Vulnerability of Seafood Capital in the US Northeast and Mid-Atlantic

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Summary
This analysis explored physical capital and capital vulnerability in the commercial fishing sector of the Northeast and Mid-Atlantic US. Physical capital includes physical assets used in production of goods and services, such as equipment and structures. For the seafood industry, this would include fishing vessels, processing facilities, and equipment. Capital stranding occurs when abrupt technological, locational, regulatory, political, or market changes lead to unanticipated or premature capital write offs, devaluation, or conversion to liabilities. This research used industry interviews and modeling of fishing profits to explore capital vulnerability in the context of large-scale offshore wind development. Eight companies participated in interviews, representing ~$600 million in annual gross sales and ~$300 million in total capital value. The value of fishing vessels and associated permits represented approximately 60% of total capital value. Approximately $80 million had been invested by these companies in physical capital over the previous three years. Information on capital stranding risk factors was collected from each company and used to calculate capital vulnerability scores, which ranged from 0 (low/no vulnerability) to 1 (high vulnerability). The distribution of capital vulnerability across companies interviewed was bimodal, with one peak just over 0.4 (low-medium risk) and another around 0.7 (medium-high risk). High capital vulnerability scores were typically due to low adaptability and low business diversification, high capital intensity, and a limited geographic footprint of operations. Fishing vessel capital vulnerability was assessed by comparing estimates of fixed costs to operating margins by vessel size class, gear type, and port. Five fleets were considered, including three gear types and two size classes (small and large trawl, small and large scallop dredge, and large clam dredge), across seven ports (New Bedford, MA; Point Judith, RI; Point Pleasant, NJ; Barnegat Light, NJ; Atlantic City, NJ; Cape May, NJ; and Hampton Roads, VA). Scallop fleets were found to have low capital vulnerability, while trawl and clam fleet fishing capital was considerably more vulnerable due to lower operating margins. The potential impacts of offshore wind development on fishing capital value were explored by reducing landings based on historical landings' overlap with offshore wind lease sites. Across ports and fleets, loss of landings in wind energy areas reduced operating margins by 0.84% (New Bedford large trawl) to 7.48% (Barnegat Light small trawl). Ports in New Jersey were found to have both higher levels of fishing capital vulnerability and greater exposure to potential reductions in operating margins from offshore wind energy development. More work is needed to comprehensively assess seafood capital values in the region, exposure to risk drivers, and connections between capital value, vulnerability, and fishing community resilience.

Introduction

Capital Valuation

Physical capital is an asset that provides a tangible means of production, used to create goods and services in order to generate a flow of income (Ruggeri, 2008). Physical capital differs from other production inputs because it is used in production but not consumed in the process, this allows physical capital to be used repeatedly where its value is generally depreciated over a period of time (Hulten and Wykoff, 1991; Ruggeri, 2008). The current value of capital is determined by discounting the expected future yield of that capital in the production process to net present value (Hulten, 1991 Escribá-Pérez, Murgui-García and Ruiz-Tamarit, 2018). Expected future yield is determined by future prices, operating costs, production levels, and future output (Repetto et al., 1989). Capital value is influenced by depreciation, which is defined as a decline in asset value over time and is influenced by deterioration (e.g., asset maintenance and aging) and obsolescence (e.g., structural and technological change) (Hulten and Wykoff, 1981; Escribá-Pérez, Murgui-García and Ruiz-Tamarit, 2018). Depreciation rates are inversely proportional to the useful life of capital assets such that an asset used over a longer period of time has a lower depreciation rate and therefore retains higher value. Depreciation of capital assets is often unobservable and difficult to quantify, however (Hulten, 1991; Escribá-Pérez, Murgui-García and Ruiz-Tamarit, 2018). The value of physical capital is also influenced by transaction costs associated with repurposing, where highly specialized physical assets often have high transaction costs and low resale potential, lowering capital value (Yousuf, 2017; Morrow, Johnson, and Busenitz, 2004; Sicherman and Pettway, 1992). Physical capital valuation is important in private and public sectors as it enables businesses to make decisions which efficiently allocate financial capital (Zenner, Berkovitz, and Clark, 2009) and also allows government agencies to evaluate tradeoffs associated with regulatory decisions as well as public investment in physical capital (Ruggeri, 2009).

Stranded Capital

The concept of stranded capital was first introduced following the deregulation of the U.S. electric power industry in the 1980s, where deregulation allowed for competition within the electric power industry (Maloney, McCormick, and Sauer, 1997). Physical capital investments under the prior regulatory regime were considered stranded when an investment was found to be less valuable under competition than it was under prior regulation because the value of capital invested would not be recoverable under competitive energy prices. Stranded capital, also known as stranded assets, are defined as physical capital assets that have suffered from unanticipated or premature write offs, devaluation, or conversion to liabilities (Caldecott, Howarth, and McSharry, 2013). Stranded capital is broadly accepted as capital which has been devalued due to an unanticipated shock, however this does not always mean the value of capital becomes zero. Capital strandings are different from risk associated with normal business operations as they are caused by unanticipated technological, locational, regulatory, political, and market changes, as well as changes in public perception of an industry (Hirst, 1998; Bos and Gupta, 2019). The potential impacts of capital strandings to specific sectors can be large for capital intense industries such as energy production (Brennan and Boyd, 1997; Wilen, 2009). Recently, literature on stranded capital has focused on the stranding of carbon producing capital assets within energy sectors (e.g., fossil fuel assets) under climate change mitigation policies and energy transformations (Bos and Gupta, 2019; Campiglio and Van der Ploeg, 2021; Agarwala et al., 2021; Curtin et al., 2019).

Capital Stranding Risks

To develop a framework that identifies the stranding risk of capital, Harnett (2018) expanded on the characteristics of sunk costs expressed by Clark and Wrigley (1995) to understand the spatial and temporal causes and impacts of strandings. Characteristics that are used to identify the level of risk for capital stranding include: information availability, to understand the level of investment risk over time; collaborative opportunities, to facilitate information sharing and reduce transaction costs; environmental risks, related to asset stranding exposure to physical environmental changes at a given location; transition risk and adaptation capacity, to understand market-based, regulatory, technological, and reputational risks associated with industry-based transition and the ability of a business to adapt to new market conditions; transferability, to determine if the asset can be reallocated or repurposed; recoverability, to determine the extent to which the investment could be recovered; longevity, to determine how long the asset will be exposed to the stranding driver; and financing need of capital, to understand risk associated with investment size (Harnett, 2018). Specific stranding risks can appear non-systematic, apply to a specific sector, and can be difficult to assess in a linear or holistic way (Caldecott, 2013). Caldecott (2013) proposes assessing the financial risk of capital stranding as equal to the intensity of the stranding driver multiplied by the exposure to this risk considering physical capital vulnerability, sensitivity, and adaptability (Caldecott, 2013).

Malleability refers to the ability for capital to be reallocated among sectors (Lanzi and Wing, 2013) and is an important factor influencing stranding risk via physical capital transferability and investment recoverability. Theoretical models developed in the renewable resources literature, such as in fisheries, frequently specify capital malleability as a parameter defining three cases: perfect malleability, quasi-malleability, and non-malleability (Clark, Clarke, and Murno, 1979; Murno and Scott, 1995; Nøstbakken, Thébaud, and Sørensen, 2011; Da-Rocha Alvarez et al., 2016). Perfect malleability refers to when there is no constraint on investment, allowing for costless capital reallocation (Clark, Clarke, Murno, 1979; Nøstbakken, Thébaud, and Sørensen, 2011). Quasi-malleability occurs when there is no constraint on investment, but due to a positive depreciation rate, capital must be sold at a lower price than its original purchase price, creating a second-hand market (Clark, Clarke, and Murno, 1979; Rust, Jennings, and Yamazaki, 2015). The theoretical definition of non-malleability refers to the existence of constraints on disinvestment of capital assets, meaning the capital has no other uses (Clark, Clarke, and Murno, 1979). In practice, non-malleability also includes cases where the value generated from alternative uses is less than the transaction cost or the current use value (Matulich, 2010). While the three types of capital malleability have differing impacts on capital value and reallocation potential, non-malleability of capital is rare in practice and perfect malleability is rare in some industries (Wilen, 2009; Lanzi and Wing, 2013).

Business diversification and structure can also influence stranding risk by affecting transferability and recoverability as well as capital financing needs. Diversification can take many forms, including producing of a wide range of products, existing in different consumer markets, input sourcing, and spatially in terms of the production process itself (Larkin, Sylvia, and Tuiniga, 2003; Capon et al., 1988; Oglend and Tveteras, 2009). Diversification creates stability in production and sales and generally allows for stranding risks to be reduced by reducing environmental risk exposure and longevity, increasing information availability, and enabling capital reallocation (Harnett, 2018; Curtin et al., 2019). The structure of a business, including vertical and horizontal integration, may also influence stranding risk. Vertical integration internalizes different stages of production, whereas horizontal integration is the consolidation of similar assets at the same level of production (Sethi, 2010). Vertical integration can reduce market risk by internalizing transactions and reducing price uncertainty (Sethi, 2010; Coase, 1937; Cheung, 1983), improving information availability and reducing financing need. Horizontal integration combines capital assets to reduce market variability or to provide access to different production environments or markets (Sethi, 2010), reducing environmental risk exposure and increasing capital transferability. Both vertical and horizontal integration increase the ability of a business to reallocate capital internally, while also increasing price control and market power, increasing business stability (Davies and Geroski, 1997). Smaller or less integrated businesses, however, have a greater capacity for adaptation in changing markets (Neagu, 2016), which may reduce stranding risk associated with industry transition.

