Save the East Coast – NJ

July 24, 2025

VIA CERTIFIED MAIL AND ELECTRONIC SUBMISSION

TIME-SENSITIVE EMERGENCY PETITION TO REVOKE EMPIRE WIND LETTER OF AUTHORIZATION

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RE: Emergency Petition to Revoke Empire Wind Letter of Authorization

Dear Director Damon-Randall:

Pursuant to the Administrative Procedures Act (APA), 5 U.S.C. § 553(e), *"(e) Each agency shall give an interested person the right to petition for the issuance, amendment, or repeal of a,"* Save the East Coast Inc. respectfully requests that NOAA exercise its authority to revoke the Empire Wind Letter of Authorization ("LOA"), by way of the emergency authority delineated at 50 C.F.R. § 216.106(f). The agency regulations at 50 C.F.R. § 216.106(f) provide in pertinent part, *"The requirement for notice and opportunity for public review in § 216.106(e) shall not apply if the Assistant Administrator determines that an emergency exists that poses a significant risk to the wellbeing of the species or stocks of marine mammals concerned."* If NOAA declines to exercise its emergency authority (which is indeed very much warranted, as explicated infra), then Save the East Coast Inc. requests, in the alternative, that NOAA exercise its authority pursuant to 50 C.F.R. § 216.106(e) to withdraw or suspend the Empire Wind LOA. The substantive justification for the alternative request is contravention of 50 C.F.R. § 216.106(e)(2), namely, *"the taking allowed is having, or may have,* more than a negligible impact on the species or stock or, where relevant, an unmitigable adverse impact on the availability of the species or stock for subsistence uses."

As such, 5 U.S.C. § 553(e) provides the procedural right for this Petition, and 50 C.F.R. § 216.106(f) and (e) provide the substantiative authority for revocation of both LOAs. Finally, if NOAA declines to invoke its emergency authority (50 C.F.R. § 216.106(f)), Save the East Coast Inc. requests that NOAA publish this petition in the Federal Register and solicit public comment pursuant to 50 C.F.R. § 216.106(e), as a prerequisite to exercising its non-emergency withdrawal authority. It further requests that NOAA publish a written determination in the Federal Register in response to this petition, as required under 5 U.S.C. § 555(e). Save the East Coast Inc. reserves the right to pursue relief under the Administrative Procedure Act, including 5 U.S.C. § 555(b) and § 706(1), should NOAA fail to act on this petition within a reasonable time. We respectfully request NOAA to provide a substantive written determination responding to this petition no later than 60 days from receipt.

Given the critically endangered status of the North Atlantic right whale—currently numbering fewer than 372 individuals—it is imperative to recognize that delays or inaction in addressing the impacts of offshore wind activities pose immediate, severe, and irreversible consequences for this species. Each additional whale mortality represents a significant, potentially irreversible loss to the genetic diversity and viability of this fragile population, necessitating swift and decisive regulatory action.

<u>Substantive Justification for LOA Revocation Under 50 C.F.R. § 216.106(f) or (e)(2)</u>

[1] North Atlantic Right Whale is Subject to Unnecessarily and Illegally Large Amount of Takes, in concert with other LOAs within the NARW critical migration route

While NOAA has previously attributed increased whale mortality primarily to vessel strikes and has consistently relied upon the findings of Thorne and Wiley (2024) to support these conclusions, our analysis clearly demonstrates fundamental methodological flaws in their approach. Specifically, their reliance on indirect proxies such as Twenty-foot Equivalent Units (TEUs) and Incidental Harassment Authorizations (IHAs) fails to accurately capture the true drivers of whale mortality. Our rigorous statistical and acoustic evidence unequivocally demonstrates that offshore wind activities, not general vessel traffic, are the primary cause of recent whale deaths.

The Empire Wind LOA[1] indicates that the North Atlantic Right Whale ("NARW") will be subject to 13 Level B harassment takes annually, and 29 Level B harassment takes over the 5-year period of the project's construction (February 22, 2024 and expiring after February 21, 2029). However, it's integral to account for all contemporaneously operating offshore wind projects within the critical migration route of the NARW, so as to most accurately assess the synergistic, cumulative effect. The Sunrise Wind LOA[2] sanctions 32 Level B harassment takes of the NARW annually and 45 Level B harassment takes over the 5-year project construction life (June 21, 2024—June 20, 2029). And the Revolution Wind LOA[3] sanctions 44 Level B harassment takes annually and 56 Level B harassment takes over the 5-year period

[1] https://www.fisheries.noaa.gov/s3/2024-02/EmpireWind-2024LOA-OPR1.pdf

[2] https://www.fisheries.noaa.gov/action/incidental-take-authorization-sunrise-wind-llc-construction-and-operation-sunrise-wind

[3] https://www.fisheries.noaa.gov/s3/2023-11/BL52-Revolution-Wind-LOA-OPR1-Final-signed-OPR1.pdf

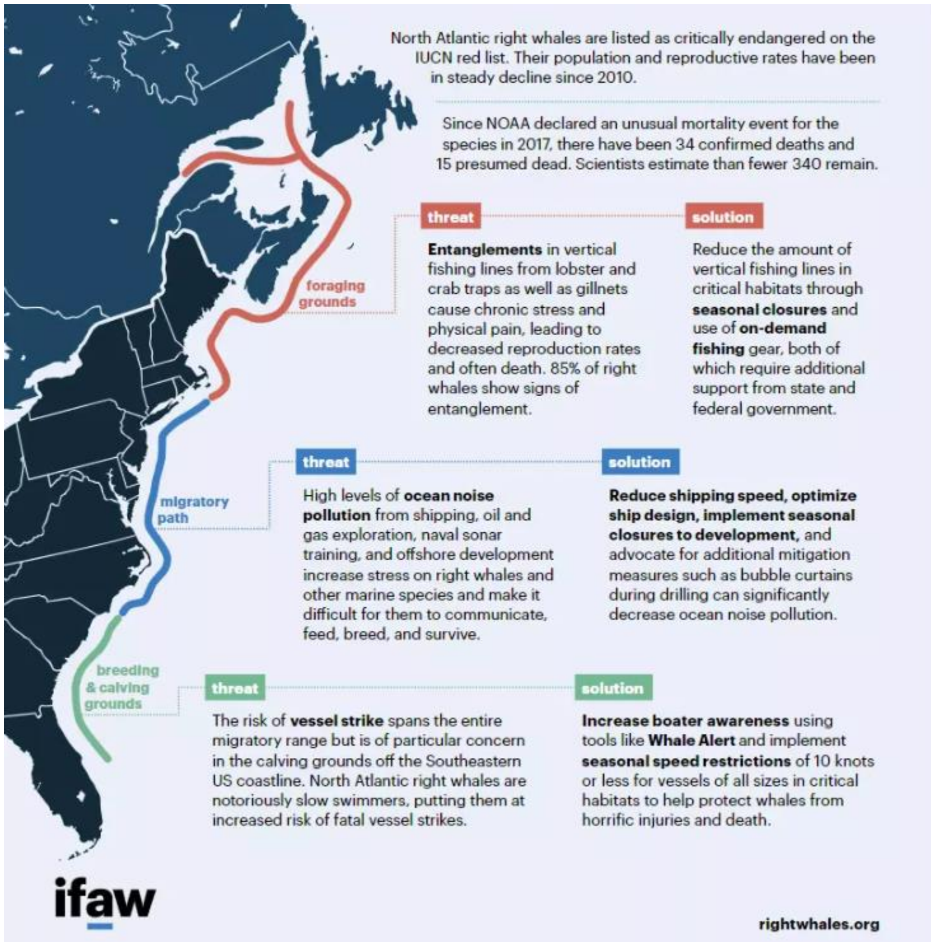
the project's construction (November 20, 2023 and expiring after November 19, 2028). New England Wind's LOA is authorized for March 27, 2025 through March 26, 2030.[4] It requests the Level B taking of 60 NARW annually and 126 NARW over the 5-year period. US Wind's LOA[5] is operational from January 1, 2025 through December 31, 2029, requesting 4 Level B takes of NARW annually and 10 over 5-years. The Coastal Virginia Offshore Wind Commercial Project[6] east of Virginia, operational February 5, 2024 until February 4, 2029, authorizes 7 NARW Level B takes annually and 17 over the 5-year period.

It is incontrovertible that the North Atlantic Right Whale critical migration route includes all of the aforementioned projects:

[4] https://www.fisheries.noaa.gov/s3/2024-07/MAAvangrid-2024LOA-LOA-OPR1.pdf

[5] https://www.fisheries.noaa.gov/s3/2024-12/MDWind-2024LOA-LOA-OPR1.pdf

[6] https://www.fisheries.noaa.gov/s3/2024-02/CVOWC-OWF-IssuedLOA-OPR1.pdf

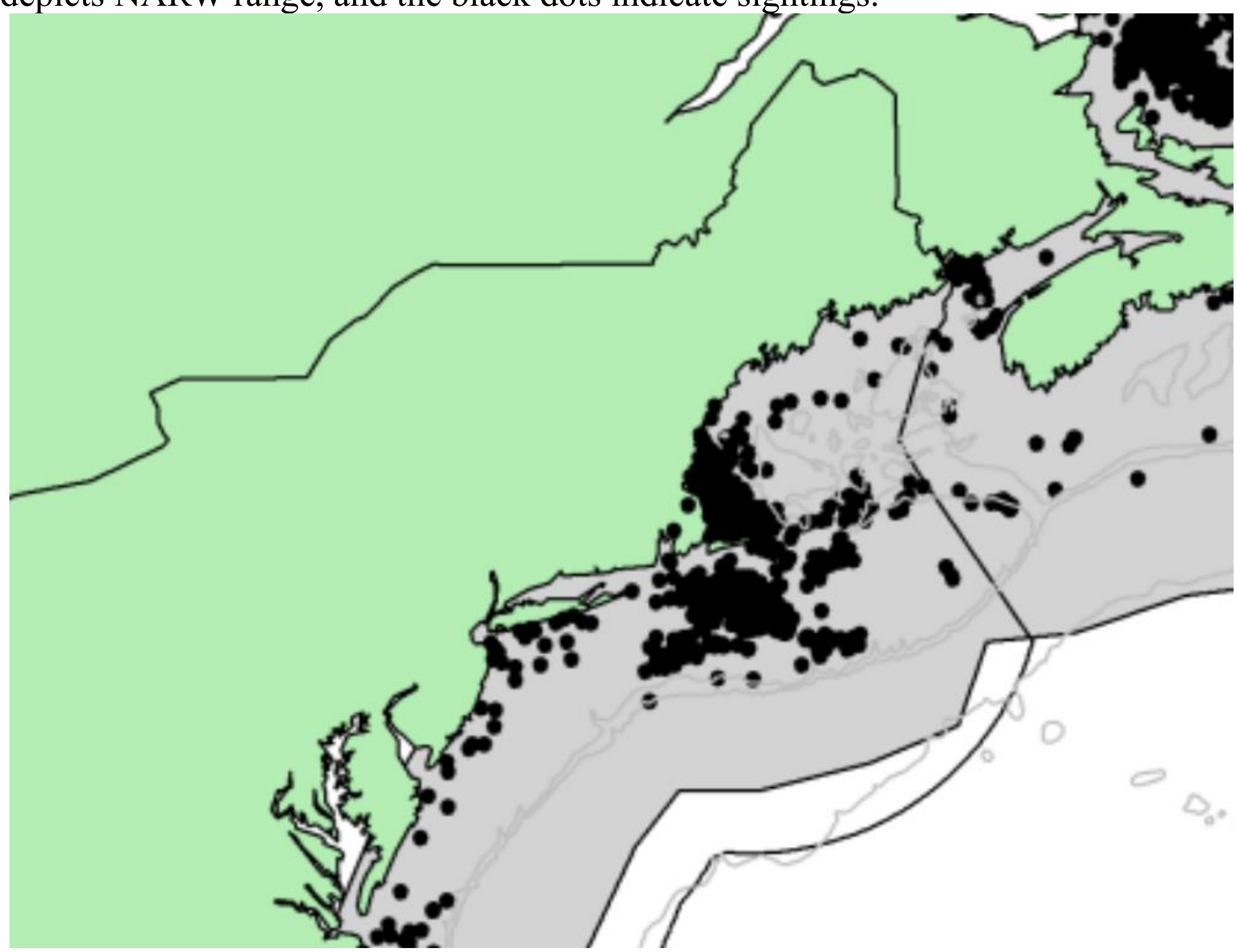


As such, there is a contemporaneous or near contemporaneous overlap of 6 discrete offshore wind projects, authorized to construct at the same time:

- Empire Wind: February 22, 2024 and expiring after February 21, 2029.
- Sunrise Wind: June 21, 2024—June 20, 2029
- Revolution Wind: November 20, 2023 and expiring after November 19, 2028
- New England Wind: March 27, 2025 through March 26, 2030
- US Wind: January 1, 2025 through December 31, 2029
- Coastal Virginia Offshore Wind Commercial Project: February 5, 2024 until February 4, 2029

From 2025 through 2028, all 6 projects are scheduled to construct contemporaneously within the critical migration route of the critically endangered NARW, which has a population number now 372 or less. The total annualized requested NARW take for all 6 projects is 160 (13+32+44+60+4+7 for all 6 projects), and 283 over the total 5-year lifespans of all 6 projects (29+45+56+126+10+17). This translates to an annual Level B taking of the NARW of 160/372 or 43% of that critically endangered whale's population, and 76% of its population cumulatively over the 6 projects' construction periods. **Both of these values constitute egregious violations of the MMPA small numbers provision.**

The NARW does not adhere to arbitrarily established human boundaries, namely, those created by demarcations between offshore wind projects like Revolution Wind, New England Wind, and Sunrise Wind. Rather, all of these projects are squarely within a high-density NARW region. See the map, derived from NOAA Stock Report,[7] depicting NARW sightings and range. The gray shaded zone depicts NARW range, and the black dots indicate sightings.



