Mitigation Practices Database (MPD) Tool for Offshore Wind Energy Development

User Manual

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Table of Contents

Section		Page
1	**Introduction**	**1-1**
2	**MPD Tool Development**	**2-1**
2.1	Sources	2-1
2.2	Definitions of Terms in the Tool	2-2
2.2.1	Stressors	2-2
2.2.2	Potential Effects	2-4
2.2.3	Development Phases	2-5
2.2.4	Industry	2-5
2.2.5	Implementation Status	2-6
2.2.6	Implementation Details	2-6
2.2.7.	Mitigation Hierarchy	2-6
2.2.8	Mitigation Approach	2-7
2.3	Resource Groups	2-8
2.3.1	Birds and Bats	2-8
2.3.2	Marine Mammals and Sea Turtles	2-9
2.3.3	Fish	2-10
2.3.4	Benthos	2-11
2.3.5	Fisheries	2-12
2.4	MPD Sorting Criteria	2-12
2.4.1	Sorting Criteria Currently Applied in the Tool	2-13
2.4.2	Sorting Criteria not Currently Applied	2-14
2.4.3	Sorting Criteria Outside the Current Scope of the Tool	2-14
3	**Tool Instructions**	**3-1**
4	**Literature Cited**	**4-1**

List of Abbreviations and Acronyms

E-TWG	Environmental Technical Working Group
EMF	electromagnetic field
F-TWG	Fisheries Technical Working Group
Hz	hertz
kHz	kilohertz
NOAA	National Oceanic and Atmospheric Administration
NYSERDA	New York State Energy Research and Development Authority
OPR	NOAA Office of Protected Resources

1 Introduction

The New York State Energy Research and Development Authority (NYSERDA) has developed this Mitigation Practices Database (Tool) for Offshore Wind as a resource to be used by the Environmental Technical Working Group (E-TWG) and the Fisheries Technical Working Group (F-TWG) in their roles to advise New York State in the responsible development of offshore wind energy. Representatives of offshore wind energy developers, New York State, and other stakeholders may also be end users of the Tool, for example during refinement of environmental mitigation plans for individual development projects.

NYSERDA published the New York State Offshore Wind Master Plan (Master Plan) in December, 2017[1]. The Master Plan outlines the state's ongoing activities to advance the development of offshore wind energy in the New York Bight, including convening Technical Working Groups focused on fishing, maritime commerce, the environment, jobs, and the supply chain. Members of the Technical Working Groups offer technical knowledge, practical experience, and personal interest that can inform the state's decision-making process.

As part of the implementation phase of the Master Plan, the state encourages the E-TWG and F-TWG to pursue several activities, including the development of fisheries and environmental best management practices (BMPs) to effectively reduce or eliminate impacts that could result from offshore wind energy development. For purposes of the Tool and User Manual, BMPs are practices that have been determined to be the best approaches to minimizing and avoiding impacts on wildlife and fisheries resources. Because the "best" practices have not yet been determined as part of New York's Master Plan, the Tool focuses on collecting a wide range of mitigation options that can help the User evaluate and consider what would constitute BMPs, at both broad and project-specific scales.

The Mitigation Practices Database Tool (formerly the Mitigation and Monitoring Practices or MMP Tool) houses a collection of mitigation options, extracted from a range of sources (including agency reports, environmental assessments, scientific literature, technical guidance documents, and others), and is intended to serve as a resource

[1] New York State Energy Research and Development Authority (NYSERDA). 2017. New York State Offshore Wind Master Plan Charting a Course to 2,400 Megawatts of Offshore Wind Energy. NYSERDA Report 17-25. https://www.nyserda.ny.gov/All-Programs/Programs/Offshore- Wind/Offshore-Wind-in-New-York-State-Overview/NYS-Offshore-Wind-Master-Plan .

to the E-TWG and F-TWG, as well as other stakeholders. The Tool is searchable by various categories, including, but not limited to:

- Resource Groups – birds/bats, marine mammals/sea turtles, fish, benthos, and fisheries;
- Stressors;
- Potential effects; and
- Development phases of offshore wind.

As part of the effort to support development and evaluation of potential mitigation options, the Tool provides details that could support further evaluation of how best to incorporate mitigation into the state's plans for offshore wind energy development. This Tool does not prioritize or judge the value of individual or combined practices in the Tool, and it does not consider site- and project-specific conditions that might affect how and whether certain practices may be practicably implemented. It does, however, provide several sorting criteria that may be useful to the E-TWG and F-TWG and other users when assessing potential mitigation options.

The geographic scope of the review includes practices that have been applied around the world, but the geographic scope of resources is limited to resources that occur in the New York Bight. For example, bottlenose dolphins occur outside the New York Bight, but they also occur within it and so are part of the resources considered. Dugongs do not occur in the New York Bight, so mitigation specifically aimed at reducing dugong impacts (to the exclusion of any species that may occur in the New York Bight), would not be included in the Tool.

The database was originally developed in 2018 by Ecology and Environment and the Biodiversity Research Institute. Updates were made by Biodiversity Research Institute and Tetra Tech to include sources through 2023 (birds and bats) and 2025 (all other resource groups).

Section 1 describes the objectives of the Tool. Section 2 describes the methodology for developing the Tool and defines the terms used throughout the Tool. Section 2 also provides a brief overview of the types of practices identified for each resource group, and provides some sorting criteria that may be useful for assessing mitigation options. Section 3 provides instructions for using the Tool, and Section 4 lists references cited in this document.

2 MPD Tool Development

The Tool is a R Shiny application that allows the User to sort and organize mitigation practices. Specific worksheets were developed for five resource groups including birds/bats, marine mammals/sea turtles, fish, benthos, and fisheries. These worksheets were then combined into a master worksheet and linked to the Tool such that mitigation options could be sorted by the User's specific interest.

The Tool houses categories that are used to filter and sort the specific type(s) of potential mitigation options, including: resource groups; subgroups; stressors; potential effects; development phases; type of industry; implementation status; generalized category; and source citations. For example, if the User decides to focus on the construction period of development, practices specific to construction activities can be extracted from the tool across all five resources; however, if birds are the topic, practices can be extracted from the tool across all phases of development for that resource.

Section 2.1 provides information on the sources included in developing the Tool, and Section 2.2 provides the definitions for the terms used in the above list of categories to sort the database. Section 2.3 describes the specific resources and subgroups for which the mitigation practices would apply and provides a brief overview of the those that have been applied to these resources. In addition, Section 2.4 provides some sorting criteria that may be useful for assessing mitigation options.

2.1 Sources

Mitigation practices were collected from a number of different sources, including agency reports; environmental assessments; stakeholder workshop proceedings; scientific literature; permits for offshore construction, cable laying, and surveys; technical guidance documents; and other sources of mitigation activities. In addition to sources relating to offshore wind energy development in the U.S., sources were drawn from Europe, the onshore wind industry, and other maritime industries and activities that are relevant to offshore wind energy development. Sources were identified via a series of google scholar searches for each combination of resource group component (e.g., birds, bats, marine mammals, sea turtles, fish, fisheries, benthos), type (e.g., wind, offshore wind, offshore), and mitigation-related terminology (e.g., mitigation, avoidance, minimization, offset, restoration). Example search terms for birds: birds + wind + mitigate*; birds + wind + avoidance; birds + wind + minimization; birds + wind + offset; birds + wind + restoration; birds + offshore wind + mitigat*; birds + offshore wind + avoidance; birds + offshore wind + minimization; birds + offshore wind + offset; birds + offshore wind + restoration; birds + offshore + mitigation; birds + offshore + avoidance; birds + offshore + minimization; birds + offshore + offset; birds + offshore + restoration. Sources were also identified in the Tethys Knowledge Base (filters: Wind energy content + resource group (birds, bats, marine mammals, fish, invertebrates; search terms

"mitigation", "minimization", "avoidance", "offset", "restoration"). Once compiled, the abstract or summary of each source was manually reviewed for initial relevance. If there was no mention of mitigation, avoidance, minimization, compensation, or offsetting, sources were deemed not relevant and were not reviewed further. The remaining sources were reviewed, and information was manually extracted. In general, the language in a source was maintained for the description of the practice in order to make it easy to locate where it occurred in the cited literature. Mitigation approaches were synthesized by resource group based on topical commonalities such that each row in the database represents a unique mitigation approach.