Capital Stranding Risk in the Seafood Industry

Physical capital used in seafood production can be highly specialized and may have limited alternative uses outside a particular fishery or region, though it is not expected to be completely non-malleable. Capital stranding risks would correspond to the devaluation of quasi-malleable capital used in the seafood industry following large unanticipated shocks. The potential for stranded capital was argued during rationalization of the U.S. West Coast groundfish fishery, which changed the prevailing bargaining structure between harvesters and the processing sector (e.g., Wilen 2009; Matulich, 2010). Seafood processers argued that the rationalization of the fishery would lead to a devaluation and stranding of existing processing capital given changes in ex-vessel market competition benefiting the harvest sector. Processors argued for compensation of their stranded capital losses by receiving direct allocation of harvester fishing quota. Wilen (2009), however, argued that rationalization of the pacific groundfish fishery is unlikely to create significant stranding for processing capital because virtually all capital used in processing, even specialized equipment, is not unique or immobile, has some alternative use, and can be reconfigured in a short time. Processing capital, therefore, was argued to be malleable and unlikely to be devalued (Wilen, 2009).

As of September 2024, there was 2.5 million acres actively leased in the U.S. Atlantic for offshore wind energy development with an additional 850 thousand acres in the Gulf of Maine projected to be leased in October 2024 (BOEM 2024a, BOEM 2024b). Large-scale development of ocean-based wind energy is anticipated to negatively impact the commercial fishing industry by reducing fishable area and landings in the U.S. Northeast and Mid-Atlantic, with impact exposure varying across fleets and ports (Kirkpatrick et al. 2017; Scheld et al. 2022). Shoreside business activity upstream and downstream of the harvest sector is also expected to be affected, though the extent of impact is uncertain (Hooper et al. 2018; Methratta et al., 2020). Offshore wind energy development may, furthermore, affect scientific surveys and resource monitoring, which could lead to increased uncertainty in stock abundances and more precautionary management (Lipsky et al. 2024; Borsetti et al., 2023; Methratta et al., 2020; Hare et al., 2022). The pace and scale of offshore wind energy development in the U.S. is unprecedented globally and it may be reasonable to assume large-scale use-conflict was not a risk many seafood businesses previously considered. Physical capital assets used in seafood production could, therefore, be subject to devaluation and stranding risks. This study investigated potential stranding risks by quantifying risk exposure and vulnerability for seafood businesses operating in the U.S. Northeast and Mid-Atlantic.

Methods

Industry Interviews

A series of semi-structured interviews were conducted with seafood harvest, processing, and distribution companies to understand the value of capital assets and capital stranding and devaluation risks. Eight interviews were conducted with companies in the seafood sector in the Mid-Atlantic and Northeast, covering a significant portion of regional market share for mixed-trawl, scallop dredge, and clam dredge fisheries. Interviews were held on Zoom and in person and typically lasted about one hour. The interview had two sections: 1) capital assets and valuation; and 2) capital stranding and devaluation risks. The first section was based on the U.S. Census Bureau Annual Capital Expenditures Survey (ACES) as companies were expected to be familiar with the question structure and content given possible prior participation in the survey. Questions in this section were designed to understand capital value. Specific questions were asked about total gross sales, total annual expenditures, value and lifespan of physical capital assets, annual maintenance expenses, financing of assets, and if any recent investments in physical capital had been made. The second section of the interviews focused on capital stranding and devaluation risk drivers identified in a literature review and described above. This section included questions covering business diversification and integration, capital malleability, and collaboration among industry participants (see Supplementary Material for question guide).

Following interviews, capital stranding risks were assessed for each business using ordinal ranking and a three-point scale (no/low, medium, and high risk) across eight risk categories. A capital stranding vulnerability score was then calculated for each business as the sum across risk categories, normalized by the highest possible score (i.e., 16), such that a zero indicated no or low risk across all categories and a one indicated high risk across all categories. Individual risk assessment categories included: business collaboration within the industry; degree of physical capital financing; diversification capacity; capital resale potential; adaptability or potential for capital reallocation within the business; geographic footprint (fishing and shoreside locations); and recent investment in capital (see Supplement Material for scoring guidelines). A histogram of scores was used to visually interpret the distribution of risks across businesses.

Fishing Capital Vulnerability

A vulnerability metric was constructed for fishing fleets in the US Northeast and Mid-Atlantic. The metric was evaluated by port, gear, and vessel size class, such that an individual value was representative of the vulnerability for a group of vessels. Vulnerability was calculated as:

$$(1)\ Vulnerability_{s,g,p} = \sum_i FC_i / \left(\sum_i Rev_i - VC_i\right)\ for\ all\ i \in s, g, p,$$

where the summation of fixed costs (*FC*) was divided by the summation of operating margins, or revenues (*Rev*) minus variable costs (*VC*), for all individual vessels (*i*) of a specific size (*s*), gear (*g*), and port (*p*). This metric provided a relative measure of financial risk for a group of vessels, where higher fixed costs relative to operating margins would indicate lower levels of profitability and therefore higher risks of capital exit. A value greater than one, indicating total fixed costs exceed operating margins, would suggest high risk for capital exit (e.g., retirement, sale, or movement to a different port or fishery).

To evaluate fishing capital vulnerability, data on revenues and costs were assembled from a variety of sources. A data request was made to the Greater Atlantic Regional Fisheries Office (GARFO) to obtain non-confidential landings and fishing effort data. Data by species and year on pounds landed, number of vessels landing, number of trips, and average days at sea per trip from 2018 to 2022 were provided separated by vessel length category (> 65 feet and ≤ 65 feet), gear type (otter trawl, clam dredge, and scallop dredge), and port (New Bedford, MA; Point Judith, RI; Point Pleasant, NJ; Barnegat Light, NJ; Atlantic City, NJ; Cape May, NJ; and Hampton Roads, VA). Covariance matrices of annual vessel landings across species by vessel size, gear type, and port were also provided. Species were only included in the analysis if their landings represented greater than one percent of total annual landings for all ports considered for a particular gear type. For the otter trawl fishery, 11 species were included: Atlantic mackerel (*Scomber scombrus*), black sea bass (*Centropristis striata*), butterfish (*peprilus triacanthus*), haddock (*Melanogrammus aeglefinus*), illex squid (*Illex illecebrosus)*, loligo squid (*Doryteuhis pealeii)*, pollock (*Pollachius virens*), Acadian redfish (*Sebastes fasciatus)*, scup (*Stenotomus chrysops*), silver hake (*Merluccius billnearis*), little skate (*Leucoraja erinacea)*, winter skate (*Leucoraja ocellata*), and summer flounder (*Paralichthys dentatus*). The scallop dredge fishery only included Atlantic sea scallop (*Placopecten magellanicus*).

Due to data confidentiality (i.e., < 3 unique dealers or < 3 unique permits) landings could not be provided for the clam dredge fishery. However, data was provided directly by four companies (Atlantic Capes Fisheries, La Monica Fine Foods, Sea Watch International, and Surfside Foods), which represent 80-90% of total landings for the fleet (Scheld et al., 2022). These data were provided at the vessel level and thus values by port and size class were constructed by aggregating across vessels. Data for clam dredge vessels less than 65 feet is not reported as there are fewer than three active vessels in this size category among the companies providing data.

Multiple information sources on vessel costs from the Northeast Fisheries Science Center (NEFSC) were combined to estimate total costs of commercial fishing for two gear types, dredge and trawl, and two vessel size classes, less than or equal to 65' and greater than 65'. Variable costs were compiled from information presented in Das (2013), which summarizes trip costs from 2005 to 2012 where costs (in 2012 dollars) include fuel and oil, ice, food and water, vessel and gear damage, and bait. Across all gear types, fuel accounted for 78% of trip costs on average. We used daily trip costs for multi-day trips as the average days-at-sea for all fleets exceeded one. Cost estimates for trawl and dredge were included in Das (2013), however, estimates were not broken down by vessel size. To accommodate an analysis with two vessel size classes, average costs by gear type were scaled up and down by a third to develop large and small size class specific trip costs (i.e., trip costs for large vessels were assumed to be about double that of small vessels). Average annual fixed costs per vessel were calculated using data from Ardini et al. (2022), which provided estimates by gear type and size class. Average values for each fixed cost category (e.g., vessel repair and maintenance, insurance and vessel fees, and captain/crew share) were calculated by weighting 2011, 2012, and 2015 cost estimates based on the observed sample size from each category. Fixed and variable cost estimates were compared against publications and reports including additional information on costs for fishing vessels in the US Northeast and Mid-Atlantic (i.e., Murphy et al., 2014; Georgianna et al., 2011; Werner et al., 2020; Scheld, 2020; Scheld et al., 2022; see supplementary materials for cost tables and comparisons). All costs were converted into 2022 US dollars using the U.S. Federal Reserve Bank Gross Domestic Product (GDP) implicit price deflator (U.S. Bureau of Economic Analysis, 2024). Fixed costs are presented as average annual costs per vessel and variable costs are trip costs per vessel per day of fishing (see supplementary Tables S1 and S2 for cost estimates).

Total annual variable costs by port, gear, and vessel size class depended on the number of trips. Available data specified the number of trips landing individual species; however, trawl fisheries are multi-species such that a vessel can target and land multiple species in one trip. This would lead to overcounting the number of trips and inflating variable cost estimates for this fleet. To account for this, species were assigned into NMFS fishery management plan (FMP) groups and the total number of trips were calculated corresponding to the number of trips landing any species in the FMP divided by the total number of species managed under that FMP. The number of trips for the scallop fleet did not need to be modified as only scallops are targeted by these vessels. Total variable costs for a given size class, gear, and port were equal to a size class and gear specific daily cost estimate multiped by total annual fishing effort (i.e., average days-at-sea per trip multiped by the number of trips) for a given size class, gear type, and port. Data available for the clam fleet specified the number of trips per vessel.

