2011).

PoEs are conceptual representations of predicted relationships between ***human activities***, their associated ***pressures or stressors*** and the ***environmental effects*** they may have on specific ***ecological components or receptors***. The design of the PoE models followed the international Driving Forces-Pressures-State-Impact-Responses (DPSIR) framework adopted by the Organization of Economic Co-operation and Development, and originally developed by the United Nations Environment Program. The PoE linkages were based on a review of strategic environmental assessments, expert panel reports, environmental assessments, monitoring reports, scientific literature and the expert judgment of the consultants and the working group members.

Figure 2 illustrates the basic structure for the PoE logic model. It consists of five main components:

1. Activity phases and sub-activities;
2. Stressors/pressures;
3. Effects on the environment, including:
    a. effects on ecosystem components;
    b. effects on the habitat/ecosystem, with potential indirect effects on ecosystem components;
4. Ecosystem components/receptors; and
5. Valued ecosystem goods & services.

Separate PoE logic models were developed for the three main **MRE Activity Phases**: (a) Site Investigations; (b) Construction, Maintenance and Decommissioning; and (c) Operations.

The pathways of effects logic model shown in Figure 2 identifies the following six **Stressors** for the operational phase of installed tidal power technologies:

1. Changes in current energy;
2. Effects of artificial structures;
3. Physical interactions with infrastructure;
4. Noise, vibration & light emitted from devices;
5. Emitted electro-magnetic fields; and
6. Release of contaminants.

Ecosystem component categories, often referred to as **Receptors**, may be affected by tidal energy developments, through one or more of the stressors listed above. The identified receptors are:

- Fish;
- Marine mammals;
- Marine plants and invertebrates, including shellfish, crustaceans and planktonic organisms; and
- Marine birds.

These receptor categories include all life stages (e.g. eggs, sperm, spawn, larvae, spat, juvenile and adult stages), as well as the habitats upon which the species depend.

It was recognized that the magnitude of the interactions (if any) will vary with the specific design concept and the sensitivity of the ecosystem components (receptors) found at any given location.

The models also highlight the **valued ecosystem goods & services** or the socio-cultural and economic interests and values that are linked to and rely upon the ecosystem receptors and which are the priority of Canadian environmental policy and regulations.

Residual environmental effects (after mitigation) may occur where the above stressors and the receptors intersect. For the operational phase of the PoEs the following effects are common to each form of MRE development:

Direct Effects on ecosystem components:

- Lethal / sub-lethal & physiological effects associated with marine organisms passing near or through TISEC devices and arrays;
- Burying or transport of eggs, larvae, benthos & in-fauna;
- Changes in behaviour, communication and/or navigation (e.g. habitat avoidance / exclusion / attraction, change in movement patterns, predator recognition and avoidance, etc.);
- Establishment of fouling assemblages, including alien species;
- Changes in health, survival and/or reproductive success;
- Changes in sediment erosion, transport and deposition patterns; and
- Changes in hydrodynamic characteristics and patterns.

Indirect Effects (effects on habitat/ecosystem) from:

- Changes in coastal / shoreline or benthic habitat;
- Changes in ambient light & water quality;
- Changes in pelagic habitat; and
- Changes in plankton & macrophyte productivity.

Draft and final PoE logic models were examined in detail by science experts and DFO managers at two workshops held in 2011 and 2012. The outcome of the workshops was a consensus that the PoE models adequately describe the important stressor-effect linkages involved in MRE development, and provide a basis for establishing priority concerns that could frame requirements for environmental assessments and research (including monitoring) as the MRE sector evolves. The models are intended to inform scientific research needs in support of effective and efficient regulation and governance of the MRE industry in Canada.

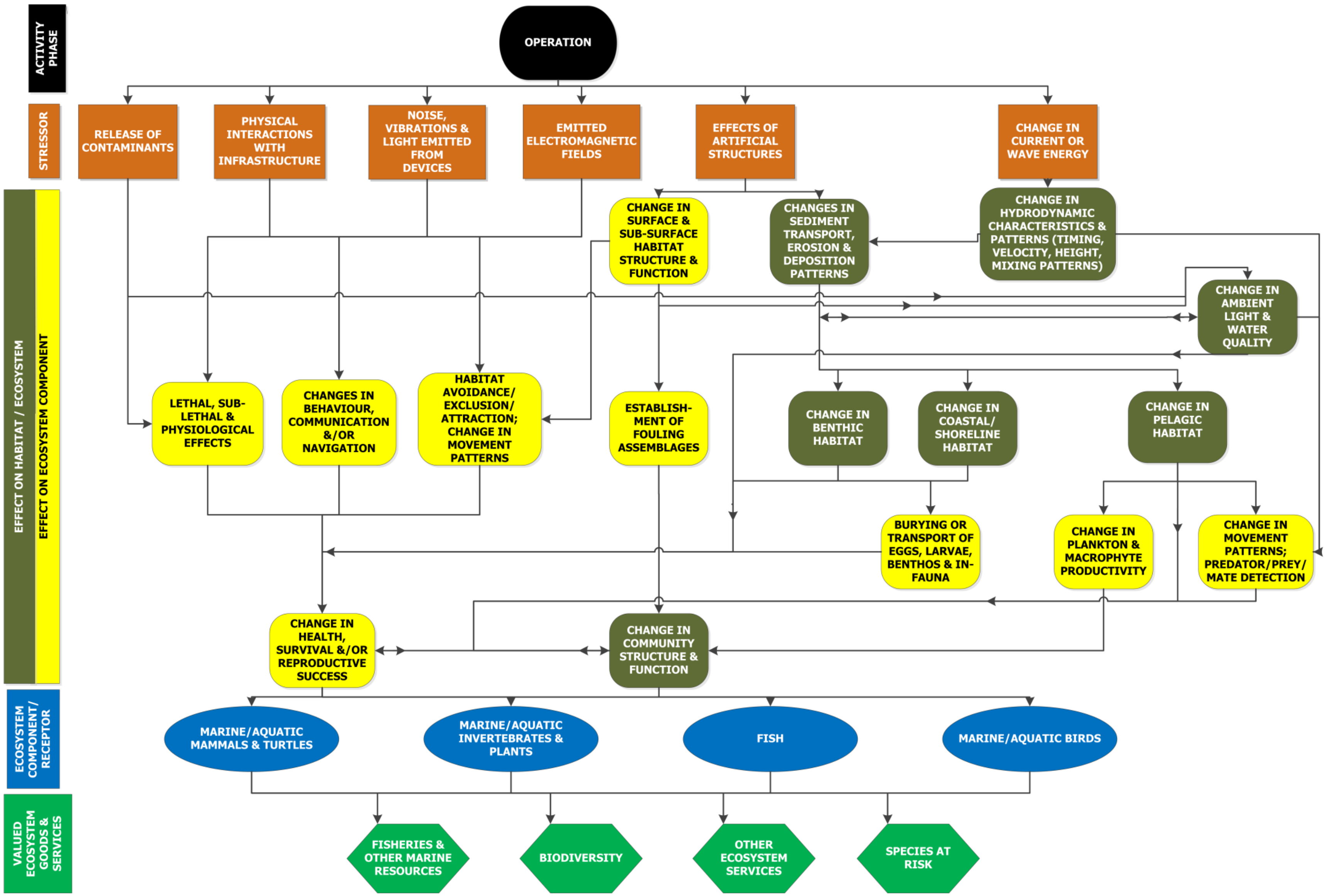

Figure 2: PoE Model for the Operations Phase Stressors in the Marine Renewable Energy Sector (Isaacman and Daborn 2011).

2.2. KEY GUIDING PRINCIPLES

2.2.1. ECOSYSTEM-SCALE AND CUMULATIVE EFFECTS

A fundamental principle of environmental assessment and regulatory decision-making processes should be to ensure that development activities do not go forward if there is a risk of significant negative change to a critical operational characteristic of the ecosystem[1]. Regulators and developers must acknowledge a stewardship responsibility to preserve those dynamic features that are critical to the ecosystem's role in a larger coastal context. This is illustrated by the Bay of Fundy: an ecosystem that is of global significance, particularly given the large number of species that migrate between the bay and the whole of the North Atlantic, North, Central and South America, and Europe (Jacques Whitford 2008).

The term 'cumulative effects' usually refers to the additive or multiplicatory effects of more than one development taking place within the same ecosystem, or affecting the same receptor (e.g. migratory species) that may move between ecosystems and be subjected to more than one development. It is highly probable that successful deployment of devices will stimulate further tidal developments within the same energy field. Cumulative effects have always been difficult to forecast. Most oceanographic relationships are non-linear, so that modification of one parameter (e.g. current velocity) may result in a magnified change in related parameters (e.g. turbulence, water column mixing, etc.) producing system-wide changes that may seem out of proportion to the original perturbation.

To this end, integrated regionally-based ocean management plans like strategic environmental assessments and marine spatial plans would provide a clear description of the environmental and social context in which in-stream tidal energy developments would be developed, including a set of strategic objectives.

2.2.2. ACKNOWLEDGING NATURAL CHANGES

A complicating factor that affects risk assessment and the selection of mitigation measures and monitoring programs arises because all tidal ecosystems are subject to changes that are natural. Some changes, such as tidal rhythms, are cyclical, varying over predictable periods ranging from weeks to years. Others are non-cyclical, resulting in progressive, uni-directional changes in coastal morphology that may exert considerable influence on critical ecosystem processes. Examples include sea level rise, sediment and nutrient inputs into the estuary, shoreline and bottom erosion, climate change, etc. Over the prolonged time expected for marine renewable energy installations (i.e. decades), such natural changes have the potential to affect the interactions between energy extraction devices and the coastal environment. It is important, therefore, that such natural changes are recognized in the

[1] In this connection, it should be noted that the Western Australian government recently amended environmental assessment requirements in respect of a proposal for tidal power development to include: *"a description of the biophysical interactions that characterize the ecosystem*..", and an assessment of: "*impacts on biophysical processes currently operating within the ecosystem*…". [Source: **Guidelines for the content of a draft environmental impact statement on the Derby Tidal Power Project, Western Australia**, EPBC ref. No. 2010/5544].

earliest phases of the risk assessment process, because they may be associated with variations in ecological phenomena (e.g. population characteristics, movement patterns, productivity, etc.) that are not attributable to the development itself. Ultimately, recognizing the probable effects of such natural changes is essential for designing monitoring programs that are capable of detecting and differentiating the environmental effects due to tidal energy development.

