The Role of Economics in Offshore Wind Development

Using Commercial Fishery Economics to Evaluate Offshore Wind Impacts

The United States is targeting the development of 30 gigawatts of offshore wind installation by 2030. Commercial fishermen are concerned with the speed of permitting and the cumulative effects of wind energy projects. This brochure describes Veritas Economics' approach for using commercial fishery economics to evaluate the impacts of offshore wind development.

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Overview

Veritas Economics is a specialty economics firm focusing on fisheries, power, and regulatory economics. Having conducted scores of studies evaluating power plant fishery impacts for regulatory purposes, we have more experience in this area than any other firm. This experience indicates that high quality quantitative fishery economics can be an essential tool for environmental permitting.

The United States has substantial offshore wind energy resources. Federal and state governments, permitting agencies, and developers intend to develop these resources rapidly. However, conflicts with the commercial fishing industry have the potential to slow these efforts and generate ill will in an important industry of longstanding ocean users. More sophisticated study and exposition offers the potential to reduce conflict with commercial fishermen by enhancing the quality and transparency of conclusions, communications, and efforts to mitigate impacts.

At Veritas Economics we believe that bringing high quality fishery economics to the offshore wind permitting realm will enhance transparency of communications with the fishing industry and allow thoughtful and targeted mitigation that will improve industry relations as well as reduce permitting friction. To support these efforts, we are developing best-in-class simulation models to evaluate economic impacts of offshore wind development and identify appropriate mitigation. Combining results from these models with clear descriptions of methods and conclusions allows implementing high-quality fisheries economics in offshore wind permitting. This document describes models of commercial fishing for evaluating offshore wind impacts and describes how fishery economics fits in the offshore wind permitting process.

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Background

The United States has substantial offshore wind energy resources and up to forty percent of Americans live in coastal counties. As the country transitions to a less carbon intensive electric grid, offshore wind will be critical for ensuring reliable power supplies to coastal regions. There is a federal target of 30 gigawatts installed by 2030 and substantial development of this resource is underway (White House 2021).

Offshore wind permitting centers around the Construction and Operation Plan (COP). COP requirements arise from the National Environmental Permitting Act (NEPA). A COP is required for wind projects located in federal waters and is approved by the Bureau of Ocean Energy Management (BOEM). Although only one COP has been approved to date, BOEM intends to evaluate at least 16 COPs by 2025 (US DOI 2021).

Thirty gigawatts of offshore wind capacity will occupy thousands of square miles. This footprint and the speed of planned offshore wind deployment foretell conflicts with current ocean users. Commercial fishing is a particularly important competing use.

To date, the only major offshore wind project to have received a Record of Decision (ROD) allowing the project to proceed to construction is Vineyard Wind, an 804-megawatt project off the Massachusetts coast (BOEM 2021a). However, a consortium of fishery interests is suing Vineyard Wind ROD signees (BOEM, the Interior Department, National Marine Fisheries Service (NMFS) and the U.S. Army Corps of Engineers). According to the lawsuit, streamlined permitting limited the opportunity for public comment and the process did not account for the importance of waters around the Vineyard Wind lease to the regional longfin squid fishery (RODA 2022). The lawsuit also notes that the BOEM ROD includes communications with fishermen indicating that the entire 75,614-acre area to be occupied by wind turbines would be abandoned by commercial fishing.

Although Vineyard Wind is intentionally located in an area with low fishing activity, all areas suitable for offshore wind receive some amount of commercial fishing effort and transit. To mitigate fishing impacts, developers reduced turbine density, created transit lanes, and promised payments in excess of $25 million (BOEM 2021a).

The 30 gigawatt federal target is nearly forty times the generating capacity of Vineyard Wind. A critical question is how to minimize conflicts with commercial fishing while rapidly deploying the thousands of turbines required for 30 gigawatts of capacity.

Reducing turbine density is the most straightforward way to minimize these conflicts. However, lower turbine densities result in higher per megawatt costs.

Because of this trade-off between generation costs and fishability, competing use issues between offshore wind and commercial fishing are not unexpected. However, it is noteworthy that the Vineyard Wind COP contains only a minimal, qualitative evaluation of “With-Project” impacts to commercial fishing. More sophistocated study and exposition offers the potential to reduce conflicts with commercial fishermen by enhancing the quality and transparency of conclusions,

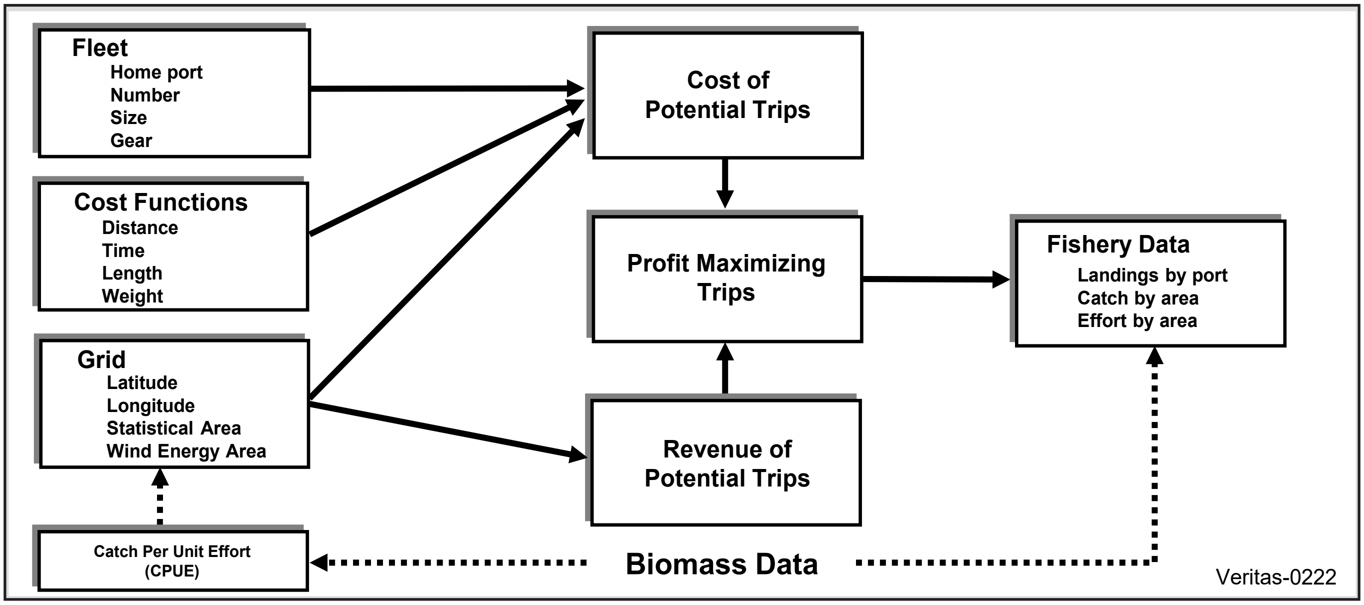


Figure 1: Veritas' Framework for Modeling Commercial Fishing

communications, and efforts to mitigate impacts.

Veritas Economics (Veritas) specializes in conducting detailed and quantitative commercial fishing economic studies. Figure 1 depicts the framework Veritas uses to model commercial fishing. The approach uses a port and vessel specific characterization of the fleet and a grid to spatially represent the fleet's fishing opportunities. Within this structure boat captains consider the expected costs and revenues of possible fishing trips to identify profit-maximizing trips. A calibrated Baseline specification characterizes catch, effort, revenue, and profit by species, port, and vessel under conditions that would exist without the offshore wind development project. Counterfactual "With-Project" specifications are used to evaluate vessel and gear-specific fishing behaviors along with outcomes under possible conditions that may exist with the offshore wind development project. These include conditions such as no access, reduced access, catch changes, gear snagging, and safety effects due to weather.

Baseline and With-Project outcomes are compared to quantitatively evaluate changes in trips, costs, revenues, catch, and profits under different conditions. This type of evaluation is explicitly required for major projects under NEPA's alternative analysis requirement (USACE 2020) and is consistent with requirements of BOEM's fifth best management practice (BMP5) to mitigate offshore wind impacts on commercial fisheries (BOEM 2014). BMP 5 states that,

> The lessee will evaluate historical fishing activities on the proposed project sites; temporal and areal restriction on fishing caused by the project; the amount of fishing that would continue on the site once it is constructed; pressure on other fishing grounds by displaced fishermen; types of fishing methods employed at the project site; species of fish caught; and the estimated value of the catch from the project site (BOEM 2014).

The following sections describe Veritas' approach for assessing commercial fishery impacts and evaluating mitigation measures.

Modeling Commercial Fisheries - Baseline

The economics of commercial fishing is complex. Many different types of vessels use various sorts of gear to target a variety of species. Fishing takes place in a dynamic and uncertain environment with regulations, stock locations, and weather that vary over the course of the year.

Commercial fishing models represent this world using equations and data. Veritas has developed economic models of commercial fisheries. The following section describes the Baseline component of Veritas' Squid Fishing Model.

Baseline Squid Fishing Model

Baseline models represent typical fishing behaviors as best as possible given available information. The Baseline component of Veritas' Squid Fishing Model intends to present a reasonable approximation of typical ongoing fishing objectives, behaviors, and outcomes. Figure 2 depicts the grid that is used to characterize the spatial nature of commercial fishing.

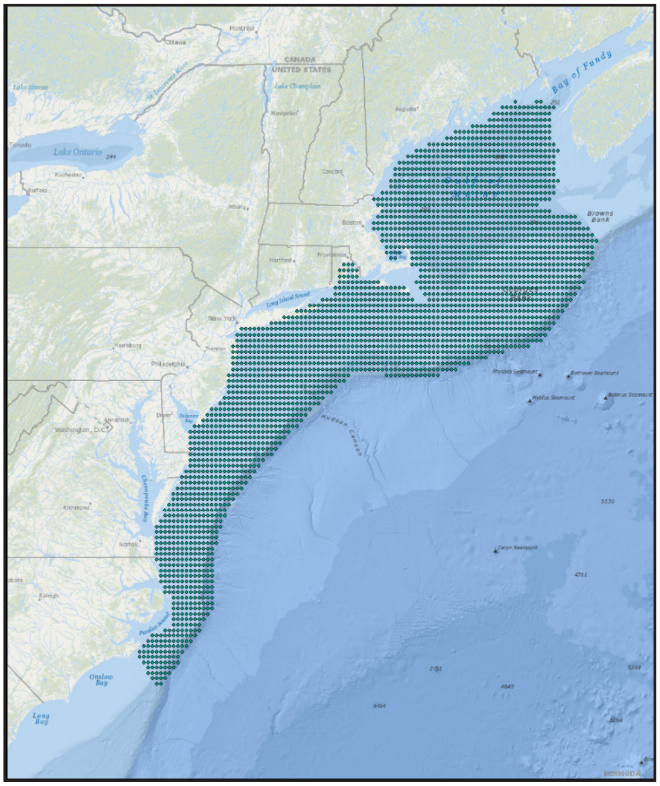


Figure 2: Spatial Grid Representing Areas Where Commercial Squid Fishing Vessels May Travel to Fish

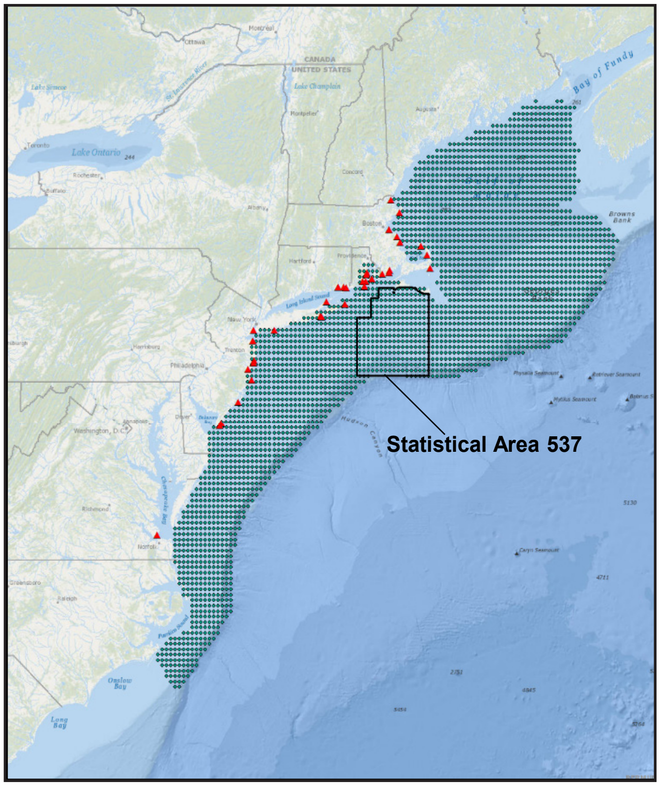


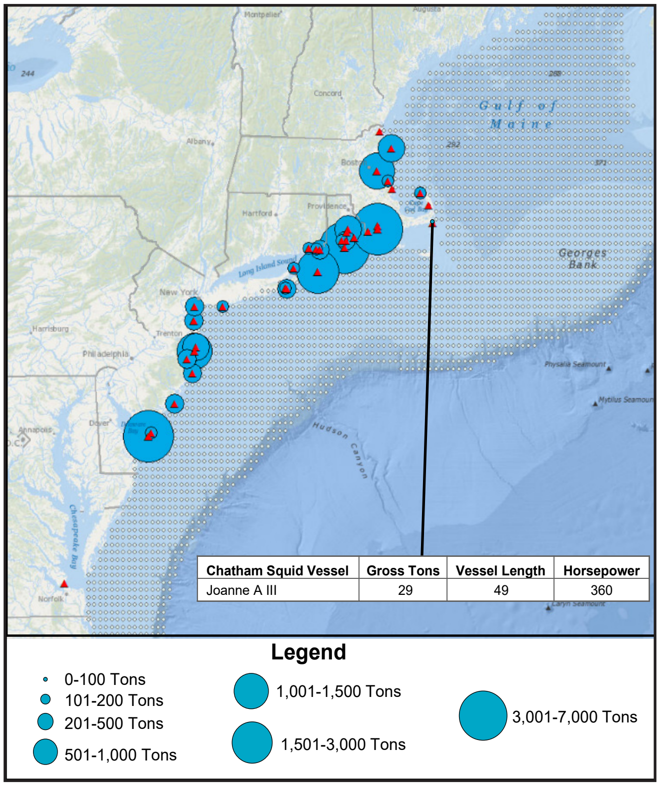
Figure 3: Different Areas of the Ocean Available to Fish

The grid represents areas of the ocean where vessels may go to fish. It is used to characterize parts of the ocean that lay within statistical and regulated fishing areas, to calculate distances from ports to fishing grounds, and to spatially model effort and catch per unit of effort.