Fixed cost estimates depended on the number of vessels in each port. GARFO vessel permit data was used to determine the number of vessels in each size class registered to each of the ports of interest. Permits are based on the FMPs in the Northeast region, where the permits of interest included: Mackerel, Squid, and Butterfish; Multispecies Groundfish; Sea Scallop; Skates; Surfclam and Ocean Quahog; and Summer Flounder, Scup, and Black Sea Bass. The total number of permits may not accurately represent the number of active vessels due to inactive permits for a variety of reasons. FMP specific latent effort estimates were calculated as the number of active FMP permits reported in the NEFSC performance measures divided by the total number of permits issued for a given FMP (NEFSC, 2024; GARFO, 2024). On average across the four permits in the trawl fleet, only 10.77% of all permits were active, signifying that latent effort was much higher compared to the scallop fleet, where 93.54% of all permits were active. To address latent effort at the port level, FMP specific latent effort estimates, expressed as a percentage, were multiplied by the total number of FMP specific permits for a particular vessel size class and gear type in each port. This established upper and lower bounds for the number of active vessels in each port as the total number of permits and the number of permits accounting for latent effort, respectively. For the clam fleet, there was no assumed latent effort as data on the number of active vessels was provided directly.

Distributions of total annual variable costs by vessel size, gear type, and port were estimated where 1,000 cost vectors were sampled from a normal distribution using available means and standard deviations (see Table S1 for means and standard deviations of trip costs, which were multiplied by port, gear, and size total effort estimates). Estimates of total fixed costs at the port level were determined by multiplying a draw of size and gear specific fixed costs from a normal distribution, using available means and standard deviations (Table S2), by a draw from a uniform distribution bounded by upper and lower estimates of the number of vessels for a given size, gear type, and port. This process was repeated 1,000 times.

Average annual landings per vessel were calculated by dividing the sum of total pounds landed by all vessels of a specific size, gear type, and port by the sum of number of vessels reported as landing the total. For the trawl fleet, 1,000 vectors were sampled for each port and vessel size class from multi-variate normal distributions with means equal to the vector of mean landings per vessel per year for each species and covariance representing the covariance of individual vessel landings across species. The scallop and clam dredge fleets target a single species per trip and therefore covariance across species was assumed to be zero. For these fleets, 1,000 draws were taken from normal distributions by port and size class for each species, with the mean equal to the mean landings per vessel per year and the variance set to the sample variance. Revenue was calculated by multiplying landings draws by species-specific per pound price estimates derived from NOAA landings data (NMFS 2024; supplementary material Table S3). Port level revenue estimates were determined by summing across all species landed in each port for a particular fleet.

Potential reductions in landings due to offshore wind energy development were calculated using estimates of landings exposure available in *Landings and Revenue Data for Wind Energy Lease Areas, 2008-2021* (NOAA, NMFS, and GARFO, 2022), which provided estimates of pounds and nominal revenue landed from all offshore wind lease sites collectively by species and year. This data was filtered to only include the years 2018-2021 and the 11 trawl species, sea scallops, Atlantic surfclam, and ocean quahog. From 2018-2021, there were no landings exposure estimates for ocean quahog, indicating that there is no spatial overlap or the data is confidential. Exposure values provide estimates of landings exposure for all of landings of a particular species in the Mid-Atlantic and Northeast whereas our analysis focused on vessel vulnerability in seven key ports. For the trawl and scallop dredge fleets, the sum of pounds landed by species in the seven ports was divided by the coastwide total (NMFS, 2024; supplementary Table S4). Landings exposure values were then reduced by one minus this fraction to account for exposed landings that may occur in ports outside those included here. For the clam fleet, it was assumed all exposed landings would occur for the included ports and vessels as landings from the remaining vessels in the fleet are thought to be further inshore from where offshore wind development is occurring. The total exposed landings by species were distributed across size class, gear types, and ports proportionally based on each group's contribution to total landings. Landings exposure estimates were subtracted from size class, gear type, and port specific total landings values to estimate potential landings for each fleet in each port following offshore wind energy development.

Fixed costs, operating margins (revenue - variable costs), and capital vulnerability were assessed by port and fleet. Revenue reductions, expressed in percentage terms, that would lead to zero profitability without offshore wind development, referred to as breakeven revenue, were calculated and compared to potential revenue loss estimates with offshore wind development. The percent difference in operating margins with and without offshore wind energy development was assessed at the port and fleet level. Median values are reported for all metrics. For capital vulnerability, only non-negative values were included when calculating medians, as negative values would bias the metric due to the discontinuity at zero (i.e., vulnerability increases with increasing values greater than zero but increases with decreasing values for values less than zero). As estimates of operating margins were generally positive, there were limited instances of negative vulnerability scores. Variability in measures was explored by assessing the interquartile range of the distribution. Finally, capital vulnerability was qualitatively compared to NOAA social vulnerability indicators to identify overlap between capital and social vulnerability.

Results

Industry Interviews
Across the eight companies interviewed, there was ~$600 million in annual gross sales and ~$300 million in total capital value. Vessel capital value, including permit value, was approximately 60% of the total capital value whereas shoreside assets covered the remining 40%. Approximately $80 million had been invested in physical capital over the previous three years. About $25 million was spent annually on capital maintenance costs, of which vessels accounted for approximately 72%. Asset depreciation lifespans ranged from five to 50 years, where processing equipment had lifespans of 5-20 years, vessels had lifespans of 10-30 years, and shoreside facilities had lifespans of 10-50 years. The primary physical capital items reported included vessels (hull and vessel permits), dock space and facilities, and shoreside machinery (e.g., automated packaging lines; freezers, such as tunnel, plate, and individual quick freezers; processing tables; and packaging machines).

Interviews also provided information regarding capital devaluation and stranding risk factors, which were varied across companies. Stranding risks were thought to increase when processing companies were capital intensive. For companies interviewed here, total physical capital value ranged from 40% to 120% of annual gross revenues. Risks of capital strandings may also increase with high recent capital investments, which here ranged from $7 million to $20 million over the last three years. In general, the industry indicated a high reliance on financing of capital, which could increase stranding and devaluation risks. Lower levels of product and spatial diversification (e.g., 1-2 species or no "value add" products, only fish in Mid-Atlantic Bight) also increased risks of capital stranding for some companies. Most companies indicated little to no resale potential for certain pieces of specialized processing equipment and vessels. Business collaboration was found to be moderate to high, primarily existing through government relations activities, though some companies bought and sold products with competitors or participated in service contracting. Views on business adaptability were varied across the sector, with some businesses indicating an ability to shift production in response to changing conditions (e.g., shift targeting of species, more importing), while other companies noted a limited ability to adapt due to specialized production of certain species.

Combining and normalizing scores for individual capital risk factors (see supplementary material for scoring categories and criteria), the average capital vulnerability score across companies was 0.50 (sd 0.19). This score represents medium vulnerability to capital devaluation or stranding on our scale. The vulnerability score followed a bimodal distribution, with one peak just over 0.4 (low-medium risk) and another around 0.7 (medium-high risk) (Figure 1), indicating two risk groups within the companies interviewed. Higher capital vulnerability scores were typically due to low adaptability and low business diversification, high capital intensity, and a limited geographic footprint.

Fishing Capital Vulnerability

Economic conditions varied by fleet and port (Tables 1-5). For trawl fleets, fixed costs frequently exceeded operating margins and thus profitability was negative in many ports and for the fleets in aggregate (Tables 1-2). Point Judith, RI was the only port with positive profitability. Due to low and negative profitability, capital vulnerability was generally high for trawl fleets. Capital for the large trawl fleet in Hampton Roads, VA and the small trawl fleets in New Bedford, MA and Barnegat Light, NJ were especially vulnerable, with scores over 10. Exposure to offshore wind energy development was found to reduce operating margins 1-3% for the large trawl fleet and 2-7% for the small trawl fleet.

Scallop fleets exhibited greater profitability with operating margins exceeding fixed costs in many ports and for the fleets overall (Tables 3-4). Fleet-wide median breakeven revenue values were ~33% for both fleets, indicating revenues would need to reduce by one third to reduce profits to zero. Unsurprisingly, these fleets also had low capital vulnerability, with scores generally less than one. Across both large and small scallop dredge fleets, four ports exhibited higher capital vulnerability due to lower profitability (Atlantic City, NJ; Barnegat Light, NJ; Point Pleasant, NJ; Point Judith, RI; Tables 3-4). Exposure to offshore wind energy was found to potentially reduce operating margins by ~1-2% for most ports and the fleets overall.

The clam fleet was characterized by negative profitability across all ports and in total, leading to higher levels of capital vulnerability (Table 5). Atlantic City, NJ displayed the highest level of capital vulnerability for the fleet, with a value nearly 10 times larger than that of New Bedford, MA, another important port. Exposure to offshore wind energy development was found to potentially reduce operating margins by 2-3%.

Considering all five fleets, four ports displayed positive combined profitability and three ports displayed negative combined profitability (Table 6). Point Judith, RI had positive median profitability including all fleets, though a small profit margin and slightly negative breakeven value. Capital vulnerability was highest in Atlantic City, NJ, followed by Barnegat Light, NJ and Point Pleasant, NJ. These three ports also showed the greatest exposure to operating margin reductions from offshore wind energy development, with values of ~4-6%. Combining all fleets and ports, profits were positive in aggregate, the vulnerability score moderate, and offshore wind energy was projected to reduce operating margins by ~3% (Table 6, bottom row). Variability in costs, operating margins, breakeven values, vulnerability scores, and offshore wind energy exposure estimates was considerable (Tables S5-S10). This introduced a degree of uncertainty into findings regarding capital vulnerability and offshore wind energy impacts, particularly for the trawl and clam dredge fleets.