[7] https://www.fisheries.noaa.gov/s3/2024-12/2023-sar-narw.pdf

Note the following critical points regarding NARW habitat pertinent here.

- "The western North Atlantic right whale population ranges primarily from calving grounds in coastal waters of the southeastern U.S. to feeding grounds in New England waters [emphasis added]."[8]

- "[P]assive acoustic studies have demonstrated year-round presence of right whales on the Scotian Shelf (DuretteMorin et al. 2022), in the Gulf of Maine (Morano et al. 2012; Bort et al. 2015), and off southern New England (Estabrook et al. 2022) [emphasis added]."[9]

-"New England and Canadian waters are important feeding habitats for right whales, where they feed primarily on copepods (largely of the genera Calanus and Pseudocalanus). Right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990, Sorochan et al. 2021). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al. 1986, 1995) [emphasis added]."[10]

-Notwithstanding any marginal spatial delta between the three offshore wind projects, it is essential to underscore that the NARW can swim as much as 60 miles in a given day,[11] and as such, it is quite facile for a single NARW to swim across the entire tri-project area in a day.

As such, given the NARW density and presence in the critical migration route which includes all of the aforesaid 6 projects, it is incumbent upon NOAA to undertake a cumulative assessment of the "small numbers" MMPA impact to the NARW. These 6 projects are scheduled to construct contemporaneously as noted, with a directly overlapping period of 4 years.

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[8] Id.
[9] Id.

[10] Id.

[11] https://www.whoi.edu/cms/files/cjfas66_1399_59385.pdf

Given that the status and survivability of a critically endangered marine mammal, the NARW, is at stake, it is incumbent upon NOAA to invoke the emergency regulations of **50 C.F.R. § 216.106(f) (or alternatively, (e)(2))** to abrogate the Empire Wind LOA forthwith. If both of these projects are permitted to proceed, irreparable harm will very likely befall the NARW as these projects will be constructed within critical habitat, critical migration route, and feeding grounds of the NARW.

[2] NOAA Significantly Underestimates the Quantity of Level B takes of the North Atlantic Right Whale in connection with Empire Wind and the other projects, thus further violating the MMPA

The most significant amount of take attributable to the Project will occur as a result of the installation of the foundations for the turbines and substations by impact pile driving. In quantifying the impacts of these activities on marine mammal behavior, NMFS relies on its historic take threshold criterion for impulsive or intermittent sources: a single, bright-line, sound pressure-based threshold for harm of 160 dB, see 87 Fed. Reg. at 79,110, below which it assumes that no animal would experience a "potential . . . disruption of behavioral patterns," 16 U.S.C. § 1362(18)(A)(ii). However, this approach is arbitrary in several respects.

First, the 160 dB threshold for behavioral, sublethal take does not reflect the best available science. Indeed, leading biologists and bioacousticians, including those whose work the agency frequently cites, have criticized the threshold as "overly simplified, scientifically outdated, and artificially rigid," and explained that the use of such a threshold to "predict potential impacts of discrete events . . . is of great concern." Christopher W. Clark et al., *Comments on Arctic Ocean Draft EIS* at 2 (Feb. 28, 2012), *available at* https://tinyurl.com/5fsfmwst.

The 160 dB threshold is purportedly based on a 1999 report from the High Energy Seismic Survey, and is based upon data gathered during seismic surveys in the 1980s. *See id.*; 77 Fed. Reg. 27222 (May 11, 2012) (citing the origin of the 160 dB threshold as a pair of studies on migrating grey and bowhead whales from the mid-1980s). However, improved technology, data collection methods, and other advancements in biology and acoustics have since demonstrated that behavioral disruptions from pulsed sources—and thus, "take"—can occur well below the 160 dB threshold. *See* Christopher W. Clark et al., *Comments on Arctic Ocean Draft EIS*, *supra*. As has been repeatedly explained to the agency, "[t]he working assumption that impulsive noise never disrupts marine mammal behavior at levels below 160 dB (RMS), and disrupts behavior with 100% probability at higher levels has been repeatedly demonstrated to be incorrect." *Id.* NMFS's continued adherence to this threshold both ignores the best available science and results in an underestimation of individuals that could potentially be subjected to take as a result of proposed activities. As a result, any determination that relies on this threshold is arbitrary and capricious. *See Sierra Club*, 671 F.3d at 965–66 (9th Cir. 2012) (overturning as arbitrary and capricious agency's action where it failed to consider newer "data [that] told a different story than . . . earlier data" that the agency had actually relied upon, and where the agency had failed to provide an adequate explanation for its reliance on outdated data).

Indeed, scientific research demonstrates that a **more realistic and supportable quantifiable threshold for Level B harassment is 120 dB, not the 160 dB propounded by the NFMS.**

For example, the Marine Mammal Commission has advanced a similar proposition regarding 120 dB as the more scientifically reasonable threshold, i.e., in their letter of 2019 regarding letter of authorization applications submitted by the Southeast Fisheries Science Center (SEFSC) and Texas Parks and Wildlife Department (TPWD).[12] The content of its letter is very much applicable here:

> "The Commission continues to believe that NMFS is using an outdated and incorrect behavior threshold for echosounders, other sonars, and subbottom profilers. A decade ago, NMFS categorized sound sources as either

[12] https://www.mmc.gov/wp-content/uploads/19-03-19-Harrison-SEFSC-TPWD-PR.pdf

impulsive or continuous when determining its generic thresholds for Level B harassment based on behavioral disturbance (160 vs 120 dB re 1 μPa, respectively; 70 Fed. Reg. 1871). Since that time, the U.S. Navy (the Navy) has twice updated the criteria and thresholds5 it uses for non-impulsive, acoustic sources (i.e., sonar and other acoustic sources) and impulsive6 explosive sources (i.e., underwater detonations; see Finneran and Jenkins (2012) and Department of the Navy (2017) for the Navy's current criteria and thresholds). NMFS instructs applicants who plan to use underwater detonations during their proposed activities to utilize the Navy's current criteria and thresholds for explosives. However, for non-impulsive, acoustic sources, NMFS continues to rely on the generic thresholds from the 2005 guidance, which do not reflect the best available science."[13]

"As discussed in previous letters to NMFS regarding echosounders, other sonars, and subbottom profilers, those sources have temporal and spectral characteristics which suggest that a lower, **more precautionary Level B harassment threshold of 120 dB re 1 μPa would be more appropriate than the 160-dB re 1 μPa threshold that continues to be used**. Numerous researchers[14] have observed various species of marine mammals, including the same species that could be harassed by SEFSC, responding to sound from sources (e.g., acoustic deterrent

[13] Id.

[14] See Watkins and Schevill 1975, Olesiuk et al. 1995, Kastelein et al. 1997, Kastelein et al. 2000, Kastelein et al. 2001, Morton 2000, Culik et al. 2001, Johnston 2002, Morton and Symonds 2002, Kastelein et al. 2005, Barlow and Cameron 2003, Kastelein et al. 2006a and b, Carretta et al. 2008, Carlström et al. 2009, Götz and Janik 2010, Lurton and DeRuiter 2011, Brandt et al. 2012 and 2013, Götz and Janik 2013, Hastie et al. 2014, Kastelein et al. 2015a and b, Tougaard et al. 2015.

> devices, acoustic harassment devices, pingers, echosounders, multibeam sonars) with characteristics similar to those used by SEFSC at received levels below 160 dB re 1 μPa. Specifically, harbor porpoises and beaked whales respond at some of the lowest source levels (Culik et al. 2001, Kastelein et al. 2001, Carlstöm et al. 2002, Barlow and Cameron 2003, Caretta et al. 2008)."

The Commission cites numerous studies further demonstrating harassment below the 160 dB magnitude. For example:

--Watkins and Schevill 1975,

-- Olesiuk et al. 1995,

-- Kastelein et al. 1997,

-- Kastelein et al. 2000,

-- Kastelein et al. 2001,

-- Morton 2000,

-- Culik et al. 2001,

-- Johnston 2002,

-- Morton and Symonds 2002,

-- Kastelein et al. 2005,

-- Barlow and Cameron 2003,

-- Kastelein et al. 2006a and b,

-- Carretta et al. 2008,

-- Carlström et al. 2009,

-- Götz and Janik 2010,

-- Lurton and DeRuiter 2011,

-- Brandt et al. 2012 and 2013,

-- Götz and Janik 2013,

-- Hastie et al. 2014,

-- Kastelein et al. 2015a and b,

--Tougaard et al. 2015.

The Commission's letter further explains that the Navy utilizes Level B behavioral harassment thresholds much lower than 160 Db. "The Navy already uses Level B behavioral harassment thresholds for non-impulsive, acoustic sources that are much lower than 160 dB re 1 µPa. In its Phase III documents, the Navy used unweighted thresholds of 120 dB re 1 µPa for harbor porpoises and a dose response function for beaked whales10 with a 50 percent probability of response at 144 dB re 1 µPa (Department of the Navy 2017)."[15] The Commission concludes:

> "As such, the facts provided **<u>continue to support using 120 rather than 160 dB re 1 µPa as the Level B harassment threshold.</u>** Therefore, for non-impulsive, acoustic sources (including echosounders, other sonars, and subbottom profilers) that NMFS plans to regulate and until such time that NMFS revises its generic Level B harassment thresholds for non-Navy-related acoustic sources, the Commission recommends that NMFS require SEFSC to **<u>estimate the numbers of marine mammals to be taken based on the 120- rather than the 160-dB re 1 µPa threshold</u>**. If NMFS again decides not to implement this recommendation, the Commission alternatively recommends that NMFS require SEFSC to estimate the numbers of marine mammal takes based on the non-impulsive, acoustic thresholds set forth in Department of the Navy (2017), including the Navy's unweighted 120-

[15] https://www.mmc.gov/wp-content/uploads/19-03-19-Harrison-SEFSC-TPWD-PR.pdf

> dB re 1 μPa threshold for harbor porpoises and the various biphasic dose response functions for the other marine mammal species. This approach is the same as NMFS has implemented for many years for thresholds involving explosives [emphasis added]."[16]

It follows that overestimation of the quantitative threshold over which marine mammals will experience behavior disruption will inescapably result in an underestimation of Level B harassment takes, which is indeed the case here.

Thus, the Level B harassment takes of the NARW are underestimated, and in fact, likely significantly underestimated, in view of the hereinabove information. Such underestimation results in even larger, more egregious MMPA violations.

Therefore, for those additional reasons, Save the East Coast respectfully requests that NOAA initiate abrogation of the Empire Wind LOA by way of the legal pathways cited above.

[3] NOAA Underestimates Level A and B Takes of the NARW and Other Marine Mammals, Rendering the Impact of Empire Wind's LOA and Related Projects Far from Negligible

Multiple rigorous statistical analyses conducted by Apostolos Gerasoulis, PhD, have thoroughly assessed the relationship between offshore wind (OSW) activities—particularly seismic surveys and pile-driving—and elevated mortality rates among North Atlantic right whales (NARWs) and humpback whales in the Central Region (NJ/NY Bight) and Central North Region (RI/MA below Cape Cod and eastern Long Island).

Utilizing the innovative and scientifically robust geospatial analysis tool LUNA, Dr. Gerasoulis demonstrated a clear and consistent correlation between OSW survey activities, including pile-driving, and whale strandings. Significantly, LUNA is the first analytical system to integrate detailed NOAA whale mortality data

[16] Id.

with Automatic Identification System (AIS) vessel traffic records, explicitly isolating OSW survey vessels from general shipping traffic. This groundbreaking methodology revealed statistically significant correlations between OSW survey activity and whale deaths across multiple temporal scales (monthly, bimonthly, and annually). In stark contrast, general maritime traffic exhibited no statistically significant correlation (see Exhibits B, C, D), thereby establishing a critical distinction and effectively refuting the conclusions drawn by Thorne and Wiley (2024). Specifically, this refutes Thorne and Wiley's assertion that increased whale mortalities are primarily attributable to general vessel traffic rather than offshore wind activities (see Exhibit A).