Figure 3 depicts the representation of different areas of the ocean. These areas indicate places that are or are not available to fish and provide spaces over which to aggregate catch for comparison with data. For example, National Oceanic and Atmospheric Association (NOAA) fisheries statistical reporting areas are regions over which catch by species and port are recorded. Figure 3 depicts statistical reporting area 537.

Areas of the ocean are fished by the squid fishing fleet. The fleet is depicted in Figure 4. In this figure, the size of the circles indicate total gross tonnage of the squid fishing vessels in each port.

The Baeline component of Veritas' Squid Fishing Model identifies and locates each squid fishing



Chatham Squid Vessel	Gross Tons	Vessel Length	Horsepower
Joanne A III	29	49	360

Figure 4: Gross Tons of the Squid Fleet by Port

vessel in its home port. The model uses grid and port locations combined with the length, tonnage, and gear type to calculate the time and cost for each vessel to steam from its home port to the fishing grounds.

Figure 4 illustrates the vessel data that the Baseline component of the Squid Fishing Model uses to calculate trip costs. As the figure shows, this data includes the gross tonnage, length, and horsepower of each vessel in the port. Figure 4 presents the data for the port of Chatham, Massachusetts which contains the smallest fleet of squid fishing vessels.

Cape May, New Jersey, located at the bottom left in Figure 4, has the largest gross tonnage of commercial squid fishing vessels, with a fleet of 20 squid fishing vessels.

In addition to modeling commercial effort in different fishing grounds, the Baseline component of the Squid Fishing Model also estimates harvest by port. Annual harvest by species and port, aggregated across vessels, is available from the Greater Atlantic Regional Fisheries Office (GARFO) and depicted in Figure 5. Along with other external information such as effort and cost, reported harvest by port is used to develop the Baseline component of the Squid Fishing Model in a manner that is consistent with typical outcomes. For example, the Baseline component of the Squid Fishing Model produces estimates of harvest by port similar to those depicted in Figure 5.

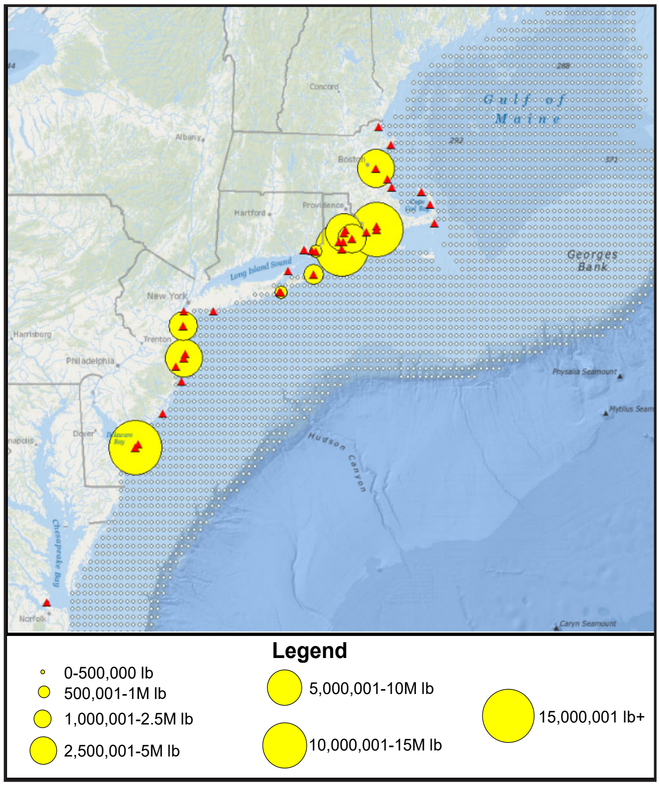


Figure 5: Squid Harvest by Port

Modeling Commercial Fisheries - Baseline

In addition to employing data on costs, the Baseline component of the Squid Fishing Model also employs data on revenue, which, when combined with cost information, provides estimates of the relative profitability of trips from each port to each fishing ground depicted by the squid fishing grid in Figure 6. Revenues for each trip are the product of dockside price and harvest. Harvest for a given trip is the product of catch per unit effort (CPUE) and time on site. Figure 6 illustrates the expected catch for different fishing grounds. Expected catch is abundance data measured in CPUE. CPUE is scaled to be consistent with aggregate harvest information (e.g., Figure 5) developed from abundance and fishing data and specified as CPUE.

Gear size varies across vessels, and this affects catch rates. Relative gear sizes are based on vessel sizes and used to develop vessel-specific catch rates.

Profitability is calculated based on trip and vessel-specific information for each possible trip. In simulations, vessels choose trips based on profitability resulting in model-based estimates of effort in various fishing grounds.

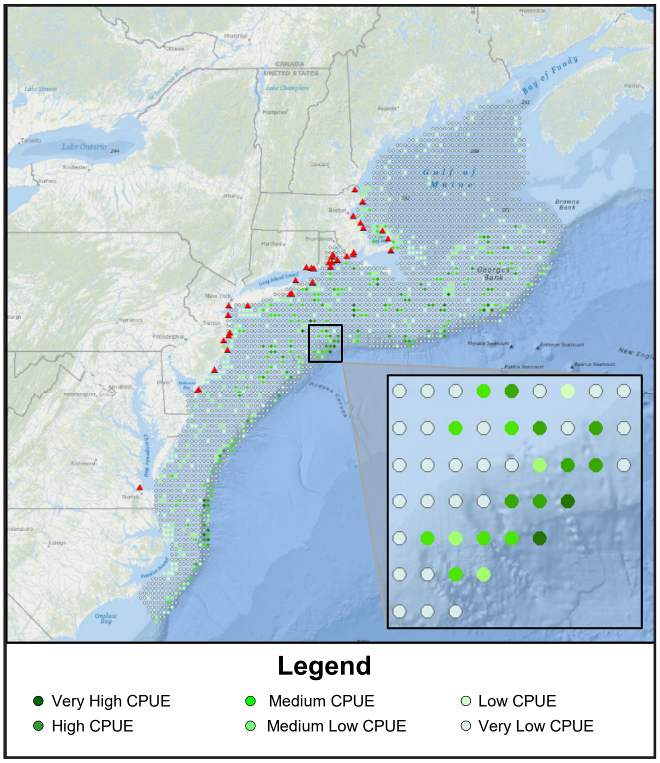


Figure 6: Relative Squid Catch Per Unit Effort (CPUE)

Photo credit: NOAA

Visual data that indicates relative Baseline fishing effort is available from GARFO. This data is mapped to the grid based on weighted average pixel intensity. Figure 7 is a grid-based depiction of squid fishing effort, where effort is the amount of time spent fishing in an individual location by gear type.

Comparisons across Figure 6 (Relative Squid Catch Per Unit Effort) and Figure 7 (Squid Fishing Effort) indicate profit-maximizing behaviors. For example, comparing across these figures, many trips go to areas with high CPUE that are far offshore. However, areas closer to shore with lower CPUE also receive high effort levels because these lower harvest trips can be profitable due to the lower costs.

Photo credit: Balashark

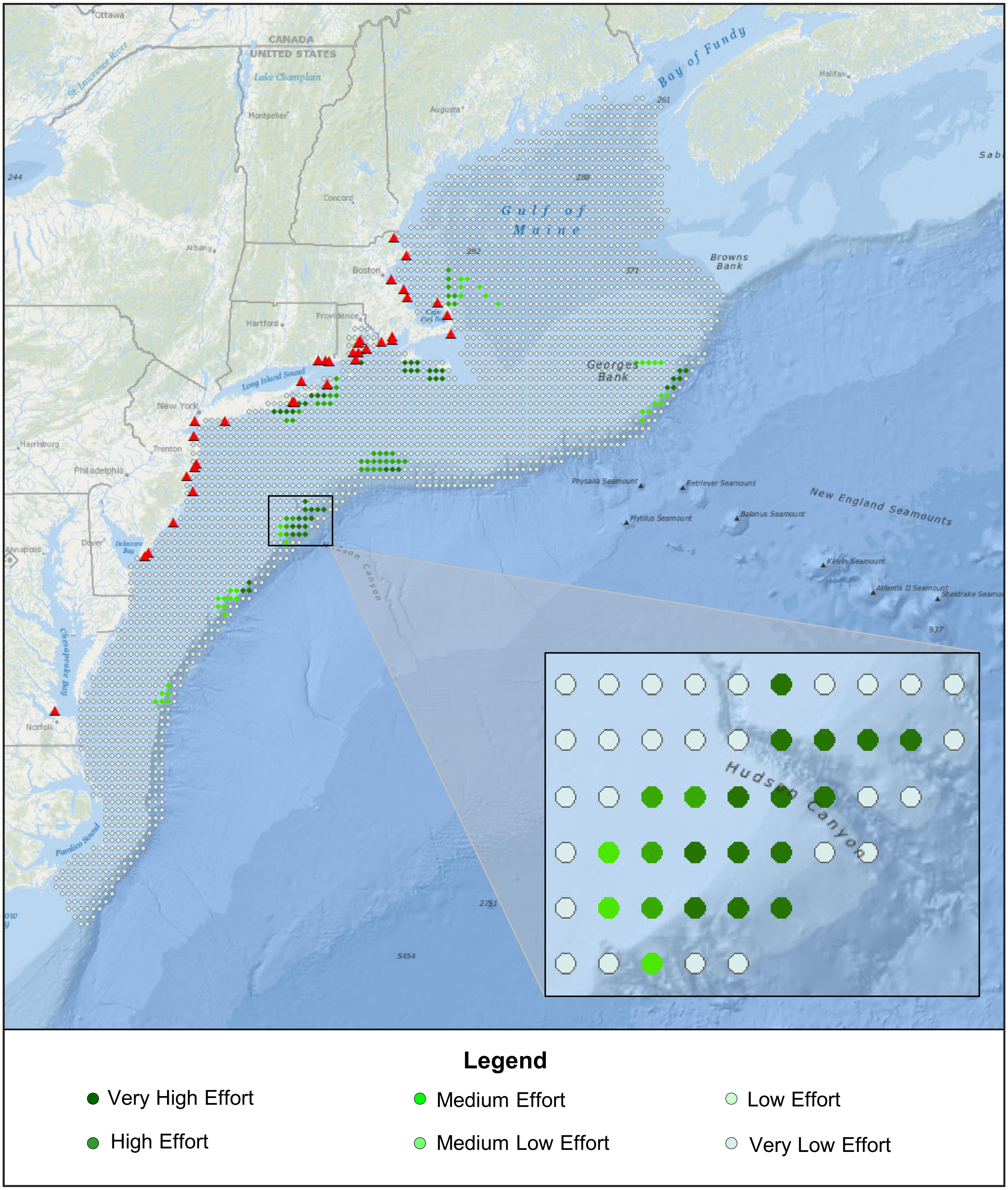


Figure 7: Squid Fishing Effort

Modeling Commercial Fisheries - With Project Conditions

Designing a wind energy area with no potential for impacts to commercial fishing is challenging. In the open ocean, vessels can fish and transit in rough weather and captains towing huge nets can make 180 degree turns at any point. Wind turbines can impact these commercial fishing operations.

Commercial fishing activities are most impacted by high turbine density, but reducing density results in increased cost per megawatt. This tension indicates that commercial fishermen are likely to view mitigation attempts as inadequate, while wind developers see fishing industry requests for wider turbine spacing as unreasonable and expensive.

Although wind energy area COPs focus on a single site, the tension between developers and fishermen takes place on a larger scale. The commercial fishing community is aware of goals for offshore wind deployment and recognizes that there will be many offshore wind areas coming soon.

This rapid deployment of offshore wind is taking place as fishermen are also concerned about dangerous weather events and stock movements.