2.2.3. USING A PRECAUTIONARY AND ADAPTIVE MANAGEMENT APPROACH TO DEAL WITH UNCERTAINTY

At the present time, the tidal energy initiative is built around a large number of alternative technologies, each of which has some unique characteristics. Few commercial scale devices have been deployed for long periods in natural environments; consequently, their durability and operational characteristics remain largely unknown, and since very few deployments have had extensive monitoring, their environmental effects remain a matter of conjecture. Furthermore, it is well known that coastal ecosystems undergo significant changes over time, some cyclical (e.g. seasonal, annual or multi-year), and others progressive (e.g. continuing system changes associated with sea level rise, shoreline erosion, subsidence or human modifications such as causeways). In the face of this variability and changing environments, identifying and quantifying the effects of marine energy extraction or the direct effects of the devices on organisms is extremely difficult.

Given these circumstances, the precautionary approach[2] needs to be applied to protect the environment against significant and/or irreversible damage. This entails a risk assessment and decision-making process that errs on the side of caution in the face of lack of full scientific certainty. Notwithstanding recognition and adoption of the precautionary approach, inability to provide a complete assessment of the project and its environmental effects in the preliminary review or assessment of the proposal would not necessarily preclude the possibility of the project moving forward. Resolving gaps in scientific knowledge will require practical real-world experience which cannot be achieved without putting devices in the water at various scales and locations.

Adaptive management[3] is the preferred approach to dealing with proposals of tidal energy development where there is insufficient experience with the technologies, a lack of knowledge about the ecosystem for which the development is proposed, or both. In fact, the novelty and continued need for refinement of the technology makes in-stream tidal energy development an ideal candidate for a staged and adaptive development approach. Except for short-term demonstration projects, most large scale tidal developments will consist of arrays of devices that could be installed over time with some units coming on stream long before the full development is completed. This iterative staged growth feature facilitates application of an adaptive management approach. The ultimate scale of a permitted project may be determined over time based on

[2] Also known as the precautionary principle. We use this term to mean 'Where there is a lack of full scientific certainty, conclusions or decisions should err on the conservative or cautious side (i.e., assume that an effect is more rather than less adverse)' (Hegmann et al. 1999). Please note this term has many similar, but differing definitions.

[3] A planned and systematic process for continuously improving environmental management practices by learning about their outcomes (CEAA 2009). Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project.

monitoring and interpretation of the results, conducted as follow up to confirm the predictions of the environmental assessments. As projects expand to full commercial scale potential, there will be a need for continuing reassessment of the implications of the development.

Cumulative effects associated with increasing numbers of installed TISEC devices, or the scale of the individual projects, in close proximity or in the same ecosystem, represent one element that requires continuous reassessment. In general, deployments will favour high velocity locations and follow up must recognize the non-linear relationships with important environmental parameters such as turbulence, sediment transport and deposition, noise transmission, etc. There is also abundant evidence (e.g. from causeway construction) that small, possibly incremental changes to critical ecosystem processes may not be evident for a long time after completion of the array, although such changes may well impact critical aspects of the environment (e.g. habitat), or progressively interact with other established resource uses. These additional elements of uncertainty highlight the need for reassessment, of any established commercial-scale development, at intervals of time over the life of the project.

Adaptive management requires continual oversight and environmental monitoring and the ability to make modifications to projects as new information is acquired. An adaptive management plan should be a requirement for project approvals, with procedures that enable rapid responses when and where an effect is detected.

2.2.4. EARLY INITIATION OF BASELINE STUDIES

A common feature of sites suitable for in-stream tidal energy developments is the paucity of environmental data and related information. Such sites are generally high current velocity locations that have not been studied for other marine resource uses (except transportation). Critical environmental and socio-economic information may therefore not be available. Environmental information relevant to assessing the risks associated with in-stream tidal energy developments takes a long period of time to acquire, and therefore early initiation of such studies is crucial.

Complex ecosystems like the Bay of Fundy have been the focus of multiple studies by government and academia for more than a century. Significant natural variability has been identified but the drivers and many of the linkages remain unknown. Given the above, it is not fair or appropriate to task individual developers with resolving issues as complex as ecosystem function. The challenge is identifying the appropriate parameters to assess operation-induced change. This circumstance needs to be addressed by a broad, collaborative approach utilizing the resources of developers, academic institutions and public service agencies.

2.2.5. CONSIDERATION OF SITE-SPECIFIC AND PROJECT-SPECIFIC CHARACTERISTICS

Multiple qualitative and numerical evaluation criteria and indicators of risk, adjustable to particular project designs and sites, are required.

Justification of regulatory decisions is made easier when the indicator threshold(s) for approval or rejection, or the selection of the degree of environmental assessment, can be expressed in quantitative terms. The current regulatory thresholds for tidal energy projects for deciding whether a given proposal should undergo an environmental assessment are based on total energy production capacity. For example, under the *CEAA 2012* regulations (as of August 2012), only tidal energy generation stations of 5 MW or more or an expansion of such a station with an increase in production capacity of more than 35% require submission of a project description to determine if a federal environmental assessment is required[4]. Projects of 2 MW or more are required to undergo a Class 1 environmental assessment under the *Nova Scotia Environment Act*. However, regulators, scientists and developers recognize that these values are essentially arbitrary and that thresholds based on scientifically justifiable criteria are needed to ensure appropriate and environmentally sound regulatory decisions are made and actions are taken. Better understanding of the real environmental effects of tidal energy extraction, derived from experimental deployment of devices and monitoring of their effects, should enable a clearer rationale for selection of indicator threshold values. However, because of the rapid development of this field, the highly variable nature of the environment and technologies, the limited knowledge of ecosystems, and the complex scale relationships (e.g. device/array scale vs. site scale), it may not be scientifically justifiable to select any one meaningful and durable universally applicable threshold for decision-making. For example, thresholds based on energy production, or size of the project, are what are typically used for other types of energy projects. However, these criteria considered in isolation from the physical and biological characteristics of the proposed site are inadequate, by themselves, to reflect the environmental risk or impact of a project. For example, the impact of a 2MW array in an open high energy site, without sensitive habitats or species, may be low, whereas the same 2MW array may have a significant impact in a semi-enclosed or lower energy site or area with sensitive species or habitats.

2.2.6. SOCIAL VALUES AND CONCERNS

Tidal energy development is likely to take place in an environment that is already extensively used for other purposes, such as fishing, aquaculture, fossil fuel exploration and extraction, conservation, transportation, tourism and recreation. Displacement of any of these resource uses to accommodate MRE development may engender difficulty or even hardship at the local community level. It is therefore critical that one of the values enshrined in or underlying any environmental assessment process be that of maintaining or ensuring community sustainability, with the focus on those communities in close proximity to the site of MRE development[5].

2.2.7. FIRST NATIONS ENGAGEMENT

[4] This threshold does not automatically trigger an environmental assessment.

[5] The Strategic Environmental Assessment for the Bay of Fundy (OEER 2008) clearly indicated that, while Nova Scotians are generally supportive of the testing of MRE devices in the hope that they will enable the Province to address its energy and carbon output problems, respondents were adamant that the benefits of MRE should flow in the first instance to the affected or proximal communities and province rather than be realized only by those living far away. Export of energy and earning of revenue through exports are not precluded thereby, but there is a desire to see that local needs are met first.

All coastal environments in Canada have been important to First Nations communities for as long as the country has been inhabited. Many sites suitable for in-stream tidal energy development may still be associated with important resources for First Nations communities, and may also be subjects of continuing discussions with provincial and federal governments regarding jurisdiction. In Nova Scotia there is an obligation to consider First Nations interests in developments, and to consult. In addition, First Nations communities often possess unique environmental information that should be utilized in assessing both the potential and risks of TISEC developments. Proponents should follow the procedures outlined in the Proponent's Guide: Engagement with the Mi'kmaq of Nova Scotia (Nova Scotia Office of Aboriginal Affairs 2009).

3.0. ENVIRONMENTAL RISK ASSESSMENT AND REGULATORY DECISION-MAKING FRAMEWORK

Regulators and proponents currently lack practical and consistent guidelines upon which to base in-stream tidal energy project planning and assessment. The following section provides recommended guidelines for science-based risk assessment and decision-making of in-stream tidal energy projects. The guidelines take the form of a framework or process for identifying the overall risk of a project and the best appropriate management decisions based on a set of defined criteria.

As illustrated in the MRE Pathways of Effects models (Figure 2, p7), MRE projects introduce seven major stressors on the environment which have the potential to cause dozens of individual and interconnected effects (stressor-effect linkages). The assessment of each individual stressor-effect linkage is not practical on a project by project basis, especially given the high level of uncertainty in terms of probability, magnitude and significance. Moreover, with the current high level of uncertainty and site-specific variability of the environmental effects of in-stream tidal energy, it is not possible to define universally applicable (to any project at any site), scientifically-justified quantitative threshold values (e.g. size, number of devices or energy production capacity) on which to judge whether a project is likely to cause adverse environmental effects.

The risk assessment framework is designed to overcome these challenges using a set of standard defined criteria and indicators (Table 3a) that:

- Are relevant, flexible and can be consistently applied to projects of any type, size or location;
- Address directly or indirectly the major environmental concerns related to the operation of in-stream tidal devices;
- Relate to specific and characterizable attributes of a development project and the environment; and
- Are based on current scientific literature, including the DFO Pathways of Effects, and expert judgment (see Recommended Resources).