Moreover, employing the North Region above Cape cod as a scientifically rigorous control group—largely devoid of OSW activities—further validated the causal inference drawn. Data spanning 2006–2024 showed stable whale mortality rates in this control region, distinctly contrasting with the pronounced increase in whale mortalities in the Central Region, concurrent with intensified OSW activities (see Table 2 of Exhibit B attached).

NOAA explicitly reviewed and acknowledged Dr. Gerasoulis's analyses alongside Thorne and Wiley (2024) during its evaluation of the Vineyard Wind Phase 2 Biological Opinion. NOAA itself recognized the significance of this correlation, explicitly stating, "Offshore wind development has increased over the same time period, so the correlation was not surprising." However, despite this acknowledgment, NOAA continued to rely arbitrarily on the fundamentally flawed methodology of Thorne and Wiley. NOAA's approach disregards robust empirical evidence demonstrating that Level B behavioral disturbances from OSW activities are likely escalating into Level A injuries and fatalities. Moreover, NOAA's assumption of zero Level A harassment incidents significantly underestimates the actual risk, effectively ignoring clear scientific data indicating serious auditory and physiological harm resulting directly from OSW activities.

The current petition provides unequivocal evidence that OSW-related activities, particularly pile-driving, produce sound exposure levels significantly exceeding NOAA's established thresholds for Level A harassment, including Permanent Threshold Shift (PTS) and auditory trauma. NOAA itself acknowledges in the Vineyard Wind Phase 2 Biological Opinion that permanent auditory injuries from pile-driving noise are possible. Consequently, the documented increase in whale mortalities represents more than mere behavioral disruptions; they clearly constitute Level A harassment, justifying immediate revocation or suspension of the LOA.

Exhibit C demonstrates that pile-driving is approximately 3.2 times more harmful than sonar surveying, reinforcing the severity of these impacts. Independent acoustical measurements by Robert Rand align closely with these findings, recording peak sonar levels reaching up to 226 dB near OSW survey vessels, sufficient to cause rapid and permanent hearing damage in cetaceans (Rand, 2023a). Additionally, Rand provided clear acoustic evidence of significant risk and direct biological harm from pile-driving activities . Rand Acoustics (2024) independently measured underwater noise emissions from pile-driving near Vineyard Wind, southeast of Nantucket Island, documenting peak noise levels exceeding 180 dB at distances greater than 1 kilometer and RMS noise levels surpassing NOAA's behavioral harassment threshold (160 dB) at distances over 3 kilometers. Continuous noise from pile-driving also exceeded NOAA's thresholds for behavioral disturbances, highlighting compounded risks of impulsive and continuous noise exposure.

Critically, NOAA acknowledges in the Vineyard Wind Phase 2 Biological Opinion that pile-driving can cause auditory injuries, including temporary or permanent hearing threshold shifts (TTS or PTS), effectively deafening affected whales: "A small number of whales of other species may experience temporary to permanent hearing impairment as a result of the noise from pile-driving" (Sennott, 2024). These findings collectively underscore NOAA's significant underestimation of the acoustic hazards posed by pile driving.

Rand Acoustics emphasizes that regulatory reliance on the 90-percent RMS noise metric significantly underestimates the actual acoustic impact on cetacean species. The comprehensive combination of rigorous statistical analyses conducted by Dr. Gerasoulis using the LUNA system and detailed acoustic measurements by Robert Rand collectively present compelling empirical evidence. This evidence unequivocally demonstrates substantial risks of significant injury and mortality associated with OSW sonar surveys and pile-driving activities, clearly refuting

NOAA's assumptions of minimal or negligible Level A and B marine mammal takes.

Crucially, the unique strength of our petition lies in the integration of multiple independent lines of evidence: rigorous statistical analyses conducted using the scientifically validated geospatial tool LUNA, combined with direct acoustic measurements conducted by Robert Rand. This comprehensive approach far surpasses the methodological rigor of NOAA's current analyses, providing a highly reliable basis for concluding that offshore wind activities, particularly pile-driving, present significant and underestimated risks to whale populations. Therefore, given the compelling evidence of significant and immediate harm to marine mammals, Save the East Coast respectfully urges NOAA to immediately invoke its emergency authority pursuant to 50 C.F.R. § 216.106(f) to revoke the Empire Wind LOA. Alternatively, if NOAA declines to use its emergency authority, we request that it promptly exercise its non-emergency authority under 50 C.F.R. § 216.106(e) to withdraw or suspend the LOA, ensuring critical protection for the endangered North Atlantic right whale and other impacted marine mammals.

CONCLUSION

Therefore, for the foregoing reasons, Save the East Coast respectfully requests that NOAA take the following actions:

- Exercise its authority to repeal the Empire Wind Letter of Authorization ("LOA"), by way of the emergency authority delineated at 50 C.F.R. § 216.106(f). The standard of (f), "poses a significant risk to the wellbeing of the species or stocks of marine mammals concerned" is attained for the NARW, as explained above. Empire Wind pile driving/construction is already ongoing an active. 5 other projects have authorizations to construct contemporaneously within the critical migration route of the NARW, a critically endangered species. The evidence presented herein and appended hereto strongly demonstrates that takes will not be limited to Level B harassment, rather, substantial Level A injuries and deaths are likely to occur as well.

- In the alternative, if NOAA declines to exercise its emergency authority, then Save the East Coast requests that NOAA exercise its authority pursuant to 50 C.F.R. § 216.106(e) to withdraw or suspend the Empire Wind LOA.
- Save the East Coast requests that NOAA publish this petition in the Federal Register and solicit public comment pursuant to 50 C.F.R. § 216.106(e), as a prerequisite to exercising its non-emergency withdrawal authority.
- Pursuant to 5 U.S.C. § 553(e) and 5 U.S.C. § 555(e), publish a written determination responding to this Petition (failure to meaningfully consider this petition and issue a reasoned written determination may constitute agency action unlawfully withheld or unreasonably delayed pursuant to 5 USC § 706(1)).
- In addition to the immediate revocation or suspension of the Empire Wind LOA, we urge NOAA to implement specific interim protective measures without delay. These measures should include the expansion of marine mammal exclusion zones during pile-driving activities, mandatory real-time acoustic monitoring, and a temporary cessation of construction activities during peak migration periods.
- Save the East Coast reserves the right to pursue relief under the Administrative Procedure Act, including 5 U.S.C. § 555(b) and § 706(1), should NOAA fail to act on this petition within a reasonable time. We respectfully request NOAA to provide a substantive written determination responding to this petition no later than 60 days from receipt.

Thank you for your careful attention to this matter.

Respectfully submitted,

A Gerasoulis

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EXHIBIT A

Comment on Thorne and Wiley (2024): Methodological Limitations Increase the Risk of False Negatives in Assessing Whale Mortality Drivers

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Abstract:

Thorne and Wiley (2024) concluded offshore wind (OSW) activities are unrelated to increased whale mortalities along the U.S. East Coast, attributing deaths solely to vessel strikes from large ships. NOAA leveraged this conclusion to justify issuing numerous incidental harassment authorizations (IHAs). Our detailed review reveals critical methodological flaws, including reliance on indirect and inaccurate proxies such as **Twenty-foot Equivalent Units (TEUs), a measure of cargo volume**, and IHAs, insufficient statistical rigor, and questionable data selection. Employing LUNA, a high-resolution geospatial tracking tool, we demonstrate empirically that OSW survey activities—not general vessel traffic—strongly correlate with whale strandings. NOAA must urgently reconsider regulatory decisions based on Thorne and Wiley (2024).

Introduction:

Thorne and Wiley (2024) analyzed humpback whale strandings from 1995–2022, dismissing Offshore Wind (OSW) activities without rigorous statistical validation, attributing increased mortalities solely to vessel strikes. Had the authors extended their analysis to 2023, they would have recognized the error in their reliance on Twenty-foot Equivalent Units (TEUs) as a proxy. In 2023, TEU volumes in the NY/NJ region dropped by 20% from the previous year, yet whale deaths tripled, directly contradicting their conclusion. Furthermore, actual OSW survey vessel traffic tripled from 2022 to 2023, precisely coinciding with the spike in whale mortalities. Given the substantial regulatory and conservation implications, strict methodological rigor and accurate data interpretation are essential to understanding and addressing whale mortality drivers.

OSW Survey Vessel Sonar and Pile Driving Impact Review

Concerns regarding the impact of offshore wind (OSW) survey sonar and pile-driving noise on cetaceans and fish have been longstanding. As early as 2002, military sonar was confirmed to cause harm and death in cetaceans (Scientific American, 2009). Similar concerns related to OSW sonar noise emerged shortly afterward, notably highlighted in studies by Helen Bailey et al. in 2010 and a subsequent paper in 2014 (Bailey et al., 2010; Bailey et al., 2014). In response, NOAA implemented a 500-meter exclusion zone for baleen whales to mitigate harm from OSW activities (NOAA Letter of Authorization, to GSOE, 2018; and to Echo Offshore, 2023; BOEM, n.d.) .

Despite recognizing potential risks, NOAA consistently maintained there was no definitive evidence linking OSW activities directly to whale mortalities, instead attributing increased whale deaths to vessel strikes from increased shipping traffic. After seven years of Unusual Mortality Event (UME) declarations, NOAA researchers published a study by Thorne and Wiley (2024), reinforcing their argument that OSW is unrelated to increased whale deaths. However, not all NOAA scientists align with this view. Dr. Sean Hayes, Director of the Protected Species Division at NOAA's Northeast Fisheries Science Center, raised significant concerns regarding potential impacts of offshore wind, such as increased noise, vessel traffic, and persistent oceanographic changes affecting whale prey distribution. Hayes particularly emphasized enduring impacts from turbine operations throughout a project's lifespan (Hayes, 2022).

One NOAA argument has been that OSW sonar, weaker than military sonar, has minimal impacts. Contradicting this, acoustician Robert Rand measured OSW sonar strength, documenting sound levels up to 226 dB LF near survey vessels, potentially causing rapid deafness in nearby whales (Rand, 2023a). Rand provided recordings demonstrating the actual sonar experienced by cetaceans (Rand, 2023b) and documented similarly harmful levels for pile driving (Rand, 2024).

Notably, NOAA has not published necropsies of whale ears to conclusively assess acoustic impacts. Recent work by Professor Ursula Siebert from the Institute for Terrestrial and Aquatic Wildlife Research in Hanover, however, identified cracked inner ears in porpoises from the North and Baltic Seas, strongly indicating severe acoustic trauma (Nature and Environment-Europe. 2025). These findings align with Rand's concerns, implicating OSW sonar and pile-driving activities as primary sources of auditory damage. Further highlighting NOAA's inconsistencies, the Vineyard Wind Phase 2 Biological Opinion admitted, "**A small number of whales of other species may experience temporary to permanent hearing impairment as a result of the noise from pile-driving**" (Sennott, 2024). This directly contradicts NOAA's broader assertions minimizing offshore wind impacts, reinforcing the need for urgent reevaluation of regulatory decisions based on Thorne and Wiley's flawed methodologies.

Methods:

LUNA Software Tool – A Higher-Resolution Alternative: LUNA is the first analytical system to integrate NOAA whale mortality data with AIS vessel traffic data (Marine Cadastre, n.d.), explicitly distinguishing Offshore Wind (OSW) survey vessels from general shipping traffic (>80 meters), the size NOAA has associated with whale strikes (Thorne & Wiley, 2024). LUNA precisely tracks vessel movements, calculates total traffic, differentiates OSW survey activities, and provides detailed visualizations of whale strandings relative to vessel activities (see I**mage-7**).

Results:

LUNA Findings: Employing advanced statistical methodologies (Anonymous Supplemental Material, 2025), our analysis identified consistently strong, statistically significant correlations between OSW survey activity and whale strandings across multiple temporal scales—monthly, bimonthly, and annually (see **Image-1** for annual correlation). In contrast, general shipping traffic showed no statistically significant correlation (**Image-2**), marking a critical distinction.

Regression analyses (Generalized Linear Models and Bayesian Regression) went beyond correlation, providing robust evidence of causality. Bayesian regression results (**Images-3** and **4**) achieved remarkable predictive accuracy for annual whale mortality, with an $\mathbf{R^2}$ of approximately 81% for OSW survey traffic, while general ship traffic yielded an $\mathbf{R^2}$ near zero, indicating no predictive capability.

Further validation appears in **Images-5** and **6**, which depict predictions trained on data from 2015–2023 and tested against 2024 observations. The OSW model accurately captured fluctuations in whale deaths corresponding precisely with substantial increases in OSW survey activity from 2022 to 2023 and sharp decreases in 2024. General shipping traffic, however, showed a flat prediction line, failing to predict whale mortality trends despite changes in traffic volume.