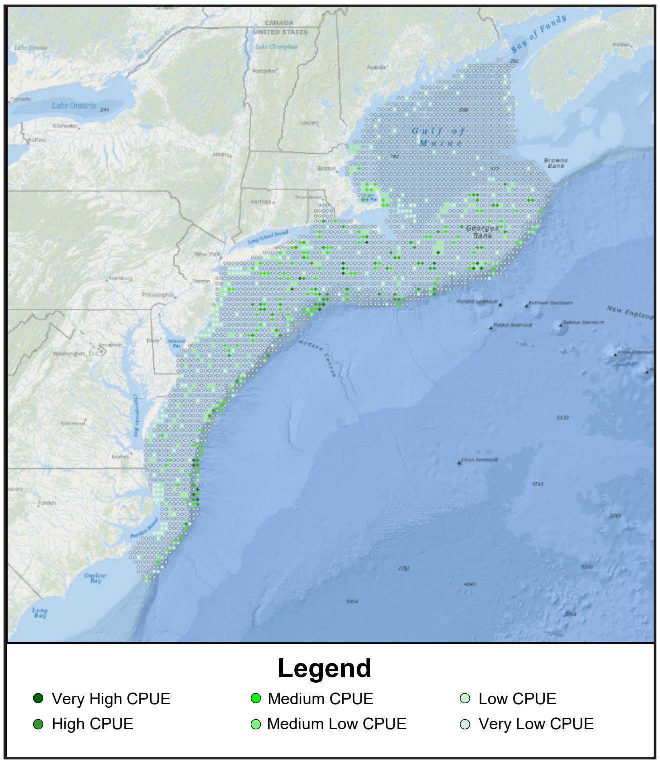


Figure 8: Baseline Conditions of the Squid Fishery

Although wind energy areas are designed to be consistent with Coast Guard safety requirements, fishermen are concerned that wind energy areas will prove difficult to fish, or, that after an accident that they will be entirely off limits.

Figures 8 and 9 present a model representation of these worst case cumulative conditions. Figure 8 shows Baseline conditions of the squid fishery. In Figure 9, grid points are removed from within each wind energy area to represent With-Project conditions where there is no fishing within the wind energy areas.

This specification represents a worst-case scenario with no commercial fishing in wind energy areas. Between the Baseline with no effects from wind energy areas (Figure 8) and this worst-case scenario (Figure 9) is a nearly infinite mixture of scenarios that can be modeled. These include all wind energy areas and all project phases (construction, operation, and decommissioning).

In practice, developers mitigate impacts to commercial fishing by implementing the best management practices presented in BOEM's 2014 Report *Development of Mitigation Measures to Address Potential Use Conflicts Between Commercial Wind Energy Lessees and Commercial Fishermen* (BOEM 2014). In its report, BOEM identifies five best menagement practices for mitigating offshore wind development impacts on commercial fisheries.

Changes in fishing behaviors and harvest depends upon the degree to which impacts have been mitigated. Certain mitigation activities are a matter of course. For example, developers minimize snagging on transmission cables by burying them, and wind facilities are well marked with radio, lighting, and safety equipment. Moreover, BOEM regulations require a safety system with procedures for collisions, gear entanglement, catastrophic failure of a turbine, or other events that could impact safety.

Despite these efforts, impacts, or the perception of them will remain. Results from Europe, where offshore wind installations are already prevalent, provides insight into potential negative outcomes.

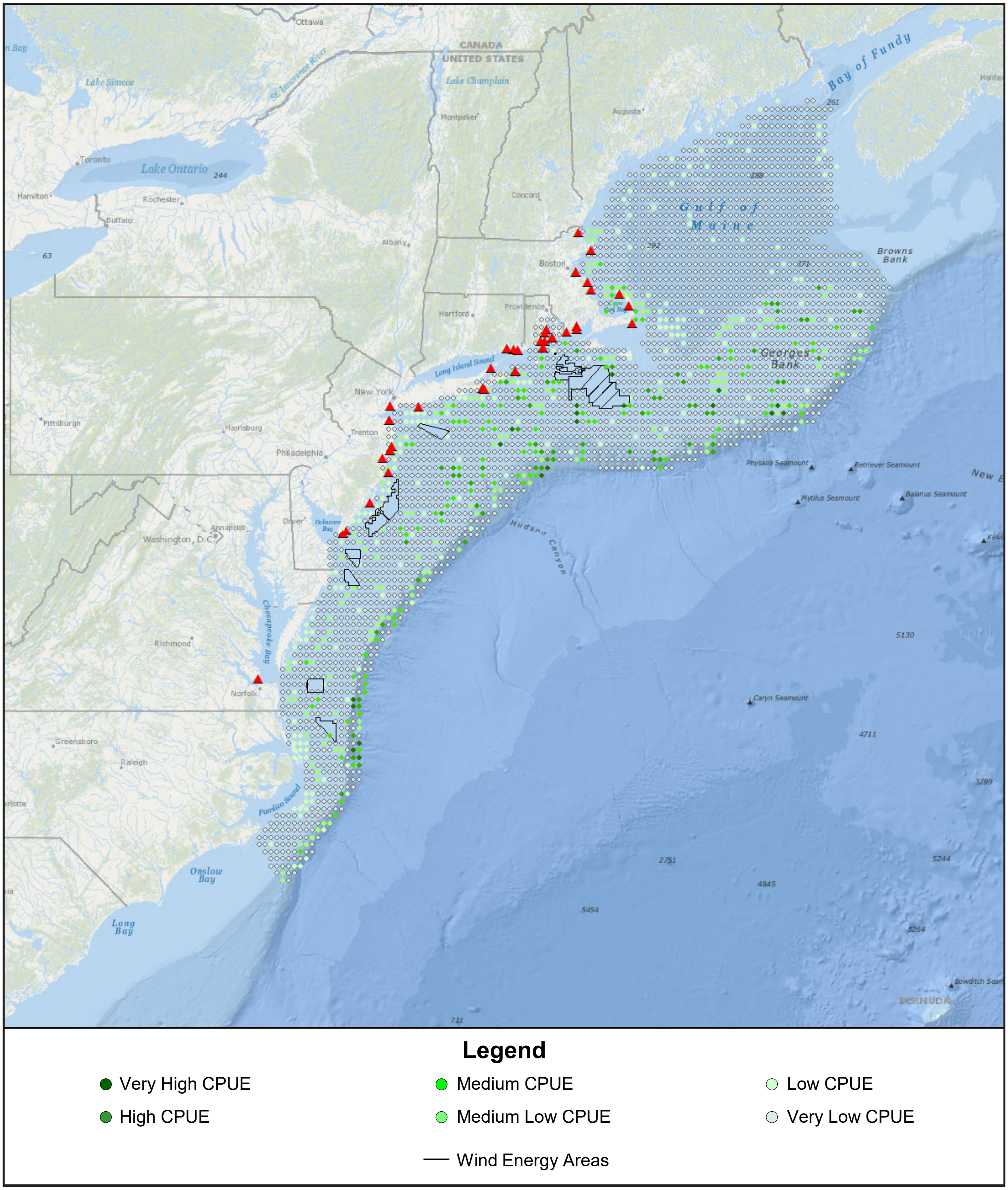


Figure 9: Cumulative Worst-Case Conditions

Modeling Commercial Fisheries - With Project Conditions

Gray, Stromberg, and Rodmell (2016) surveyed fishermen to understand changes to fishing practices resulting from the development of five offshore wind energy areas around the United Kingdom. Most surveyed fishermen said that the wind energy areas had either a negative or very negative impact on their income. Surveyed fishermen stated that they either reduced or stopped fishing near wind energy areas and cabling during construction and only a small number returned post construction.

Safety was the primary reason cited for avoiding wind energy areas. Fishermen report believing that fishing within offshore wind energy areas is risky, primarily due to potential gear snagging and the possibility that engine failure within a wind energy area would lead to collisions with turbines. This result indicates that even with substantial up front mitigation, impacts to commercial fishing may nevertheless occur.

Impacts to commercial fishing that are not mitigated under BOEM's first four best management practices (BMP 1-4) are to be offset under BOEM's fifth best management practice: BMP5 - Financial Compensation.

Figure 10 depicts how commercial fishing economic models fit into this regulatory structure and provide the basis for determining appropriate financial compensation. As Figure 10 illustrates, a quantitative fishery model incorporates Baseline conditions as an input and provides the ability to quantitatively evaluate potential impacts from offshore wind development. This evaluation provides the basis of conducting the Impact Assessment of offshore wind development as described in BOEM's 2015 Report *Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic*. The analysis in the Impact Assessment provides the basis for evaluating the four main provisions in BMP 5:

- Gear and Safety,
- Fishery Enhancement,
- Offsetting Lost Income, and
- Enhancing Fishing Ports.

The following sections describe how Veritas uses its commercial fishing models to evaluate each of these provisions.

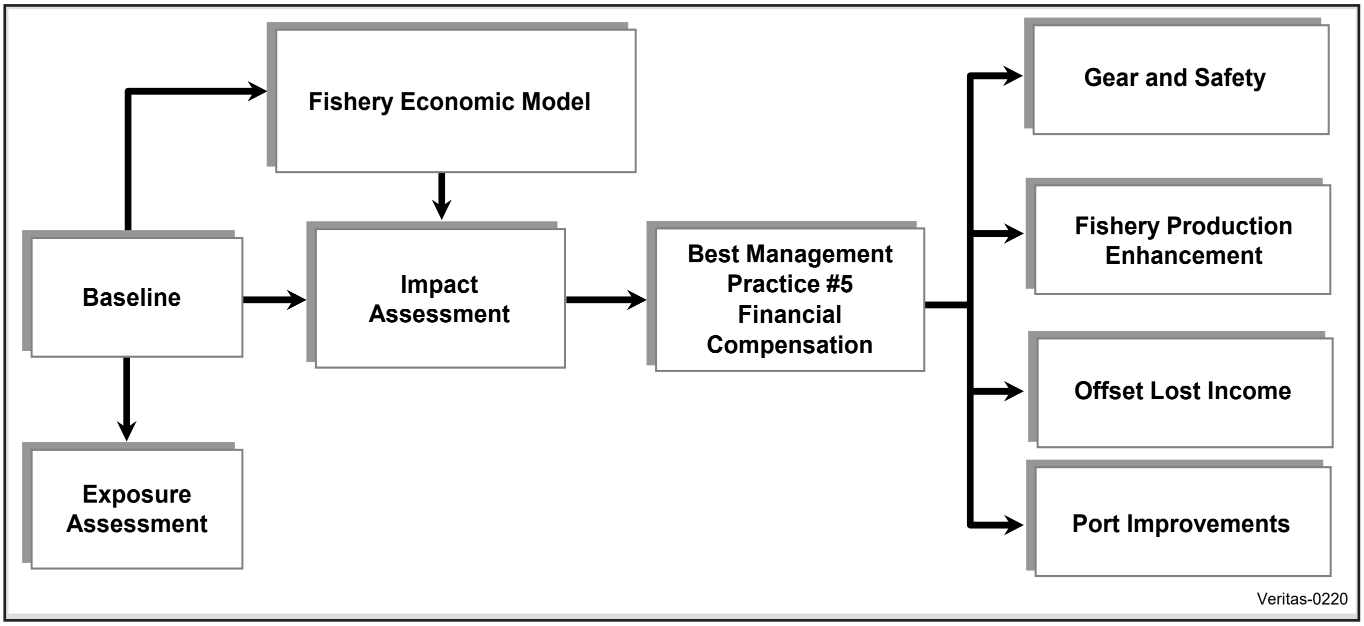


Figure 10: The Role of Commercial Fishing Economic Models in Determining the Appropriate Financial Compensation under BOEM's Best Management Practices (BMP5 in BOEM 2014)

Satisfying BMP 5 Requirements

Gear and Safety

Some commercial fishermen are concerned that they will not be able to safely fish in wind energy areas. An important safety concern arises from gear snagging. BOEM's BMP 5 states that the lessee "will consider various forms of direct compensatory mitigation support for gear loss or modification in order to develop or purchase wind facility safe fishing gear" (p.v BOEM 2014).

Fishing gear consists of nets, traps, pots, dredges, lines, and hooks. Fishing gear is deployed in a dynamic and opaque environment, and its repair and replacement is an ongoing part of commercial fishing. Snagging on electrical cables or wind turbines could lead to additional gear damage and loss.

Cables are buried under the ocean floor, when possible, to minimize conflicts with gear that fishes the ocean bottom. Approaches for mitigating turbine impacts can include considering turbine density and layout, developing gear that is wind facility safe, and replacing lost gear.

Impacts from wind turbines depend on the type of gear being deployed. Fixed gear consists of pots and traps that are baited to attract and capture crabs and lobsters. Fixed gear is placed on the ocean bottom with a rope and buoy connecting it to the surface. Fixed gear is less affected by turbines than mobile gear. However, space that is occupied by fixed gear presents a use conflict with mobile gear that could be exacerbated by wind energy development.


Photo credit: Katie Rodriguez


Photo credit: Bob Brewer

Mobile gear such as long lines, purse seines, trawl nets, and dredges rely on vessel movement. Long lines and purse seines are rarely used in US Atlantic wind development areas. Trawl nets target demersal and midwater species. The largest of these are towed behind beam trawlers which tow nets from derricks that extend from the sides of the vessel. Beam trawlers are prohibited in certain North Sea wind installations and these vessels are unlikely to be used in U.S. sites with spacing at one nautical mile.

Sea scallop dredges consist of a steel frame and collection bags made of a mesh of steel rings. These dredges are dragged on the ocean bottom. Like trawls, dredges can be deployed from beams or directly behind a vessel. By regulation, larger vessels with limited access permits can employ up to two 15-foot-wide dredges while smaller vessels with general category permits employ a single dredge with a maximum 10.5′ width.

Clam dredges target surf clams and ocean quahogs using pumped seawater to separate clams from sand. The clams are collected in steel mesh dredge chambers that are used to raise them to the surface. Clamming is regulated by quotas rather than gear restrictions. As a result, clamming vessels are often larger than scalloping vessels. The Vineyard Wind Environmental Impacts Study (BOEM 2021b) notes that clam industry representatives state that their operations require a minimum turbine spacing of two nautical miles.