The proposed **regulatory decision-making process** uses the criteria and indicators above, and involves the following seven steps (Figure 3a):

1. Define the scope of the review.
2. Evaluate the project site characteristics.
3. Evaluate the environmental risk of the project proposal based on a set of standard defined criteria and indicators *(as in Table 3a).*
4. Identify risks of interference with other human uses of the ecosystem (e.g. fisheries, recreation).
5. Categorize the overall risk of the proposed project and make a management decision.
6. Propose supplementary mitigation measures to reduce the overall risk of the project, where applicable.

7. Prepare an environmental monitoring and adaptive management program for an approved project.

Table 3a. Environmental Risk Assessment Criteria and Indicators

Criteria	Indicators
1. **Extent of habitat alteration due to the presence of physical infrastructure**	• Physical presence of infrastructure on benthic habitat (seabed) • Physical presence throughout the water column • Physical presence on the surface
2. **Effect on water movement and sediment dynamics**	• Amount of kinetic energy expected to be extracted by the project compared to the total available kinetic energy in the system (percentage) • Physical configuration of the site in which the development is to be located (site-scale relationship) • System characterized by seasonal or spatial fluctuations in natural flow patterns that may be affected by a regulation or disruption of current flow • Other MRE developments, in operation or planned, in the system (cumulative effects)
3. **Timing of short term projects (for projects that will be in place for less than one year)**	• Timing of project activities in relation to known spawning, nursery, migratory or other critical time periods
4. **Physical obstacle to marine organisms**	• Capability of marine organisms to detect and actively avoid the infrastructure • Proportion of the specific pathway occupied by the project • Presence and suitability of other natural pathways available to the population to move between habitats • Presence of other developments in the area that may also present obstacles to movement of marine organisms (cumulative effects)
5. **Noise, vibrations and turbulence effects on marine organisms due to turbine operation**	• The size of the project (physical size of devices, number of turbines) • Characteristics of ambient conditions • Presence of other anthropogenic signals • Presence of species known to be sensitive • Ability of organisms to evade affected area
6. **Effects of other signals emitted by project infrastructure**	• The extent of the power cabling and lights • Characteristics of ambient conditions • Presence of other anthropogenic signals • Presence of species known to be sensitive • Ability of organisms to evade the affected area

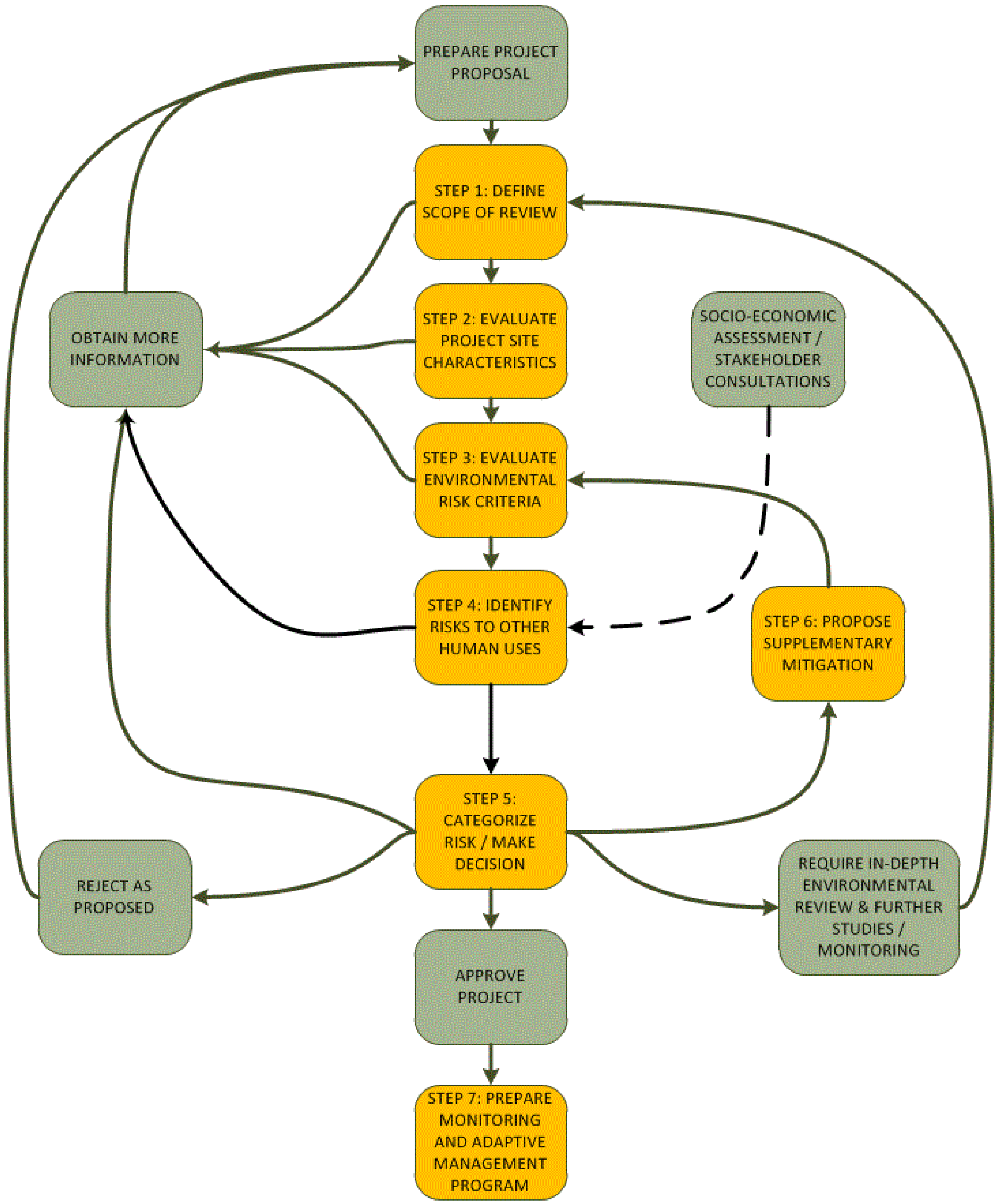

Figure 3a. Proposed Environmental Risk Review and Decision-Making Framework.

3.1. STEP 1: DEFINE SCOPE OF THE REVIEW

3.1.1. STRESSORS

The criteria in this framework are focused on the risks related to the presence and operation of a tidal energy development. In reviewing proposals, regulators are faced with novel and/or poorly understood factors that cannot always be adequately addressed using current metrics or procedures. Standard assessment criteria generally applicable to marine site investigation, construction, maintenance and decommissioning activities, as well as the potential releases of chemical contaminants (e.g. antifoulants, lubricants), should be adequate to deal with such aspects of tidal development proposals.

3.1.2. SIZE OF THE PROJECT

Scientists and regulators have generally considered small-scale, short-term deployments (e.g. single device prototype or pilot trials) to present a fairly low environmental risk that could be addressed by application of standard mitigation measures, especially given the option to cease operations if a problem becomes detectable. However, at least until more knowledge and experience are gained on the interactions of moderate to large-scale devices or multi-device arrays with the environment, any demonstration or commercial scale deployment should undergo, at minimum, a preliminary review and risk assessment, following the framework prescribed below.

3.1.3. ECOSYSTEM COMPONENTS

While a thorough examination of every ecosystem component may not be warranted, a proper risk assessment must recognize the complexity of the interconnections among and between species and the physical environments. Following on the MRE Pathways of Effects models (Isaacman and Daborn 2011; see Figure 2), the framework adopts a broad view of the ecosystem components and effects that should be considered in the risk assessment and decision-making process.

While federal and provincial regulators may be primarily concerned with certain species or habitats of social or economic importance (such as commercially valuable fish species, marine mammals or species at risk), legislated review and permitting processes (e.g. under Fisheries Act, Canadian Environmental Assessment Act and provincial environmental assessment acts) recognize the need to consider the effects on the whole biological community as well as the physical habitats on which they depend.

As identified in the Pathways of Effects models, the four main ecosystem component categories that may be affected by tidal energy developments are:

- Fish;
- Marine mammals;

- Marine plants and invertebrates, including shellfish, crustaceans and planktonic organisms; and
- Marine birds.

These categories include all life stages (e.g. eggs, sperm, spawn, larvae, spat, juvenile and adult stages), as well as the ***habitats*** upon which the species depend.

We define 'habitat' broadly as the benthic, pelagic, shoreline and/or surface areas, and the physical, chemical and biological conditions, on which individual species depend, directly or indirectly, including:

- Spawning, nursery, rearing or food supply areas;
- Migration routes;
- Refuges from predation (e.g. seaweed beds, marshes, etc.); and
- Biological community and food-web structure and interactions.

3.1.4. SPATIAL SCALE

A key aspect of the environmental review of a tidal project is defining the geographic scope of the affected area. Due to the nature of in-stream tidal energy, the scope of the affected area may extend well beyond the area of direct physical occupation of infrastructure. While information may be insufficient to define accurately the entire extent of affected area, a conservative and scientifically justifiable approximation must be considered when assessing each of the criteria.

Definitions

While the terms 'footprint', 'near-field' and 'far-field' are widely referred to in MRE environmental assessment processes, to date, these terms remain undefined and are thus ambiguous. In some cases, authors of reports have assigned values (for distance, area) but with no scientific justification. For example, 'near-field' has sometimes been used to refer to the 'footprint', set as some arbitrary distance (e.g. up to 10m around the turbine or some multiple of blade length or turbine diameter) or left completely undefined. 'Far-field' is often left to refer to an unbounded area outside the near-field.