2.2 Definitions of Terms in the Tool

Specific definitions were developed in the Tool to ensure consistency in meaning across the marine resources (Birds and Bats, Marine Mammals and Sea Turtles, Fish, Benthos, and Fisheries). Within each category, terms listed in alphabetical order except in cases where there is a defined order (i.e., development phase, mitigation hierarchy).

2.2.1 Stressors

Stressors are external stimuli that can cause changes to the behavioral, physical, chemical, and/or biological characteristics of an organism, species, or the ecosystem inhabited by the organism/species. In the case of fisheries, stressors are unintended consequences of offshore wind energy development activities that potentially affect fishing and fisheries. While stressors can occur in the natural environment or from human activities, in this case, the New York State Energy Research and Development Authority (NYSERDA) is focusing on anthropogenic stressors associated with offshore wind energy development on the Outer Continental Shelf (not in state waters or the cable interconnect to land). NYSERDA has endeavored to include all stressors that could occur within federal offshore wind lease areas. While many of the stressors defined below are applicable to all resource groups, some are only applicable to fisheries.

Bottom Disturbance. Bottom disturbance is physical change to the substrate as a result of wind farm activities, such as packing down sediment with piles or digging up sediment with anchors or jet plows. Changes in turbidity (i.e., measure of suspended particles in water) are considered water quality changes and are not included in bottom disturbance. Displacement of sediment around a structure is considered scouring and is not included in bottom disturbance.

Changes in Vessel Traffic. Changes in vessel traffic include changes the abundance, densities, types, and routes of vessels compared to what currently exist, due to activities relating to the offshore wind facility or to displacement of other vessel operations as a result of offshore wind facility activities. This includes, but is not limited to, vessels operating in pre-construction site assessment surveys, construction activities, and maintenance activities. This also includes changes in fishing or shipping patterns in response to wind farm activities.

Effects on Fishery Target Species. Effects on fishery target species are changes in the abundance, distribution, and or/behavior of target fish species as a direct or indirect result of offshore wind energy development. Such changes are considered effects on fish and other organisms, but are a stressor to fisheries, potentially causing changes in fishery effort or loss of revenue.

Electromagnetic fields (EMF). Electromagnetic fields (EMF) can be generated by the cables that carry electricity from and between energy sources to power stations and may produce local

distortions in Earth's main electric and magnetic fields.

Habitat Alteration. Habitat alteration primarily involves introducing hard structures into previously soft sediment environments. This modification can initially involve seabed disturbance and subsequent changes to the benthic community.

Heat. Heat is an increase in water or air temperature above typical levels.

Impaired Safe Fishery Access. Impaired safe fishery access is an inability to safely access and operate within fishing grounds (e.g., impairment of navigational equipment, potential to catch buried cables in fishing gear and/or anchors, increased risk of collision with structures).

Inadequate Infrastructure. Inadequate infrastructure includes situations in which offshore wind energy development may increase the strain on shoreside infrastructure such as ports and docks, fueling stations, fish processing facilities, and other related systems. Inadequate infrastructure also includes situations in which vessel infrastructure and equipment such as engines, global positioning systems, radar, fishing gear, and safety equipment may be insufficient to account for changes in fishing vessel behavior caused by the need to navigate around or through offshore wind energy facilities.

Insufficient Communication. Insufficient communication includes situations in which there is inadequate dialog, information sharing, workshops, and/or development of novel communication strategies between stakeholders, offshore wind energy developers, regulatory agencies, and/or advisory groups related to offshore wind energy projects relevant to fisheries.

Light. Light is artificial light produced by, or in relation to, the offshore wind energy development at a project site. Artificial light produces a luminescence that is brighter or different in color than natural light occurring at the site during the period in question. Examples include lights on vessels, construction equipment, turbines, and other infrastructure to aid in navigation and construction, among other purposes.

Long-term Structures. Long-term structures are objects added to the environment that occupy physical space and are present for longer than the construction period. Examples of long-term structures include offshore wind turbines, foundations, scour protection, substations, and other infrastructure associated with the operational offshore wind facility. This term may also apply to the pre-construction phase in the case of meteorological towers, and to the decommissioning phase in the case of any below-water (e.g., foundations) or subsurface (e.g., cables) infrastructure that may be left in place after the towers have been removed. Displacement of sediment around a structure is considered scouring and is not included in long-term structures.

Loss of Fishing Grounds. Loss of fishing grounds is loss or inaccessibility of usual fishing areas resulting from short- and long-term aspects of offshore wind energy development. Loss or inaccessibility could be due to factors such as physical barriers, difficulty in maneuvering or setting gear, and risk of gear damage or loss. Safety issues are considered impaired safe access and not included in loss of fishing grounds. Reduction in desirability of fishing grounds in association with changes in fish abundance, distribution, and/or behavior is considered an effect on fishery target species, defined above, and is not included in loss of fishing grounds.

Scouring. Scouring is a physical process related to the movement of seabed sediment around a structure due to its presence, which causes changes in wave or current flows, and results in a reduction in seabed levels around the structure.

Sound. Sound is created by a vibrating object and travels as a pressure wave through a medium, and these pressure waves can be sensed by organisms using hearing organs. Activities that produce sound include, but are not limited to, exploratory surveys, pile driving (i.e., turbine foundation installation), dredging, and vessel operation. Vibrations that are not related to sound are considered in the Electromagnetic Fields (EMF), Vibration, and Heat stressor category.

Vibration. Vibration is an oscillation of parts of a fluid. Vibration can result in particle motion, which is detectable by some marine organisms. Although sound usually has a vibratory component, it differs from vibration in general in that sound also contains a waveform and is perceived by hearing organs; sound is not included in this category.

Water Quality Changes. Water quality is a description of the chemical, physical, and biological characteristics of water as it relates to the health of an organism or ecosystem within the marine environment. Examples of changes in water quality include, but are not limited to, changes in turbidity (i.e., the amount of suspended particles in water), addition of chemicals (e.g., antifouling paint or oil) and changes in dissolved oxygen (e.g., reductions in oxygen due to warming of the water).

2.2.2 Potential Effects

Potential effects are the changes to the behavioral, physical, chemical, and/or biological characteristics of an organism, species, or the ecosystem inhabited by the organism/species due to stressors related to offshore wind energy development. In the context of fisheries, potential effects are impacts on fishing activities and revenue as a result of stressors related to offshore wind energy development. Additionally, changes in fishing effort, grounds, and revenue can result from changing markets, ocean conditions, permit and licensing requirements, protected species interactions, natural fish abundance and distribution patterns, and other factors unrelated to offshore wind energy development. For purposes of describing potential mitigation options to address effects of stressors on fisheries, effects are considered outcomes that are a result of offshore wind energy development and not other biological, physical, and economic factors that affect fisheries.

Attraction. The movement of individuals or groups toward areas associated with offshore wind energy development in response to a stressor (e.g., attraction to a light source on a wind turbine). This can be caused by sensory attractants or other attractants such as increased prey availability, ways to avoid predators, or changes in other resources.

Behavioral Disturbance. Behavioral disturbance is a change in individual or group short-term natural behavior (e.g., movement patterns, alertness) or behavior patterns (e.g., change from spawning, feeding behavior, social behavior) as a result of exposure to a stressor(s), not including changes that would constitute displacement/barrier effects and attraction (listed separately below).