These findings conclusively refute NOAA's assertion that general shipping traffic is primarily responsible for increased whale deaths. Instead, our rigorous analyses demonstrate that OSW survey activities directly drive whale mortality, while general vessel traffic alone has no significant impact. (Anonymous Supplemental Material, 2025),

Thorne and Wiley (2024) Findings: Thorne and Wiley's conclusions rely on two major flawed assumptions:

1. **TEUs Accurately Represent Big Ship Traffic –** Thorne and Wiley use Twenty-foot Equivalent Units (TEUs)—a measure of cargo volume—as a proxy for large vessel traffic. Based on this flawed proxy, they concluded that the rise in whale deaths is due primarily to increased ship strikes associated with greater traffic volume.
2. **Lack of IHAs Indicates Absence of OSW Activity –** Thorne and Wiley assume that if no Incidental Harassment Authorizations (IHAs) were issued, then no offshore wind (OSW) survey activities occurred. Specifically, they cited the absence of IHAs in New Jersey in 2019 to conclude that OSW could not be responsible for increased whale strandings.

These assumptions significantly weaken their conclusions, resulting in an underestimation of OSW's potential impact on whale mortalities.

Detailed Methodological Critique of Thorne and Wiley (2024) Findings:

Invalid Proxies:

Misuse of TEUs and Flaws in Vessel Traffic Estimates:

Thorne and Wiley's reliance on Twenty-foot Equivalent Units (TEUs) as a proxy for vessel activity is fundamentally flawed because TEUs measure cargo volume, not actual vessel traffic. TEUs fail to capture essential aspects such as vessel counts, types, sizes, and movements critical for assessing whale strike risks. Container ships constitute only about 50% of large vessel traffic, entirely excluding significant categories like cruise ships, tankers, and vehicle carriers.

Additionally, TEU-based analysis neglects critical industry shifts following the 2016 Panama Canal expansion (Panama Canal Expansion Project, n.d., 2025), where fewer, larger vessels replaced numerous smaller ships, significantly reducing total vessel counts despite rising cargo volumes. Data from LUNA indicate that, between 2016 and 2024, mega-ships (≥340 meters) increased sharply from 4 to 47, and large vessels (≥300 meters) rose from 35 to 98 during January alone.

Actual traffic trends within the NY/NJ polygon (see **Image-8)** further expose TEU inadequacies. While TEU volumes increased steadily until 2022, they declined by 20% in 2023—the same year New Jersey experienced its highest humpback whale mortality. In contrast, general ship traffic decreased between 2016 and 2020, gradually recovering to 2016 levels by 2023. Crucially, from 2023 to 2024, general traffic surged by 17%, reaching its highest point since 2015, yet whale deaths sharply declined from 21 to just 9. This reduction in whale mortality aligns directly with a marked decrease in offshore wind (OSW) vessel activity—from 171,000 to 38,000 miles—not with fluctuations in general shipping.

These observations underscore that TEU volumes inadequately reflect actual vessel activities and strongly suggest OSW vessel traffic, rather than general ship traffic, as a primary driver of whale mortality.

Misinterpretation of IHAs and Flaws in OSW Survey Estimates:

Thorne and Wiley incorrectly assume the absence of Incidental Harassment Authorizations (IHAs) equates to no offshore wind (OSW) survey activity. IHAs do not reliably indicate actual survey occurrences or intensity, as significant OSW activities have occurred without them. For example, Ørsted,(Orsted. 2019), conducted extensive seismic surveys in New Jersey from April to December 2019 without obtaining an IHA (see **Image-7**).

Thorne and Wiley's reliance on IHAs is problematic because:

1. **IHAs Do Not Capture All OSW Survey Activity:** Surveys frequently occur without IHAs, such as Ørsted's extensive 2019 seismic surveys.
2. **IHAs Provide Only Broad Estimates**: Covering 1–5-year periods without precise dates, IHAs cannot reliably correlate with actual survey activities.
3. **IHAs May Misrepresent Actual Survey Intensity:** Survey plans often change post-issuance, diminishing IHAs' reliability.

The Case of New Jersey, 2019:

Thorne and Wiley's claim—"**The largest increase in strandings in New Jersey was observed in 2019, when no surveys were authorized in this state**"—is misleading. This simple yet erroneous observation led the authors to incorrectly exclude OSW as a cause of whale deaths. In April 2019, Ørsted publicly announced significant OSW surveys without obtaining an IHA(Orsted. 2019). Whale deaths, previously at zero, surged dramatically, totaling 23 by December 2019. LUNA documented a notable increase in OSW vessel activity from an average of 1,210 miles/month (Jan–Mar) to 7,226 miles/month (Apr–Dec) (see **Image-7**).

This evidence decisively refutes Thorne and Wiley's assertion, demonstrating that IHAs inadequately reflect OSW survey activity and undermining their conclusions about whale mortality.

Lack of Statistical Rigor:

- **Descriptive Analysis Only:** No formal hypothesis testing, correlations, or regressions were conducted.
- **Absence of Power Analysis:** Statistical power required to detect rare events was ignored, increasing the risk of false negatives.

Discussion:

NOAA's Regulatory Response and Contradictions: Early LUNA research was presented to NOAA scientists from the Office of Protected Resources, including author David Wiley, on July 29, 2024, and published in news articles on July 14, 2024 (Andersen, 2024a, 2024b). NOAA responded in the Vineyard Wind Phase 2 Biological Opinion , (NOAA Biological Opinion. 2024.,p. 45–46; NOAA. 2025), simultaneously evaluating Thorne and Wiley's peer-reviewed paper and early LUNA research. While NOAA cited Thorne and Wiley to justify its stance of no connection between offshore wind (OSW) activities and whale strandings—thus supporting the Vineyard Wind IHA—it acknowledged LUNA's findings, stating: "**Offshore wind development has increased over the same time period, so the correlation was not surprising**."

This juxtaposition exposes NOAA's internal contradictions and uncertainties regarding Thorne and Wiley's conclusions. Although NOAA raised concerns about the non-peer-reviewed status of LUNA's research and requested comparative analyses with **general vessel traffic**, it continues basing regulatory decisions predominantly on Thorne and Wiley's flawed conclusions.

Conclusion:

Our critique highlights critical methodological flaws in Thorne and Wiley's study—particularly reliance on inaccurate proxies (TEUs and IHAs), inadequate statistical analyses, and selective data usage. LUNA's high-resolution analysis robustly demonstrates that OSW activities significantly correlate with increased whale mortalities (Anonymous Supplemental Material, 2025). Given NOAA's mandate to rely on the best available science, it must urgently reconsider its dependence on Thorne and Wiley's flawed study. NOAA should promptly reassess its policies and reevaluate previously issued incidental harassment authorizations to ensure effective whale protection.

Statement on the Use of AI

We have utilized AI tools—specifically ChatGPT 4.0 and ChatGPT 4.5—to assist with programming tasks for LUNA, implementing statistical methods, and improving the clarity and readability of my original writing.

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Image-1: Offshore Wind Traffic vs Whale Deaths in the Central Region from 2015-2024(excluding 2021 outlier year)

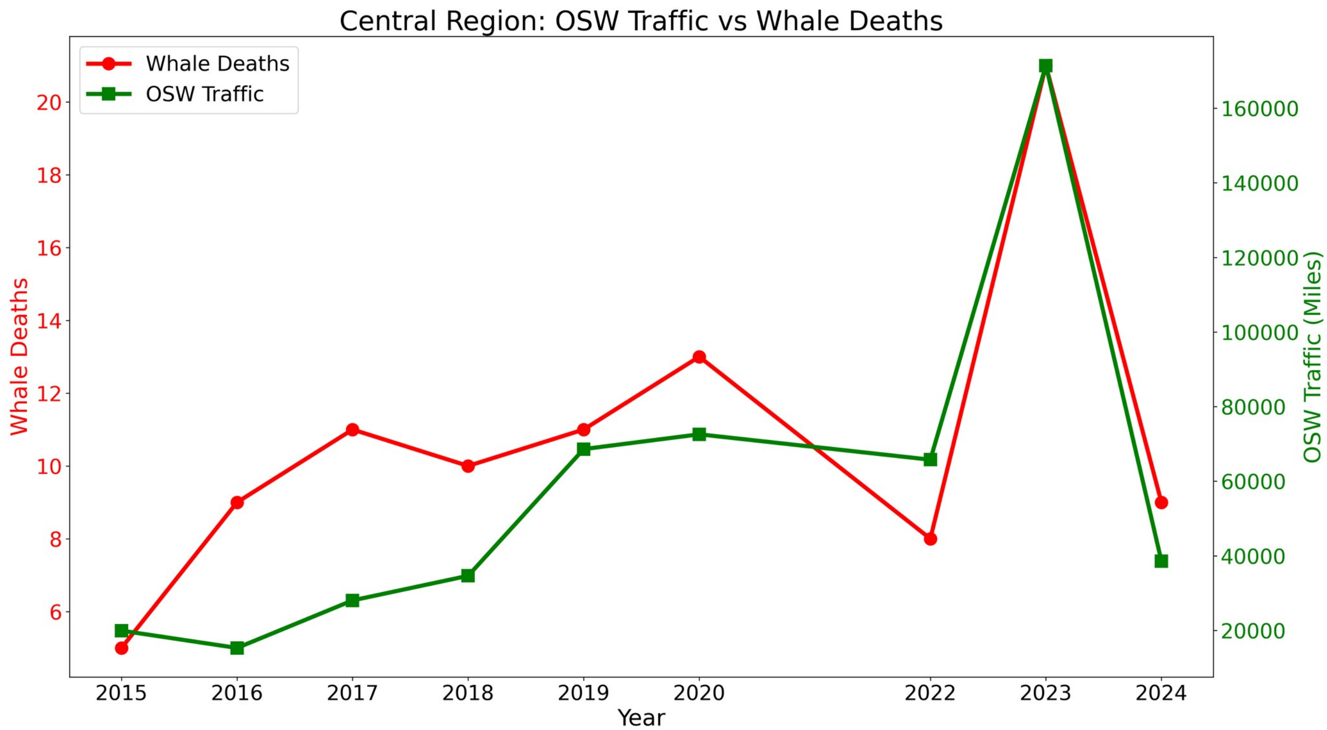


Image-2: General Ship Traffic (>80m) vs. Whale Deaths in the Central Region 2015–2024 (Excluding 2021 Outlier Year)

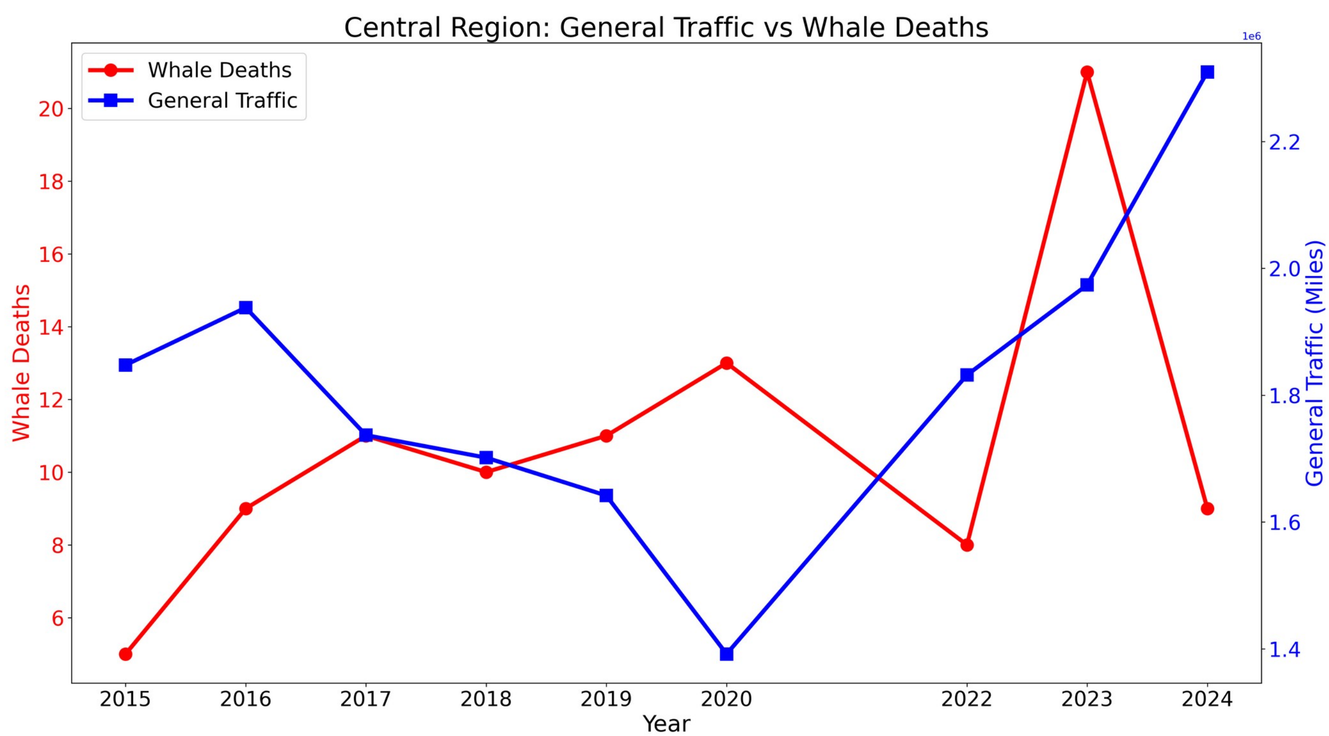


Image-3 : OSW -Actual vs. Predicted Whale deaths using the Bayesian regression yearly model