The BOEM best management practice of developing or purchasing wind facility safe gear, recognizes that problems arise when fishing gear is snagged on wind facility components (BOEM 2014). However, gear that mitigates this problem without having a negative impact on catch rates has not been developed. Given that gear loss from snagging predates offshore wind, breakthroughs in this area appear unlikely. In the absence of such gear, fishermen may experience increased gear loss, use smaller gear, change fishing patterns within the wind energy area, or avoid the area altogether.

With weather, catch rates, and fishing regulations all varying by time of year, there is an important interaction between the time of year and the effect that offshore wind development has on fishing. For example, because of rougher weather, commercial fishermen that fish a wind energy area consistently in the summer may avoid it in the winter for safety reasons. Veritas is able to estimate the effect of this situation by employing a seasonal representation of commercial fishing as depicted in Figure 11. The top panel of Figure 11 shows the modeled catch per unit effort in Spring, Summer, and Fall months for the wind energy area, and the bottom panel shows the modeled catch per unit effort for Winter months. To evaluate the effect of commercial fishermen avoiding the wind energy area in the winter, the winter component of the commercial fishing model reduces catch per unit effort to zero for each fishing location in the wind energy area. This is illustrated in Figure 11 by removing the dots (fishing areas) within the wind energy area.

Photo credit: KenWiedemann

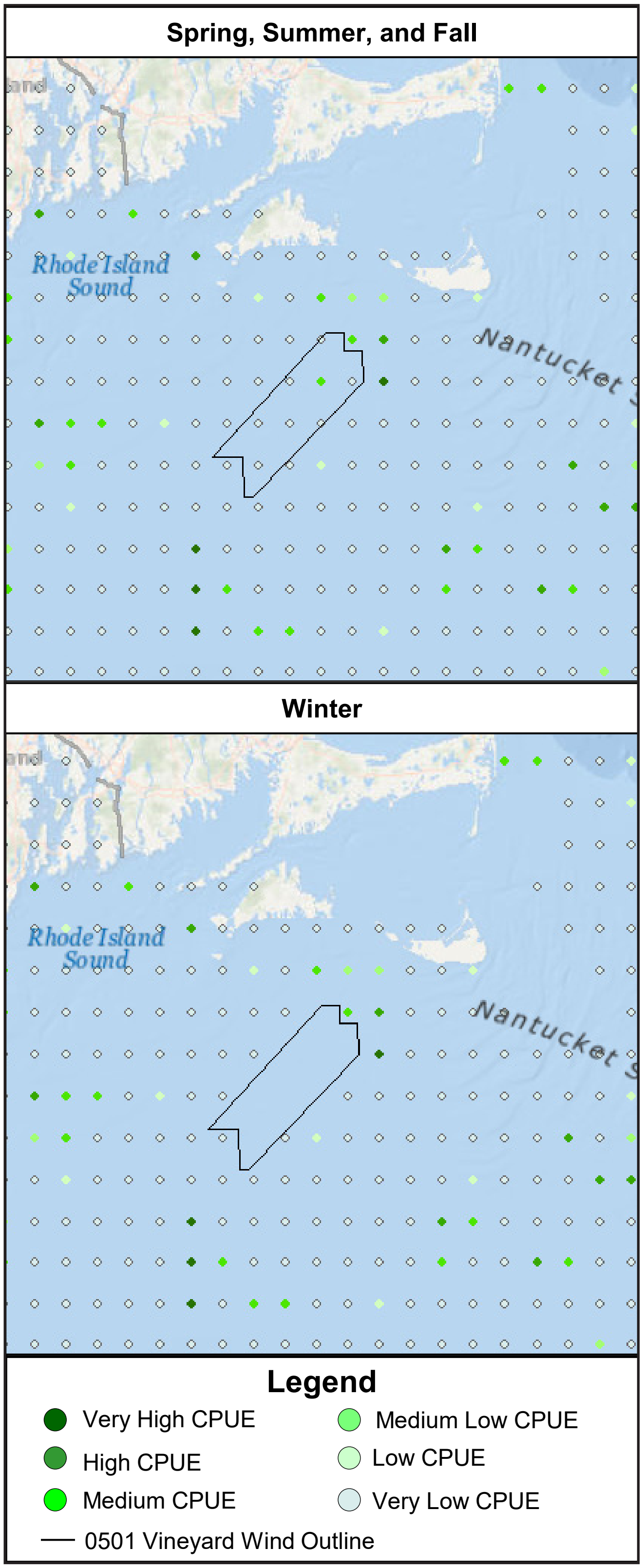


Figure 11: Fishing Avoided in Winter

Fishery Production Enhancements in Lease or Nearby Areas

It may be that despite mitigation efforts, certain vessels will avoid wind energy areas or experience lowered catch rates within them. A potential mitigation approach involves offsetting this impact by boosting densities of target species. This is consistent with BMP 5 which states that “the lessee will explore measures that could have a beneficial impact on fishing to offset any negative consequences” (p. 5-23 BOEM 2014). Approaches that have been employed to enhance fish stocks include establishing marine protected areas (MPAs), enhancing or creating habitat, and direct stock enhancement approaches such as stocking and seeding.

MPAs are an area of the ocean that is managed for conservation purposes. MPAs typically restrict human activity including tourism, oil and gas development, and fishing. Although their efficacy for enhancing stocks of highly mobile species is unclear, MPAs have been shown to be effective in supporting many different types of marine life. MPAs often do not allow commercial fishing; however, their outside boundaries can be productive fishing areas. With respect to mitigation of wind farm impacts, MPAs have limited value because they often make an area of ocean unavailable for commercial fishing. This is looked upon unfavorably by commercial fishermen.

Direct stock enhancement approaches include hatching and seeding. Marine hatcheries are not common. However, Texas Parks & Wildlife Department’s marine hatcheries produce juvenile red drum, spotted seatrout and southern flounder for stock enhancement and similar operations could be developed to support East Coast fisheries.

Seeding programs that focus on less mobile species such as clams, oysters, scallops and lobsters are much more common, and for many species hatchery production is already established at commercial or near-commercial scales. Figure 12 depicts modeling of clam enhancement to offset

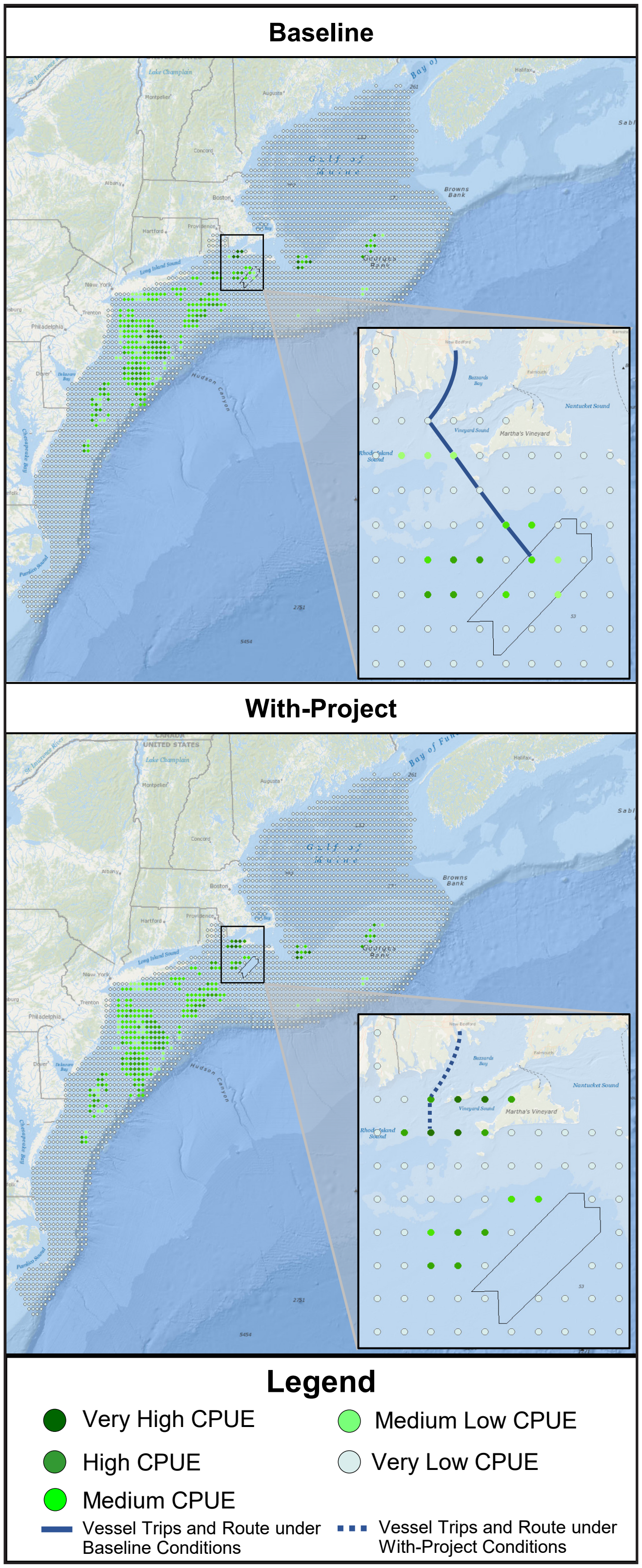


Figure 12: Modeling Clam Enhancements

impacts to clamming vessels that avoid a wind energy area. The top panel in Figure 13 depicts a Baseline in which the vessel goes past areas with low catch rates to a site with medium-high catch per unit effort within the wind energy area. In the With-Project case, illustrated in the bottom panel, seeding has improved clam harvest in the areas the vessel previously bypassed. The vessel makes a shorter trip to harvest more clams than under Baseline conditions, thereby offsetting the wind energy area impact.

Offsetting Lost Income

Even with mitigation in turbine layout and programs to enhance safety, some vessels may choose not to fish in a wind energy area. Moreover, for some fisheries, it may be impractical to offset impacts by stocking or seeding. BMP 5 notes that a, "fuel purchase subsidy program could be established if fishermen become displaced" (p. 5-23 BOEM 2014) and notes that fuel subsidies may be appropriate if, "offshore wind facility locations result in increased fuel costs from increased steaming time as fishermen avoid traveling through a wind facility" (p. 5-23 BOEM 2014).

Avoiding fishing or transiting a wind energy area places costs on commercial fishermen that can be identified using appropriate With-Project specifications. To model areas as not being fished, sites within wind energy areas are removed from the model, making them unavailable for fishing. The measured differences in costs and revenues across Baseline and With-Project conditions are used to estimate financial impacts to be offset.

A similar exercise can be conducted for vessels that will not transit a wind energy area. For these vessels, in the With-Project representation, routes that travel through the wind energy area are changed so that they go around the wind energy area. Again, Baseline and With-Project results are compared to measure differences in costs between the two routes and provide an estimate of the lost income to be mitigated. Figure 13 depicts this process.

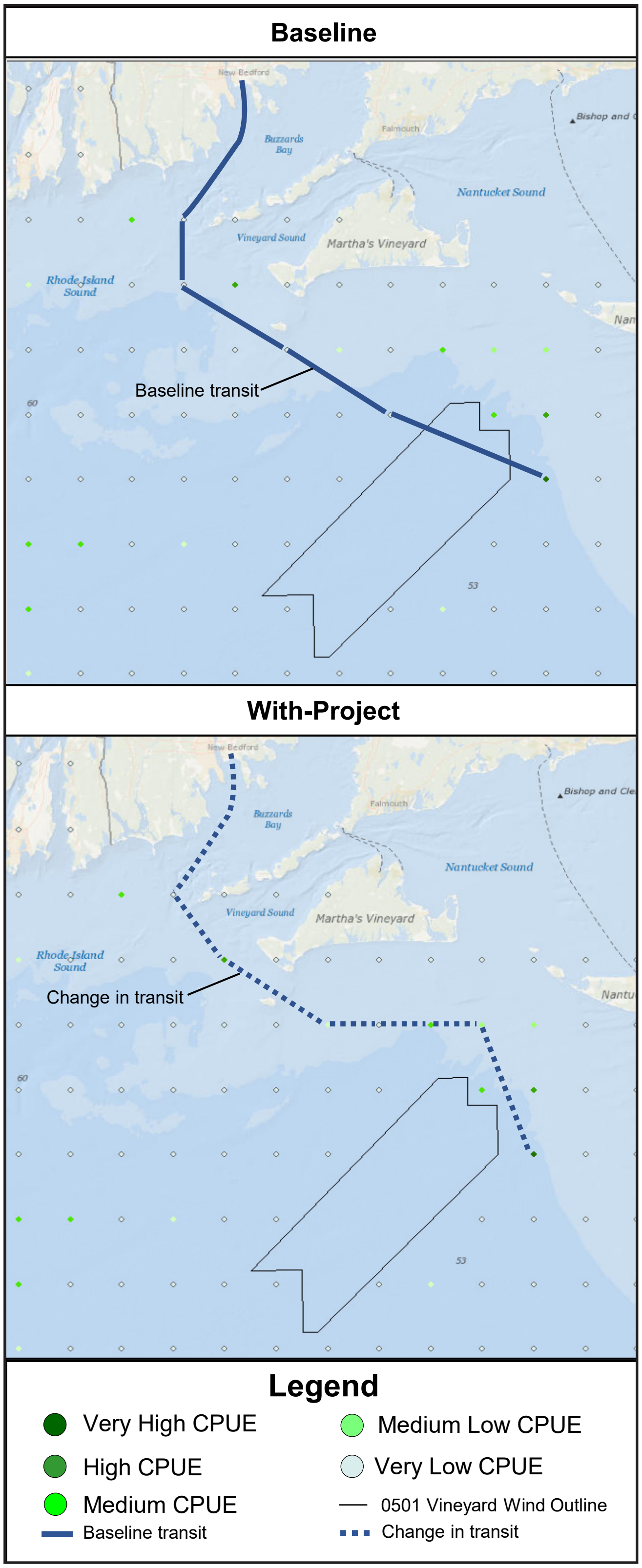


Figure 13: With Project - Financial Offset

Enhancing Fishing Ports

BOEM's BMP 5 states that, "the lessee will consider monetary support for enhancing or improving fishing port or shore-side facilities associated with an offshore wind facility" (p. 5-23 BOEM 2014). Fishing ports are critical to the economies and local culture of many coastal communities. Because commercial fishing brings revenue and provides a sense of identity, thriving fisheries support the viability of these communities. In addition to offshore wind, many of these fisheries are under pressures from regulations, stock movements, and other competing uses.