Change in Fishing Effort. Change in fishing effort is short- or long-term change in common fishing patterns in time and space, including fishing outside typical fishing grounds, increased effort and/or competition among fishing vessels at available fishing areas, and changes in the numbers of fishing vessels or fisheries in a given area as result of offshore wind energy development.

Community Alteration/Invasive Species. Community alteration is a change to the composition, structure, or function of an ecological community (a group of populations of multiple species occupying the same geographic area at the same time). Invasive species are non-native species that are introduced into a new environment as a result of offshore wind energy development and cause ecological and/or economic harm.

Displacement. Displacement is avoidance of an area associated with offshore wind energy development by individuals or groups as a result of exposure to a stressor(s).
This can include short- or long-term effective loss of habitat (such as foraging or roosting grounds, calving/spawning grounds, and above- or below- water movement areas). This also includes barrier effects, in which individuals may alter local or long-distance movements to avoid aspects of offshore wind energy development (including offshore infrastructure and vessel traffic). Avoidance may occur at multiple scales including macro- (whole wind farm), meso- (turbines), and micro- (turbine blades) avoidance.

Habitat Fragmentation/Modification. Habitat fragmentation is the loss of habitat that results in division of large, contiguous habitats into smaller disconnected habitat patches. Habitat modification is the change in size, composition, structure, or function of an existing habitat (e.g., wind turbines provide new substrate that can support encrusting organisms that would not otherwise be present in the same numbers or species composition).

Injury/Mortality. Injury includes physical damage to the body, internal or external, permanent or temporary, as well as physiological changes (e.g., stress) that may or may not be expected to lead to death. Mortality is death of an organism.

Loss of Fishing Revenue. Loss of revenue is reduced fisheries revenue from typical baseline or expected ranges due to offshore wind energy development.
Loss of revenue can result from loss of gear, damaged gear, reduced catch, additional fuel and other operations costs, etc. Changes in fishing effort due to offshore wind energy development may be accompanied by loss of revenue, but in some cases, revenue may not be affected within normal and/or expected ranges despite changes in fisheries.

2.2.3 Development Phases

Development phases are the stages of offshore wind facility development/operation, each of which encompass a number of activities and, as a result, may have different types of stressors. Mitigation options are likely to be implemented by development phase.

Pre-construction. This phase includes site assessment work such as geotechnical and geophysical surveys, installation of meteorological towers or buoys, and environmental or other surveys.

Construction. This phase, which can last for several years, includes various activities associated with building the turbines and connecting them to the electrical grid, including jack-up barges and other vessel activity. Construction also includes installation of undersea cables among turbines and sub-stations.

Operations & Maintenance. This phase, which can last 25 years or more, is the period in which turbines are generating electricity and includes activities relating to turbine monitoring and maintenance.

Decommissioning. This phase includes decommissioning activities chosen for a given project site, which may include full removal of structures, removal of above-water structures (to a certain water depth to avoid navigational hazards), or repowering.

2.2.4 Industry

Industry terms define the type of industry for which mitigation options have been suggested or implemented in the U.S. or other countries.

Offshore Wind. Offshore wind refers to any offshore wind energy development in marine or freshwater (e.g., Great Lakes) locations.

Onshore Wind. Onshore wind refers to wind energy development in terrestrial locations.

Oil and Gas. Oil and gas includes both onshore and offshore oil and gas development.

Maritime. Maritime refers to any marine or freshwater activity other than offshore wind and oil & gas. This includes shipping, fisheries, transmission, and other industries that operate in the marine environment.

Generic/General. Generic/general includes any industry that is not included in the above options, or situations where an industry was not specified.

2.2.5 Implementation Status

The implementation status defines the degree to which the use or efficacy of activity has been tested.

Not Implemented. Not implemented means that the mitigation option was not implemented in the source literature.

Field Tested. Field tested refers to a situation in which an practice has not been implemented in a real-world development situation but has been tested in another way, such as academic research or prototypes.

Implemented. Implemented means that the mitigation practice was implemented in the source literature, but there was no testing or assessment indicated as to whether it was effective at reducing impacts on the resource of interest.

Implemented and Evidence of Effectiveness. Implemented and evidence of effectiveness means that the mitigation practice was (1) implemented in the source literature, and (2) found to be effective when tested or assessed for effectiveness at reducing impacts on the resource of interest.

Unknown. Unknown means that, based on source literature, it is unclear whether or not the mitigation practice was implemented.

2.2.6 Implementation Details

The implementation details provide one or two examples from scientific literature or technical documents of how the mitigation practice has been implemented and/or tested in cases for which testing or implementation has occurred.

2.2.7. Mitigation Hierarchy

The most applicable level(s) of the mitigation hierarchy was(were) chosen for each mitigation practice. For mitigation practices that were solely monitoring recommendations, no mitigation hierarchy levels were chosen.

Avoidance. Avoidance will eliminate impacts entirely. For example, siting a project outside the range of an animal completely avoids impacts on that animal. As another example, operating equipment outside the hearing range of an animal avoids sound impacts on that animal.

Minimization. Minimization will reduce the impacts. For example, sound dampening technology may reduce the amount of sound, thus reducing the impact of sound on organisms.

Restoration. Restoration refers to measures taken to improve or rehabilitate ecosystem components that are impacted by the project. For example, if a met tower were placed in a mesophotic coral area and after removal of the tower, coral was transplanted back to the area.

Offset. Offset is compensation for impacts. For example, monetary compensation could be provided for loss of fishery access. As another example, improvement of off-site habitat or establishment of a marine protected area in another place could offset degradation of habitat in the project area. (Restoration defined above requires restoration of areas directly impacted by the project; other rehabilitation or preservation efforts are offsets typically described as compensatory mitigation.)

2.2.8 Mitigation Type

Categories or types of mitigation practices identified during literature review.

Barriers. Barriers include activities such that physical creation of an obstacle prevents or limits a stressor (e.g., sound, EMF) from propagating (e.g., bubble curtains to block sound, cable burial to block EMF, scour protection to block sediment movement).

Compensation. Compensation includes mitigation options that involve offsetting an impact through financial means or by restoration, enhancement, or other conservation measures offsite (e.g., outside of the project area).

Deterrence/Attraction Reduction. Deterrence/attraction reduction mitigation options include efforts to actively discourage animals from approaching activities and/or structures (e.g., use of pingers) or reduce the attractiveness of activities or structures (e.g., avoid including nesting habitat on turbines, use colors not attractive to birds). This does not include choices in lighting meant to reduce attraction, which is considered a lighting alternative.

Engagement/Communication. Engagement/communication activities include outreach efforts, information sharing, research facilitation, and other efforts to inform and learn from stakeholders in ways that will minimize and avoid impacts of offshore wind energy development.

Fisheries Safety. Fisheries safety mitigation options are direct actions to reduce hazards of offshore wind energy development to increase safety of people and vessels (e.g., safety protocols for designating vessel right-of-way, marking designated transit zones, and infrastructure modifications to improve offshore communication and reduce interference with navigational equipment). This does not include outreach, research, and information sharing efforts, which are considered engagement/communication.

Lighting Alternatives. Lighting alternatives include choices in lighting that can minimize attraction or deter animals, including considerations like number and intensity of lights, lighting color, and periodicity.

Limit an Activity. Limit an activity includes mitigation options that do not fall into other categories and include a restriction in activity (e.g., avoiding pile driving at night, not using explosives).

Shutdown/Low Power. Shutdown and low power include mitigation options that require stopping or reducing the power of an activity (e.g., shutdown of geophysical surveys when marine mammals are present, soft-start pile driving). This also includes curtailment of turbine operations but not feathering or increasing cut-in speed, which are included in turbine operation parameters.

Siting/Seasonality. Siting and seasonality include activities that consider geographic location choices for long-term wind farm structures (e.g., macro- siting) and/or time of year of activities, including vessel activities. Micro-siting of turbines is considered a structure configuration topic rather than siting/seasonality.