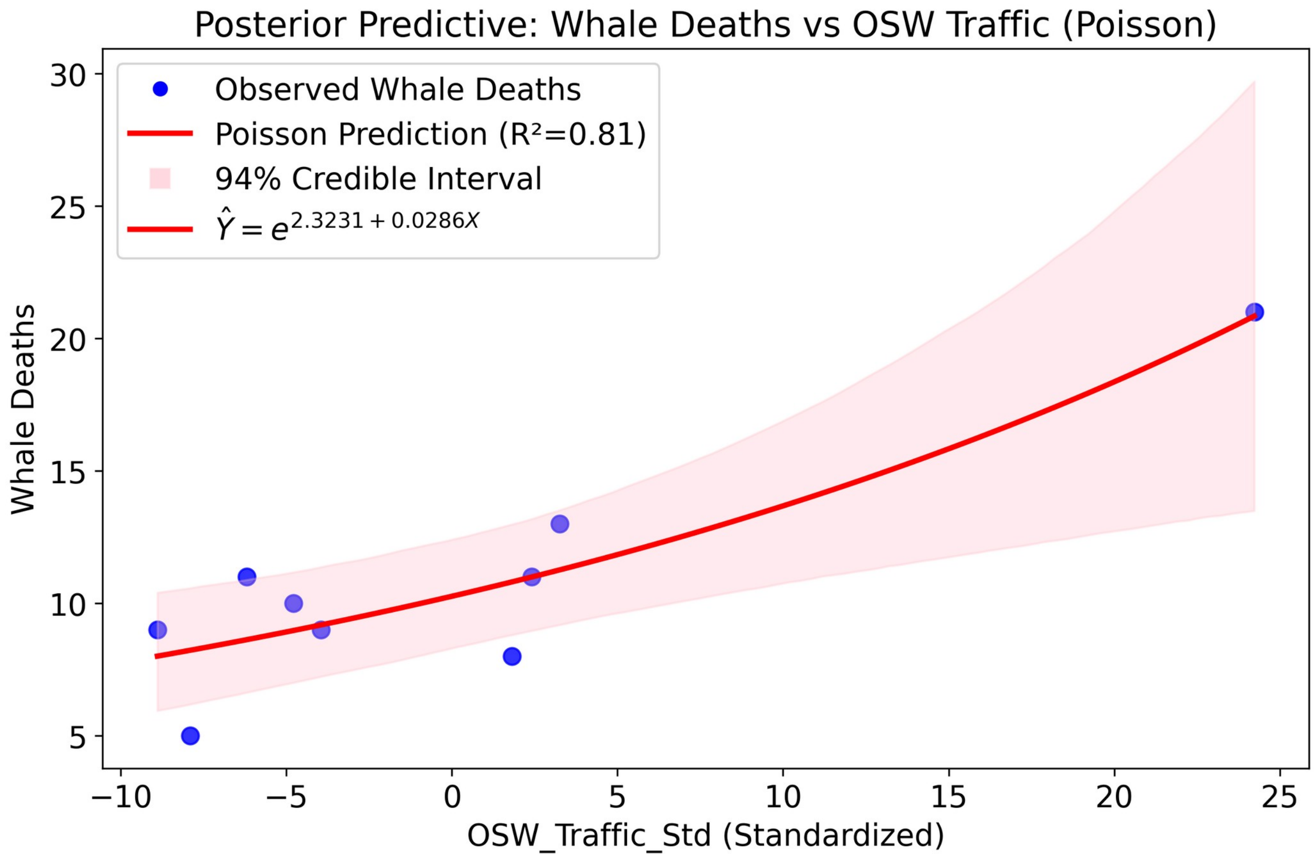
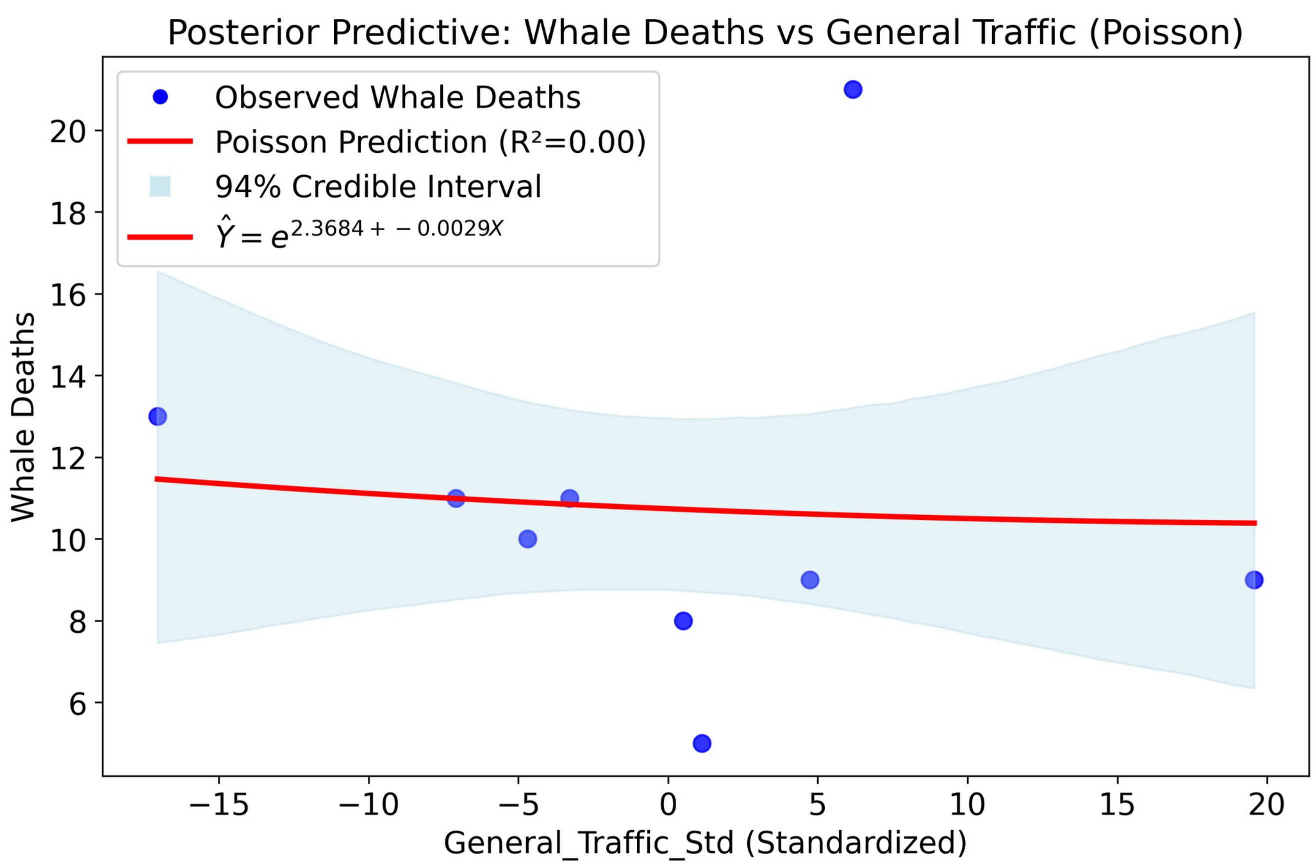


Image-4 : General Traffic-Actual vs. Predicted Whale deaths using the Bayesian regression yearly model

Image-5: OSW Actual vs. Predicted Whale deaths using the yearly GLM model



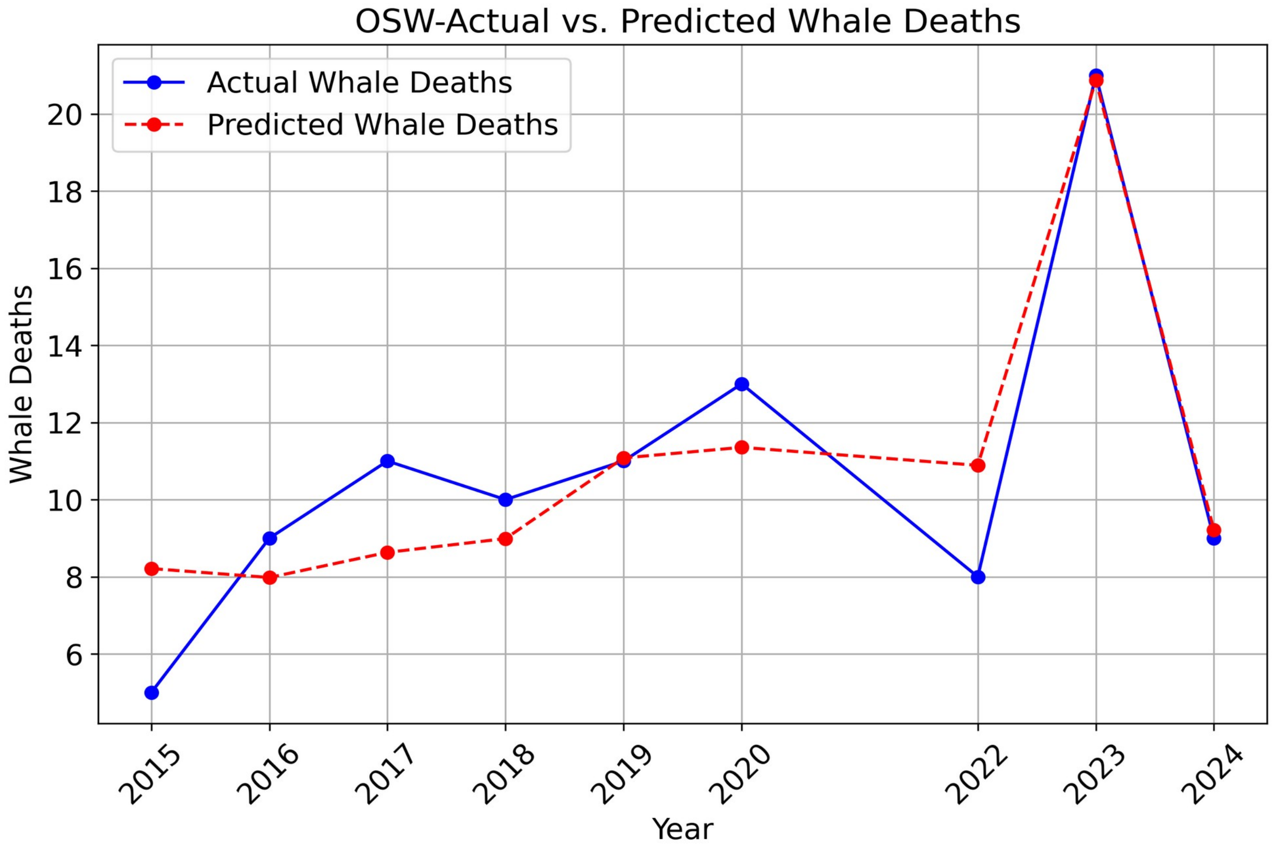


Image-6: General Traffic-Actual vs. Predicted Whale deaths using the yearly GLM model

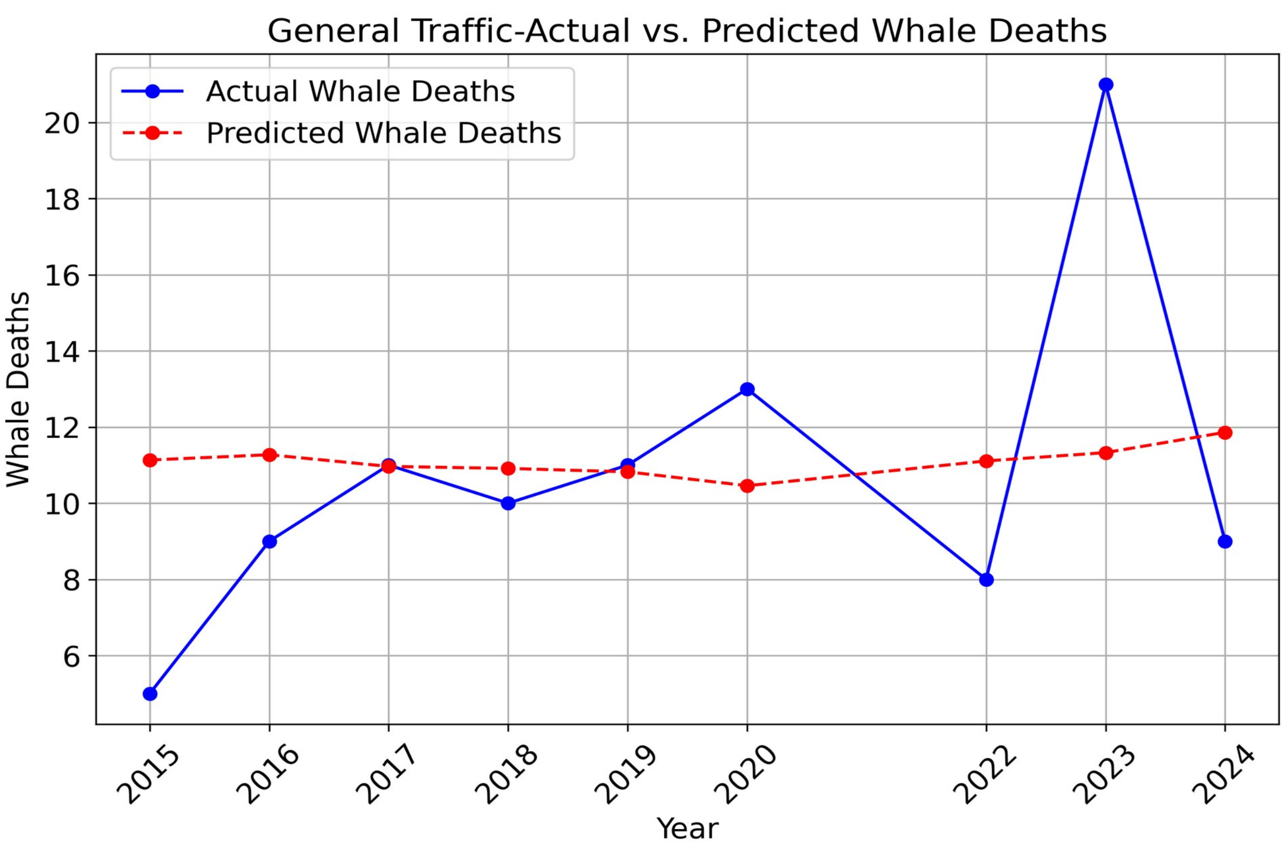


Image 7: NY/NJ Central Region—OSW Vessel Traffic and Whale Mortalities (April–December 2019). After Ørsted Began Surveys: 23 Whale Deaths, 65,034 Survey Miles.