Fishing capital vulnerability was compared to NOAA social vulnerability indicators (NOAA, 2020). All ports considered in this analysis exhibited high values for commercial fishing engagement, which measures commercial fishing activity in a port. Atlantic City, NJ and Hampton Roads, VA exhibited low reliance on commercial fishing, which is the measure of commercial fishing activity in relation to the population size of the community. New Bedford, MA, Point Judith, RI, and Point Pleasant, NJ exhibited medium commercial fishing reliance while Barnegat Light, NJ and Cape May, NJ exhibited high reliance on commercial fishing. Barnegat Light, NJ and Point Pleasant, NJ also exhibited high fishing capital vulnerability (Table 6, values > 1), suggesting these ports may be especially vulnerable.

Study Limitations

Industry interviews covered only a small number of companies. Though these companies represent a relatively substantial amount of market share, the diversity of business types present in seafood harvest, processing, and distribution within the region may not be well represented. Additional work is needed to understand capital value and devaluation risks across the industry, including with respect to small and medium sized businesses.

There are several limitations and uncertainties associated with assessment of vessel costs and fishing capital vulnerability. For all variable costs and many of the fixed costs, the standard deviations exceed the mean estimate, leading to a high degree of variability. Uncertainty in the number of active vessels further increased variability in fixed costs. Estimates of fixed costs, operating margins, and other metrics had somewhat large measures of variability due to large variability in input cost data. This increased uncertainty in findings related to capital vulnerability considerably. Additional work is needed to better understand cost distributions throughout the fleets. The trawl fleets referenced in this analysis were stylized versions these fleets, as often individual fishing vessels will target particular species or species groups and would not catch all of the species included in the analysis. The estimates of offshore wind development impacts used in this analysis are extrapolated from coast wide estimates of offshore wind development impacts. Individual impacts could differ by port.

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Tables and Figures

Table 1. Large trawl (> 65') fleet median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$35,623,641	$4,214,820	-	4.25	0.84%
Point Judith, RI	$6,876,433	$11,752,948	15.74%	0.45	1.61%
Point Pleasant, NJ	$3,989,513	$2,468,384	-	0.88	2.01%
Cape May, NJ	$18,138,742	$7,252,165	-	1.68	1.53%
Hampton Roads, VA	$9,741,516	$658,344	-	11.52	2.55%
Fleet-Wide	$78,810,163	$26,808,085	-	1.96	1.63%

Table 2. Small trawl (≤ 65') fleet median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$3,775,794	$381,762	-	10.64	2.39%
Point Judith, RI	$5,828,359	$8,068,813	4.60%	0.73	3.19%
Point Pleasant, NJ	$2,830,600	$472,273	-	5.99	3.29%
Barnegat Light, NJ	$2,952,255	$118,804	-	26.28	7.48%
Fleet-Wide	$16,556,712	$9,028,091	-	1.79	3.79%

Table 3. Large scallop dredge (> 65') median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$76,523,077	$174,109,385	39.81%	0.44	1.91%
Point Pleasant, NJ	$10,940,348	$3,777,255	-	1.61	1.60%
Barnegat Light, NJ	$7,818,773	$585,384	-	2.13	3.25%
Atlantic City, NJ	$15,275,355	$3,556,557	-	4.03	1.94%
Cape May, NJ	$35,418,583	$79,781,231	40.70%	0.44	1.96%
Hampton Roads, VA	$16,106,621	$45,224,614	47.41%	0.35	1.97%

Fleet-Wide	$161,842,892	$307,462,088	33.55%	0.53	1.91%

Table 4. Small scallop dredge (≤ 65’) fleet median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$5,268,374	$15,354,081	60.67%	0.34	1.54%
Point Judith, RI	$3,900,126	$458,576	-	6.75	1.40%
Point Pleasant, NJ	$3,065,060	$2,098,109	-	1.59	1.71%
Barnegat Light, NJ	$3,847,743	$7,291,186	28.67%	0.59	2.25%
Cape May, NJ	$2,789,234	$6,759,417	51.34%	0.41	1.65%
Hampton Roads, VA	$269,568	$1,265,116	67.75%	0.21	2.60%
Fleet-Wide	$19,308,603	$33,487,116	32.76%	0.58	1.80%

Table 5. Large clam dredge (> 65’) median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$11,413,522	$3,929,480	-	2.64	1.92%
Point Pleasant, NJ	$7,263,150	$5,558,493	-	1.22	3.48%
Atlantic City, NJ	$18,676,672	$762,184	-	20.30	3.35%
Fleet-Wide	$37,353,344	$10,358,734	-	3.96	2.52%

Table 6. All fleets median total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$134,728,610	$198,493,939	21.29%	0.68	2.11%
Point Judith, RI	$17,523,157	$18,636,997	-1.22%	0.85	2.94%
Point Pleasant, NJ	$29,044,583	$12,654,758	-	1.58	4.13%
Barnegat Light, NJ	$15,197,718	$7,677,251	-	1.87	3.88%
Atlantic City, NJ	$33,762,772	$4,583,002	-	2.62	5.98%
Cape May, NJ	$57,306,794	$92,397,521	23.77%	0.64	2.08%
Hampton Roads, VA	$26,806,207	$47,057,652	29.90%	0.58	2.03%
Total	$320,892,203	$383,879,987	9.07%	0.85	2.77%

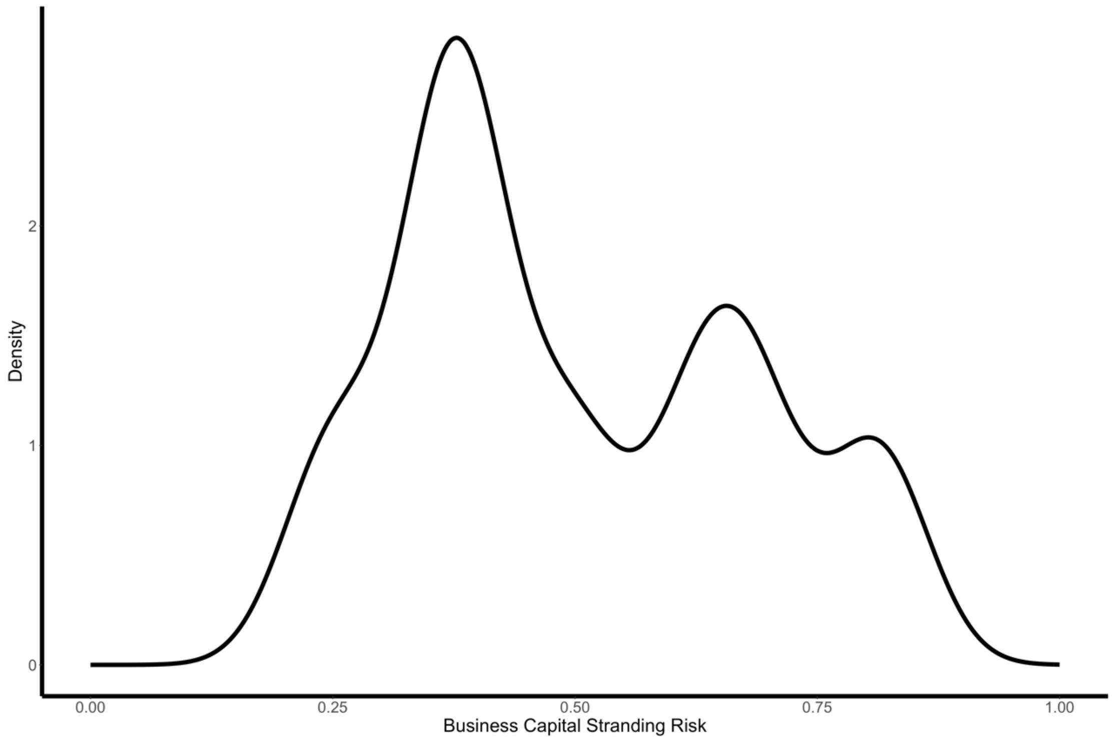

Figure 1. Physical capital stranding risk from ranking of risk drivers.

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Supplementary Material

Interview question guide:

Capital Valuation

1. What are your approximate total gross sales per year? (last three years)
2. What are your approximate total gross expenditures per year? (last three years)
3. What is the approximate value of your gross depreciable assets? How is this value estimated?
4. What is the average yearly maintenance/retirement costs for your gross depreciable assets?
5. What is the estimated lifespan for key depreciable assets?
6. Are any of your business's physical assets financed? Roughly what proportion of your business's physical assets are financed?
7. How much have you invested in new equipment or other significant physical assets during the last three years?
8. What factors do you consider in evaluating whether or not to invest in new equipment and/or other significant physical assets?
9. Do you plan on investing in any new equipment or other significant physical assets over the next five years? Why or why not?