Structure Configuration. Structure configuration includes mitigation options that involve choices in turbine numbers and sizes, foundation types, and how turbines are arranged in space (e.g., micro-siting).

Turbine Operation Parameters. Turbine operation parameters include options that focus on movement of turbines (e.g., increased cut-in speed to avoid bats).
Curtailment is not included in this category as it is considered a shutdown/low power activity.

Vessel Operation Parameters. Vessel operation parameters include mitigation options that involve choices in vessel number, behavior, location, direction, equipment, and actions of vessel crew (e.g., positioning vessels with thrusters, educating crew to avoid whale collisions). Vessel location choices are different than siting choices for structures or seasonal activities (see Siting/Seasonality). This is also different from shutdown/low power. If equipment on a vessel is being shut down or run at low power (e.g., shutdown of an echosounder), it is considered a shutdown/low power activity rather than a vessel operation parameter.

Water Quality Management. Water quality management includes activities that are designed to avoid water quality impacts, such as following dumping and bilge water regulations.

2.3 Resource Groups

Mitigation practices are focused on minimizing and avoiding potential impacts of offshore wind energy development on the following resources:

- Birds and Bats,
- Marine Mammals and Sea Turtles
- Fish,
- Benthos, and
- Fisheries.

2.3.1 Birds and Bats

2.3.1.1 Bird and Bat MMP Overview

Flying wildlife that interact with offshore wind energy facilities fall into two general types. First, marine birds (e.g., waterbirds such as sea ducks, gulls, terns, and alcids) use the ocean environment for many purposes, including foraging, roosting, travel to and from breeding colonies, and migration. Second, bats and more land-based bird taxa such as passerines, raptors, and shorebirds, are most likely to encounter offshore wind energy development during migration, though some species are also known to forage and roost offshore (e.g., peregrine falcons). When an mitigation practice was general enough to pertain to all birds or all bats, "all birds" or "all bats" was chosen as the subgroup within the resource.

Mitigation options for migrants and more land-based taxa most often address potential impacts from collisions (e.g., mortality or injury) and, to a lesser degree, displacement from typical migratory routes. Potential effects on marine birds are more varied. While mortality and displacement from typical habitat use areas are still the most common concerns, topics also focus on habitat modification, behavioral disturbance, and attraction to structures. Long-term structures and artificial light are prominent stressors. Other stressors, such as changes in vessel traffic, primarily affect marine birds that use the aquatic environment. Overall, most mitigation practices for birds and bats focus on the following:

- Siting and configuration of turbines and wind farms,
- Lighting alternatives
- Deterrence/attraction reduction, and
- Turbine operation parameters

These management practices are primarily aimed at reducing collision risk, as well as disorientation from lighting, and draw a great deal from other marine industries (e.g., offshore oil and gas) and the onshore wind energy industry.
Displacement and barrier effects for birds are commonly monitored at offshore wind energy facilities, but there are few accepted mitigation strategies for these types of impacts.

2.3.1.2 Bird and Bat Subgroup Definitions

Birds are animals in the class Aves, and bats are animals in the order Chiroptera. The Tool focuses on practices that would apply to birds and bats that rely on or travel through the ocean and marine ecosystems. Practices that have been applied to onshore wind projects are included in the Tool in cases in which they could be applicable to offshore wind energy development.

Marine Birds. Marine birds are defined for this purpose as waterbirds that are expected to interact with marine environments on the Outer Continental Shelf on a regular basis. This includes auks, gannets, cormorants, gulls, skuas, jaegers, loons, grebes, sea ducks, shearwaters, petrels, storm-petrels, terns, and phalaropes (which are shorebirds but occur pelagically).

***Nocturnal Aerial Migrants*.** Bats and many species of birds migrate at night, including over the water. This group can include passerines, shorebirds, some waterfowl, some raptors, and other bird species, as well as bats.

2.3.2 Marine Mammals and Sea Turtles

2.3.2.1 Marine Mammal and Sea Turtle MPD Overview

Marine mammals and sea turtles often are subject to similar or the same mitigation to protect these

resources from sound, vessel strike, and other disturbance. Mitigation options for offshore wind energy development for these resources generally address potential impacts from behavioral disturbance, displacement, habitat modification, and injury/mortality. The major stressors associated with these potential impact are sound, long-term presence of structures, and changes in vessel traffic. Because marine mammals are specialists in different hearing frequencies, they are split into hearing groups for purposes of evaluating impacts from sound under the U.S. regulatory framework[2]. Thus, practices were considered for low-frequency, mid- frequency, and high-frequency cetaceans and pinnipeds (seals) separately.
Furthermore, because North Atlantic right whales are subject to laws that do not apply to other marine mammals, North Atlantic right whales were considered as a separate subgroup within the resource. When a practice was general enough to pertain to all marine mammals, "all marine mammals" was chosen as the subgroup within the resource. Practices directed at sea turtles were not species- specific, so sea turtle mitigation options were considered to apply to "all sea turtles." Overall, most practices to protect marine mammals and sea turtles focus on the following:

- Seasonal activity periods,
- Siting that considers important habitats,
- Minimizing received sound levels, and
- Avoiding vessel strike.

2.3.2.2 Marine Mammal and Sea Turtle Subgroup Definitions

Marine mammals are mammals that rely on the ocean and marine ecosystems and include the cetaceans (baleen and toothed whales), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), and polar bears. Of these, only cetaceans and seals occur within New York State's geographic scope. Sea turtles are turtles that rely on the ocean and marine ecosystems and include seven species, of which loggerhead, leatherback, Kemp's ridley, and green sea turtles seasonally live in the New York Bight.

Low-Frequency Cetaceans. Low-frequency cetaceans are more sensitive to lower frequency sound. Their generalized hearing range is from 7 hertz (Hz) to 35 kilohertz (kHz). Low-frequency cetaceans include all mysticetes (baleen whales) (NOAA OPR 2018).

Mid-Frequency Cetaceans. Mid-frequency cetaceans are more sensitive to mid- frequency sound. Their generalized hearing range is from 150 Hz to 160 kHz.
Mid-frequency cetaceans include most delphinid species (dolphins), beaked whales, and sperm whales (but not pygmy and dwarf sperm whales) (NOAA OPR 2018).

High-Frequency Cetaceans. High-frequency cetaceans are more sensitive to high-frequency sound. Their generalized hearing range is from 275 Hz to 160 kHz. High-frequency cetaceans include porpoises, river dolphins, pygmy/dwarf sperm whales, *Cephalorhynchus* species, and some *Lagenorhynchus* species (NOAA OPR 2018).

Pinnipeds. *Phocid* pinnipeds include all earless seals or "true seals," such as harbor or common seals and gray seals. *Otariid* pinnipeds include all eared seals (fur seals and sea lions) and walruses.

North Atlantic Right Whale. The North Atlantic right whale (*Eubalaena glacialis*) is listed as endangered under the Endangered Species Act. This sub- taxon was applied in the case that an MMP applied only to North Atlantic right whales and not to other marine mammals (i.e., regulations and guidelines specifically for North Atlantic right whales).

Sea Turtles. Sea turtles includes any of seven species of marine turtles, including both leatherback and hard-shelled turtles. Sea turtles live most of their lives at sea but come onto beaches for nesting.

2.3.3 Fish

2.3.3.1 Fish MPD Overview

Although fish resources can experience impacts from offshore wind energy development, a variety of mitigation options to avoid and/or minimize impacts have been developed and/or discussed within a laboratory setting, the literature, and field investigations. Although practices for fish cover a range of potential impacts, the majority generally address behavioral disturbances, displacement, habitat fragmentation and/or modification, and injury/mortality. The stressors associated with these impacts are sound, bottom disturbance, the presence of long-term structures, and EMF/vibration/heat. Because fish can spend their lives in different regions within the water column, they can be separated into two groups for the purpose of evaluating these impacts: pelagic fish (those living mainly within the water column) and demersal/groundfish (those living mainly on the seafloor).