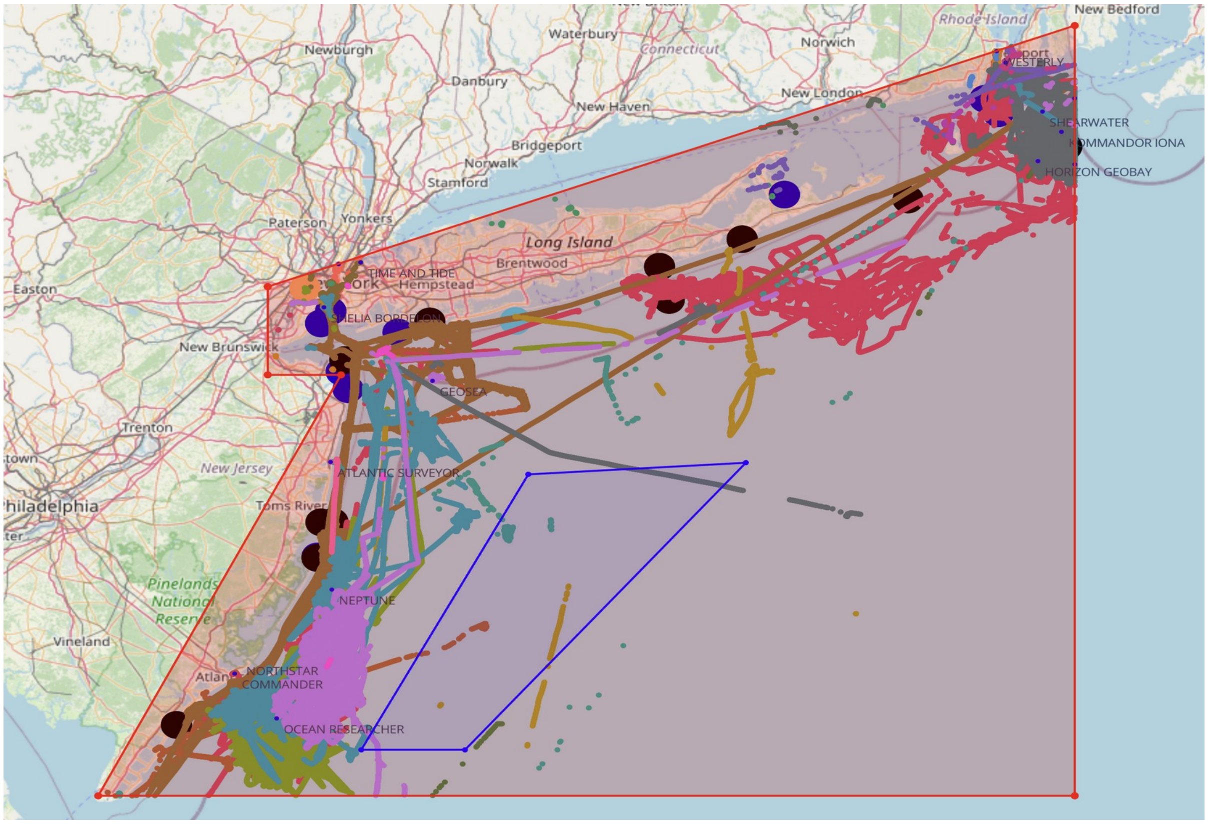


Image-8: General Ship Traffic with Length >80m (Blue) vs TEU count (Red) in NY/NJ region polygon(see Image 7)

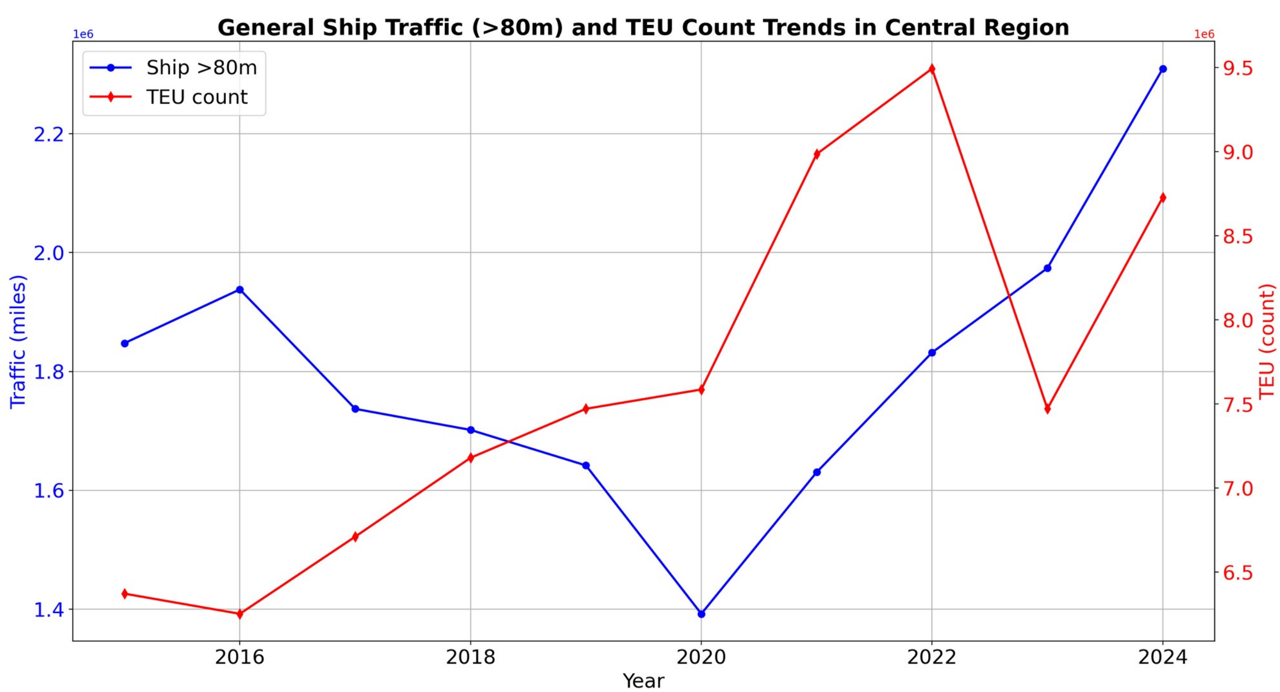


EXHIBIT B

Offshore Wind Sonar Surveying as a Primary Cause of Elevated Whale Mortality: A Geospatial and Statistical Analysis in the Central Region-Part I

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Abstract

This study provides strong statistical and geospatial evidence that offshore wind (OSW) sonar survey activities significantly contribute to increased whale mortalities along the Central Region (New York and New Jersey coastline) from 2015 to 2024. Advanced analyses—including rolling-window correlations, pairwise data aggregation, and Generalized Linear Models (GLMs)—consistently demonstrate a statistically significant link between intensified sonar surveying and heightened humpback whale deaths. Crucially, no meaningful correlation between whale mortalities and general shipping traffic was found, challenging NOAA's assertions attributing whale deaths primarily to vessel strikes. Independent biological evidence of auditory trauma from similar sonar exposures further supports our conclusions. Immediate regulatory action and targeted mitigation strategies are urgently recommended.

Introduction

A significant rise in whale mortality along the U.S. East Coast, notably within the Central Region (New York and New Jersey coastline), has led to heightened ecological concern and widespread debate over potential anthropogenic drivers. Since NOAA declared an ongoing Unusual Mortality Event (UME) in 2016, humpback whale mortalities have notably increased, prompting NOAA to identify vessel strikes as the primary cause. However, NOAA's explanation inadequately addresses numerous whale deaths that lack definitive evidence of vessel collisions or entanglements. At the same time, offshore wind (OSW) sonar surveying has markedly intensified within crucial whale habitats, yet the ecological impacts of these activities remain insufficiently assessed by regulatory agencies.

Our study directly addresses this critical gap through rigorous statistical and geospatial analyses, explicitly investigating whale mortalities in relation to OSW sonar survey activities conducted from

2015 to 2024. Utilizing the LUNA marine geospatial analytical system, we performed detailed rolling-window correlation analyses, pairwise data aggregation, and applied Generalized Linear Models (GLMs) to clearly distinguish OSW sonar impacts from general maritime traffic. This comprehensive analytical framework enabled us to rigorously document spatial and temporal correlations linking intense sonar surveying operations to increases in whale deaths.

Our analyses demonstrate a robust, statistically significant correlation between OSW sonar survey intensity and whale mortalities in the Central Region. Importantly, general shipping traffic—previously highlighted by NOAA as the primary threat—shows no statistically significant relationship to whale deaths. Additionally, independent biological evidence documenting severe auditory trauma in marine mammals exposed to sonar strongly aligns with our statistical findings, highlighting acoustic disturbances caused by sonar as the most plausible primary cause.

Given these conclusive results, regulatory authorities must urgently reconsider current assumptions about offshore wind sonar impacts. Targeted mitigation measures, stricter regulatory oversight, and enhanced monitoring protocols focused explicitly on sonar surveying activities are imperative to safeguard whale populations from further harm.

OSW Survey Vessel Sonar and Pile Driving Impact Review

Concerns regarding the impact of offshore wind (OSW) survey sonar and pile-driving noise on cetaceans and fish have been longstanding. As early as 2002, military sonar was confirmed to cause harm and death in cetaceans (Scientific American, 2009). Similar concerns related to OSW sonar noise emerged shortly afterward, notably highlighted in studies by Helen Bailey et al. in 2010 and a subsequent paper in 2014 (Bailey et al., 2010; Bailey et al., 2014). In response, NOAA implemented a 500-meter exclusion zone for baleen whales to mitigate harm from OSW activities (NOAA Letter of Authorization, to GSOE, 2018; and to Echo Offshore, 2023; BOEM, n.d.) .

Despite recognizing potential risks, NOAA consistently maintained there was no definitive evidence linking OSW activities directly to whale mortalities, instead attributing increased whale deaths to vessel strikes from increased shipping traffic. After seven years of Unusual Mortality Event (UME) declarations, NOAA researchers published a study by Thorne and Wiley (2024), reinforcing their argument that OSW is unrelated to increased whale deaths. However, not all NOAA scientists align with this view. Dr. Sean Hayes, Director of the Protected Species Division at NOAA's Northeast Fisheries Science Center, raised significant concerns regarding potential impacts of offshore wind, such as increased noise, vessel traffic, and persistent oceanographic changes affecting whale prey distribution. Hayes particularly emphasized enduring impacts from turbine operations throughout a project's lifespan (Hayes, 2022).

Further challenging NOAA’s narrative, acoustician Robert Rand directly measured OSW sonar emissions, recording peak sonar levels up to 226 dB near OSW survey vessels, capable of causing rapid and permanent hearing damage in cetaceans (Rand , 2023a). Rand also provided detailed acoustic evidence illustrating actual sonar exposures experienced by marine mammals, underscoring significant risk and direct biological harm (Rand , 2023b).