Given the importance of spatial scale delineation for defining environmental assessment and monitoring requirements and to maintain consistency among projects, scientifically well-justified spatial boundary definitions are required. Given the number of factors that need to be considered (including differences among environmental effect types and site characteristics), this will require a consensus process among experts in environmental monitoring in high flow environments. We recommend this as a discussion topic for a future workshop.

In the absence of agreed upon definitions, we suggest using the terms 'localized' and 'system-scale' in place of 'near-field' and 'far-field', respectively, when describing the spatial area related to environmental effects.

‘Footprint’ is most often loosely deemed to be the area physically occupied or covered by some structure(s). For most marine activities, especially tidal power, this definition is of little scientific utility in terms of environmental effects. Devices with a large gravity base obviously may have a large surface that overlies the substrate, essentially smothering the benthic habitat and fauna; other devices, however, may be supported on pilings inserted into the substrate, or tethered by cables, and thus have a minor direct contact with the bottom; yet others may be suspended from floating structures restrained by cables and anchors. Arrays of turbines, however, collectively modify habitat processes, and have direct effects on flow characteristics that extend well beyond the minimal ‘footprint’ of each device. For these reasons, we opt to avoid its use as a separate category in these guidelines, in favour of including the effects of the ‘footprint’ together with those of the ‘localized’ area.

For practical purposes, ‘localized’ effects can be considered as those occurring in the immediate space occupied by the development outward to a distance of up to 20x the diameter of the turbine or array (which is the approximate distance of the wake effect observed with the OpenHydro turbine in the FORCE site in 2009) (i.e. the direct zone of influence). ‘System-scale’ effects can be seen as those extending beyond the localized area and well beyond the direct zone of influence. System-scale effects can be regional extending up to tens or hundreds of kilometers or more depending on the site and scale of the project, and the indicators being measured.

3.1.5. CUMULATIVE EFFECTS

All proposals should be evaluated in the context of other established or projected human activities in the affected area. For example, while a given turbine or array may be expected to result in only a minor reduction in tidal energy or affect only a small fraction of habitat in the system, many activities (tidal or other) acting in concert (cumulatively or synergistically) may result in major changes to the tidal ecosystem.

3.1.6. TIMESCALE

Effects may change, intensify or only become detectable over a period of time. Thus, impacts should be assessed over the entire predicted life of the project.

3.1.7. STAGED DEVELOPMENTS

Although proposals for single or small-scale devices or demonstration projects may not exhibit a high risk or trigger environmental assessment requirements, proponents and regulators should keep in mind any intentions for expansion (scaling-up) of the project, as larger, longer-term projects will present different environmental risks in a given area. By considering projected scale-ups in the review of early phase proposals, regulators and proponents can be better prepared to address potential future environmental concerns, including preparation of adaptive management strategies and initiation of data collection and monitoring programs. This would permit a streamlined and progressive environmental assessment process in the event that an expansion is pursued.

3.2. STEP 2: EVALUATING THE PROJECT SITE CHARACTERISTICS

A basic prerequisite to making scientifically sound and well informed decisions is the availability of information of sufficient detail and quality on the nature of the project proposal and the physical and biological environment at the site. Therefore, all project proposals must start with a detailed project description and baseline site assessment / characterization. The scope of the baseline survey requirements should be aligned with the anticipated scale of the project and its associated effects. Where information is unavailable or high uncertainty exists in a given criterion, risk level decisions must err on the side of the precautionary approach.

3.2.1. SITE SCALE RELATIONSHIPS

Assessing the implications of TISEC developments requires recognition of the important interrelationship between the scale of the development and the size and characteristics of the site itself. TISEC developments require high flow locations. Strong current flows, sufficient for renewable energy extraction, are found in three different situations: through the narrow entrance of a coastal basin, through multiple passages between landforms, and in certain coastal areas offshore (Figure 3b).

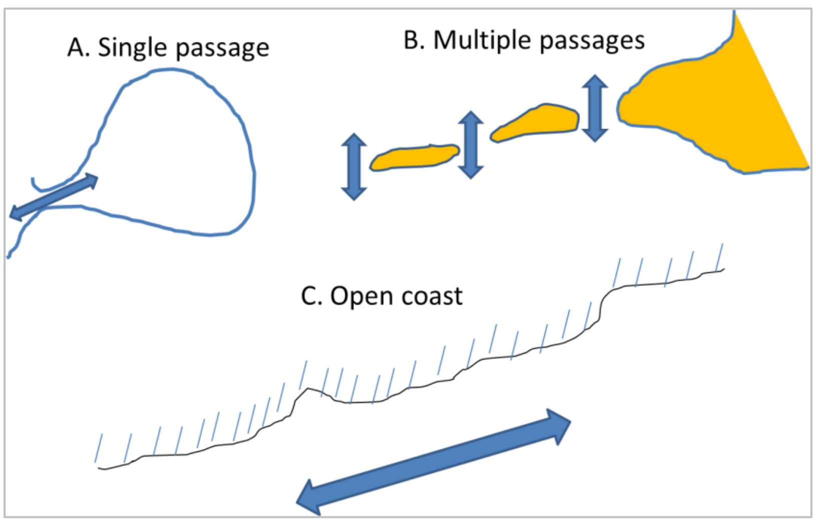

Figure 3b. Types of Tidal Energy Sites

The environmental effects of energy extraction in these three situations differ significantly, as discussed below.

A. Single narrow passage

The confined entrance to a basin or bay represents the only passage through which water and migrating animals can pass. TISEC devices will resist and divert flow into and out of the basin, resulting in increasing elevation differences (and hence faster flows up to a point – cf. Garrett and Cummins 2008) on either side of the passage, until increasing friction begins to limit flows and therefore decrease kinetic energy. As the scale of development increases relative to the width (scale) of the passage, a TISEC array would begin to act more like a barrier, affecting the tidal resonance, and hence the amplitude as well as the phase of the tide. In general, a basin entrance location is more likely to produce system-scale effects than either inter-island or coastal locations. The problems for organisms are varied: decreasing water velocity behind the array would be expected to affect sediment erosion and deposition, and hence benthic habitat and biota in the bay; migrating fish have no alternative but to pass through the passage, and as the scale of the development increases, this will represent an increasing risk of encountering TISEC devices; and noise and turbulence in the passage will change, with consequent effects on animal communication, prey/predator detection, etc..

B. Multiple passages between landforms

Canada's three ocean coasts exhibit numerous sites with multiple high flow passages between islands and other landforms. Because there are alternate pathways that the water can follow, the restrictive effects of TISEC devices will be different: increasing resistance to flow will mean that more water will pass through other open passages. Similarly, tidal amplitude, flow velocity, and resonance relationships are likely to be less affected than in a single narrow passage site. Whether any alternate passages can be used by migrating animals will depend upon local circumstances (e.g. water depth, current velocities, etc.), and perhaps also on stock genetic characteristics that might determine migratory route.

C. Open coast

By comparison, open coast sites with high current speeds exhibit few of the above interrelationships. Increasing array size will have much less effect on flow dynamics or tidal characteristics, and animal movements will be far less restricted. For the biota, the localized effects (e.g. entrainment, benthic and pelagic habitat characteristics, noise and turbulence, etc.) are likely to be of greatest importance.

3.2.2. PRESENCE OF SPECIES AND/OR HABITATS OF HIGH CONSERVATION CONCERN

Projects proposed to take place in an area containing one or more species or habitats of high conservation concern (HCC)[6] should automatically be flagged as potentially high risk. This is because HCC are more susceptible to being significantly and adversely affected by added stressors and less capable of recovery (low reversibility). Thus, there would be higher consequences to assuming risks from the project. For a project to be approved or permitted to continue, adequate mitigation measures must be put in place to ensure no adverse impacts to HCC.

[6] An ecosystem component that is considered of ecological, economic or cultural concern or is sensitive to disturbance. Concept similar to "Valued Ecosystem Components (VEC)"

Table 3b. Species and Habitats of High Conservation Concern

HCC		Explanation
Species - resident or seasonal	Federally or provincially listed Species at Risk, their residence and/or critical habitat	Species at risk are protected under federal and/or provincial species at risk legislation. Given they are already vulnerable and at low numbers, the loss or disturbance of even one or small number of individuals can be significant and thus pose unacceptable consequences to the survival of the species. Many species at risk require specific habitat conditions; such species will be more sensitive to changes caused by TISEC developments and thus risks may be higher.
	Non-listed species that are at risk or regionally rare	Although not listed under legislation, many species have been identified as at risk or rare through various national or international scientific assessment bodies like COSEWIC or IUCN. Given they are already vulnerable and at low numbers, the loss or disturbance of even one or small number of individuals can be significant and thus pose an unacceptable consequence to the survival of the species. Many species at risk require specific habitat conditions; such species will be more sensitive to changes caused by TISEC developments and thus risks may be higher.
	Species harvested in commercial, recreational or aboriginal fisheries	Harvested species may be less able to tolerate the added stressors from tidal developments. Moreover, changes caused by tidal developments may affect the productivity and sustainability of fisheries and thus will be under a higher level of public scrutiny. It should also be noted that commercially important species may be harvested in regions well away from the spawning or rearing habitat where the tidal developments may occur.
	Marine mammals, sea turtles and other species of high public concern	Whether or not considered at risk, many species may be highly valued by the public and the loss or disturbance of even one individual may be deemed unacceptable. Where these species are present, a proposed project will be under greater public scrutiny.
	Migratory species (especially those that cross international boundaries)	Species that migrate between habitats may be subject to additional stresses. There may also be legal implications if a species crosses an international boundary between feeding and spawning habitats.
	Species known to be highly sensitive to perturbation	Some species have limited tolerance to changes in environmental parameters (e.g. temperature, turbidity, etc.); such species will be more sensitive to changes caused by TISEC developments and thus risks may be higher.
Habitat	Habitat of listed or unlisted, at risk or rare species	Areas designated as residences or critical habitat for species at risk are protected under provincial or federal legislation. Whether legally designated or not, risks to the essential habitat of an at-risk or rare species need to be minimized to ensure the survival of the species.