When a mitigation option was general enough to pertain to all fish, the "all fish" category was selected as the subgroup within the resource. Fisheries-specific resources were considered separately from fish as a taxonomic group. Overall, most Mitigation practices to protect fish resources focus on the following:

- Siting that considers important habitats, species-specific spawning, and migration patterns
- Minimizing received sound levels,
- Use of proper shielding and/or burial depths of cables, and
- Engagement/communication with stakeholders

2.3.3.2 Fish Subgroup Definitions

Fish are organisms in the taxonomic groups of teleosts (bony fish such as sturgeon), elasmobranchs (cartilaginous fish such as sharks), and agnaths (jawless fish such as lamprey).

***Pelagic Fish*.** Pelagic fish are fish that live and feed mainly in the water column.

***Demersal/Groundfish*.** Demersal and groundfish are fish that live and feed mainly on or close to the seafloor.

2.3.4 Benthos

2.3.4.1 Benthos MPD Overview

Mitigation options for impacts on the benthic environment are similar to those for impacts on fish species and mainly address bottom disturbances, scouring, and the presence of long-term structures. Because benthic resources can be divided into sessile/unable to easily escape (e.g., some invertebrates, seagrass/kelp/algae) and mobile, and because some stressors may have more of an impact on invertebrates or seagrass/kelp/algae, they can be separated into three groups for the purpose of evaluating these impacts: demersal/groundfish (those living mainly on the seafloor), benthic invertebrates (organisms without backbones that live mainly on the seafloor as adults), and seagrass/kelp/algae. When a mitigation practice was general enough to pertain to all benthic resources, the "all benthos" category was selected as the subgroup within the resource. Some practices for impacts on demersal/groundfish are also included under fish resources. Overall, most mitigation options to protect benthic resources focus on the following:

- Siting that considers important habitats, sensitive seafloor habitats, and current flow,

- Use and routine inspection of scour protection devices,
- Engagement/communication with stakeholders, and
- Construction methods that limit impacts on the benthic environment.

2.3.5.2 Benthos Subgroup Definitions

Benthos are organisms that spend the majority of their lives on the seafloor. These organisms include both flora and fauna.

Demersal/Groundfish. Fish are organisms in the taxonomic groups of teleosts (bony fish such as sturgeon), elasmobranchs (cartilaginous fish such as sharks), and agnaths (jawless fish such as lamprey). Demersal and groundfish are fish that live and feed mainly on or near the seafloor.

Benthic Invertebrates. Benthic invertebrates are organisms without backbones (e.g., crabs, lobsters, and sea slugs) that live mainly on the seafloor as adults.

Seagrass/Kelp/Algae. Seagrass are flowering plants that grow entirely underwater, though they may be exposed to air at different tidal stages. Kelp are large, brown algal underwater seaweeds of the order Laminariales. Algae are non- flowering plants that grow entirely underwater, though they may be exposed to air at different tidal stages.

2.3.5 Fisheries

2.3.5.1 Fisheries MPD Overview

Fisheries resources can experience a series of interrelated impacts from offshore wind energy development, including impacts on target species (discussed in detail in the fish and benthos sections); where the wind farm(s) is sited with respect to ports, transit routes, and prime fishing grounds; and impacts on the livelihood and revenue from operating in a wind farm (e.g., safety, loss of gear). Mitigation practices included in the Tool cover both commercial fisheries (conducted with the goal of selling the catch for profit) and recreational fisheries (conducted for sport or pleasure), but in general, most mitigation practices address concerns related to commercial fisheries. Overall, most options to protect fisheries resources focus on the following:

- Siting that considers important fishery grounds and transit routes,
- Engagement and communication between the fishing industry and developers during all stages of development,
- Development of compensation fund distribution programs, and
- Safety measures to minimize danger and conflicts between vessels and wind farms.

2.3.5.2 Fisheries Subgroup Definitions

Commercial Fisheries. Commercial fisheries are fisheries conducted with the goal of selling the catch for profit.

Recreational Fisheries. Recreational fisheries are fisheries conducted for sport or pleasure (including charter and for-hire fishing).

Essential Fish Habitat (EFH). Essential Fish Habitat are waters and substrate which are necessary to fish for spawning, breeding, feeding, or growth to maturity.

2.4 MPD Sorting Criteria

There are myriad mitigation options available to address the potential effects of offshore wind energy development on marine wildlife and fisheries. Each proposed offshore wind energy project will have unique factors associated with location, wildlife present, size of the project, and specific activities and equipment that will affect which mitigation practices will constitute BMPs for each phase of the project. BMPs will be implemented as suites of actions, so the synergism among BMPs is also important for each project. However, BMPs can also be considered generally in the context of broad assessment criteria, without requiring detailed information about proposed projects. The approach described below can provide quantitative and qualitative assessments of mitigation practices to evaluate which may be BMPs, address future project needs and BMP gaps, and better understand stakeholders' priorities regarding wildlife and fisheries protection.

The example criteria provided in this User Manual are meant to suggest some criteria that may be useful to the User when referencing or assessing mitigation options. These criteria could simply be used for sorting in the Tool. Alternatively, such criteria can be used to develop a rating system by which to quantitatively evaluate each criterion for a given mitigation practice.

The Tool is not designed to assign value judgements or assess mitigation priorities using any of the potential sorting criteria. Section 2.4 is meant to describe some ways the User could go about assessing and organizing mitigation options

Example potential assessment criteria are presented below. In Section 2.4.1, the focus is on criteria that could be reasonably evaluated by the E-TWG and F- TWG or other users as part of a generalized process. In Section 2.4.2, other criteria are mentioned that may be important but are unlikely to be evaluated at this stage, mainly because the available data are insufficient to evaluate them or they need to be considered on a more project-specific basis (such as cost of implementation).

2.4.1 Sorting Criteria Currently Applied in the Tool

Implementation Status and Demonstration of Efficacy. Users may choose to focus on mitigation options that have been successfully implemented and demonstrated to have effectiveness.

Applicability to Multiple Taxonomic Groups. Mitigation practices may address potential impacts on multiple resource groups and/or subgroups, rather than focusing on a specific group of organisms. The Tool indicates whether mitigation options apply to marine mammals, sea turtles, fish, fisheries, birds, bats, and/or benthos, and also provides some sub-groups within these resource categories that would allow for sorting relative to the type of resources addressed.

Species of Conservation Concern. Users may want to sort mitigation options relative to minimizing and/or avoiding impacts on species with special conservation status. For example, a criterion could be associated with minimizing impacts on species listed under the Endangered Species Act with categories broken down by numbers of ESA-listed species affected or specific ESA species. The Tool specifically indicates when North Atlantic right whales are the target of a mitigation practice. Additionally, other resources or sub-groups can be used to determine ESA status. For example, practices aimed at low-frequency cetaceans would affect endangered baleen whales, or those aimed at sea turtles would affect threatened and endangered sea turtles. The species notes section of the Tool also indicates if a particular species is targeted, but in some cases,

the sub-group in which an ESA species would fall, would be the indicator as to whether a mitigation practice may affect an ESA-listed species. For example, roseate terns would likely be affected by practices that target Marine Birds or All Birds. All marine mammals and all migratory birds have protected status under U.S. laws, so a criterion for species protected under laws other than ESA could be applied.

Applicability to Multiple Phases of Development. Four phases of development are included in the Tool and can be used to rank the numbers and types of phases of development to which a mitigation option is applicable.

Application to Industry. Four industries are included in the Tool and can be used to evaluate which industry or number of industries apply to a practice.

Applicability to Stressors. The number or type of stressors to which mitigation options apply are indicated in the Tool and can be used to create criteria for sorting based on type or number of stressors addressed.