Port enhancement offers opportunities for wind developers to adhere to a best management mitigation practice in a tangible way that is visible to the local community. Port enhancement can come about as developers create the facilities needed to build and operate wind energy areas, as additional efforts that focus exclusively on supporting commercial fishing, and as more broad-based efforts that improve fishing ports more holistically.

Economic Impacts of Offshore Wind Development Activities

Offshore wind development is a substantial construction undertaking that requires port facilities for staging and shipping, infrastructure for electricity routing, and facilities for ongoing maintenance. Although components are generally sourced globally, construction and operation activities that result in jobs and expenditures will occur in local areas.

Photo credit: Cwieders

The largest effect is likely to result from development and use of port facilities. These facilities are needed for offloading shipments of components, preparing them for installation, and loading them onto vessels headed to the lease area. Developers face some limitations in selecting ports for this purpose. Access to interstate highways and proximity to the wind energy area are important. Also, supporting installation activities requires port facilities with berths to accommodate construction vessels, and decking with sufficient space and support for laydown and fabrication.

Ports with industrial waterfronts and the ability to host construction and installation activities would require the least modification. However, even these ports are likely to require development. Possible activities include grading, resurfacing, dredging, shoreline stabilization, and berth construction. Ports may also need new structures to accommodate workforce and equipment.

Certain requirements may have limited flexibility. For example, onshore locations for a new substation to support power distribution will typically have a small number of potential locations, and ports suitable for receiving and shipping parts needed for in-water construction activities may require a minimum channel depth. However, there is flexibility within these decisions that allow addressing local concerns. For example, a developer could choose a location based on both its convenience and beneficial outcomes to a particular local economy.

Veritas measures economic impacts in local economies using a technique called input-output analysis. Input-output models include inter-industry relationships to represent economic linkages. This allows input-output models to characterize the downstream "ripple" effects that occur as expenditures pass through supply chains and wages are spent in a local economy.

Efforts that Focus Directly on Commercial Fishing

Figure 14 depicts downstream economic effects that occur as demand for labor increases in a local area. As new employees are paid, they spend money in local economies, improving the prospects of local small businesses. These businesses may also synergistically support commercial fishing. For example, as depicted in Figure 14, restaurants have an increased demand for local caught fish.

Although the construction and operations activities of offshore wind development will boost a local economy, these activities have location limitations, and they typically do not directly improve commercial fishing. However, it is possible to have synergistic effects. For example, if a port requires additional berths to support development of a wind energy area these berths may exceed what is required for ongoing maintenance. In this case, development activities will result in additional berthing capacity that can directly benefit commercial fishing. Looking for such opportunities, quantifying their economic benefits, and emphasizing these benefits in communications is potentially an important strategy for cost-effectively enhancing a commercial fishery.

Activities that can improve a port can also occur independently from wind development efforts. In either case, the best opportunities emerge by evaluating specific ports to identify constraints to commercial fishing viability. An understanding of port economics and review of publicly available information can provide insights. Considering port economics, certain aspects of ports are what economists refer to as quasi-public goods. These types of goods are often subject to funding difficulties because they are difficult to charge for and shared by multiple users of different types.

For example, safe access to open waters is critical to commercial fishing harbors. For many har-

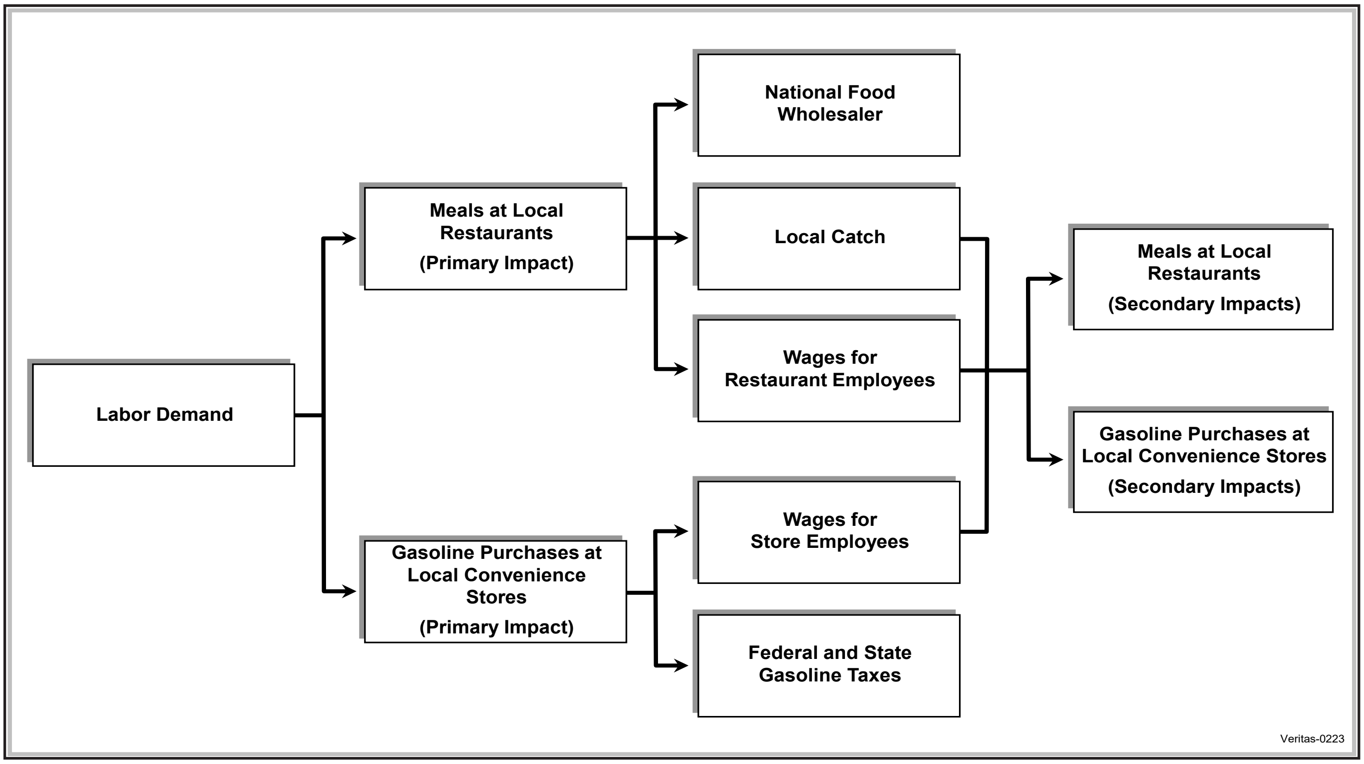


Figure 14: Local Economic Effects of Increased Labor Demand

bors, this requires expensive channel dredging. Because there are significant asymmetries in the amount of channel usage and depth requirements for different vessels, charging vessel owners to fund dredging can be difficult. Harbor dredging was historically funded by a tax on shipping. However, with the size growth of cargo ships, smaller harbors no longer ship and receive cargo, and shippers no longer pay for dredging these harbors. As described in the following section, this funding loss led to Veritas being involved in a multi-year study of six harbors to evaluate ways to enhance their viability. Activities to deepen channels can include dredging, funding dredging, and participating in developing and supporting municipal dredging plans.

Harbors may also lack sufficient berthing to accommodate the commercial fishing industry. Berthing remedies should be based on an evaluation of supply and demand conditions for each harbor with consideration of on-site conditions. Possibilities for improvements include optimizing existing berthing via repair and reorganization, finding more efficient means to use existing mooring and dock space, offsetting commercial berthing fees, providing new dedicated berthing for commercial vessels or securing access rights to existing berths, and reducing conflict with recreational users by creating transient recreational dockage.

Fish offloading capabilities may also be insufficient. This can lead to longer waits and turnaround times. This situation can be improved by installing or repairing hoists and cranes, reconfiguring dock or shoreside space, building more space, repairing space, and providing staff to facilitate loading and offloading.

In some ports there may be limited parking for commercial fishermen. Improving this situation requires first determining how parking is used during different times of day and over the year. Results may indicate that dedicating parking for commercial fishing, increasing parking spaces, and expanding opportunities for overnight parking will benefit commercial fishermen.

A final potential consideration would improve the fishing situation for very small vessels that use ramps to access the fishery. Many of these ramps are seasonally crowded or in disrepair. Adding new ramps, improving existing ramps, and creating ramps that are dedicated to commercial fishing would improve fishing access for small vessels.

Synergistic Considerations

As touched on previously, there is a potential overlap between offshore wind development activities and port improvements. Cost-effective and socially beneficial outcomes can be identified by thinking through these relationships.

For example, a developer that chooses a port that is slightly undersized for development and maintenance activities may need to build new berths and dredge. After completing development, berths could be made available to commercial vessels and ongoing dredging for maintaining wind energy areas could also benefit commercial fishing.

Photo credit: halbergman

Satisfying BMP 5 Requirements

Efforts that Holistically Address Port Viability

Port enhancements can also be independent from development activities and completely focused on enhancing port viability and sustainability. Veritas has evaluated economic development strategies at six port cities as part of the Michigan Sea Grant Sustainable Small Harbors project (Michigan Sea Grant 2016). Economic modeling used in these studies includes input-output, tourism, and microsimulation as depicted in Figure 15.

Economic evaluations were applied in the context of a larger framework that consists of the following five steps.

1. **Community Inventory:** Getting to know the community through census data, planning documents, aerial photos, and other sources of information.
2. **Waterfront Inventory:** Getting to know the community's waterfront assets through marina statistics, federal dredging records, and other sources of information.
3. **Visioning/Planning:** Bringing the community together to discuss strengths, weaknesses, and visions for the future.
4. **Value Capture:** Understanding the flow of funding through the community and potential ways to leverage waterfront assets to generate more economic activity.
5. **Implementation:** Identifying people and actions that can propel the plan forward.

This approach was applied at six diverse communities in Michigan in a public process that engaged the local community to identify approaches for enhancing waterfront sustainability. Insights about the process were compiled in the Sustainable Small Harbors Tools and Tactics Guidebook (Michigan Sea Grant 2016). The project team continues to work closely with communities in Michigan and is available to identify cost effective port enhancements.

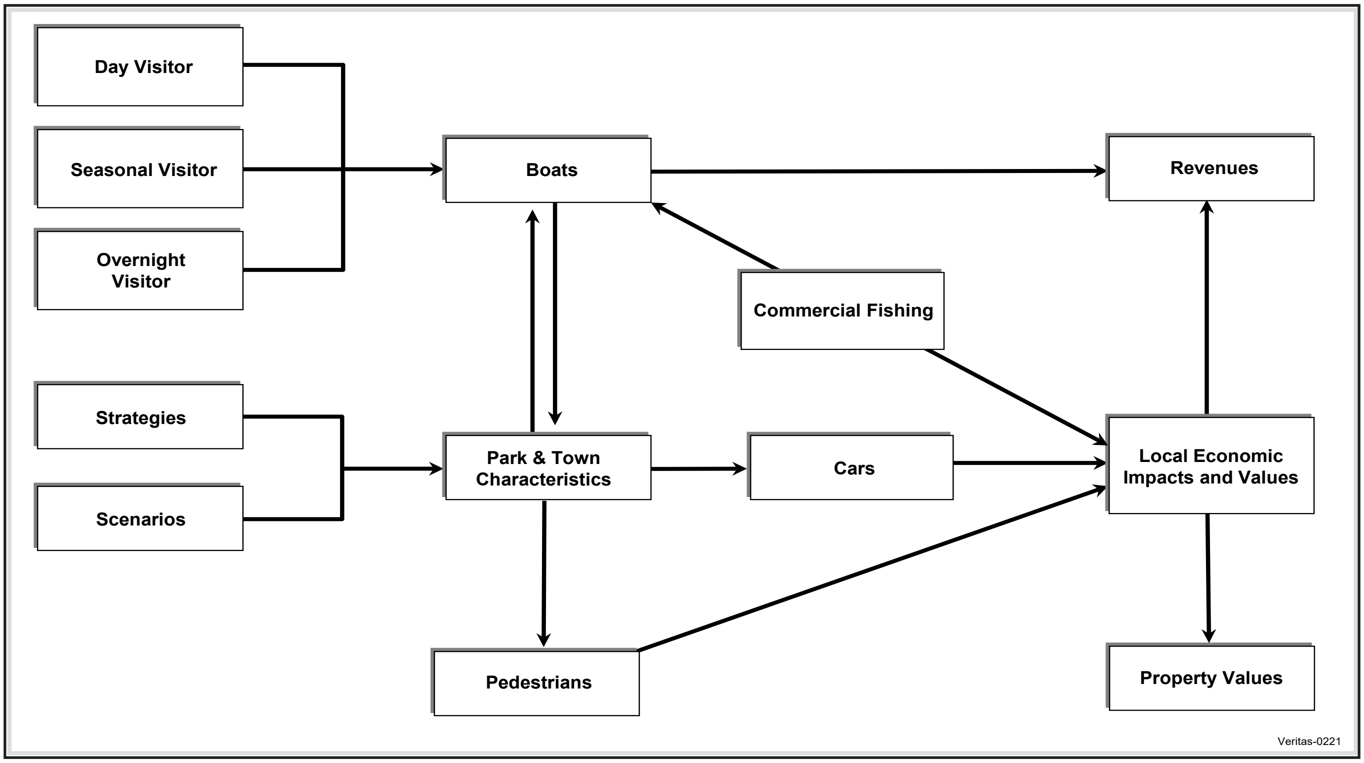


Figure 15: Economic Modeling Structure for Evaluating Port and Harbor Changes

Qualifications and Experience

Veritas conducts economic analysis to understand energy, environmental, and economic challenges including evaluating the economic impacts of offshore wind development, valuing changes in commercial and recreational fisheries throughout the United States, evaluating the socioeconomic impacts of changes to communities throughout the United States, and conducting power system modeling to evaluate the policy and site-specific implications of compliance with new regulations.