		Rare or uncommon habitats are often important to rare or uncommon species and, therefore, are of concern for conservation of biodiversity.
	Ecologically significant or rare ecosystems	Some areas may be regionally, nationally or internationally recognized and thus any activities in those areas would be under high public scrutiny (e.g. marine protected areas). By definition, ecologically significant areas have a high ecological value, in terms of providing valuable ecological services, supporting high levels of biodiversity or containing unique or rare features or species. They are often also more sensitive to perturbation. Even a small loss or disturbance of an ecologically significant or rare ecosystem can have significant consequences.
	Regionally uncommon habitat that is essential for one or more species	Even where the habitat is not considered rare, it may be regionally uncommon. Local populations that depend on these habitat conditions may be harmed if they do not have access to other areas of similar habitat in the region.
	Habitats highly sensitive to perturbation	Habitats characterized by soft or loose sediments are more prone to sedimentation and erosion as a result of changes to current flows, turbulence or water column mixing, with consequent effects on the biota. Moreover, some habitats are sensitive to changes in tidal range, such as seagrass, macroalgae and salt marshes, which may be present in lower flow environments within the system-scale affected area.

3.3. STEP 3: EVALUATION OF ENVIRONMENTAL RISK CRITERIA

To determine the risk level for the project, the risk evaluator will need to evaluate the intensity of the negative environmental effects in terms of the species and habitats that may be affected. Whether or not HCC components are in the affected area, risks to ecosystems and marine organisms are present and potentially significant. Even where HCC components are present, a project may not be considered a high risk if none of the criteria fall outside acceptable parameters. Conversely, a project where a criterion has been flagged could be considered a high risk even if no HCC components are present.

While it may not be possible to make a thorough and individualized risk evaluation for each species or habitat (due to lack of resources or knowledge), a generalized assessment needs to be made based on the best available information on the types of species and habitats present. Given the higher concern and risk, a more detailed risk assessment may be required where HCC components have been identified.

In cases of uncertainty, the risk evaluator should err on the side of precaution, and either request more information from the planner or rate the criterion as higher risk.

Criteria indicators should be analyzed based on objective, science-based judgments of the attributes of the forecast effect (Table 3c).

Table 3c. Attributes of the Forecast Effect upon which to Assess Indicators

Characteristics	Nature of the forecast effect
Probability	What is the likelihood of the stressor or effect occurring?
Detectability	1. Magnitude of the anticipated impact. Is the effect forecast to be within detectable levels? 2. Measurability. Is it directly or indirectly measurable using currently available tools?
Spatial extent (localized and/or system-scale)	Variability in effects throughout the entire affected area should be recognized.
Significance	To the ecosystem or ecosystem component (e.g. how sensitive is the receptor to changes?, are the consequences ecologically acceptable?).
Duration	Most operational effects should be considered long-term (for the duration of the project) or permanent.
Reversibility	This is the ability of the ecosystem component to recover (return to approximate pre-development conditions) once the stressor is removed. It is not a measure of whether the stressor itself can be removed. Some effects may be reversible if detected and appropriate actions (e.g. mitigation, cessation of operations, removal of structures) are taken in a timely manner. Others may be irreversible, such as destruction or harm to rare or at risk species or habitats. Even where direct effects are reversible once a stressor is removed (e.g. the effect on hydrodynamic and sediment processes and patterns due to removal of tidal energy), it may not be possible for habitats, populations or community structure to recover from long-term changes (i.e. to return to previous conditions).

3.3.1. CRITERION 1: EXTENT OF HABITAT ALTERATION DUE TO THE PRESENCE OF PHYSICAL INFRASTRUCTURE

This criterion addresses the physical affects of infrastructure on the habitat within the 'localized' area of the project. This includes the physical space of benthic, pelagic, and coastal habitat occupied or directly affected by the physical infrastructure, including cables and inter-structure gaps.

The nature and significance of the effect will depend on:

- The structure of the pre-existing habitat (e.g. complex or homogeneous, hard or soft-substrates, vegetated or not, species diversity, biomass); and
- The amount of area physically occupied by the development compared to the total amount of similar habitat available (and accessible to organisms) in the system (i.e. how much of this habitat type does the array occupy?).

Table 3d. Criterion 1 Indicators of Environmental Risk

Indicators	Explanation
Physical presence of infrastructure on benthic habitat (seabed)	Alteration could include: • Physical loss of habitat of a particular type (e.g. covering, clearing, smothering or flattening); • Change in the composition (e.g. hard versus soft-sediments) and complexity of the habitat. This may result in a change in the biological community, especially in areas with soft-sediments, vegetation and/or homogeneous habitats; • Potential for scour and/or sedimentation. Are structures placed on soft or loose sediments vulnerable to erosion / scour around the bases of structures? Are any mitigation measures in place to address this issue? Is it possible to forecast the fate of sediments mobilized by the infrastructure? Will scouring be continuous or progressive during the existence of the project?
Physical presence in the water column	The structure may: • Create an obstacle for some organisms; • Serve as an artificial reef or aggregation device for some organisms; • Provide surfaces for epibenthic colonization (may include alien species) especially where sheltered from strong currents; • Cause wake / turbulence effects.
Physical presence on the surface	Some technologies may have components at the water surface. The increase in structure may: • Create an obstacle for some marine mammals or seabirds; • Act as an aggregating device or provide haul-out or roosting surfaces; • Provide surfaces for epibenthic colonization; • Affect light levels penetrating through water column.

3.3.2. CRITERION 2: EFFECT ON WATER MOVEMENT AND SEDIMENT DYNAMICS

Installation of any marine infrastructure is expected to have effects beyond the immediate area occupied by the device (both in the localized and system-scale area). While nearby areas may experience changes in sediment deposition or erosion, current velocity and turbulence, the spatial extent of the effect will vary depending on a number of factors, including the physical characteristics of the site. If the site is the sole entrance to a bay, changes may be more consequential, and extend further because of resonance effects, whereas a site between landforms may have less effect because alternate passages are available for water movement, mobile fauna, etc.

The size and configuration of the development needs to be scaled to the type of site (see 3.2.1. Site Scale Relationships). It is not possible at this time to specify a numerical threshold (e.g. amount of extracted energy) over which changes in water and sediment dynamics are likely to become detectable or significant. Any threshold value is likely variable between systems and seasons. Some systems may respond to only a slight decrease in energy, while others may require a large reduction to experience noticeable changes. Moreover, the significance of any level of change will be directly related to the ecological requirements of the system, including the dependency of local species and habitats on the specific flow velocities, patterns and seasonal fluctuations and the vulnerability of seabeds and coastlines to erosion and sedimentation.

Table 3e. Criterion 2 Indicators of Environmental Risk

Indicators	Explanation
Amount of kinetic energy expected to be extracted by the project compared to the total available kinetic energy in the system (percentage).	The intent is to compare the amount of energy being removed from the system with that required to maintain natural processes and patterns. The higher the percentage, the greater the likelihood to cause noticeable changes to localized and/or system-scale water and sediment dynamics.
Physical configuration of the site in which the development is to be located (site-scale relationship).	The project might be placed in a single narrow passage (entrance to a basin), a multi-passage system or open coast environment. See *3.2.1. Site Scale Relationships*. Each type of site may experience different localized and regional system-scale changes due to resonance effects, turbulence and proximity to coastlines. The size and configuration of the development needs to be scaled to the type of site.
System characterized by seasonal or spatial fluctuations in natural flow patterns that may be affected by a regulation or disruption of current flow.	The intent is to identify the degree of dependence of ecosystem processes and species on seasonal and spatial fluctuations and variability. This acts as a qualitative measure of the significance of forecasted change in tidal energy and associated processes.
Other MRE developments, in operation or planned, in the system (cumulative effects).	The proposed reduction in tidal energy of the present proposal should be considered in combination with that of the other developments to address the potential for cumulative or synergistic effects.

3.3.3. CRITERION 3: TIMING OF SHORT-TERM PROJECTS

Table 3f. Criterion 3 Indicators of Environmental Risk

Indicators	Explanation
Timing of project activities in relation to known spawning, nursery, migratory or other critical time periods	Where projects will be in place for less than one year, the intent is to ensure that the potential risks from short-term deployments (e.g. demonstrations or trials) are not discounted due to their temporary nature. While the stressor may be temporary, long-term and population-scale effects may be possible depending on the location and timing of the project.

3.3.4. CRITERION 4: PHYSICAL OBSTACLE TO MARINE ORGANISMS

This criterion is intended to serve as a measure of:

a) The potential of injury or mortality to organisms from collisions with (e.g. blade strikes or encounters with cables) or passing through (e.g. entrainment in downstream turbulence or pressure effects) project infrastructure;
b) The potential of the project to impede natural movement or migration patterns, either through (a) or active avoidance.

These factors are relevant for both migratory and resident species, which may be affected at the individual or population scales directly through physical or physiological injury (i.e. increased mortality, reduced fitness) or indirectly through avoidance or exclusion from important areas of habitat, with potential for impacts to be seen locally and ecosystem-wide.