Risk to Capital Stranding

1. Could you please describe your business's physical assets, including vessels, plants, machinery, storage or refrigeration facilities, and cars or trucks? Please note the physical location of these assets. (vertical, horizontal integration, diversification; environmental, transferability risk)
2. How many different species does your business process? From what region(s), including outside the U.S., do you source landings? (diversification; environmental risk)
3. What types of seafood products does your business produce (e.g., fresh, frozen, breaded, soups, sauces, etc.)? Does production of any of these products require specialized equipment? Do you produce multiple different products using the same equipment in any instances? (vertical integration, malleability; transferability, recoverability risk)
4. Is there a secondhand market for specialized equipment and physical assets used by your business? If so, who might be the buyers? If selling in this market, is there a significant discount? (malleability; recoverability risk)
5. What would your business do if landings of one or multiple species that you currently process decreased significantly? Are there costs associated with shifting production to a different mix of species? (malleability; transition, adaptation, transferability risk)

6. How would you describe competition within your industry? Do businesses ever share information or act in a coordinated way? (information availability, collaborative opportunities)

Capital risk scoring

Scoring of Risk – Low (0), Medium (1), High (2) for each risk category:
Total Risk Max Score: 16
<u>Categories for Ranking & Ranking System:</u>

1. Business collaboration within the industry:
   - Low (multiple collaborations stated), medium (one or a small number of collaborations stated), high (no collaborations stated)
2. Financing of capital:
   - Low (none/very low financing of assets), medium (some financing of assets), high (most/all assets financed)
3. Capital intensive:
   - Low (total physical capital value represents <50% of annual revenues), medium (50-100%), high (>100%)
4. Diversification capacity
   - Low (imports seafood, produces multiple products, and targets >1 of: small pelagic, groundfish, bivalves), medium (2 of 3 categories described in low), high (1 of 3 categories described in low or less)
5. Secondhand Market:
   - Low (easy resale), medium (some assets could be resold), high (specialized use, little to no asset resale)
6. Adaptability (reallocation potential):
   - Low (easily adaptable, stated multiple solutions to adapt), medium (stated 1 way to adapt), high (no ability to adapt stated)
7. Spatial diversification (fishing and business locations):
   - Low (2 or more locations spread out geographically), medium (2 locations in a small area), high (1 location); however, targeting mobile species can substitute for having spread out locations (e.g., 1 location but mobile species = medium risk opposed to 1 location and sessile species = high risk)
8. Recent Investment in capital (last 3 years):
   - Low (< 10% annual revenue invested in physical capital during the last 3 years), medium (10 - 20%), high (> 20%)

Table S1. Average trip costs. Values are 2022 USD.

Vessel Type	Mean Variable cost	sd
Large Dredge	$5648.96	7327.69
Small Dredge	$3193.48	5509.54
Large Trawl	$4096.15	5710.62
Small Trawl	$2315.65	4293.69

Table S2. Annual fixed costs by cost category. Values are 2022 USD.

Cost Category	Vessel Type	Mean Fixed Cost	sd
Repair and Maintenance	Large Dredge	$116,697.48	87344.44
Upgrades/ Improvements	Large Dredge	$48,894.73	60048.65
Insurance/ Vessel Fees	Large Dredge	$78,561.89	34815.8
Vessel Level Business expense	Large Dredge	$99,850.64	87886.56
Captain/ Crew Share	Large Dredge	$685,460.84	423787.41
Repair and Maintenance	Small Dredge	$22,461.61	13672.5
Upgrades/ Improvements	Small Dredge	$21,181.34	34021.66
Insurance/ Vessel Fees	Small Dredge	$17,358.15	14407.09
Vessel Level Business expense	Small Dredge	$25,011.62	34678.16
Captain/ Crew Share	Small Dredge	$177,286.49	264773.49
Repair and Maintenance	Large Trawl	$73,278.33	56863.11
Upgrades/ Improvements	Large Trawl	$33,523.08	45361.01
Insurance/ Vessel Fees	Large Trawl	$48,292.00	29833.4
Vessel Level Business expense	Large Trawl	$59,948.89	50650.75
Captain/ Crew Share	Large Trawl	$236,975.38	205769.14
Repair and Maintenance	Small Trawl	$23,676.52	24008.36
Upgrades/ Improvements	Small Trawl	$13,493.70	20146.56
Insurance/ Vessel Fees	Small Trawl	$9,233.88	7538.55
Vessel Level Business expense	Small Trawl	$22,319.42	27111.98
Captain/ Crew Share	Small Trawl	$57,227.16	61278.84

Table S3. Per pound revenue estimates. Values are in 2022 USD.

Species	Gear Type	Average Price per Pound
Atlantic Surfclam	Clam Dredge	$0.98
Ocean Quahog	Clam Dredge	$0.92
Sea Scallop	Scallop Dredge	$12.82
Acadian Redfish	Trawl	$0.62
Atlantic Mackerel	Trawl	$0.32
Black Sea Bass	Trawl	$3.32
Butterfish	Trawl	$0.88
Haddock	Trawl	$1.25
Illex Squid	Trawl	$0.52
Little Skate	Trawl	$0.17
Loligo Squid	Trawl	$1.58
Pollock	Trawl	$1.08
Scup	Trawl	$0.91
Silver Hake	Trawl	$1.01
Summer Flounder	Trawl	$3.46
Winter Skate	Trawl	$0.24

Table S4. Percent of requested data landings of total regional landings. Note, only calculated for trawl and scallop dredge fleets. Landings values are 2022 USD.

Species Name	Ports' Landings	Regional Landings	Port % of Regional
Sea Scallop	188,521,629	242,197,372	77.84%
Acadian Redfish	9,798,053	55,383,493	17.69%
Atlantic Mackerel	4,818,217	63,997,612	7.53%
Black Sea Bass	8,201,666	19,592,637	41.86%
Butterfish	4,430,751	21,493,811	20.61%
Haddock	21,715,435	83,205,393	26.10%
Illex Squid	111,510,435	222,678,515	50.08%
Little Skate	4,687,960	18,980,799	24.70%
Loligo Squid	64,490,613	137,758,170	46.81%

Pollock	4,080,140	36,186,145	11.28%
Scup	26,080,822	65,329,427	39.92%
Silver Hake	29,704,806	53,544,848	55.48%
Summer Flounder	23,364,193	37,551,335	62.22%
Winter Skate	4,687,960	18,980,799	24.70%

Table S5. Large trawl (> 65') fleet interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$20,439,816.00-$57,367,347.00	-$4,657,268.00-$12,221,681	-	2.27-7.94	-1.0%-1.2%
Point Judith, RI	$4,024,027.00-$10,305,145.00	$347,289.20-$21,836,544.00	-33.97%-57.18%	0.27-0.89	1.43%-3.07%
Point Pleasant, NJ	$2,328,894.90-$6,215,480.90	-$1,660,896.00-$6,395,274.00	-	0.51-1.65	-2.21%-3.24%
Cape May, NJ	$10,833,323.00-$27,524,163.00	-$1,737,779.00-$14,749,938.00	-	0.96-3.41	-1.48%-2.63%
Hampton Roads, VA	$5,696,331.50-$15,309,489.20	-$32,980.69-$1,142,013.60	-	6.60-22.09	-1.89%-4.29%
Fleet-Wide	$55,773,829.00-$109,598,974.00	-$7,298,823.00-$57,398,340.00	-	1.25-3.63	-1.47%-2.57%

Table S6. Small trawl (≤ 65') fleet interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$2,151,498.00-$5,993,494.00	$174,977.20-$510,269.90	-	5.44-18.95	1.93%-4.02%
Point Judith, RI	$3,423,229.90-$9,162,084.40	$2,871,750.00-$12,319,781.00	-36.37%-43.36%	0.39-1.43	2.77%-5.71%
Point Pleasant, NJ	$1,605,620.00-$4,411,915.80	$138,440.20-750,960.80	-	3.20-10.82	2.98%-5.97%
Barnegat Light, NJ	$1,674,128.30-$4,711,572.80	$53,707.46-$169,751.37	-	14.11-49.67	6.21%-12.99%
Fleet-Wide	$11,306,877.00-$23,616,188.00	$3,176,899.00-$13,808,302.00	-	1.11-3.18	2.79%-5.79%

Table S7. Large scallop dredge (> 65') interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$55,922,961.00-$97,454,176.00	$121,435,257.00-$233,569,503.00	15.32%-60.61%	0.30-0.65	1.44%-2.72%
Point Pleasant, NJ	$8,041,071.00-$14,036,308.00	-$1,011,718.00-$9,336,519.00	-	1.08-3.46	-1.98%-3.29%
Barnegat Light, NJ	$5,662,946.00-$9,872,948.00	-$2,675,302.90-$4,425,082.00	-	1.49-7.01	-4.84%-4.74%
Atlantic City, NJ	$10,975,832.00-$19,242,311.00	$1,991,439.00-$5,165,368.00	-	2.70-6.71	1.45%-3.18%
Cape May, NJ	$25,599,642.00-$45,230,892.00	$56,927,004.00-$106,555,477.00	17.39%-60.78%	0.30-0.65	1.50%-2.73%
Hampton Roads, VA	$11,710,979.00-$20,567,611.00	$33,250,566.00-$59,226,476.00	24.35%-66.79%	0.24-0.53	1.52%-2.69%
Fleet-Wide	$117,575,097.00-$205,969,858.00	$210,577,529.00-$421,503,802.00	7.48%-55.55%	0.35-0.79	1.47%-2.87%

Table S8. Small scallop dredge (≤ 65') interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$2,635,748.00-$8,693,385.10	$14,007,437.00-$16,525,184.00	38.15%-76.45%	0.17-0.57	1.42%-1.68%
Point Judith, RI	$1,932,483.10-$6,454,397.60	-$16,806.14-$880,826.30	-	3.43-12.50	-1.22%-2.57%
Point Pleasant, NJ	$1,556,453.50-$5,061,590.90	$1,626,230.20-$2,457,148.50	-	0.81-2.63	1.46%-2.21%
Barnegat Light, NJ	$1,940,817.70-$6,410,183.00	$4,976,185.00-$9,085,690.00	-2.48%-56.48%	0.29-1.00	1.82%-3.29%
Cape May, NJ	$1,414,800.10-$4,708,119.20	$6,061,480.00-$7,398,742.00	24.43%-70.33%	0.21-0.71	1.50%-1.83%
Hampton Roads, VA	$135,554.16-$447,121.49	$1,110,679.10-$1,391,056.30	53.61%-80.01%	0.11-0.36	2.36%-2.96%

Fleet-Wide	$9,676,999.00-$31,89,6514.00	$28,396,447.00-$37,202,894.00	-0.05%-59.18%	0.30-1.00	1.60%-2.10%

Table S9. Large clam dredge (> 65') interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$8,163,581.00-$14,718,163.00	-$9,719,021.00-$17,870,195.00	-	0.59-INF	-3.50%-4.94%
Point Pleasant, NJ	$5,195,006.20-$9,366,103.60	-4,118,108.00-$15,952,918.00	-	0.42-INF	-5.36%-7.56%
Atlantic City, NJ	$13,358,587.00-$24,084,266.00	-$10,994,787.60-$10,626,300.70	-	1.87-INF	-12.07%-14.32%
Fleet-Wide	$26,717,175.00-$48,168,533.00	-$16,294,869.00-$37,360,790.00	-	0.86-INF	-8.97%-10.97%

Table S10. All fleets interquartile range for total fixed costs (FC) and operating margins (OM), breakeven revenue percentage, vulnerability metric, and percentage reduction in operating margins with offshore wind energy exposure (OWEE). Fixed costs and operating margins are in 2022 USD.