Crucially, NOAA has not published necropsies of whale ears to conclusively assess acoustic impacts. Recent work by Professor Ursula Siebert from the Institute for Terrestrial and Aquatic Wildlife Research in Hanover, however, identified cracked inner ears in porpoises from the North and Baltic Seas, strongly indicating severe acoustic trauma (Nature and Environment-Europe. 2025). These findings align with Rand's concerns, implicating OSW sonar and pile-driving activities as primary sources of auditory damage. Further highlighting NOAA's inconsistencies, the Vineyard Wind Phase 2 Biological Opinion admitted, "**A small number of whales of other species may experience temporary to permanent hearing impairment as a result of the noise from pile-driving"** (Sennott, 2024). This directly contradicts NOAA's broader assertions minimizing offshore wind impacts, reinforcing the need for urgent reevaluation of regulatory decisions based on Thorne and Wiley's flawed methodologies.

Critique of Thorne and Wiley (2024) and NOAA's Regulatory Contradictions

Thorne and Wiley (2024), heavily cited by NOAA to discount OSW impacts, present several fundamental methodological flaws(see details here):

- **Incorrect Proxy for Ship Traffic**: Their reliance on cargo volume (Twenty-foot Equivalent Units—TEUs) as a proxy for actual ship movements obscures vital distinctions between vessel types, sizes, and movements, critically misrepresenting true traffic dynamics and whale strike risks.
- **Misrepresentation of OSW Survey Activities**: Thorne and Wiley incorrectly assume the absence of Incidental Harassment Authorizations (IHAs) indicates no sonar survey activities. This is disproven by documented instances, such as Ørsted's extensive sonar surveys conducted without IHAs in 2019 ((Orsted. 2019). This oversight undermines their analysis, significantly weakening their conclusions.
- **Lack of Statistical Rigor**: Their conclusions lack robust statistical methods, relying instead on descriptive observations without rigorous hypothesis testing or correlation analyses

NOAA's Regulatory Response and Internal Contradictions:

Early research, presented directly to NOAA scientists—including Thorne and Wiley's co-author David Wiley—on July 29, 2024, and widely publicized in July 2024 (Andersen, 2024a, 2024b), prompted NOAA's formal response in the Vineyard Wind Phase 2 Biological Opinion (NOAA Biological Opinion., 2024, p. 45–46; NOAA, 2025). While NOAA cited Thorne and Wiley to defend its regulatory stance, concluding no direct link between OSW activities and whale strandings, it simultaneously acknowledged our findings: "**Offshore wind development has increased over the same time period, so the correlation was not surprising**"(NOAA summary of p 45-46, 2024).

This conflicting stance highlights NOAA's internal uncertainties and contradictions. Despite recognizing the validity of LUNA's correlation-based results, NOAA continues to base regulatory decisions predominantly on Thorne and Wiley's flawed conclusions, reflecting a critical inconsistency in NOAA's regulatory approach.

Section 1: Introduction to LUNA – A Geospatial Marine Analysis System

LUNA: Geospatial Marine Analysis Software System

LUNA is an advanced geospatial software system developed for detailed marine analysis. Its capabilities include:

- Calculating vessel traffic density and analyzing whale mortality data.
- Partitioning geographic regions into precise polygons for spatial assessments.
- Visualizing vessel movements and whale strandings effectively.
- Conducting sophisticated statistical analyses, including correlation studies and Bayesian regression modeling.
- Tracking and analyzing temporal trends over various intervals, such as months or years.

LUNA integrates comprehensive datasets from **NOAA** (stranded large whales and small cetaceans), **Marine Cadastre** (vessel AIS data), and independently conducted analyses. Utilizing this extensive data integration, LUNA has identified offshore wind sonar surveying as the primary driver behind the significant increase in whale deaths following NOAA's declaration of an Unusual Mortality Event (**UME**). Our analyses clearly demonstrate that general vessel traffic does not significantly contribute to the observed rise in whale mortality.

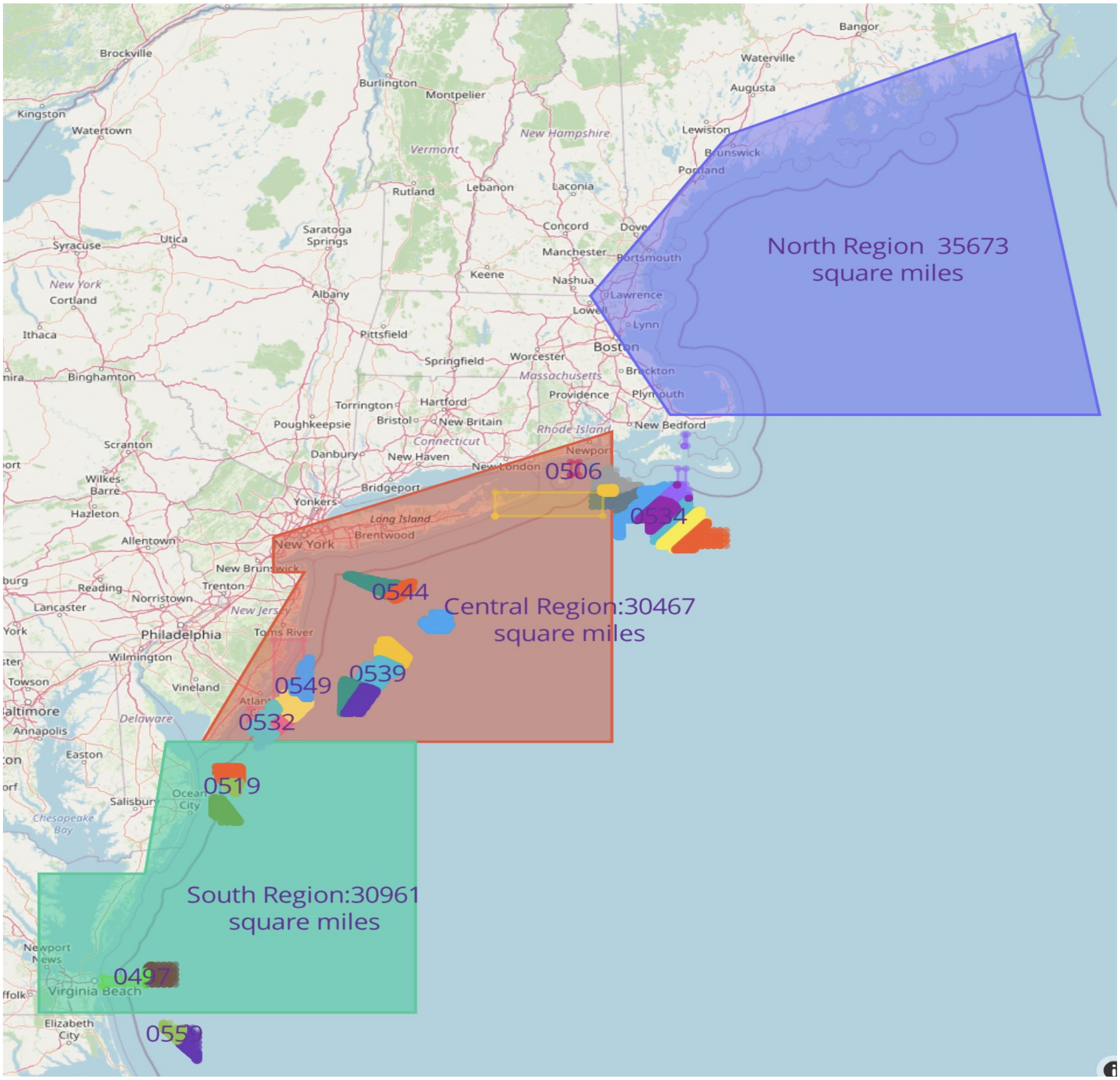
LUNA: Partitioning the East Coast into Evaluation Regions

To effectively evaluate the impact of offshore wind on whale deaths, LUNA partitions the East Coast into three distinct regions based on geographic and ecological characteristics, including polygon size, pre-UME whale death rates, and humpback whale densities:

- **South Region (DE, MD, VA)**: Comparable in size and whale density to the Central Region, this area contains offshore wind leases and serves as a critical zone for examining changes in whale mortality post-UME.
- **Central Region (NY, NJ)**: Similar in size and pre-UME death rates to the South Region, this region also hosts offshore wind leases, facilitating direct comparisons of whale mortality trends. Both the South and Central Regions exhibited comparable whale mortality rates from 2006–2014.
- **North Region (MA north of Cape Cod, ME, NH)**: Slightly larger with notably higher whale densities and approximately double the whale deaths pre-UME compared to other regions. Importantly, this region lacks offshore wind leases, making it an ideal baseline for comparison.

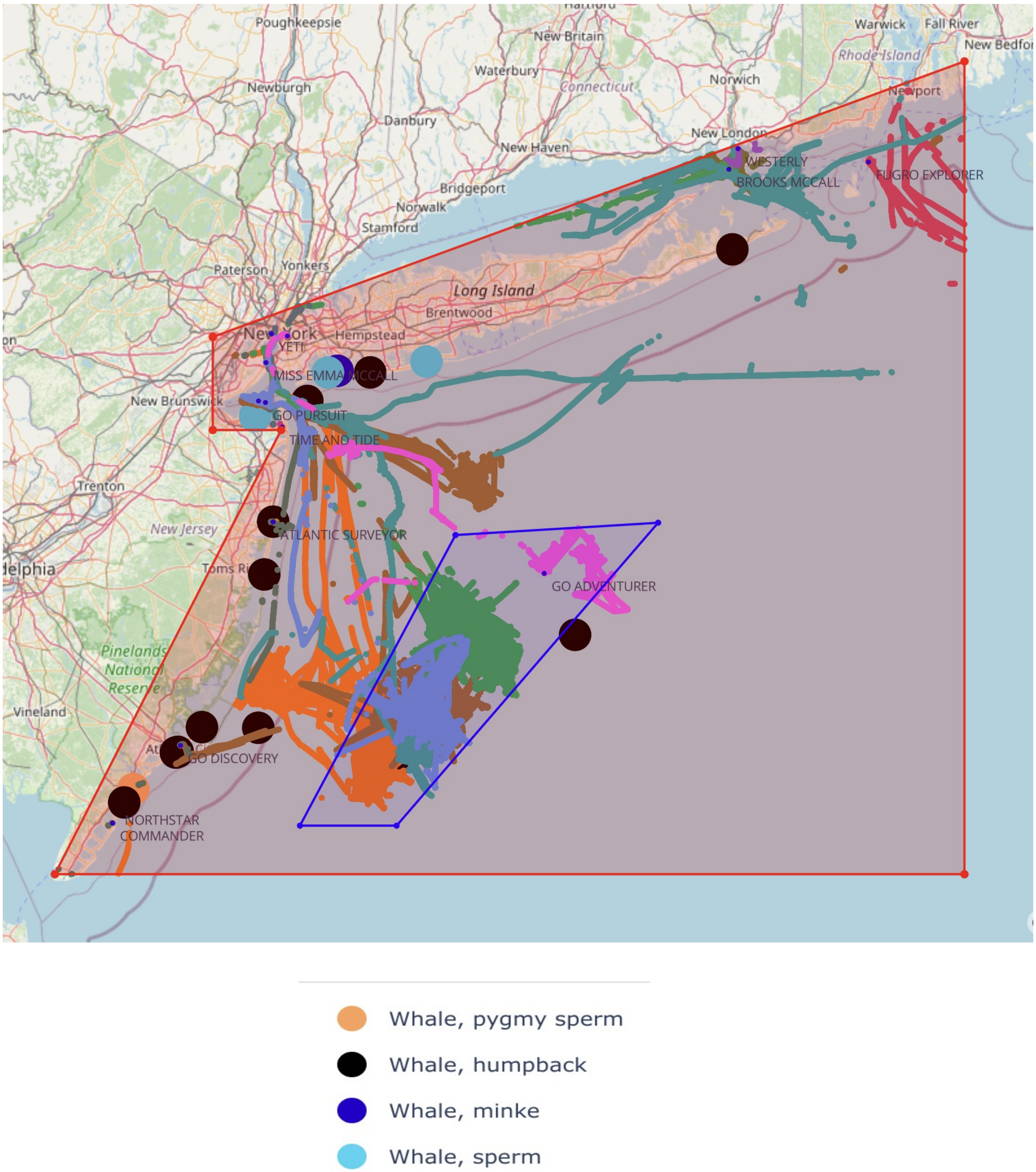
This strategic partitioning allows LUNA to visually and analytically compare whale mortality rates across regions with and without offshore wind development (see **Image-1**). The North Region serves as a control group, providing a clear baseline to assess the impacts of offshore wind activities observed in the South and Central Regions.

Image-1: North Central and south regions with offshore wind projects shown



LUNA can generate visualizations such as **Image-2**, which highlights the Central Region, including the '**Death Valley**' polygon outlined in blue, from December 1, 2022, to March 31, 2023. During these months, this area experienced an unprecedented spike in whale deaths, totaling 20—an average of five per month, a rate not observed prior to intensified offshore wind survey activities. The map clearly illustrates the spatial correlation between these whale fatalities and offshore wind survey operations, emphasizing the concentration of incidents within areas of intense surveying.

Image-2: Central Region and Death Valley Analysis: OSW Traffic and 17 Whale Mortalities, December 1, 2022 to March 31, 2023 27582 OSW monster miles with 500 meter sonar radius.