Table 3g. Criterion 4 Indicators of Environmental Risk

Indicators	Explanation
Capability of marine organisms to detect and actively avoid the array	This is intended as a measure of the risk of injury from physical interaction with project infrastructure that is applicable regardless of the characteristics of the specific type of device or array. This measure is based on the assumption that passing through the site occupied by the turbine (localized) increases the risk of physical or physiological injury. Signals produced by TISEC devices, including visual, noise, vibrations, EMF and turbulence, may enhance their detectability by marine organisms and thus reduce the potential for physical encounters. This is only the case for organisms able to take evasive actions and/or take another route. Some organisms may be stronger or more agile, able to overcome currents and swim around multiple obstacles, while weaker swimmers or non-motile organisms (that travel with the currents) may be unable to avoid entrainment or navigate through complex obstacles. Given that the ability of many species and life stages to detect and avoid these devices is poorly understood, this indicator should at minimum be based on the general understanding of swimming ability and behaviours, where known. Please note, the signals emitted by the device(s) may be far-reaching, and thus affect the movements and behaviours of organisms well beyond the localized area. Moreover, these signals may have negative consequences for organisms unable to avoid the affected area (see Criterion 5 and 6).
Proportion of the specific pathway occupied by the project	This is a measure of whether the project presents a total or partial obstacle to the use of the particular route in which the project is located. Given the above, will the species be able to follow their natural migration route / movement pathway without having to pass through the array (i.e. is there available and suitable space to go

	around it)? Both the horizontal (e.g. width of the channel) and vertical range (depth in the water column) must be considered.
Presence and suitability of other natural pathways available to the population to move between habitats	This is a measure of how important the specific pathway in which the project is to be located is to the population and the ability / probability of individuals and/or the entire population to take an alternate route. An example may be where the project is placed in one of multiple channels in the system (see 3.2.1. Site Scale Relationship). However, in this case, it should not be assumed that all the channels may serve as suitable routes. Some considerations include: • The frequency of use of the route and its alternatives by each population. o Is the project placed in the primary or a less frequented route? • Are individuals strongly predisposed (e.g. genetically or behaviourally) to prefer one route over another or are they equally likely to take more than one route? • Capability of marine organisms to actively avoid the array (see above). • Are the alternate routes capable of supporting a higher level of traffic and/or could there be a cost to concentrating movement through fewer routes (e.g. increased competition, risk of predation)?
Presence of other developments in the area that may also present an obstacle to movement of marine organisms (cumulative effects)	Either within the particular pathway or within alternative routes.

3.3.5. CRITERION 5: NOISE, VIBRATIONS AND TURBULENCE EFFECTS ON MARINE ORGANISMS DUE TO TURBINE OPERATION

The intent of this criterion is to serve as a measure of the likelihood that noise, vibrations and/or turbulence produced by the operation of tidal turbines will adversely affect the behaviour or physiology of marine organisms.

Responses to noise and vibrations could include:

- Avoidance of affected areas (may exclude a species from habitat or be a barrier to movement);
- Interference with navigation or orientation mechanisms/cues;
- Increased stress;
- Interference with communication, and mate and prey detection;
- Physical or physiological damage to auditory systems.

Changes in down current turbulence have the potential to cause fatigue, stress and disorientation in some organisms, reducing their fitness or ability to avoid predators, and increasing mortality in vertebrate larvae and eggs, and invertebrates.

While the intensity may be highest in the immediate vicinity of devices, noise and other disturbances emitted by devices may be detectable well beyond the immediate location of the project, producing potentially adverse behavioural and physiological responses to sensitive species at some distance from the actual project site. Thus, risk evaluators should consider the detectability and reactions of organisms present in both the localized and system-scale area.

The intent of this criterion is to permit an assessment of risk even where there is little or no data and thus much uncertainty in (a) noise and turbulence created by specific devices at specified scales, (b) how the devices interact with ambient / existing environmental conditions, and (c) the reactions of various organisms to device effects on noise and turbulence.

Table 3h. Criterion 5 Indicators of Environmental Risk

Indicator	Noise and vibrations	Turbulence
Size of project (physical size of devices, number of turbines and associated infrastructure)	With the assumption that, the larger the project, the greater the intensity and spatial extent of the disturbance.	
Characteristics of ambient conditions	This is intended as a measure of whether the signals are likely to be detectable by marine organisms against pre-existing conditions. Marine organisms may respond to sounds or vibrations of a greater intensity or different quality than they are accustomed to. Even in noisy or turbulent environments, the operation of devices may alter the sound or vibrational environment for a considerable distance. However, in a naturally noisy and/or turbulent environment, the additional signals generated by the turbines may be masked by (undetectable against) the natural conditions. Moreover, marine organisms in the area may be accustomed to that type of an environment.	
Presence of other anthropogenic signals	Pre-existing anthropogenic activities, including other tidal developments, may already be producing similar or greater signals, which may mask or offset the risk of any additional signals produced by the proposed project. However, it is possible that the signals from each of the activities may interact to produce an even greater response in marine organisms.	
Presence of species known to be sensitive	Given that a full assessment of this criterion is both labour and data intensive, focus should be placed on HCC and other species known to be particularly sensitive to this stressor (e.g. marine mammals). Several syntheses of information on impacts of tidal turbine noise on marine organisms are available (see Recommended Resources).	Lower mobility organisms, including smaller fish, invertebrates, plankton, eggs and larvae, may be particularly vulnerable to entrainment in and disturbance by turbulence, rendering them more susceptible to injury and /or predation.
Ability of organisms to evade affected area	Noise, vibrations and turbulence signals produced by the devices may enhance the detectability of the turbines by marine organisms and thus reduce the potential of physical encounters by organisms able to evade the structures or take another route. In fact, the use of noise-making devices (e.g. seal deterrents) may be considered as a mitigation measure to reduce the likelihood of strike or entrainment by deterring organisms (particularly marine mammals) from the site. Please note that not all organisms may be able to leave or avoid the affected areas, especially where the signals extend well beyond the area of entrainment (see Criterion 4).	

3.3.6. CRITERION 6: EFFECTS OF OTHER SIGNALS EMITTED BY PROJECT INFRASTRUCTURE

The intent of this criterion is to serve as a measure of the likelihood that signals emitted by the project infrastructure, other than those dealt with in Criterion 5, will adversely affect the behaviour or physiology of marine organisms.

Signals to consider include:

a) Electromagnetic fields (EMF) produced by the power cables or turbines;
b) Artificial light; and
c) Other emissions produced during operations, as identified by the proponent or regulator.

These stressors are generally considered to present less of a risk to marine organisms at the present time, than those in Criterion 5. Moreover, there is great uncertainty regarding whether EMFs produced by power cables of the type used in tidal projects are at levels that would be detectable or of concern to marine organisms, and if so, at what distances and directions. Nevertheless, these stressors are of public concern and may be determined to present a higher risk as more experience is gained. Thus, they should be included in risk assessment, mitigation, monitoring and adaptive management.

Responses to EMFs could include:

- Avoidance of or attraction to affected areas;
- Interference with navigation or orientation mechanisms/cues;
- Increased stress;
- Interference with communication and mate and prey detection; and
- Physical or physiological damage.

Artificial lights may attract certain organisms, particularly marine birds, mammals and turtles, which may increase risk of strikes or entrainment.

The intent of this criterion is to permit an assessment of risk even where there is uncertainty in: (a) outputs (EMFs) from the specific devices at specified scales; (b) how these interact with ambient / existing environmental conditions; and (c) the reactions of various organisms.

Table 3i. Criterion 6 Indicators of Environmental Risk

Indicator	EMF	Artificial light
The extent of the power cabling and lights	With the assumption that the more extensive the cabling, and higher the transmission capacity, the greater the potential intensity and spatial influence. This should also take into consideration whether the cables are shielded and/or buried. Characteristics of the transmission (e.g. DC vs. AC) are also important.	This would only be a factor associated with surface structures.

Characteristics of ambient conditions	This is intended as a measure of whether the disturbance is likely to be detectable by marine organisms against pre-existing conditions. Marine organisms may respond to EMFs of a greater intensity or different quality than they are accustomed to. While it is possible that fields may be masked by (undetectable against) the natural conditions or that marine organisms may be accustomed to such signals, this should not be assumed.	n/a
Presence of other anthropogenic signals	Pre-existing anthropogenic activities, including other tidal developments, may already be producing similar or greater signals, which may mask or offset the risk of any additional signals produced by the proposed project. However, it is possible that the signals from each of the activities may interact to produce an even greater response in marine organisms.	
Presence of species known to be sensitive	Given that a full assessment of this criterion is both labour and data intensive, focus should be placed on HCC and other species known to be particularly sensitive to this stressor. Several syntheses of information on impacts of electromagnetic fields on marine organisms are available (see Recommended Resources). For example, elasmobranchs are known to be particularly sensitive to EMFs and may exhibit behavioural reactions to underwater power cables of the type associated with tidal turbines (including avoidance, attraction and aggression towards the cables). Benthic organisms may also be particularly vulnerable to EMFs given their proximity to the source of the emissions.	Artificial lights may attract certain organisms, particularly marine birds, mammals and turtles, which may increase risk of strikes or entrainment.
Ability of organisms to evade the affected area	Some organisms may be repelled by EMFs. This may reduce the potential of physical encounters by organisms able to evade the structures or take another route. However, not all organisms may be able to relocate or avoid the affected areas, especially if the site has extensive cabling systems or cables that extend across migratory pathways (see Criterion 4).	Artificial lights may enhance the detectability of the turbines by marine organisms and thus reduce the potential for physical encounters by organisms able to evade the structures or take another route.

3.4. STEP 4: IDENTIFYING RISKS OF INTERFERENCE WITH OTHER HUMAN USES

One non-scientific factor that is appropriate for inclusion as a distinct criterion in the categorization of risk level is the potential for interference with other human uses of the marine and coastal ecosystem. Examples of relevant human uses include:

- commercial, recreational, subsistence and aboriginal fisheries;
- aquaculture;
- marine transportation/navigation;
- tourism and recreational uses (e.g. boating, surfing, diving, whale watching, beaches);
- subsea cabling and pipelines; and
- mining and oil and gas operations.

Some uses may be displaced or disrupted by the presence of a tidal energy development. Others may be able to coexist without significant disruption. Both current and probable future uses should be considered. However, the risk level may be weighted higher for current uses. By incorporating implications for the environment and other human uses, an integrated management approach can be taken in project planning and decision-making, including the design of mitigation and adaptive management measures. Information on the degree of risk to various uses may be available through marine spatial planning, socioeconomic impact assessment and/or consultations with stakeholders.