Applicability to Potential Effects. The number or type of potential effects to which the mitigation practices apply are indicated in the Tool and can be used to create criteria for sorting based on type or number of potential effects addressed.

Mitigation Hierarchy. The type of mitigation within the mitigation hierarchy (avoidance, minimization, restoration, offset) can be specified to evaluate the level of mitigation associated.

2.4.2 Sorting Criteria Outside the Current Scope of the Tool

To meet User goals, there may be additional criteria that are difficult to address using the Tool framework. Such criteria may be useful, but may be difficult to adequately assess without site- and project-specific information or additional scientific data. In some cases, proxies might be applied to address such criteria if they are of critical importance to User goals. For example, it may be reasonable to use potential to reduce lethal impacts as a proxy for addressing the potential to reduce population-level consequences. Some examples of criteria of this type are the following:

- Reduction in Population-level Consequences
- Cost
- Feasibility
- Ease of Implementation
- Relationship to Statues/Regulations

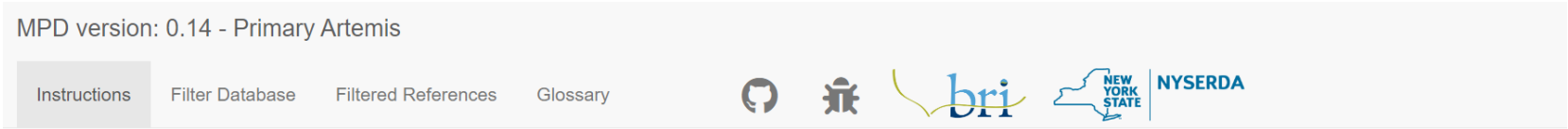
This is not an exhaustive list of potential criteria of interest to Users but provides examples of criteria that may be of interest based on the literature reviewed in creating the Tool.

3 Tool Instructions

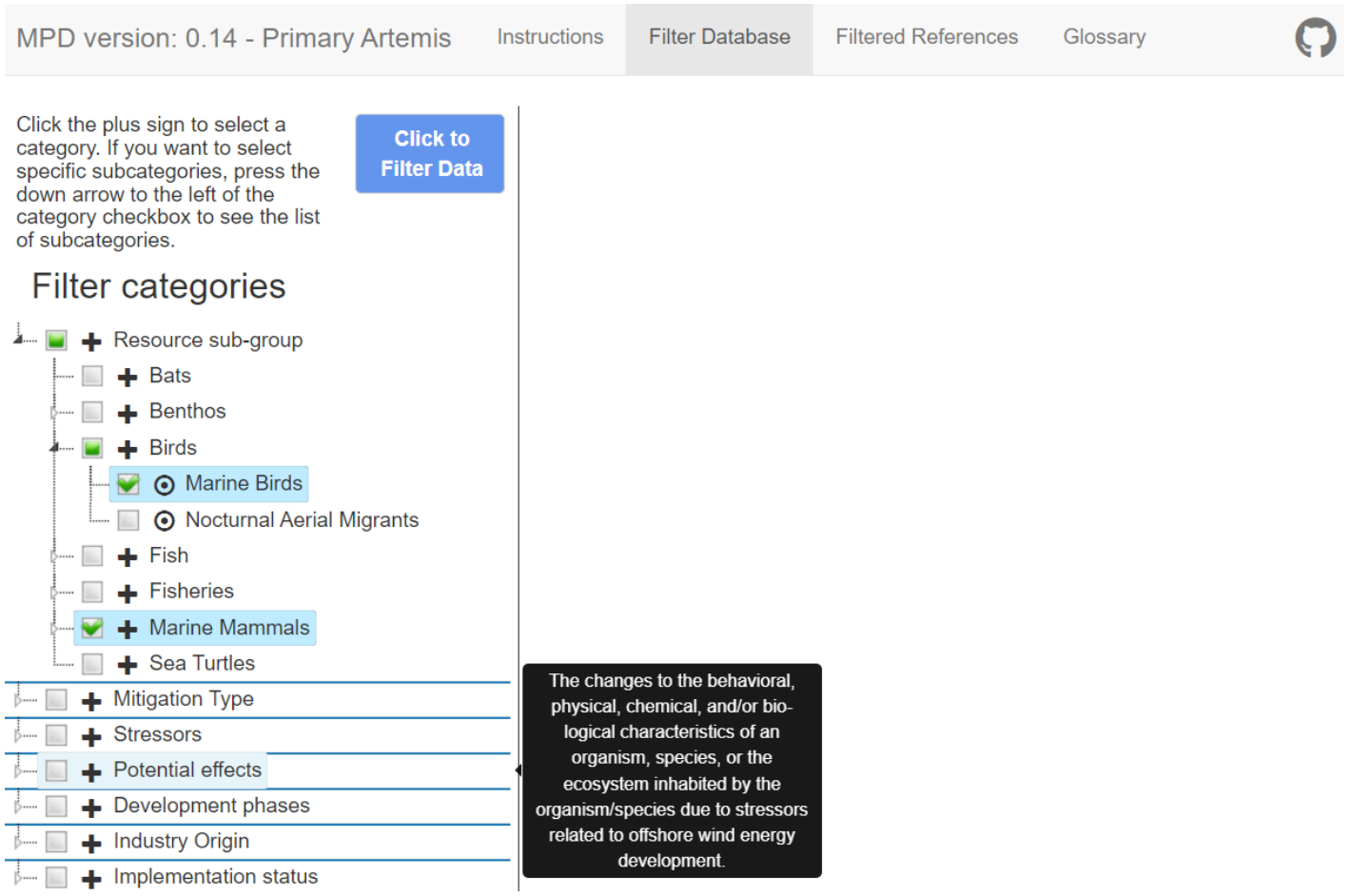
Steps 1 through 7 below include instructions on how to use the Tool, which can be accessed on the E-TWG (nyetwg.com/mpd-tool) and F-TWG website (nyftwg.com/mpd-tool).

Step 1. Opening the Tool. The Tool is located on both the E-TWG and F-TWG websites under the Resources tab at the top of the homepage, whereby the user can navigate to the "MPD Tool". Once on the MPD Tool webpage, click the box that reads "Open MPD Tool"