Port	FC	OM	Breakeven	Vulnerability	OWEE
New Bedford, MA	$98,264,078.00-$176,866,710.00	$130,435,408.00-$259,269,173.00	-4.32%-42.31%	0.46-1.06	1.65%-3.21%
Point Judith, RI	$11,452,290.00-$25,056,547.00	$601,709.00-$28,196,881.00	-40.31%-29.72%	0.51-1.60	2.08%-4.97%
Point Pleasant, NJ	$21,869,900.00-$36,912,878.00	-$223,238.00-$26,141,520.00	-	0.90-2.92	-3.53%-8.49%
Barnegat Light, NJ	$9,729,911.00-$20,638,702.00	$3,522,073.00-$10,987,620.00	-	1.13-3.24	2.80%-6.43%
Atlantic City, NJ	$26,994,201.00-$40,985,838.00	-$8,399,914.00-$15,250,658.00	-	1.57-4.68	-12.19%-13.63%
Cape May, NJ	$40,815,386.00-$75,817,225.00	$67,605,458.00-$114,773,453.00	3.47%-43.27%	0.43-0.92	1.60%-2.84%
Hampton Roads, VA	$18,884,294.00-$35,527,726.00	$34,789,928.00-$60,791,664.00	6.11%-50.54%	0.39-0.86	1.59%-2.75%
Total	$233,203,381.00-$406,258,661.00	$247,569,520.00-$498,336,692.00	-13.50%-32.49%	0.58-1.20	2.16%-4.12%

Supplementary Cost Tables

Total costs for commercial fishing businesses are comprised of fixed costs including vessel and business expenses and variable trip costs. The Social Sciences Branch (SSB) of the Northeast Fisheries Science Center (NEFSC) collects both fixed and variable costs. Multiple cost information sources from the NEFSC were combined to estimate total costs of commercial fishing for two gear types, dredge and trawl. Estimates of fixed and variable costs in 2022 dollars are shown in tables S11 and S12. Estimates of fixed and variable costs in using the original values, from each report described below, are shown in tables S13 and S14.

The base fixed costs used to model fishing costs were determined using, An Overview of the Social Sciences Branch (SSB) Commercial Fishing Business Cost Survey in the Northeast: Protocol and Results for Survey Years 2011, 2012, and 2015 (Ardini et al., 2022). This technical memorandum provides the most recent NOAA estimates on fishing costs in the Northeast region where cost information is provided on a voluntary basis using a SSB cost survey which is the only source of fixed cost information collected by NOAA fisheries in the Northeast. The report provided tables which stated fixed costs, in 2015 dollars, by gear type and vessel size. For our analysis, we calculated average cost for each fixed cost category by taking the weighted average of 2011, 2012, and 2015 costs based on observed sample size from each category. We calculated average fixed costs for four fleets, large dredge (> 71.9 feet), small dredge (< 71.9 feet), large trawl (> 60.7 feet), and small trawl (< 60.7 feet). Ardini et al., 2022 suggests using two sources for variable trip costs: Das 2013 and Werner et al., 2020 which calculated trip costs via at-sea observers.

Das, 2013 is a NOAA technical memorandum entitled Northeast Trip Cost Data- Overview, Estimation, and Predictions (Das, 2013). This report summarizes trip costs from 2005 to 2012 where costs (in 2012 dollars) include fuel, ice, food, damage, bait, water, and oil. On average, fuel accounted for 78% of trip costs. The report shows 1999 unique vessels and 908,172 total trips observed in the time period. Costs were broken out by gear type, vessel length categories, and species groups for both single day and multi-day trips. Cost estimates for trawl and dredge were included, however, estimates based on gear type were not broken down by vessel size. For our analysis we only included multi-day trips because single-day trips are less likely to be impacted due to offshore wind energy development.

Werner et al., 2020 is a peer reviewed study entitled ‘Estimation of commercial Fishing Trip Costs Using Sea Sampling Data’. This study was conducted to investigate the effect of sampling bias on trip costs because data are usually collected for biological purposes rather than economic. Werner et al., determined the impact of selection bias on trip costs using three approaches; weighted/unweighted least squares (OLS and WOLS) and Heckman sample selection models which also allowed estimates of average trip costs by gear type for both single day and multiday

trips, where we only used multi-day trip estimates. Data were provided from observer data and vessel trip reports (VTR) from 2007 to 2015 and cost estimates are in 2010 dollars.
Unweighted average fixed costs, average fixed cost sd, and sample size of each cost category from Ardini et al., 2022, are provided in tables S15 and S16. Additional tables produced using data from Das, 2013 showing the average trip costs and sd as well as a table from Werner, et al., 2020 (Tables S17 and S18).
Additional tables (S19:S24) show both fixed and variable costs provided by various fishery dependent reports (surf clam, longfin squid, and groundfish) to benchmark against the base fixed and variable costs provided using Ardini et al., 2022, Das, 2013, and Werner et. Al., 2020. Surfclam data provided from Scheld et al., 2022 benchmarked the dredge fixed and variable costs. The average variable costs for surfclam trips were $7485.67 which is lower than the variable costs reported by Das, 2013 and Werner, 2020. The categories for fixed costs differed, however, the budget for maintenance and repairs was higher using the SEFES model than fixed costs reported by the other studies, however, the total fixed costs reported by Das, 2013 and Werner et al., 2020 were higher. Surfclam effort including trips per year, number of vessels, and hours fished per year were provided in table 10, these data were provided from the Mid-Atlantic Fishery Management Council and Munroe et al., 2022. Longfin squid cost estimates provided by Scheld, 2020 were used to benchmark trawl cost estimates which showed that total costs estimates are between the estimates of total costs for large and small trawl provided using Ardini et al., 2022, Das, 2013, and Werner et al., 2020. Multiple reports were used to benchmark groundfish costs, Murphy et al., 2014, 2012 final report on the performance of the northeast multispecies (groundfish) fishery (May 2012-April 2013) was used to show variable costs and trip information across size classes from 2009 to 2012. Georgianna et al., 2011, Breakeven Analysis New England Groundfish Fishery for FY2009 and FY2010 showed fixed cost range estimates for three size classes (<50 feet, 50 to 75 feet, and > 75 feet) for the groundfish fishery. Fixed cost estimates from Ardini et al., 2022 were contained within the fixed cost ranges when looking across all size classes. An additional table was produced using data from Georgianna et al., 2011 which provided trip attribute data for three size classes (< 50 feet, 50 to 65 feet, and > 65 feet) including average multi-day trip costs, these estimates were much lower than the values reported by Das, 2013 and Werner et al., 2020.

Table S11. Average fixed and variable costs for multi-day commercial fishing trip. Average fixed cost estimates from 2011, 2012, and 2015 provided from Ardini et al., 2022 and variable cost data provided from Das, 2013. Variable cost standard deviation in parentheses. Costs estimates in 2022 dollars.

	Large Dredge		Small Dredge		Large Trawl		Small Trawl	
Fixed Costs:	Cost	sd	Cost	sd	Cost	sd	Cost	sd
Repair and Maintenance	$116,697.48	87,344.44	$22,461.61	13,672.50	$73,278.33	56863.11	$23,676.52	24,008.36
Upgrades/ Improvements	$48,894.73	60,048.65	$21,181.34	34,021.66	$33,523.08	45361.01	$13,493.70	20,146.56
Insurance/ Vessel Fees	$78,561.89	34,815.80	$17,358.15	14,407.09	$48,292.00	29833.40	$9,233.88	7,538.55
Vessel Level Business	$99,850.64	87,886.56	$25,011.62	34,678.16	$59,948.89	50650.75	$22,319.42	27111.98
Vessel/ Permit Value	$4,172,186.69	2,846,307.90	$1,000,589.73	1,359,146.00	$756,396.27	451568.36	$404,640.80	506,273.23
Captain/ Crew Share	$685,460.84	423,787.41	$177,286.49	264,773.49	$236,975.38	205769.14	$57,227.16	61,278.84
Total Fixed Costs:	$5,199,376.23	184,134.61	$975,153.38	41,952.29	$1,205,850.02	125711.99	$525,520.18	59,683.18
Variable (Trip) Costs:	$17,421.74 (12,868.53)				$12,632.79 (10,028.70)			

Table S12. Average fixed and variable costs for multi-day commercial fishing trip. Average fixed cost estimates from 2011, 2012, and 2015 provided from Ardini et al., 2022 and variable cost data provided by Werner et al., 2020. Costs estimates in 2022 dollars.