The results of Veritas' analysis are used for strategic decision making, regulatory compliance, informing policy decisions, providing litigation support, and conducting market and non-market valuations of complex environmental resources and commodities. The following sections describe Veritas' experience in:

- Offshore Wind Development,
- Commercial Fishery Valuation,
- Recreational Fishery Evaluation,
- Economic Impact Analysis,
- Power System Modeling, and
- NEPA Compliance and Socioeconomic Analysis.

Offshore Wind Development

Veritas has modeled commercial and recreational fishery impacts of offshore wind development, supported the incorporation of model results into economic impact models to assess port-based onshore impacts, and developed mitigation strategies. The following list highlights some of Veritas' relevant offshore wind development experience:

Evaluated Commercial Fishing Impacts of Offshore Wind Development in the New York/New Jersey (NY/NJ) Bight and off the Rhode Island (RI) and Southern Massachusetts (MA) Coasts

Veritas has developed commercial fishing models to estimate the economic effects of offshore wind development on commercial fisheries in the NY/NJ Bight and off the coasts of RI and Southern MA. Veritas developed commercial fishing models to evaluate the potential effects that offshore wind development may have on the squid, mackerel, scallop, Jonah crab, and silver hake fisheries.

The models evaluate changes in commercial fishing supply resulting from changes in harvest costs caused by a simulated closure of the lease areas to fishing. The model interacts changes in supply with demand for the commercial fish species harvested in the lease areas.

Veritas developed supply functions using vessel trip cost functions expressed in a spatial framework of ports and fishing sites. The functions require inputs on vessels and fuel costs as well as trip durations and distances.

Fishery-specific vessel information is used to represent a typical vessel across size (tonnage, length) and gear type (pot, net, trawl) for each modeled fishery. Veritas created supply curves by integrating vessel cost information with data on commercial fishing trips. The model results provide the ability to evaluate changes in commercial fishing revenue and profit as a result of simulated harvest changes.

Photo credit: Shaun Dakin

Offshore Wind Development, continued

Supported the Evaluation of Port-Based, Onshore Economic Impacts of Offshore Wind Development in the NY/NJ Bight and off the RI and Southern MA Coast

To understand the full impact of offshore wind development, the results from Veritas' commercial fishing models are incorporated into an economic impact model to evaluate the onshore impacts at ports most likely to be affected by changes in commercial fishing harvest rates and revenue. Veritas developed the estimates of changes in commercial fishing revenue and profit by port for incorporation into an economic impact model. The economic impact model provides insight into the potential effects on employment and economic output from decreases in commercial fishing revenue associated with offshore wind development.

Evaluated Recreational Fishing Impacts of Offshore Wind Development in the NY/NJ Bight and off the RI and Southern MA Coast

Offshore wind development has the potential to improve recreational catch rates because offshore wind areas can serve as artificial reefs. Veritas developed a recreational fishing demand model that simulates recreational fishing boat trips in the NY/NJ Bight and off the coasts of RI and southern MA under Baseline conditions (i.e., without offshore wind). The model then simulates changes in recreational fishing catch rates under With-Offshore-Wind-Project conditions and evaluates changes in recreational fishing trips and angler wellbeing under the improved catch rates.

Developed Mitigation Strategies for Commercial Fishing Impacts from Offshore Wind Development in the NY/NJ Bight and off the RI and Southern MA Coast

Offshore wind development is occurring in a complex and evolving fishery and ecology. Within this context, offshore wind developers interface with potentially affected commercial fishermen and are expected to mitigate and compensate those commercial fishermen for wind energy area impacts. Veritas has developed mitigation strategies that evaluate the relationship between its commercial fishing model results and regulatory mitigation requirements in BOEM's 2014 Final Report on Best Management Practices and Mitigation Measures.

Photo credit: Insung Yoon

Commercial Fishery Valuation

Veritas has modeled changes to commercial fisheries throughout the United States. Veritas works with its clients to tailor models that fit the relevant complexity of the specific challenge, be it a scoping-level investigation of potential impacts to an individual commercial fishery or evaluating the impacts of a new regulatory policy that will impact commercial fisheries across the United States.

Veritas has compiled commercial fishing data throughout the country and developed more than 20 commercial fishing models to value changes to commercial fisheries in the Atlantic and Pacific Oceans, Gulf of Mexico, Great Lakes, and numerous U.S. inland lakes and rivers. Veritas also maintains population dynamic models for each fishery. These models include estimated commercial harvest rates and population sizes for many major commercial species. The following list highlights some of Veritas' relevant commercial fishery experience:

Evaluated Commercial Fishing Impacts of Offshore Wind Development

Veritas has developed commercial fishing demand models to estimate the economic impacts of offshore wind development on commercial fisheries in the NY/NJ Bight and off the RI and MA coasts.

Evaluated Commercial Fishing Impacts Throughout the United States

Veritas assessed the economic implications of the 2014 316(b) regulation. A major component of Veritas' effort included evaluating changes in commercial harvest rates on the economic welfare of commercial anglers (EPRI 2011a). To conduct this work, Veritas simulated changes in commercial harvest in the context of species-specific fisheries in the Gulf of Mexico; Great Lakes; the Mid-Atlantic, North Atlantic, and Pacific coasts; and numerous inland rivers.

Evaluated the Implications of Alternative Policy Management and Market Structure for the New England Groundfish Fishery

Fishery regulators increasingly apply management approaches such as individual transferable quotas (ITQs or catch shares), which have been implemented in New England and the Gulf of Mexico.

Advocates of catch shares argue that the policy will increase stock sizes and catch, decrease costs, reduce price variability, and increase quality.

Veritas examined these conjectures within the context of biological modeling of the New England groundfish fishery and an economic model of fishing effort and related impacts (fleet, market, financing, profitability, and local and regional economic impacts that have not been studied extensively). Veritas' bioeconomic model uses available data to project how the policy may impact catch-share values and how they accrue to various stakeholders. Factors considered include existing effort, the structure for assessing value (likelihood of return in each time period), and how values from catch shares result in regional economic impacts (Bingham et al., 2010).

Valued Changes to specific Atlantic, Pacific, Gulf of Mexico, Great Lakes, and Inland Commercial Fisheries

Veritas has developed a population-dynamic, bioeconomic simulation approach to estimate the commercial benefits from reducing the impingement and entrainment of commercially valuable species. Veritas has estimated the commercial fishing benefits from impingement and entrainment reductions at more than 20 commercial fisheries including each of the following:

- Long Island Sound
- NY/NJ Bight
- Delaware Bay
- Chesapeake Bay
- Florida Gulf Coast
- Hawaiian Islands
- Lake Superior
- Mississippi River
- Ohio River
- California Pacific Coast

Recreational Fishery Valuation

Veritas has modeled changes to recreational fisheries throughout the United States. Veritas has compiled recreational fishing data throughout the country and conducted valuations of changes in more than 60 recreational fisheries throughout the United States including the Atlantic and Pacific Coasts, Gulf of Mexico, Great Lakes, and numerous U.S. inland lakes and rivers. The following list highlights some of Veritas' relevant recreational fishery experience:

Evaluated Recreational Fishing Impacts of Offshore Wind Development

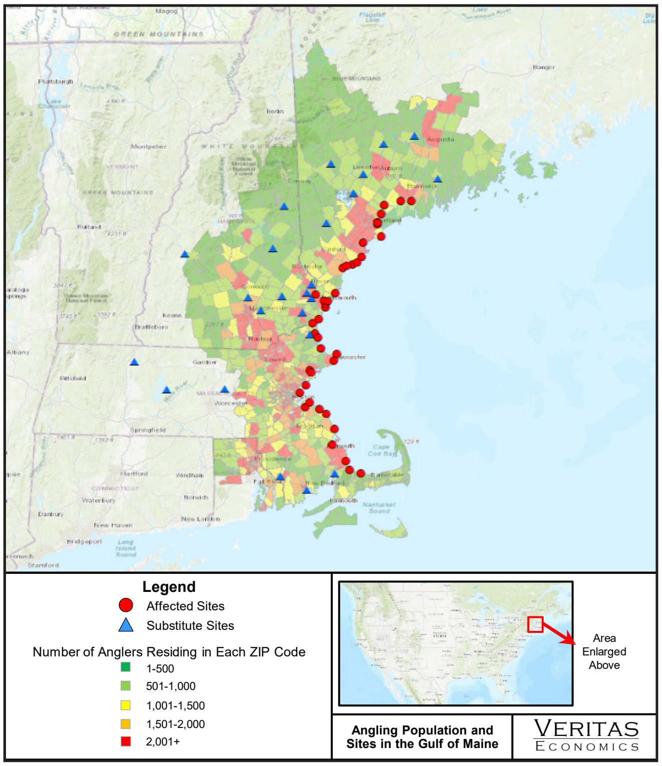
Veritas has developed recreational fishing demand models to estimate the economic impacts of offshore wind development on recreational fisheries in the NY/NJ Bight and off the RI and MA coasts.

Evaluated Recreational Fishing Impacts Throughout the United States

Veritas assessed the economic implications of the 2014 316(b) regulation. A major component of Veritas' effort involved evaluating changes in recreational catch rates on the economic welfare of recreational anglers. To conduct this work, Veritas simulated changes in recreational catch in the context of species-specific fisheries in the Gulf of Mexico; Great Lakes; the Atlantic and Pacific coasts; and numerous inland rivers, lakes, and reservoirs (EPRI 2011a). To estimate recreational fishery impacts, Veritas developed site-specific recreational angling demand models that simulate changes in expected catch resulting from impingement and entrainment reductions and estimated the effect of increased catch rates on recreator wellbeing.

Evaluated Changes in the Passaic River Recreational Fishery

Veritas staff have participated in numerous efforts to evaluate changes in recreational fishing for both the Passaic River Natural Resource Damage Assessment and Restoration evaluation and the Remedial Investigation and Feasibility Study. This includes developing a recreational demand model of the fishery using the 2013 and 2000 NJ Outdoor Recreation Surveys (Bingham et al., 2011), supporting the development and management of the 2011-2012 Passaic River Creel Angler Survey (Bingham et al., 2014 and Kinnell and Bingham 2014), and managing the 2000–01 Passaic River Creel Angler Survey (Kinnell et al., 2007). Veritas developed estimates of recreational fishing losses from fish consumption advisories and the benefits of restoration projects.



Gulf of Maine Study Area, Affected and Substitute Recreational Fishing Sites, and Potentially Affected Recreational Angler Population

Valuated changes to specific Atlantic Coast, Pacific Coast, Gulf of Mexico, Great Lakes, and Inland Recreational Fisheries

Veritas has developed a population-dynamic, bioeconomic simulation approach to estimate the recreational fishing benefits of reducing the impingement and entrainment of numerous species at more than 60 fisheries throughout the country. Veritas has evaluated these impacts in the following fisheries:

- Gulf of Maine
- Chesapeake Bay
- Atlantic and Pacific Coasts
- Gulf Coast
- Great Lakes
- Delaware River
- Numerous inland lakes and rivers

Economic Impact Analysis

Identifying total economic impacts requires developing a predictive model that incorporates appropriate parameters across relevant sectors of the evaluated economy. Such an analysis is typically accomplished via a mathematical economic technique called input-output analysis. Input-output analysis assesses the effects of economic impacts in a particular economic system (e.g., town, county, state, region, or national level) and measures the effects across three categories: direct effects, indirect effects, and induced effects.

Veritas uses IMPLAN, an economic impact planning model, to conduct input-output analysis. IMPLAN contains detailed input-output information on more than 500 economic sectors at the national level. In addition, it captures the input-output relationships that are relevant at the county and ZIP Code level using data compiled specifically for the evaluated geography. Veritas has used IMPLAN to develop input-output models to evaluate the economic impacts from each of the following:

Supported the Evaluation of the Economic Impacts of Offshore Wind Development on Commercial Fishing Ports and Towns

Veritas estimated commercial and recreational fishery impacts with offshore wind projects in the NY/NJ Bight and off the coasts of Rhode Island and southern Massachusetts. Veritas' estimates of changes in commercial fishery revenues and profits by port were incorporated into an economic impact model evaluating the ports associated with potentially affected vessels to estimate the onshore impacts from offshore wind development.

Evaluated the Economic Impact of New Regulations

Veritas developed an economic impact model to estimate the employment impacts of classifying coal combustion residuals as hazardous substances (EPRI 2010).