The purpose of this guidance document is to support objective planning and decision-making that prevents development projects from causing significant adverse effects on the natural environment. Other socioeconomic values, such as effects on the local and regional economy, jobs, business development, contribution to meeting renewable energy targets etc., *should not* be considered within the environmental risk assessment and decision-making process. These should be considered *after* the project is determined to be environmentally acceptable.

3.5. STEP 5: CATEGORIZING RISK

Once a project proposal is received, the available information would be reviewed against each criterion. Each criterion (environmental and other human uses) should be considered of equal weight. Therefore, following a precautionary approach, a high risk score in one criterion could place the entire project in the high risk level. With no high risk criteria, and even one moderate, the overall risk level of the project would be moderate. If all criteria are low risk, the project would be classified as low risk.

Each risk level is associated with an appropriate regulatory decision on the environmental assessment and approval requirements for the project to proceed (Management Decision). Using these criteria, risk evaluators can make and scientifically justify decisions on the likely overall risk, necessary environmental assessment, and approval requirements for a particular project.

Table 3j. Categories of Risk of a Proposed Project

Risk Level	Recommended management decision
Low	Project may proceed without further review.
Moderate	Project as proposed will require a more detailed review and/or environmental studies and/or monitoring program before receiving approval.
High	Project as proposed will require an in-depth review with further environmental studies and/or monitoring before receiving approval.
Extremely high	Project poses an unacceptable risk and may not proceed as proposed. Major redesign and/or relocation are required. Revised proposals will need to be re-submitted.

For large-scale commercial projects, where there may be a greater potential for an environmental impact, the risk can be mitigated using an adaptive, staged development approach, where the development is scaled-up in size (number of devices, production capacity) in incremental stages over time. Proposals for larger-scale projects which incorporate an incremental growth approach may qualify at a lower risk, requiring a less extensive initial review (than an equivalent project without staged growth), as long as a well-designed monitoring, re-assessment (at each stage) and adaptive management procedure is put in place.

By developing commercial-scale projects in a staged, precautionary and adaptive manner, regulators, scientists and developers will be able to gain valuable information and data on baseline environmental conditions and the effects of the technology. Since project proponents cannot be expected to be responsible for research and monitoring beyond the scope of their project, credit should be given to projects which include a strong *independently-run* environmental research and monitoring program. Applied research and monitoring would benefit both proponents and regulatory agencies by facilitating efficient project planning, environmental assessment, monitoring and mitigation.

3.6. STEP 6: SUPPLEMENTARY MITIGATION

Moderate and/or high risk projects face delays and added costs associated with the need for a more in-depth review, baseline studies and monitoring program, as well as the continued risk that the project could be rejected. However, the project may be downgraded to a low risk level by applying appropriate mitigation measures that address all the *indicated* risks (both to the environment and other human uses), thereby allowing the project to proceed without the need for further review. Mitigation may involve relocation to a site less likely to be negatively affected, change in the timing of project activities (especially for short-term projects), adjustments to the size or configuration of the development, or use of mitigation devices, such as erosion protection, or fish/marine mammal deterrents. Extremely high risk proposals require major revisions, and must again proceed through all the Steps.

3.7. STEP 7: PREPARING A MONITORING AND ADAPTIVE MANAGEMENT PROGRAM

When a project is approved, follow-up activities, including research and monitoring, are key to reducing scientific uncertainty and allow informed decisions to be made in the future. These activities should be incorporated into the conditions for approval of any project.

An iterative process of risk assessment and mitigation is required. This could be achieved by establishment of an independent oversight committee, such as the Environmental Monitoring Advisory Committee (EMAC) established by FORCE. At minimum, both proponents and regulators need to work together from the outset to design a long-term adaptive environmental monitoring and management program. Such a program would include:

- monitoring requirements;
- timelines and/or conditions for re-assessment; and
- an adaptive response plan.

Part of the role of monitoring will be to confirm the predictions of the environmental assessment and demonstrate that mitigation is functioning as intended. If unanticipated changes are detected, the adaptive response plan will ensure that appropriate and timely actions are taken to mitigate the cause of the change and minimize the potential for a significant adverse ecological effect to result. Response(s) could include:

- modification of project design or expansion plans;
- modification or addition of mitigation measures; or, if necessary;
- cessation of operations and/or removal of some or all devices.

Following the adaptive response plan, re-assessments would occur, at a predefined interval or condition and/or as new or improved information is gained on the baseline environment or impacts. Where new risks are identified or previously predicted risks are unsubstantiated, monitoring and mitigation requirements can be adapted.

4.0. CONCLUDING STATEMENTS AND RECOMMENDATIONS

This report provides a framework and guidance for best practices in environmental risk assessment and decision-making of in-stream tidal energy development proposals and projects, regardless of site size and location or scale of development (i.e. demonstration, commercial). It identifies guiding principles and offers an approach for environmental risk assessment and decision-making based on adaptive management principles and primary risk criteria and associated risk indicators. It is intended that these guidelines assist in the development of a Statement of Best Practice for the management of in-stream tidal energy development proposals and projects, and serve as guidance for regulatory and licensing authorities to ensure Canada's tidal energy industry develops in an environmentally safe and sustainable manner.

Recommended next steps to further the development of management practices for the emerging tidal energy industry include the following:

1. Workshop exercises, with policy makers, regulators, developers, academics and government scientists, and other stakeholders, focused on the development of
    a. case study scenarios which address environmental issues and risks for a range of existing and potential development sites (types shown in Section 3.2.1) and development levels (demonstration to large commercial activity);
    b. minimum requirements or standards for site assessment and environmental monitoring;
    c. 'near-field' (localized) and 'far-field' (system-scale) definitions in relation to the effects of in-stream tidal energy developments. Clarity on these terms is required to reduce ambiguity when they are used in relation to environmental risk assessment and effects monitoring; and
    d. policies, with respective responsibilities for proponents and regulators (and/or the science community), regarding collection of baseline environmental data.
2. Further refinement of the decision making framework and environmental risk assessment criteria.
3. Development of practical checklists, worksheets, diagrams and other tools for developers and regulators.
4. Development of guidelines for preparing adaptive management plans that enable rapid responses where an environmental effect is detected. Adaptive management would require continual oversight and environmental monitoring, and the ability to make modifications to projects as new information is acquired.

5.0. REFERENCES

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6.0. RECOMMENDED RESOURCES

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APPENDIX A: FEDERAL REGULATORY CONTEXT

NOTE: As per the 2012 Budget Implementation Act, several Canadian environmental laws, including the CEAA and the Fisheries Act, are currently being revised. If and when the changes come into force, some of the following may need to be revised accordingly.

A1. FEDERAL ENVIRONMENTAL ASSESSMENT PROCESS

The *Canadian Environmental Assessment Act* (CEAA) is the legal basis which sets out the responsibilities and procedures for the federal environmental assessment process. Under the CEAA 2012, an environmental assessment of a designated project (as prescribed under the *Regulations Designating Physical Activities*) ***may*** be required when there is the potential for adverse environmental effects that are within federal jurisdiction, including:

- fish and fish habitat;
- other aquatic species;
- migratory birds;
- federal lands;
- effects that cross provincial or international boundaries;
- effects that impact on Aboriginal peoples, such as their use of lands and resources for traditional purposes; and,
- changes to the environment that are directly linked to or necessarily incidental to any federal decisions about a project.

Included in the *Regulations Designating Physical Activities* are tidal generation stations of 5 MW or more or an expansion of such a station with an increase in production capacity of more than 35%.

CEAA 2012 requires that proponents of designated projects must submit a project description for review by the Canadian Environmental Assessment Agency. The Agency then determines whether an environmental assessment is required and if so, what type.

Projects that are not listed under the *Regulations Designating Physical Activities* may be required to undergo an environmental assessment if the Minister of Environment considers that the project has the potential to cause significant adverse environmental effects or there is public concern.

There are two types of federal environmental assessments: those conducted by the responsible authority (i.e. Canadian Environmental Assessment Agency) and those conducted by a review panel (i.e. appointed experts). The decision to refer a project to a review panel is made by the Minister of Environment based on consideration of the following factors:

- the potential for the project to cause significant adverse environmental effects;
- public concerns about those effects; and
- opportunities for cooperation with another jurisdiction.

Both processes must consider the following factors:

- environmental effects, including environmental effects caused by accidents and malfunctions, and cumulative environmental effects;
- significance of those environmental effects;
- public comments;
- mitigation measures and follow-up program requirements;
- purpose of the designated project;
- alternative means of carrying out the designated project;
- changes to the project caused by the environment;
- results of any relevant regional study; and
- any other relevant matter.

For more information visit: http://www.ceaa.gc.ca/default.asp?lang=En&n=4F451DCA-1

A2. CURRENT DFO RISK MANAGEMENT FRAMEWORK

The *Fisheries Act* provides the legal basis for the protection of fish and fish habitat. The main mechanism for the protection of fish habitat is the prohibition against ***the harmful alteration, disruption or destruction (HADD) of fish habitat (section 35).***

Other provisions of relevance to in-stream tidal projects are the prohibitions against:

- the destruction of fish by any means other than fishing (section 32); and
- the deposit of deleterious substances into fish habitat (section 36).

DFO is responsible for the administration of Section 32 and 35. Section 36 is administered by Environment Canada.

Given it is the principal authority responsible for the regulation of activities that may affect fish, fish habitat, and the marine environment, DFO is likely to be the lead agency with respect to the review, approval and follow up of environmental matters for proposed tidal energy development projects. One of the tools currently used by DFO Habitat Management Staff to support decision-making under the habitat protection provisions of the *Fisheries Act* is *The Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff.* The Risk Management Framework employs pathways of effects to assess residual effects to fish habitat based on a number of defined risk factors or attributes related to the *Scale of Negative Effects* and the *Sensitivity of Fish and Fish Habitat* (Table A1).