	Large Dredge		Small Dredge		Large Trawl		Small Trawl	
Fixed Costs:	Cost	sd	Cost	sd	Cost	sd	Cost	sd
Repair and Maintenance	$116,697.48	87,344.44	$22,461.61	13,672.50	$73,278.33	56863.11	$23,676.52	24,008.36
Upgrades/ Improvements	$48,894.73	60,048.65	$21,181.34	34,021.66	$33,523.08	45361.01	$13,493.70	20,146.56
Insurance/ Vessel Fees	$78,561.89	34,815.80	$17,358.15	14,407.09	$48,292.00	29833.40	$9,233.88	7,538.55
Vessel Level Business	$99,850.64	87,886.56	$25,011.62	34,678.16	$59,948.89	50650.75	$22,319.42	27111.98
Vessel/ Permit Value	$4,172,186.69	2,846,307.90	$1,000,589.73	1,359,146.00	$756,396.27	451568.36	$404,640.80	506,273.23
Captain/ Crew Share	$685,460.84	423,787.41	$177,286.49	264,773.49	$236,975.38	205769.14	$57,227.16	61,278.84
Total Fixed Costs:	$5,199,376.23	184,134.61	$975,153.38	41,952.29	$1,205,850.02	125711.99	$525,520.18	59,683.18
Variable (Trip) Costs:								
OLS Predicted	$11,673.62				$8,409.92			
WOLS Predicted	$11,994.37				$8,467.68			
Heckman Predicted	$11,571.78				$8,631.00			

Table S13. Average fixed and variable costs for multi-day commercial fishing trip. Average fixed cost estimates from 2011, 2012, and 2015 provided from Ardini et al., 2022 and variable cost data provided from Das, 2013. Fixed cost estimates in 2015 dollars and variable cost estimates in 2012 dollars.

	Large Dredge	Small Dredge	Large Trawl	Small Trawl
Fixed Costs:				
Repair and Maintenance	$96,034.74	$18,484.50	$60,303.49	$19,484.30
Upgrades/ Improvements	$40,237.31	$17,430.92	$27,587.40	$11,104.47
Insurance/ Vessel Fees	$64,651.53	$14,284.67	$39,741.30	$7,598.91
Vessel Level Business expense	$82,170.84	$20,583.00	$49,334.19	$18,367.49
Vessel/ Permit Value	$3,433,449.08	$823,422.86	$622,466.89	$332,994.11
Captain/ Crew Share	$564,091.46	$145,895.71	$195,015.94	$47,094.38
Total Fixed Costs:	$4,278,761.92	$802,490.33	$992,339.26	$432,470.29
Variable (Trip) Costs:	$14,337.00 (10,590)		$10,396.00 (8,253)	

Table S14. Average fixed and variable costs for multi-day commercial fishing trip. Average fixed cost estimates from 2011, 2012, and 2015 provided from Ardini et al., 2022 and variable cost data provided from Werner et. al., 2020. Fixed cost estimates in 2015 dollars and variable cost estimates in 2010 dollars.

	Large Dredge	Small Dredge	Large Trawl	Small Trawl
Fixed Costs:				
Repair and Maintenance	$96,034.74	$18,484.50	$60,303.49	$19,484.30
Upgrades/ Improvements	$40,237.31	$17,430.92	$27,587.40	$11,104.47
Insurance/ Vessel Fees	$64,651.53	$14,284.67	$39,741.30	$7,598.91
Vessel Level Business Expense	$82,170.84	$20,583.00	$49,334.19	$18,367.49
Vessel/ Permit Value	$3,433,449.08	$823,422.86	$622,466.89	$332,994.11
Captain/ Crew Share	$564,091.46	$145,895.71	$195,015.94	$47,094.38
Total Fixed Costs:	$4,278,761.92	$802,490.33	$992,339.26	$432,470.29
Variable (Trip) Costs:				
OLS Predicted	$9,606.66		$6,920.84	
WOLS Predicted	$9,870.62		$6,968.37	
Heckman Predicted	$9,522.85		$7,102.77	

Table S15. Average fixed costs, sd, and sample size by cost category for large and small dredge from 2011, 2012, and 2015. Data provided from Ardini et al., 2022.

	Large Dredge			Small Dredge		
	Average Cost	n	sd	Average Cost	n	sd
2011						
Repair and Maintenance	$120,621.00	2	86,237.00	$22,497.00	9	13,361.00
Upgrades/ Improvements	$45,509.00	2	48,633.00	$18,453.00	7	30,341.00
Insurance / Vessel Fees	$67,815.00	2	34,238.00	$13,290.00	9	13,130.00
Captain/ Crew Share	$587,009.00	2	360,888.00	$209,463.00	8	282,944.00
Vessel Level Business	$118,696.00	2	87,955.00	$15,919.00	9	12,964.00
Vessel/ Permit Value	$3,293,545.00	2	1,879,524.0	$924,852.00	1	12,727,813.0
Total Fixed Costs:	$4,233,195.00			$1,204,474.0		
2012						
Repair and Maintenance	$56,962.00	11	38,772.00	$22,812.00	4	8,604.00
Upgrades/ Improvements	$24,705.00	9	23,868.00	*	*	*
Insurance / Vessel Fees	$62,509.00	11	23,276.00	$20,886.00	4	16,876.00
Captain/ Crew Share	$476,557.00	11	362,106.00	$148,022.00	4	185,093.00
Vessel Level Business	$21,101.00	9	40,936.00	*	*	*
Vessel/ Permit Value	$3,225,662.00	1	1,905,493.0	$569,850.00	4	$573,110.00
Total Fixed Costs:	$3,867,496.00			$761,570.00		
2015						
Repair and Maintenance	$83,676.00	7	63,765.00	$7,800.00	5	8,672.00
Upgrades/improvements	$45,000.00	5	24,341.00	$16,000.00	5	24,341.00
Insurance / Vessel Fees	$58,076.00	7	12,461.00	$10,794.00	5	3,655.00
Captain/ Crew Share	$632,893.00	7	284,374.00	$42,487.00	5	53,674.00
Vessel Level Business	$39,850.00	6	37,123.00	$34,575.00	3	45,409.00
Vessel/ Permit Value	$4,150,000.00	7	3,741,546.0	*	*	*
Total Fixed Costs:	$5,009,495.00			$111,656.00		

Table S16. Average fixed costs, sd, and sample size by cost category for large and small trawl from 2011, 2012, and 2015. Data provided from Ardini et al., 2022.

	Large Trawl			Small Trawl		
	Average Cost	n	sd	Average	n	sd
2011						
Repair and Maintenance	$72,877.00	3	55,496	$21,275.00	27	18,834.00
Upgrades/ Improvements	$29,094.00	2	43,388.00	$10,008.00	26	15,324.00
Insurance/ Vessel Fees	$43,175.00	2	29,144.00	$7,647.00	26	5,574.00
Vessel Level Business	$56,149.00	2	48,611.00	$16,341.00	25	14,484.00
Vessel/ Permit Value	$672,652.00	3	423,187.00	$364,827.00	27	212,977.00
Captain/ Crew Share	$236,609.00	2	205,637.00	$54,768.00	22	56,483.00
Total Fixed Costs:	$1,110,556.00			$474,866.00		
2012						
Repair and Maintenance	$47,440.00	2	34,182.00	$11,900.00	12	12,806.00
Upgrades/ Improvements	$26,841.00	1	30,291.00	$13,208.00	12	19,954.00
Insurance/ Vessel Fees	$40,179.00	2	18,473.00	$7,382.00	12	7,087.00
Vessel Level Business	$42,889.00	1	32,628.00	$33,167.00	9	39,954.00
Vessel/ Permit Value	$611,508.00	1	328,350.00	$308,451.00	12	429,204.00
Captain/ Crew Share	$164,631.00	2	125,710.00	$32,301.00	12	42,428.00
Total Fixed Costs:	$933,488.00			$406,409.00		
2015						
Repair and Maintenance	$20,325.00	3	9,908.00	$25,579.00	7	30,263.00
Upgrades/ Improvements	$20,590.00	4	10,730.00	$11,571.00	7	14,570.00
Insurance/ Vessel Fees	$18,075.00	5	14,772.00	$7,768.00	8	6,707.00
Vessel Level Business	$33,011.00	5	23,046.00	$6,577.00	7	11,156.00
Vessel/ Permit Value	$363,000.00	5	84,971.00	$220,000.00	5	135,093.00
Captain/ Crew Share	$75,316.00	5	34,775.00	$48,182.00	8	43,329.00
Total Fixed Costs:	$530,317.00			$319,677.00		

Table S17. Average single day, multi-day trip, and all trips cost and standard deviation for trawl and dredge commercial fisheries, 2005 to 2012. Data provided by Das, 2013.

	Type of Trip	Average Cost	sd
Trawl	All Trips	$5,117.00	7554
	Single Day Trip	$407.00	379
	Multi-day Trip	$10,396.00	8253
Dredge	All Trips	$12,011.00	10,946
	Single Day Trip	$583.00	567
	Multi-day Trip	$14,337.00	10,590

Table S18. Average trip cost estimates using unweighted/ weighted regression as well as Heckman sample selection models for single day and multi-day trawl and dredge commercial fishing trip. Data provided by Werner et al., 2020.

		OLS Prediction	WOLS Prediction	Heckman Predicted
Trawl	Day Trip	$418.84	$409.96	$949.94
	Multi-day Trip	$6,920.84	$6,986.37	$7,102.77
Dredg	Day Trip	$788.02	$1,107.78	$862.09
	Multi-day Trip	$9,606.66	$9,870.62	$9,522.85

Fishery Specific Tables:

Table S19. Comparison of annual vessel cost estimates from a 2011 NEFSC cost survey (n = 7 respondents) with estimates from the economic parameterization for vessels in the Spatially Explicit Fishery Economics Simulator (*SEFES*) model and annual fishing activity calculated from vessel trip reports (number of trips, steam time, fishing time, catch; n=6,830 trip observations 2015-2019 for 33 vessels). The 2011 NEFSC cost survey was distributed to all commercial vessels targeting federally managed species in the northeast U.S. Estimates provided here are for those vessels that indicated surf clam or ocean quahog were their highest grossing species. Calculation of insurance costs in the SEFES parameterization relied on crew sizes provided by industry advisors in addition to vessel trip report data. Estimates 1366 surf clam trips per year. Data provided from Scheld et al., 2022.