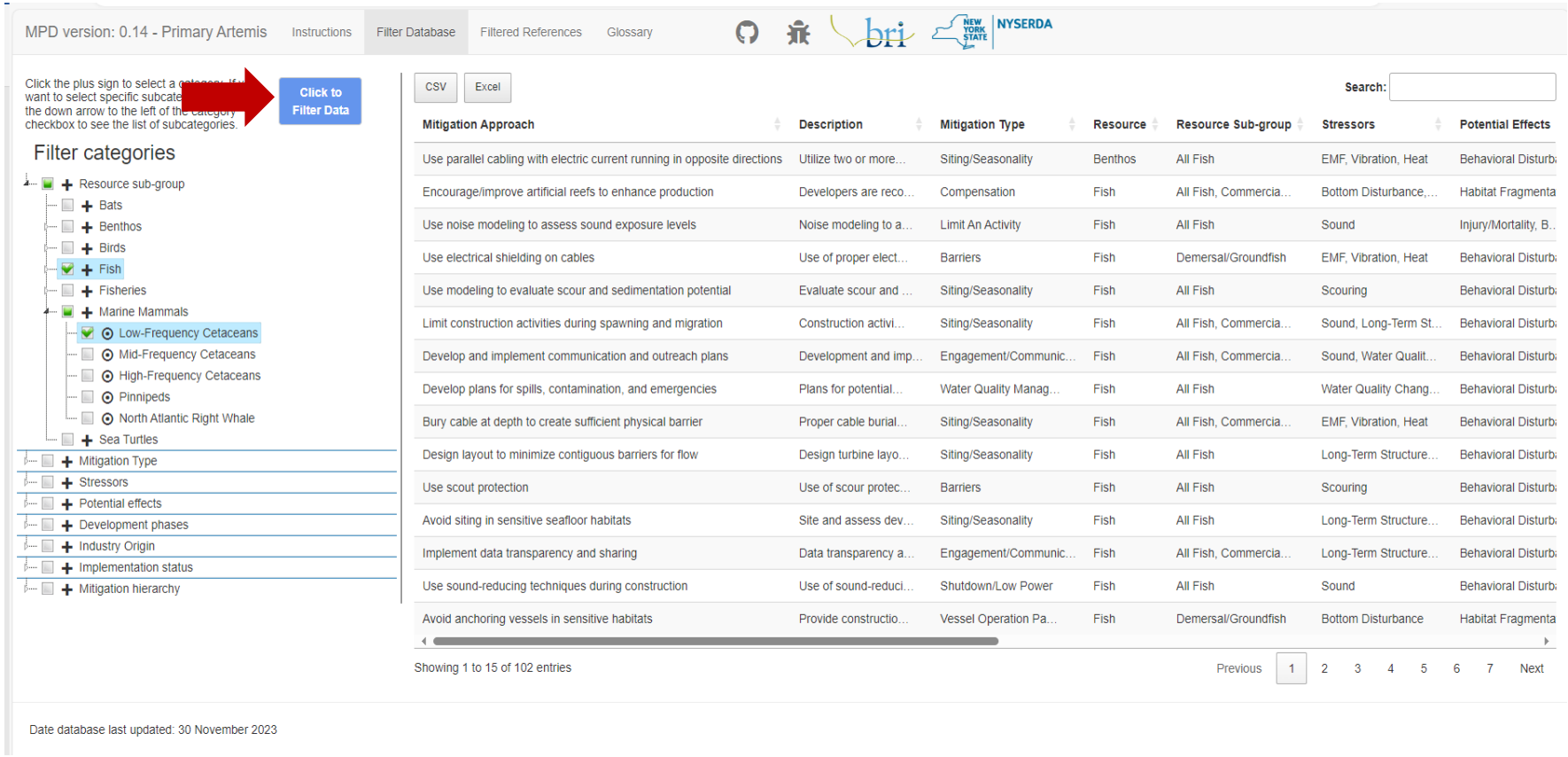
Step 2. View homepage of the R Shiny MPD Tool. From this page, you can access the Tool interface, references and the glossary via the menu at the top of the page. You can also download the User Manual (this document) or the full database by clicking the links under "Resources".



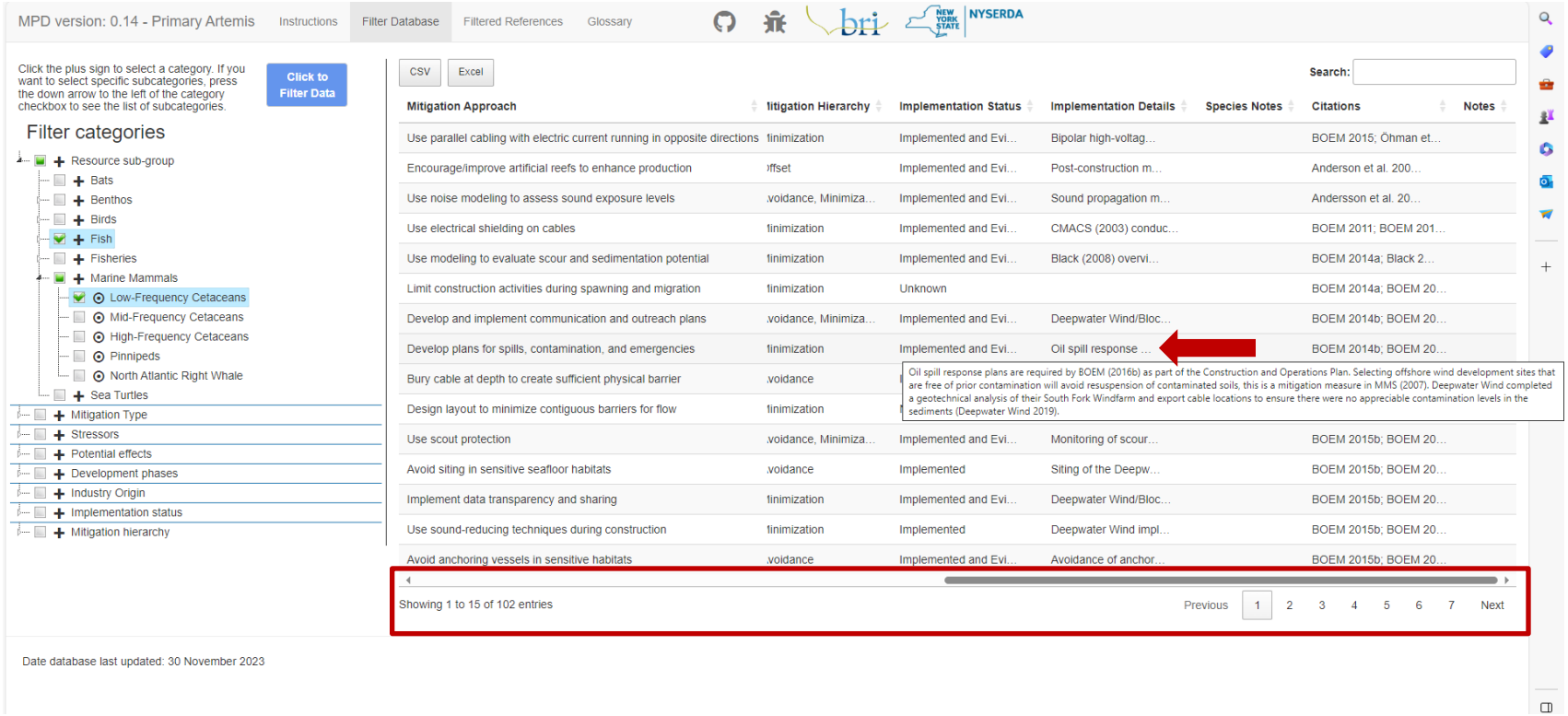
Step 3. Filter the Mitigation Practices Database. Navigate to the "Filter Database" page via the menu at the top of the page. On the lefthand side of the page are categories for filtering. Filter subcategory options are expanded by clicking the arrow to the left of the category. Some resource groups have additional subgroups for filtering (e.g., Birds include Marine Birds and Nocturnal Aerial Migrants). The User may select one or more filters by clicking the box or plus sign to the left of the text. A green check mark indicates that the filter has been selected. Adding criteria is an "and" condition. For example, if the user chooses fisheries and marine mammals as resources, mitigation options for both resources will be included in results. *Note: Hovering over a filter category provides a pop-up box with the definition.*