Table A1: Attributes to Describe Risk

Scale of Negative Effects	Sensitivity of Fish and Fish Habitat
Extent **Duration** **Intensity**	• Species Sensitivity • Species' Dependence on Habitat • Rarity • Habitat Resiliency

Source: Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff. http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155/risk-risque/page03-eng.asp

The existing framework is particularly designed for activities occurring in freshwater habitats, where the potential effects and appropriate mitigation measures are fairly well understood. While many of the general guidelines are relevant or can be adapted to tidal energy developments in marine environments, sector-specific guidance for In-stream Tidal Energy risk assessment is warranted to help regulators and proponents overcome the high level of complexity, variability and uncertainty presented by these novel activities occurring in dynamic marine environments.

Based upon these attributes, one of the following determinations is to be made:

(a) the project is unlikely to cause a HADD and/or the destruction of fish, providing appropriate mitigation measures are applied. This category usually pertains to activities where effects are temporary, well understood, and easily mitigable using standard measures. Many site investigation and construction related activities associated with in-stream tidal projects would fall into this category. In this case, an authorization is not required as long as proponents apply appropriate mitigation measures.

(b) the project is likely to cause a HADD and/or the destruction of fish and a detailed review and issuance of a section 35 and/or 32 authorization are required to proceed. Included in this category may be activities where there is a high level of uncertainty, in particular the magnitude of offsite effects. The level of review, mitigation measures, compensation, and monitoring would depend on the level of impact associated with the project.

(c) the project is likely to result in Significant Negative Effects and cannot proceed as proposed. Included in this category may be projects proposed in areas recognized as critical habitats and/or occupied by listed Species at Risk. Redesign or relocation may be options.

Category (b) projects are those that would ‘trigger’ an environmental assessment (most commonly screening level) under the CEAA.

A3. SPECIES AT RISK ACT (SARA)

The federal *Species at Risk Act* (SARA) includes provisions for the protection and recovery of species listed as endangered, threatened, of special concern or extirpated under the Act. The Act is applicable to all species under federal jurisdiction, including those covered under the *Fisheries Act* and *Migratory Birds Convention Act* and any other species on federal and territorial lands. The *Nova Scotia Endangered Species Act* provides protection for provincially listed species under provincial jurisdiction on provincial lands (i.e. species not covered under the *Fisheries Act* or *Migratory Birds Convention Act*).

Under the SARA, it is an offence to:

- kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened (s. 32);
- damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species (if a recovery strategy has recommended its reintroduction into the wild in Canada) (s. 33);
- destroy any part of the critical habitat of any listed endangered or threatened species or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada (s. 58).

The Section 32 and 33 prohibitions are applicable to both federally and provincially listed species under federal jurisdiction.

SARA allows the Minister to issue a permit or agreement authorizing a person to affect a listed species provided the three following pre-conditions are met:

- all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
- all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
- the activity will not jeopardize the survival or recovery of the species.

SARA is not a trigger for CEAA. The issuing of a SARA permit is not listed under the *Law List Regulations* of CEAA and thus does not, in itself, trigger the need for an environmental assessment. However, the presence of a federal or provincially listed species at risk and/or its critical habitat may, itself, be a trigger for the need to issue an authorization (e.g. under the *Fisheries Act*). Moreover, if an environmental assessment is required via another trigger (e.g. *Fisheries Act* authorization), the presence of and potential adverse effects to listed species at risk, their residence or critical habitat must be determined within the scope of the project. In fact, the presence of a listed species at risk and/or its residence or critical habitat in the project site could put an immediate end to a proposal unless the above conditions can be met and a SARA permit is issued. For more information visit: http://www.sararegistry.gc.ca/default_e.cfm

APPENDIX B: NOVA SCOTIA REGULATORY CONTEXT

B1. NOVA SCOTIA ENVIRONMENTAL ASSESSMENT PROCESS

Under the *Nova Scotia Environment Act (1994 as amended 2006)*, the province is responsible for the environmental assessment of designated projects which may have an adverse effect on the environment. Developments subject to an environmental assessment are listed as either Class 1 or Class 2 undertakings in the *Environmental Assessment Regulations*. For Class 1 undertakings, the proponent's initial project submission undergoes a public review to determine if the project is likely to cause a significant environmental impact or be of sufficient concern to the public, after which the Minister may decide a more detailed review and/or public hearing is required. Class 2 undertakings are usually larger and considered to have the potential to cause significant environmental impacts and concern for the public. An environmental assessment for any other projects may be required at the discretion of the Minister.

Under the current regulations, in-stream tidal energy developments with a production rating of at least 2MW derived from the tides are listed as Class 1 undertakings. Projects with ratings below 2MW are not required to undergo a provincial environmental assessment unless requested by the Minister. Currently, tidal energy projects are not covered in the list of Class 2 undertakings. For more information visit: http://www.gov.ns.ca/nse/ea/

B2. STRATEGIC ENVIRONMENTAL ASSESSMENT FOR BAY OF FUNDY TIDAL ENERGY

In 2007 the Nova Scotia government authorized the Offshore Energy Environmental Research Association (OEER) to conduct a Strategic Environmental Assessment on tidal energy development in the Bay of Fundy. The assessment process involved preparation of a Background Report (Jacques Whitford 2008) describing the environmental, socio-economic and regulatory context in which marine renewable energy might be developed in the Bay of Fundy, a series of public community forums, and creation of a Stakeholder Roundtable that advised the OEER on the preparation of the SEA. The SEA made 29 recommendations. Of interest among these recommendations were: adherence to Principles of Sustainability (#1); development of renewable energy legislation (#3); requirements for research (##4-7); and recommendations for a framework in integrated coastal zone management (#25).

The response from the Minister of Energy (Nova Scotia Department of Energy 2008) outlined a joint federal-provincial environmental assessment review process designed to safeguard environmental attributes of the marine environment and assess the implications for other users of marine resources.

Jacques Whitford. 2008. Background report for the strategic environmental assessment for Bay of Fundy tidal power development. Report prepared for Offshore Energy Environmental Research Association. 273 p .
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B3. NOVA SCOTIA RENEWABLE ELECTRICITY PLAN 2010

Nova Scotia's Renewable Electricity Plan lays out a programme aimed at moving the Province away from carbon-based electricity towards local renewable sources. The Plan commits to a target of 25% renewable energy by 2015 and 40% renewable energy by 2020. Although a large role will initially be played by land-based wind power, a significant contribution is expected to be obtained from tidal current energy. To that end, Nova Scotia has supported development of the Fundy Ocean Research Centre for Energy (FORCE), which is becoming the second largest tidal energy testing facility in the world. For more information visit: http://nsrenewables.ca/

Nova Scotia Department of Energy. 2010. Nova Scotia's Renewable Electricity Plan.
http://www.gov.ns.ca/energy/resources/EM/renewable/renewable-electricity-plan.pdf

B4. FUNDY OCEAN RESEARCH CENTRE FOR ENERGY (FORCE)

Nova Scotia and the federal government have jointly supported development of a four-berth tidal turbine testing centre for commercial scale TISEC devices in Minas Passage, in the Bay of Fundy. Submarine electrical transmission cables are to be installed during 2012-2013 to connect the four test berths to land-based transmission lines. Each berth holder will be provided with a permit to test their device(s). An environmental assessment for the test facility was completed in 2009, just prior to the installation of the first demonstration turbine (OpenHydro) which was recovered in late 2010. During 2009, FORCE established an independent Environmental Monitoring Advisory Committee (EMAC) to provide advice to FORCE on the conduct and interpretation of ongoing environmental monitoring activities. FORCE continues to collect data on currents and bottom conditions at the site, to aid cable lay planning and project development, and supports environmental research that will help address the determination of environmental effects when further devices are installed. For more information visit: http://www.fundyforce.ca/

B5. FIT & COMFIT

Nova Scotia has developed a programme for feed-in tariffs that will apply to commercial installations (FIT) and community-owned initiatives (COMFIT) to stimulate interest and investment in TISEC development. Several COMFITs have already been awarded. For more information visit: http://nsrenewables.ca/

B6. MARINE RENEWABLE ENERGY LEGISLATION FOR NOVA SCOTIA

In response to the SEA recommendation #3, the Nova Scotia Government commissioned Dr. R. Fournier to conduct a consultative examination of the need for, and the elements of, new legislation in support of marine renewable energy, including tidal power. Fournier's report (Fournier 2011) emphasized the need for a Strategic Plan, including clear statements of vision, mission and goals, as a necessary precursor to selection of legislative and regulatory options in support of MRE development. While outlining the need for a Strategic Plan, Fournier also noted that there is an inherent conflict between a precisely defined regulatory process and the degree of flexibility that is desirable in new developments, especially where the environmental and socio-economic implications are so uncertain. Other relevant recommendations include:

- the need for a set of *guiding principles*[7] for the MRE sector (#2);
- the need for the federal and provincial governments to collaborate on modifying existing environmental assessment regulations *in advance of* development of the MRE sector (#6);
- the need for incorporation of MRE development in the proposed Nova Scotia Coastal Strategy as part of *marine spatial planning* (#11);
- the need for a *long term research plan* as part of the Strategic Plan (#14);
- the need to circulate forthcoming research information widely among researchers, developers, regulators, investors and the public (#17);
- the need for creation of a *nationally acceptable framework* that addresses environmental assessment, monitoring, safety, property rights and economic regulation (#19); and
- the need to repeat Strategic Environmental Assessments at regular intervals.

The Province is currently in the process of developing legislation and policy to govern marine renewable energy development and regulation in Nova Scotia.

Fournier, R.O. 2011. Marine Renewable Energy Legislation: A Consultative Process. Report to the Government of Nova Scotia. **http://www.gov.ns.ca/energy/public-consultation/marine-renewable-energy.asp**

[7] Italics added for this report.