Source:	2011 NEFSC cost survey	SEFES (n=33
Maintenance & Repair (Fixed)	$47,500.00	$214,000.00
Fishing Related Business	$334,143.00	$391,933.00
Other (Fixed)	$209,785.00	
Trip Costs (Variable)	$479,046.00	$247,027.00
Total Costs:	$1,070,474.00	$852,960.00

Table S20. Number of vessels, hours flushed, and estimated number of trips 2012 to 2015 for the surf clam fishery. Hours fished per year is provided from MAFMC surf clam fishery update 2018, number of vessels per year is provided from MAMFC Atlantic surf clam fishery information document. The number of trips per year was estimated by dividing hours fished per year by an average trip duration of ~38 hours determined by Munroe et al., 2022. The average trips to year based on this estimate is 1318 trips per year.

Year	2012	2015	2016	2017	2021
Trips per Year -	~1147	~1352	~1542	~1542	~1010
Number of Vessels	42	37	38	40	41
Hours Fished per Year	43606	51397	58601	58612	38414

Table S21. Average cost for the trawl fleet using cost shares provided for longfin squid vessels (n = 12). Costs were provided as percentages in Scheld, 2020 and were converted to average costs by multiplying the revenue share by total revenue of the trawl fleet (i.e., $31 million). In calculating averages, data was weighted assuming 50% of landings were fresh (n = 9), 50% of landings were frozen (n = 5), 75% of landings were by independent vessels (n = 3), and 25% of landings were by processor owned vessels (n = 9). Standard deviations in parentheses. Per vessel costs were determined by dividing the average cost by 48.7 because according to Scheld, 2020, there are 97.4 vessels in the fleet that make up approximately 50 percent of income from squid which gives the per vessel cost. There are 500 estimated trips per year.

	Average Cost	sd	Per Vessel Cost
Equipment Purchase			
Electronics	$41,431.00	(130667)	$850.7
Fishing nets	$47,805.00	(101984)	$981.6
Fishing tackle, reels, other gear	$331,448.00	(302765)	$6,805.9
Safety equipment	$15,935.00	(22309)	$327.2
Miscellaneous hardware	$685,205.00	(356944)	$14,069.9
Equipment repair & maintenance			
Electronics	$28,683.00	(63740)	$589.0
Fishing gear, nets	$761,693.00	(334635)	$15,640.5
Vessel & engine	$2,269,144.00	(936978)	$46,594.3
Trip (Variable) expenses			
Bait	$0.00	(0)	$0.0
Fuel & lubricants	$4,576,532.00	(914669)	$93,974.0
Groceries, food, & supplies	$286,830.00	(525855)	$5,889.7
Ice	$401,562.00	(315513)	$8,245.6
Offloading/non-crew labor costs	$379,253.00	(143415)	$7,787.5
Packaging and other materials	$1,131,385.00	(627839)	$23,231.7
Fixed and general expenses			
Accounting	$363,318.00	(114732)	$7,460.3
Bank fees and services	$66,927.00	(213529)	$1,374.3
Capital expenditures (boats)	$522,668.00	(1109076)	$10,732.4
Communications	$175,285.00	(73301)	$3,599.3
Dues/Association Fees	$35,057.00	(57366)	$719.9
Insurance	$1,654,053.00	(372879)	$33,964.1
Licenses, permits	$54,179.00	(66927)	$1,112.5
Monitoring/enforcement	$22,309.00	(66927)	$458.1
Moorage	$127,480.00	(111545)	$2,617.7
Real estate	$0.00	(0)	$0.0
Taxes	$57,366.00	(165724)	$1,177.9
Travel	$31,870.00	(28683)	$654.4
Trucking/shipping	$6,374.00	(19122)	$130.9
Utilities: electricity	$25,496.00	(38244)	$523.5
Utilities: natural gas	$0.00	(0)	$0.0
Utilities: propane	$0.00	(0)	$0.0
Utilities: waste & sewer	$0.00	(0)	$0.0
Utilities: water	$0.00	(0)	$0.0
Vehicle costs	$22,309.00	(28683)	$458.1
Other expenses	$433,432.00	(1169629)	$8,900.0
Crew & captain shares	$17,072,759.00	(2928853)	$350,570.0

Profit	$242,212.00	(1529760)	$4,973.6
Total	$31,870,000.00		$654,414.8

Table S22. Per day trip cost, owner share, crew share, number of trips, average trip duration, and duration standard deviation for groundfish trips of four trawl vessel size category (less than 30 feet, 30 to 50 feet, 50 to 75 feet, and larger than 75 feet), 2009 to 2012 for the groundfish fleet. Provided from Murphy et al., 2014, 2012 final report on the performance of the northeast multispecies (groundfish) fishery (May 2012-April 2013).

	< 30 Feet	30 to 50	50 to 75	> 75 Feet
2009				
Per Day Trip Cost	$685.00	$709.00	$1,160.00	$1,791.00
Owner Share per Day	$1,073.00	$3,240.00	$3,574.00	$2,260.00
Crew Share per Day	$478.00	$1,062.00	$1,069.00	$347.00
Number of Trips	435	19193	4957	1312
Average Trip Duration	0.38	0.47	1.7	5.49
Duration sd	(0.18)	(0.56)	(2.29)	(3.06)
2010				
Per Day Trip Cost	$716.00	$1,420.00	$2,249.00	$4,085.00
Owner Share per Day	$1,408.00	$3,714.00	$3,597.00	$2,583.00
Crew Share per Day	$592.00	$1,167.00	$978.00	$355.00
Number of Trips	136	9263	2838	1237
Average Trip Duration	0.45	0.58	2.05	5.75
Duration sd	(0.13)	(0.66)	(2.45)	(2.79)
2011				
Per Day Trip Cost	$794.00	$1,239.00	$2,265.00	$4,595.00
Owner Share per Day	$939.00	$3,508.00	$3,197.00	$2,368.00
Crew Share per Day	$439.00	$1,056.00	$861.00	$273.00
Number of Trips	275	11122	3381	1180
Average Trip Duration	0.37	0.59	2.05	6.63
Duration sd	(0.12)	(0.72)	(2.48)	(2.86)
2012				
Per Day Trip Cost	$773.00	$2,000.00	$3,240.00	$4,614.00
Owner Share per Day	$2,504.00	$4,442.00	$6,460.00	$1,718.00
Crew Share per Day	$604.00	$1,549.00	$907.00	$163.00
Number of Trips	192	9745	3416	1143
Average Trip Duration	0.39	0.61	1.91	6.44
Duration sd	(0.14)	(0.75)	(2.34)	(2.82)

Table S23. Groundfish trawl fixed costs estimates from interviews with vessel owners to assess the uncertainty in trip and overhead costs. Data provided from Georgianna et al., 2011, Breakeven Analysis New England Groundfish Fishery for FY2009 and FY2010.

Cost Category	< 50 Feet	50 – 75 Feet	> 75 Feet
Repair and Maintenance	$2000.00- $3500.00	$400.00 - $33,656.00	$16,000.00 -
Insurance	$0.00 - $10,000.00	$5000.00 - $14,365.00	$40,000.00 -
Improvements/Investments	$4,900.00 -	$700.00 - $25,000.00	$18,000.00 -
Non-Crew Labor Services	$0	$0 - $9,150.00	$0 - $20,000.00
Association Fees	$0 - $300.00	$0- $3,000.00	$0 – $2,400.00
Hull/Vessel Insurance	$0 - $10,000.00	$5,000.00 -	$40,000.00 -
Interest Payments on Loans	$0 - $790.00	$2,500.00 -	$0 - $124,176.00
Mooring/Dockage Fees	$2,000.00 -	$1,000.00 -	$1,500.00 - $17.000.00
Permit/Licensing Fees	$410.00 - $750.00	$450.00 - $500.00	$500.00 - $2,000.00
Professional Fees	$900.00 - $8,500.00	$700.00 - $3,600.00	$5,000.00 - $11,500.00
Business Taxes	$0 - $7,500.00	$344.13 - $12,753.00	$500.00 - $1,100.00
Business Travel	$0 - $500.00	$0 - $1,500.00	$1,500.00 - $14,000.00
Business Vehicle	$3,500.00 - $4,000.00	$0 - $7,800.00	$0 - $4,000.00
Communications	$1,400.00 - $1,750.00	$1,964.83 - $4,241.00	$1,500.00 - $6,000.00
Safety Equipment	$600.00 - $3,600.00	$336.45 - $1,800.00	$500.00 - $2,000.00
Haul Out Cost	$3,600.00 - $6,00.00	$2,500.00 -	$2,500.00 - $10,000.00

Table S24. Information on trip costs, revenue, number and duration of trips from Data provided from Georgianna et al., 2011, Breakeven Analysis New England Groundfish Fishery for FY2009 and FY2010. Average trip costs were estimated from 2008 to 2011 observed trip data. Trip costs include gallons of fuel used, fuel price, use and price of ice, as well as the total costs of food, oil, water, bait, and general supplies purchased for the trip. Trip costs for multi-day trips were converted to a cost per day by dividing total trip costs by the trip duration. Costs are in 2009 dollars.

Vessel Size	< 50 Feet	50 – 65 Feet	> 65 Feet
Total Groundfish Revenue	$77,329.00	$199,838.00	$584,720.00
Average Total Day Trip Cost	$258.60	$323.80	$373.80
Average Total Multi-Day Trip Cost	$297.10	$861.70	$1,386.90
Sector Fees ($0.04/ lb)	$1,388.00	$4,227.00	$14,329.00
Average Number of Groundfish	20.8	$21.30	$18.70
Average Total Trips	72.4	87.7	40.8
Total Multiday trips (2010)	171	425	1753
Average Multiday Trip Duration	3	4	6