Evaluated the Economic Impacts of Creating New Recreation Facilities

Veritas evaluated the socioeconomic impacts to Johnson County, Tennessee resulting from developing Doe Mountain for recreation purposes (Kinnell et al., 2011).

Evaluating the Economic Impacts of Plant Conversion

Veritas assessed the economic implications to households, businesses, and government of converting the Virgin Islands Water and Power Authority's Randolph Harley Power Station and Richmond Power Station from oil to propane (Bingham and Woodard 2013).

Evaluated the Economic Impacts of Hazardous Algae Blooms in Western Lake Erie

Veritas developed an economic impact model to evaluate the effects of changes in commercial activity and profits from hazardous algae blooms in Western Lake Erie (Bingham, Sinha, and Lupi 2015).

Evaluated the Economic Impacts of Plant Closures

Veritas developed economic impact models to evaluate the effect of plant closures on related local economies. Examples include evaluating the shutdowns at Buckeye Technologies' Foley Plant in Taylor County, Florida (Bingham et al., 2008); Mirant's Canal Plant in Sandwich, Massachusetts; Exelon's Quad Cities Nuclear Generating Station in Rock Island County, Illinois; Great River Energy's Coal Creek Station in McLean County, North Dakota; and a confidential mine site in New Mexico.

Power System Modeling

The United States power market is an intricate system of plants, utilities, and Independent Service Operators. The relationship between these entities varies widely based on location and scenario, as do the technological specifications of the plants involved. Veritas developed the Environmental Policy Simulation Model (EPSM) to be able to precisely simulate power markets nationwide (Veritas Economics 2011). Veritas' EPSM is an analytical tool designed to assist policy makers and corporate strategists in their evaluations of alternative electricity-system and resource-allocation choices. EPSM can be used to evaluate resource changes and environmental policies at the national, regional, or local level. It can also be used to evaluate the choice among new electricity generation alternatives or the impacts of demand changes at specific locations. Results from the model include the physical, economic, and financial performance of the electricity system and of its elements and institutions.

User Interface of Veritas' Environmental Policy Simulation Model

EPSM is populated with up-to-date plant and market-specific data at a granular level to provide output that is site and scenario specific. EPSM solves by simulation, based on established behavioral rules for each supplier in a market. The interactions of these agents, given their technological, economic, and financial constraints, determine the system, element, and institutional outcomes. Physical characteristics of all thermal generating units as well as the technological, economic, and financial constraints are integrated into the model in order to get optimized solutions that follow real-world criteria. EPSM incorporates the physical characteristics of all thermal generating units, including heat rate, capacity, and fuel type. The interannual, temporal decay in the efficiency of these generation assets is calibrated to historical data. The transmission, generation, and sale of power varies greatly by location. EPSM has the capability to take these variable market factors into account through capacity, generation, load, fuel inputs, heat rates, and marginal cost at the plant or system level. EPSM models scenarios at the hourly level to produce output with the highest level of detail. This means that changes in generation, fuel consumption, emissions, and costs can be evaluated incrementally as well as hourly. This profit-maximized solution allows for the analysis of socioeconomic, technological, financial, and environmental impacts. These well-rounded and precise analyses allow for objective, strategic, and well-informed decision making. Veritas has used EPSM in the following applications throughout the United States:

Conducted Power System Modeling for Regulatory Compliance

Veritas used EPSM to evaluate the effect of changes in power plant configuration (i.e., changes in fixed costs from alternative regulatory compliance options) on system-level generation costs and increased electricity prices at more than 60 plants throughout the country.

Conducted Power System Modeling for Policy Analysis of Proposed Regulations

Veritas used EPSM to evaluate the financial, economic, and reliability impacts of a national closed cycle cooling retrofit requirement at existing power plants throughout the country (Veritas Economics 2011). Veritas also used EPSM to evaluate the economic and financial impacts of categorizing coal combustion residuals as hazardous substances.

Conducted Power System Modeling at Mirant's Canal Generating Station

Veritas used EPSM to evaluate the likelihood that a closed cycle cooling retrofit would lead to a premature retirement of Mirant's Canal Plant (Bingham, Mathews, and Kinnell 2009). Veritas also evaluated the effect on electricity prices and system reliability in ISO-NE as a result of the plant's premature closure.

National Environmental Policy Act (NEPA) Compliance and Socioeconomic Analysis

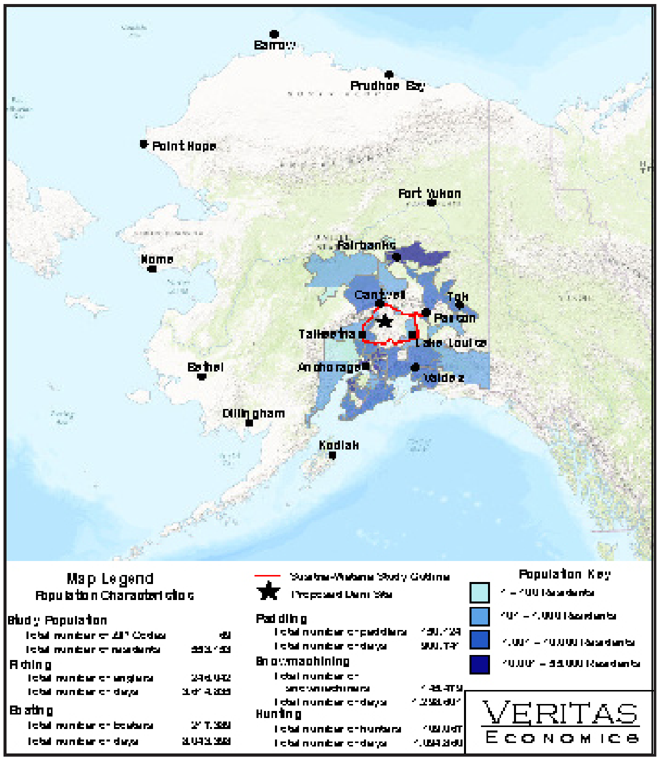
The National Environmental Policy Act was enacted to establish policy, set goals, and provide a means for environmental protection. The Act requires regulatory agencies to objectively assess the potential environmental and socioeconomic impacts of proposed projects as part of the decision making regarding a project's implementation. Veritas conducts the socioeconomic analysis that is required in these assessments.

The impacts are unique to every project. Once identified, each of the impacts must be appropriately quantified through rigorous and scenario-specific analyses that allow for an accurate and representative assessment of the project's potential environmental, technical, social, and economic impacts. Properly conducting the scenario-specific analysis requires evaluating Baseline and With-Project Conditions where the difference between the two conditions represents the socioeconomic changes. Veritas specializes in conducting the scenario-specific analysis required to properly assess the socioeconomic impacts of proposed projects requiring NEPA compliance. The following examples highlights some of Veritas' NEPA compliance efforts.

Susitna-Watana Hydroelectric Project

Veritas supported the Alaska Energy Authority's (AEA) efforts to characterize changes in recreation demand and social welfare for the recreator populations that would be most affected by the Susitna-Watana Hydroelectric Project—a 705 foot hydroelectric dam and impoundment of the Susitna River (www.susitna-watanahydro.org). Veritas developed and distributed the Alaska Outdoor Recreation Survey and compiled the data to build recreation demand models to assess changes in demand for hunting, fishing, recreational boating, and snow machining—the four recreation activities expected to be most affected by the project (AEA 2014).

Veritas conducted its research as part of the Socioeconomic and Transportation Resources Study Plan (AEA 2014) for use in the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP). Under the ILP, FERC staff, pursuant to NEPA requirements, will prepare an Environmental Impact Statement which FERC will use to determine whether, and under what conditions, to issue a license for the project.



Susitna-Watana Study Area and Characteristics of Potentially Affected Population

Doe Mountain Development

Doe Mountain, located just southwest of Mountain City in Johnson County, Tennessee, is home to some 40 species of rare plants and animals as well as deer, turkey, and black bear. When Doe Mountain was offered for sale, the densely forested 8,600-acre mountain was one of the largest remaining privately owned blocks of forest in the Southern Blue Ridge region. The Nature Conservancy and State of Tennessee collaborated to purchase Doe Mountain with the intention of preserving it and making it available for public enjoyment.

The Nature Conservancy engaged Golder and Veritas to support their decision making. Veritas evaluated the tourism, recreation, income, and employment implications of operating Doe Mountain under various levels of trail-based recreation (Kinnell et al., 2011). The now sustainably developed Doe Mountain Recreation Area (www.doetn.com) features 8,600 acres of protected mountain wilderness with multi-use trails for off-highway vehicles, horseback riding, mountain biking, and hiking.

Veritas developed an economic simulation model to estimate the socioeconomic impacts of four recreation development scenarios. Veritas used the simulation model to quantify the effect of the alternative scenarios on recreational user days and trip value, costs borne by recreators, job creation, and the economic impacts on the local economy.

Boardman River Dam Removal

The Boardman River Dams Committee evaluated the fate of four dams on the Boardman River in Grand Traverse and Kalkaska Counties Michigan. The dams were installed for electricity generation and flood management, and at the time of Veritas' evaluation, the electric utility decided not to seek relicensing them for electricity production. As a result, the community had to determine the dams' fate. The community's choices ranged from taking over and continuing the dams' operation to decommissioning and removing them. In between these extremes were a large number of alternatives that would have varying socioeconomic impacts on the community. An important input to informed decision making is evaluating the socioeconomic impacts of the various dam management alternatives. Veritas developed economic models to evaluate the socioeconomic impacts of the dams' management alternatives (Bingham and Kinnell 2012). The result of Veritas' analysis helped inform decision making in support of NEPA permitting requirements.


Boardman River Dam

In their baseline state, the dams provided economic benefits associated with flood protection, recreational opportunities, and the ability to produce electricity from a renewable energy source. In addition to the costs of operating and maintaining the dams to provide these benefits, the dams' presence comes at the cost of forgone ecological production associated with the river's natural riparian and aquatic state. While removing the dams also comes at a cost, there are benefits associated with changes in the characteristics of the river. For example, both ecological production and recreational opportunities would change in newly open sections of free-flowing river that restore anadromous fish runs.

Properly evaluating the alternatives requires addressing the complexities associated with accurately measuring the socioeconomic impacts and trading off the incremental costs and benefits associated with each option: for example, comparing the costs of continuing to operate the dams and the resulting benefits (flood protection, recreation, and renewable energy production) to the costs associated with the dams' removal and restoration of the river's riparian and aquatic habitat and the resulting benefits (ecological production and recreation opportunities). Identifying which set of potential alternatives maximizes benefits to society requires accurately evaluating and comparing the benefits and costs associated with each alternative.

To conduct its analysis, Veritas developed economic models to properly characterize the baseline conditions of leaving the dams installed and

then conducted counterfactual (i.e., alternative scenario) analysis to evaluate the socioeconomic impacts of each management alternative. Veritas evaluated the socioeconomic impacts associated with alternative outcomes for the Boardman River dams by performing counterfactual experiments that simulated changes in the current dam and river conditions that arise from the various management alternatives. The simulations estimate changes in recreational usage and values for fishing, canoeing, and kayaking; tourism expenditures; property values; and electricity production and prices that result from changes to one or more of the existing dams.

Based on the results of the analysis, the dam owners decided to remove the Sabin, Boardman, and Brown Bridge dams and modify the Union Street dam for fish passage. Under the dam removal determination, the Boardman River Dams Ecosystem Restoration Project (www.theboardman.org/dam-project) is one of the largest dam removal projects in the Great Lakes Basin. The project is reconnecting over 160 miles of a coldwater river system and restoring hundreds of acres of wetlands and habitat. See Bingham and Kinnell (2012) for a detailed description of Veritas' socioeconomic models and results.

Clinton River Flow Management Evaluation

Veritas developed the socioeconomic components of an integrated assessment that evaluated ecologically and economically sound approaches to managing the flow of the Clinton River in Oakland and Macomb Counties, Michigan (Bingham, Woodard, and Kinnell 2012). The integrated assessment evaluated the impact of flow regulation policies on water quality, fish and wildlife habitat, recreational opportunities in and along the river, property values, income, and taxes. The goal of the assessment was to develop a more comprehensive and holistic approach to flow management.

Veritas characterized changes in recreation demand and social welfare for recreators that utilize the Clinton River under different flow management alternatives. The Clinton River is popular among recreators, and flow regulation would have a significant effect on recreational opportunities as well as water quality, habitat, property values, income, and taxes. Veritas developed an economic simulation model that utilized a travel-cost based, recreation site choice evaluation to discern differences between current and potential future recreation activity under alternative river management scenarios. Veritas' simulation model integrated recreation behavior, site characteristics and quality, population dispersion, and ZIP Code differentiated travel costs to simulate changes in recreation usage and value as well as market level economic and tax impacts under different river management alternatives.

Ocoee River

The Ocoee River in Tennessee is one of the most popular rivers in the eastern United States for whitewater rafting. Creating the water flow to support Ocoee River rafting trips requires restricting otherwise available hydropower generation. Veritas evaluated the existing economic characteristics of the southeastern rafting market and its effects on local businesses and residents using linked simulation models (Veritas Economics 2017). Veritas used the economic models to evaluate the economic impacts of three alternative action plans in support of NEPA compliance requirements. Outputs of the model include changes in rafting trips taken, consumer surplus (a dollar measure of the value that rafters derive from rafting trips), and expenditures by rafters taking single or multiple-day trips by expenditure type.