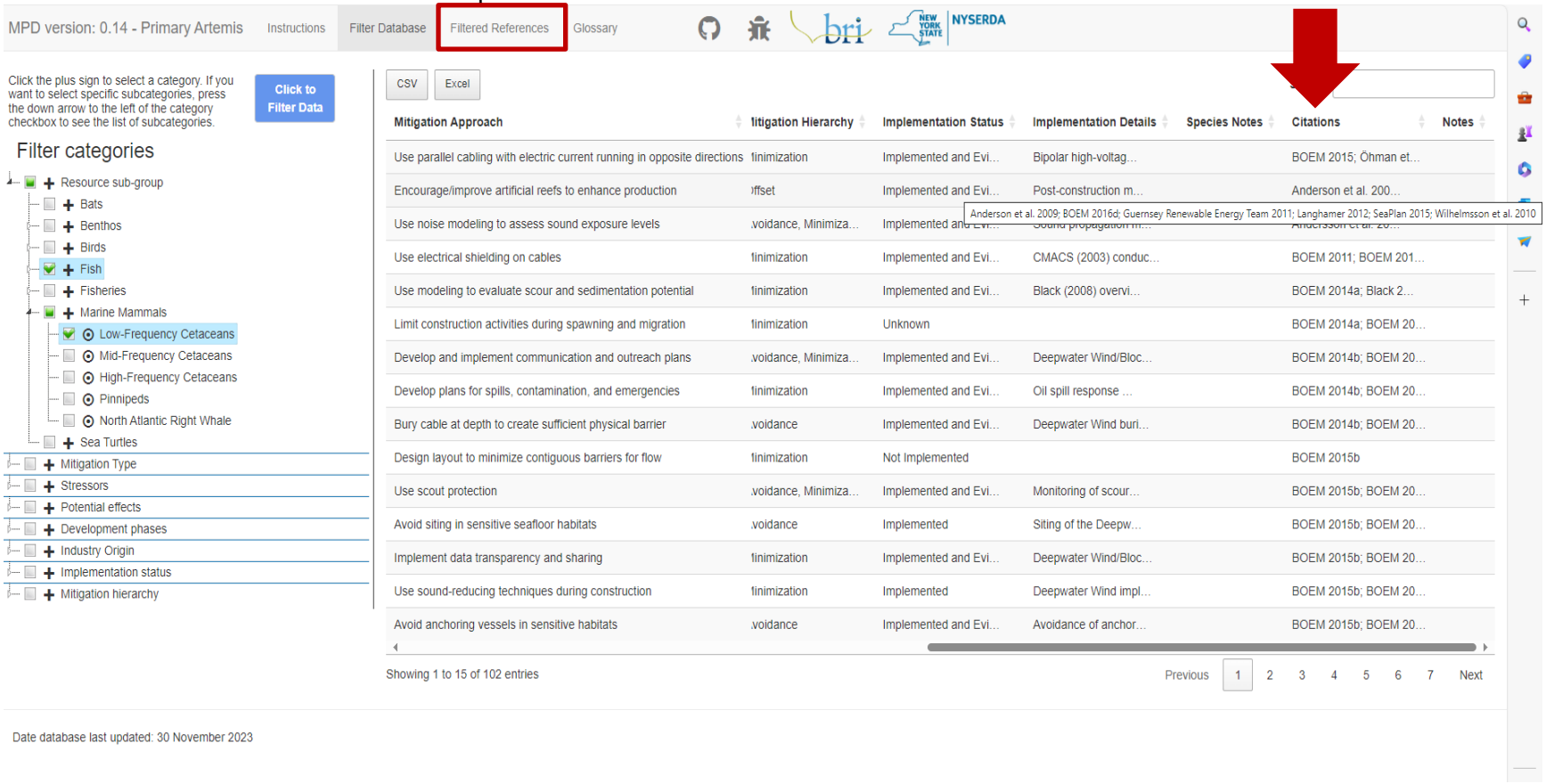
Step 4. Click the blue "Click to Filter Data" to see filtered entries once categories of interest have been selected. To the right of the category boxes, an output table will appear that shows the results of sorting and filtering the database for the combination of chosen filters.



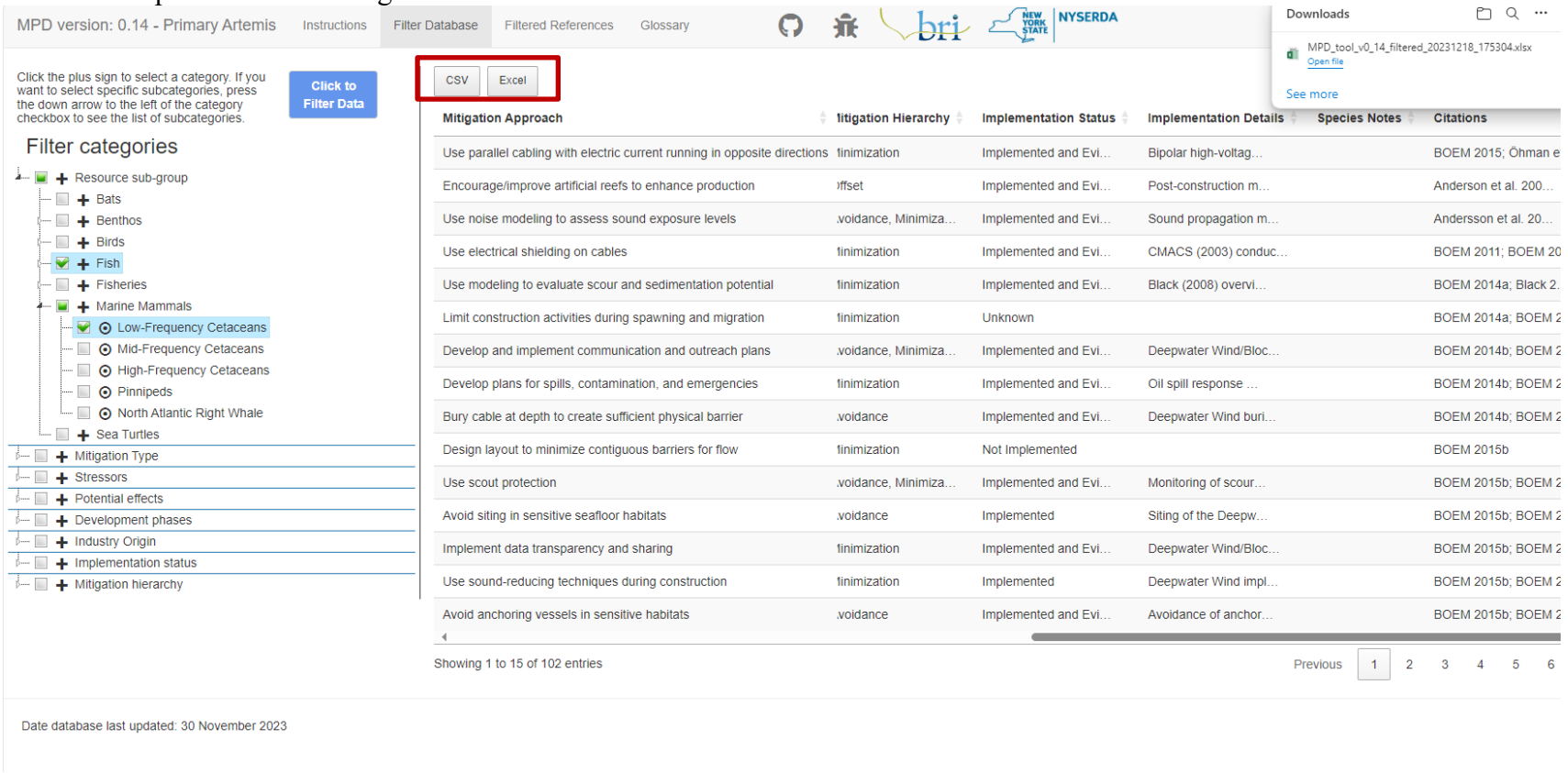
Step 5. Viewing all information associated with filtered entries. Scroll bars at the bottom right allow the User to slide the output box to see information that does not fit on the screen. Depending on filtering, there may be multiple pages of mitigation approaches. Columns have limited total characters to maintain a user- friendly screen view. An ellipsis can be seen at the end of the characters in the cell. The User can their cursor hover over the cell to access the full entry.



Step 6. Viewing Citations. To the far right of the output box is a column entitled “Citations” - The User can hover over the citation to access the full citation. All references for the filtered mitigation approaches can be viewed and exported by clicking on the “Filtered References” tab on the top menu.



Step 7. Downloading Filtered Data. Outputs from the Tool can be downloaded into an excel spreadsheet for CSV to preserve the record or further manipulate the information for evaluation. To do this, the User clicks the either the “CSV” or “Excel” radio button at the top of the screen. Similarly, the filtered references can be downloaded by navigating to the “Filtered References” tab via the top menu can clicking either the “CSV” or “Excel” radio button.



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