References

Alaska Energy Authority. 2014. Social Conditions and Public Goods and Services Study, Study Plan Section 15.6—Initial Study Report Part A: Sections 1–6, 8–9. Prepared by Northern Economics, Inc. and Veritas Economic Consulting. Susitna-Watana Hydroelectric Project (FERC No. 14241). Anchorage, AK: Alaska Energy Authority.

Bingham, M.F., S.K. Sinha, and F. Lupi. 2015. Economic Benefits of Reducing Harmful Algal Blooms in Lake Erie. Submitted to the International Joint Commission, 66 pp. September. Ann Arbor, MI: Environmental Consulting & Technology, Inc. Available at https://legacyfiles.ijc.org/tinymce/uploaded/Publications/Economic-Benefits-Due-to-Reduction-in-HABs-October-2015.pdf. Retrieved on June 24, 2020.

Bingham, M.F., S.G. Veale, Z. Li, G.S. Crownfield, D.M. Woodard, and J.C. Kinnell. 2014. "Integrating Revealed and Stated Preference Data to Improve the Estimation of Baseline Risk Fish Ingestion." Working Paper No. 2014-03. Available at http://www.veritaseconomics.com/Working%20Papers/Bingham.et.al.2014.Integrating.RP.and.SP.Data.to.Improve.Estimation.of.Baseline.Risk.Fish.Ingestion.pdf.

Bingham, M.F. and D.M. Woodard. 2013. US Virgin Islands LPG Conversion—Preliminary Assessment of Economic Market Implications for Households, Businesses and Government. Cary, NC: Veritas Economics.

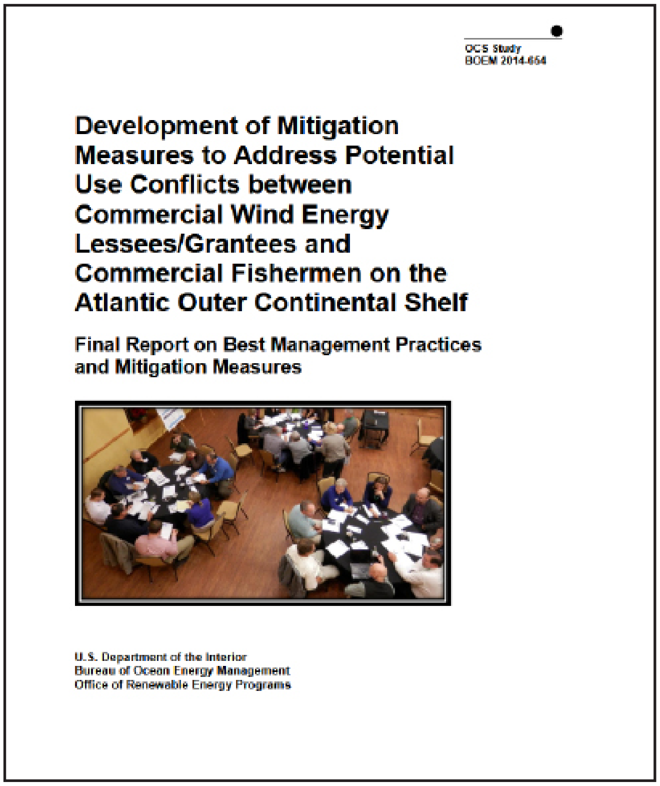
Bingham, M.F., D.M. Woodard, and J.C. Kinnell. 2012. Integrated Economic and Social Analysis of the Clinton River Flow Management. Prepared for Lawrence Technological University, Southfield, Michigan. Cary, NC: Veritas Economics.

Bingham, M.F., and J.C. Kinnell. 2012. "The Role of Socioeconomic and Behavioral Modeling in an Integrated, Multidisciplinary Dam-Management Study: Case Study of the Boardman River Dams." In Environmental Land Use Planning, Seth Appiah-Opoku, ed. ISBN 978-953-51-0832-0. Rijeka, Croatia: InTech. Available at http://www.intechopen.com/articles/show/title/the-role-of-socioeconomic-and-behavioral-modeling-in-an-integrated-multidisciplinary-dam-management-

Bingham, M.F., Z. Li, K.E. Mathews, C.M. Spagnardi, J.S. Whaley, S.G. Veale, and J.C. Kinnell. 2011. "An Application of Behavioral Modeling to Characterize Urban Angling Decisions and Values." North American Journal of Fisheries Management 31:257–268.

Bingham, M.F, D.M. Woodard, Z. Li, and G. Crownfield. 2010. "Behavioral and Bioeconomic Considerations of Catch Share Policies." Presented at the American Fisheries Society Conference, Pittsburgh, Pennsylvania. September 14.

Bingham, M.F., K.E. Mathews, and J.C. Kinnell. 2009. "Economic Issues Regarding BTA for Canal Generating Station." Exhibit 12 of Comments of Mirant Canal, LLC on Draft National Pollutant Discharge Elimination System (NPDES) Permit No. MA0004928 Proposed by EPA New England Region 1 and Massachusetts Department of Environmental Protection Public Notice No. MA-004-09. Available at http://www.epa.gov/region1/npdes/mirantcanal/pdfs/MirantCanalCommentsonReopenedPermit.pdf. Retrieved on June 24, 2020.



OCS Study
BOEM 2014-654

Development of Mitigation Measures to Address Potential Use Conflicts between Commercial Wind Energy Lessees/Grantees and Commercial Fishermen on the Atlantic Outer Continental Shelf

Final Report on Best Management Practices and Mitigation Measures

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

Bingham, M.F., J.C. Kinnell, K.E. Mathews, and D.M. Woodard. 2008. Assessing the Economic and Community Impacts Associated with a Theoretical Closure of Buckeye Technology's Foley Plant: Preliminary Results. Cary, NC: Veritas Economics.

Bureau of Ocean Energy Management. 2021a. Record of Decision Vineyard Wind 1 Offshore Wind Energy Project Construction and Operation Plan. Washington, DC: U.S. Department of the Interior. Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Final-Record-of-Decision-Vineyard-Wind-1.pdf

Bureau of Ocean Energy Management. 2021b. Appendix K in Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume III. OCS EIS/EA BOEM 2021-0012. Available at https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-3.pdf. Retrieved on February 24, 2022.

Bureau of Ocean Energy Management. 2017. Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic: Volume I—Report Narrative. OCS Study BOEM 2017-012 Prepared under BOEM Interagency Agreement No: M12PG00028. Woods Hole, MA: Northeast Fisheries Science Center.

Bureau of Ocean Energy Management. 2014. Development of Mitigation Measures to Address Potential Use Conflicts between Commercial Wind Energy Lessees/Grantees and Commercial Fishermen on the Atlantic Outer Continental Shelf: Final Report on Best Management Practices and Mitigation Measures. OCS Study, BOEM 2014-654. Virginia Beach, VA: Ecology and Environment, Inc.

Electric Power Research Institute. 2011a. National Benefits of a Closed-Cycle Cooling Retrofit Requirement. Product ID 1023401. Palo Alto, CA: EPRI.

Electric Power Research Institute. 2011b. Evaluation of the National Financial and Economic Impacts of a Closed-Cycle Cooling Retrofit Requirement. Product ID 1022751. Palo Alto, CA: EPRI.

Electric Power Research Institute. 2011c. Maintaining Electrical System Reliability under a Closed-Cycle Cooling Retrofit Requirement. Product ID 1023174. Palo Alto, CA: EPRI.

Electric Power Research Institute. 2010. Cost Analysis of Proposed National Regulation of Coal Combustion Residuals from the Electric Generating Industry. Product ID 1022296. Palo Alto, CA: EPRI.

Gray, Mark, Paige-Leanne Stromberg, and Dale Rodmell. 2016. Changes to Fishing Practices around the UK as a Result of the Development of Offshore Windfarms—Phase 1 (Revised). ISBN: 978-1-906410-64-3. Available at https://www.thecrownestate.co.uk/media/2600/final-published-ow-fishing-revised-aug-2016-clean.pdf. Retrieved on March 30, 2022.

King, Dennis M. 2019. "Economic Exposure of Massachusetts Fisheries to the Vineyard Wind Project." Prepared for Vineyard Wind LLC. Plymouth, MA: King and Associates, Inc. Available at https://static1.squarespace.com/static/5a2eae32be42d64ed467f9d1/t/5d68295e81187e00014ee5c1/1567107429061/MA+Fisheries+Economic+Exposure+final+-+April+2019.pdf. Retrieved on March 9, 2022.

King, Dennis M. 2019. "Economic Exposure of Rhode Island Commercial Fisheries to the Vineyard Wind Project" Prepared for Vineyard Wind LLC. Plymouth, MA: King and Associates, Inc.

Kinnell, Jason C. and Matthew F. Bingham. 2014. "Developing Baseline Risk Fish Ingestion Estimates for Baseline Human Health Risk Assessments." Technical Working Paper. Veritas Economic Consulting. Cary, NC. Available at http://www.veritaseconomics.com/Working%20Papers/Kinnell.and.Bingham.2014.Developing.Baseline.Risk.Fish.Ingestion.Estimates.pdf.

Kinnell, Jason C., Matthew F. Bingham, Sara G. Veale, and Dawn M. Woodard. 2011. "Socioeconomic Analysis of Alternative Development Scenarios for Doe Mountain—Preliminary Evaluation." Prepared for Golder Associates and The Nature Conservancy. Cary, NC: Veritas Economics.

Kinnell, Jason C., Matthew F. Bingham, Elizabeth A. Hastings, Rose Ray, Valerie Craven, and Miranda Freeman. 2007. "A Survey Methodology for Collecting Fish Consumption Data in Urban and Industrial Water Bodies (Part 1)." Journal of Toxicology and Environmental Health, Part A 70:477–495.

Michigan Sea Grant. 2016. Sustainable Small Harbors Tools and Tactics Guidebook. MICHU-17-502 Version 1. Ann Arbor, MI: Michigan Sea Grant.

Responsible Offshore Development Alliance, Plaintiff, v. United States Department of the Interior et al., Defendants. "Complaint for Declaratory and Injunctive Relief." United States District Court for the District of Columbia Case No. 22-237.

The White House. 2021. FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs. The White House Briefing Room. Washington, D.C. Available at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

U.S. Department of the Interior (USDOI). 2021. "Secretary Haaland Outlines Ambitious Offshore Wind Leasing Strategy." Available at https://www.doi.gov/pressreleases/secretary-haaland-outlines-ambitious-offshore-wind-leasing-strategy

United States Army Corps of Engineers (USACE). 2020. "Alternatives Analysis Framework." Portland District. Available at https://www.nws.usace.army.mil/Portals/27/docs/regulatory/Forms/Alternative%20Analysis%20Framework%20NWS%20(4-18-16).pdf?ver=2016-06-07-111159-147. Retrieved May 2022.

Veritas Economics. 2017. "Appendix D—Evaluation of Economic Effects from Alternative Ocoee River Release Schedules." In [May 2018] Ocoee River Whitewater Rafting Agreement: Final Environmental Assessment Polk County, Tennessee. Project Number 2016-30. Knoxville, TX: Tennessee Valley Authority.

Veritas Economics. 2011. "Veritas Economics Environmental Policy Simulation Model (EPSM): Technical Development Document." Working Paper 2011-01. Cary, NC: Veritas Economics.

Veritas Economics (Veritas)

Veritas conducts economic analysis to understand energy, environmental, and economic challenges. The results of Veritas' analysis are used for strategic decision making, regulatory compliance, informing policy decisions, providing litigation support, and conducting market and non-market valuations of complex environmental resources and commodities.

Veritas has conducted Policy Analysis, Regulatory Impact Analysis, and Regulatory Compliance for

- Offshore Wind Development in the NY/NJ Bight and off the coasts of Rhode Island and Massachusetts
- Sections 304, 316(a), 316(b), and 402 of the Clean Water Act,
- Section 169 of the Clean Air Act,
- the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process (ILP), and
- the National Environmental Policy Act (NEPA).

Veritas has also built custom models to solve its client's energy, environmental, and economic challenges. Examples include Veritas'

- Custom Commercial and Recreational Fishing Models that evaluate the relationship between power plant operation and commercial and recreational fisheries along the Atlantic and Pacific Coasts, the Great Lakes, the Gulf of Mexico, and within numerous U.S. inland lakes, rivers, and reservoirs.
- Environmental Policy Simulation Model (EPSM) that identifies baseline values for electricity generation assets and evaluates the results of electricity production, pricing, and reliability models for seven of the United States' Independent System Operator (ISO) regions.
- Alternative Dam-Restoration Options Model that evaluates the relative costs and socioeconomic benefits of alternative dam-restoration options ranging from repowering to removal.

Veritas has also conducted economic analysis and built custom software to model adoption rates of new technologies including

- Electric Vehicles,
- Electricity Service Plans, and
- Residential Solar.

Veritas also conducts economic analysis to inform

- Benefit-Cost Analysis
- Socioeconomic Analysis
- Environmental Impact Statements (EIS),
- Natural Resource Damage Assessment and Restoration (NRDAR) Evaluations, and
- Exposure Assessments.

The results of Veritas' research have been used by and/or presented and submitted to the U.S. House of Representatives, EPRI, USEPA, NOAA, USDOI, USFWS, USACE, FERC, the National Park Service, and numerous state regulatory agencies. Our areas of technical expertise include commercial and recreational fishery modeling; socioeconomic analysis; econometric, bio-economic, and power-system modeling; environmental and resource economics; survey design and administration; water resource economics; and benefit-cost analysis. Veritas' staff have published 17 books and book chapters as well as more than 35 articles in top-tier, peer-reviewed economic, environmental, energy, engineering, and risk journals.

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