Section 2: Central Region Visual and Statistical Analysis

We conducted a rigorous analysis of whale mortality rates in the Central Region and specifically within the Empire Wind area, using the following large whale species:

- North Atlantic right whale, Minke whale, Fin whale, Sperm whale, Humpback whale,Sei whale, Blue whale

In **Images 3 and 4**, we compare whale mortalities across two distinct periods: 2006–2014 (before significant offshore wind (OSW) activities began) and 2015–2023 (after OSW activities commenced). During these intervals, total large whale deaths increased dramatically from 62 to 160—representing an increase by a factor of 2.58. The rise is particularly pronounced for humpback whales, which experienced a staggering 5.45-fold increase in mortalities.

Images 6 and 7 focus specifically on humpback whale deaths. Prior to 2015, there were 17 recorded humpback deaths; post-2015, deaths surged to 89—a remarkable 5.3-fold increase. This significant rise directly aligns with intensified OSW sonar surveying in the region. Humpbacks appear especially vulnerable to OSW activities due to their feeding habits in proximity to survey areas. For whales to experience significant impacts, proximity to concentrated and overlapping survey vessel activity (cumulative impact) is essential.

In **Images 7 and 8**, we further highlight this troubling pattern within the Empire Wind polygon specifically. Whale mortalities increased from 16 (2006–2014) to 47 (2015–2023), marking a 2.94-fold rise. The increase is even more severe for humpback whales, whose deaths rose from 3 to 23, an alarming 7.7-fold increase. This sharp escalation corresponds precisely to intensive, overlapping OSW survey operations for cable routes and Empire Wind project infrastructure.

We summarize the results in **Table-1.**

Table-1 : All Dead whales in central and empire wind polygons from 2006-2014 and 2015-2023.

Region	Period	All Whale Deaths	Humpback Deaths	Increase Factor (All Whales)	Increase Factor (Humpbacks)
Central Region	2006 - 2014	67	17	**2.39x**	**5.24x**
Central Region	2015 - 2023	160	89		
Empire Wind	2006 - 2014	16	3	**2.94x**	**7.67x**
Empire Wind	2015 - 2023	47	23		

Image-3: Dead Big whales in central region wind polygon from 2006-2014. Total inside the polygon 67.

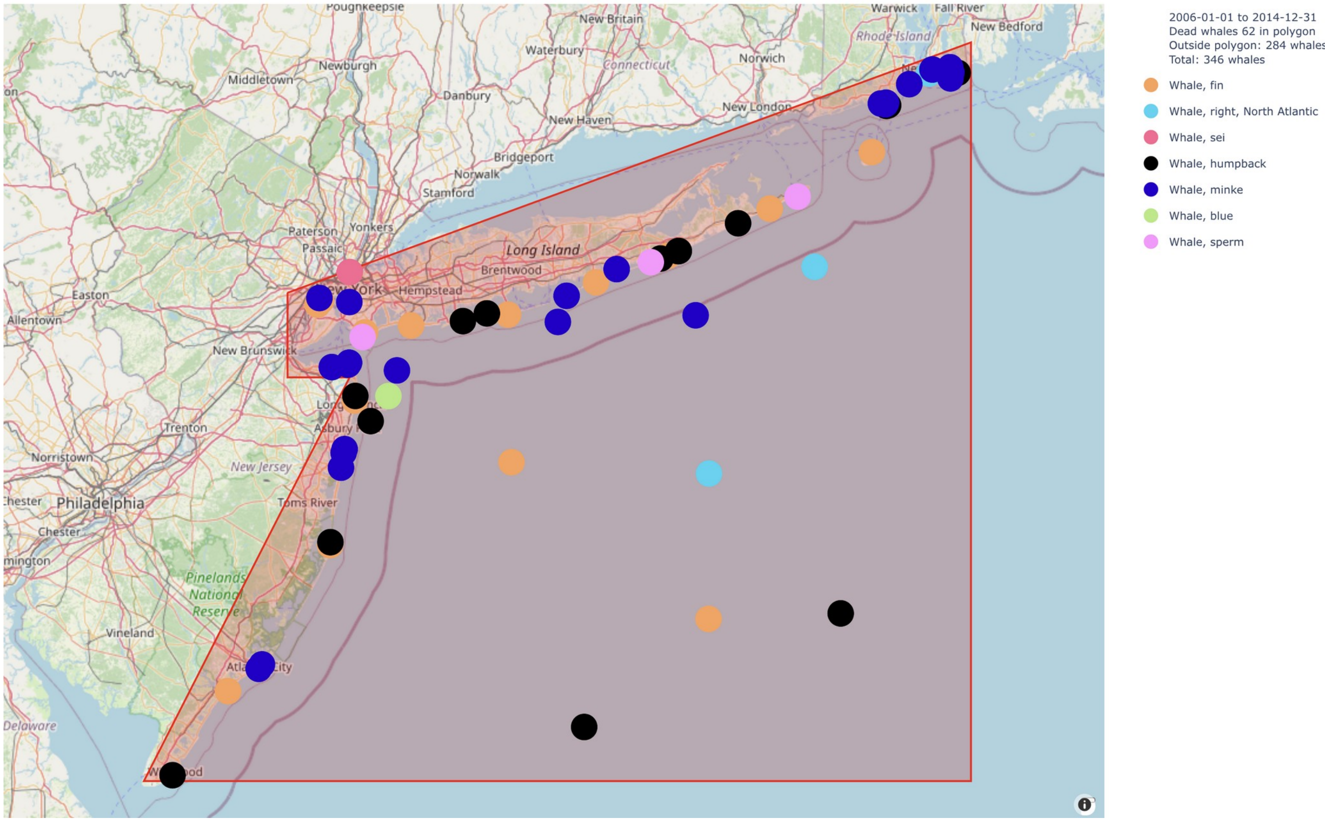


Image-4: Dead Big whales in Central region wind polygon from 2015-2023. Total inside the polygon 160.

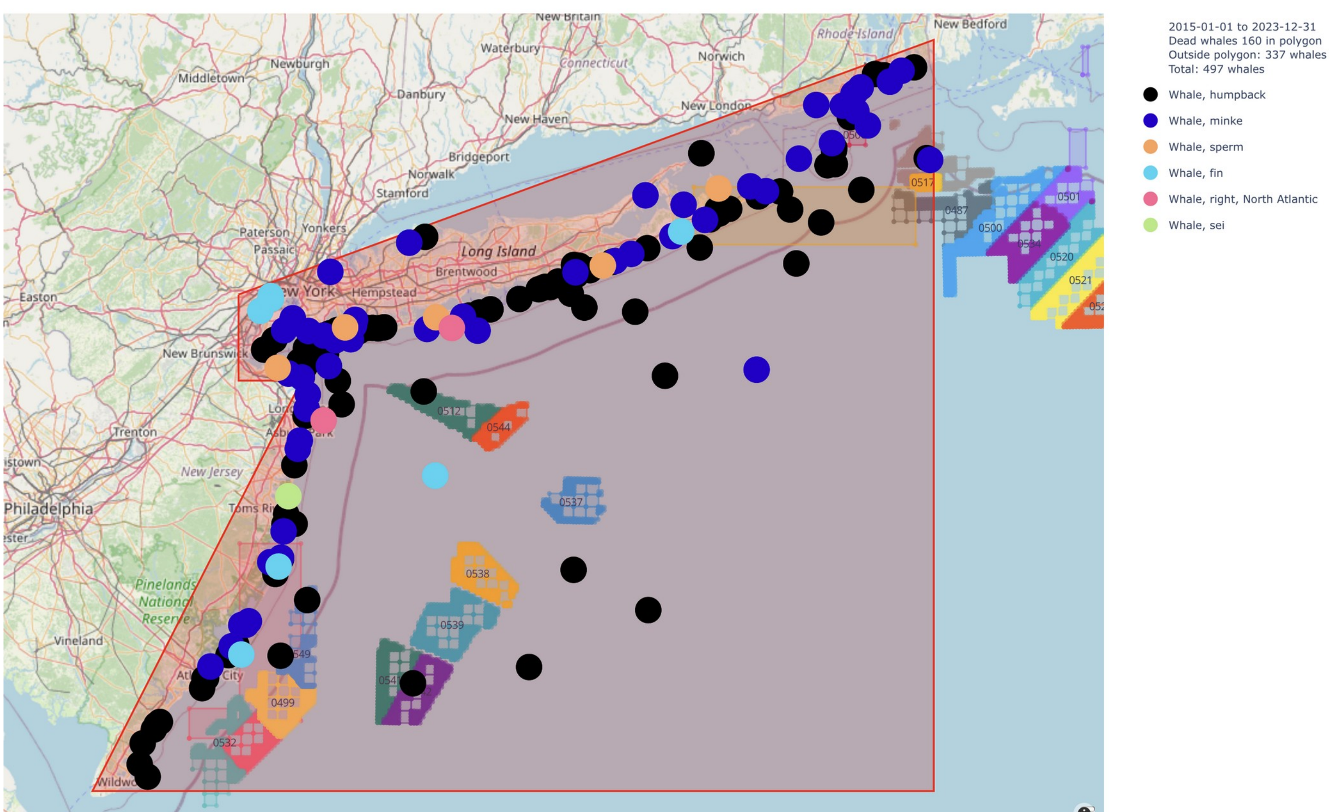


Image-5 : Dead Humpback whales in central region wind polygon from 2015-2023. Total inside the polygon 89

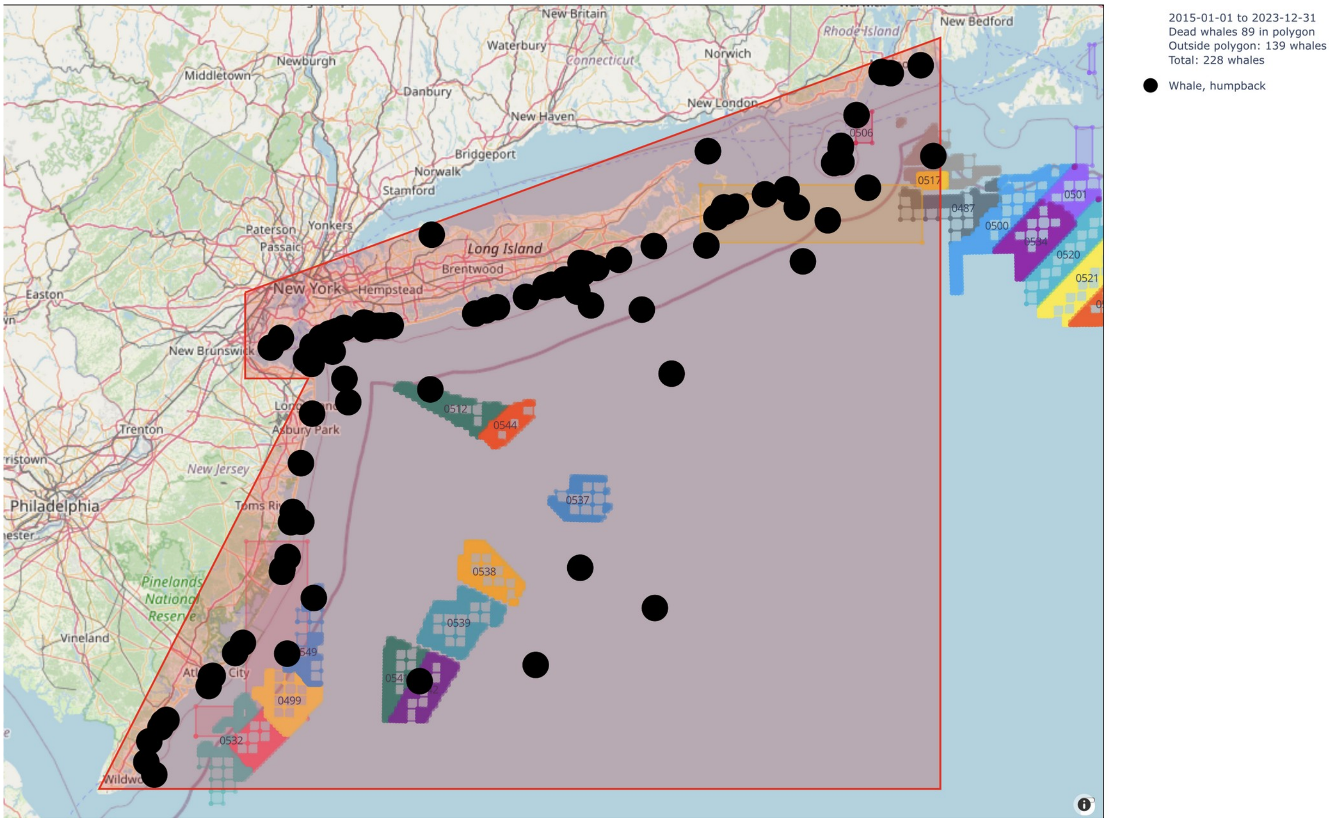


Image-6: Dead Humpback whales in central region wind polygon from 2006-2014. Total inside the polygon 17.

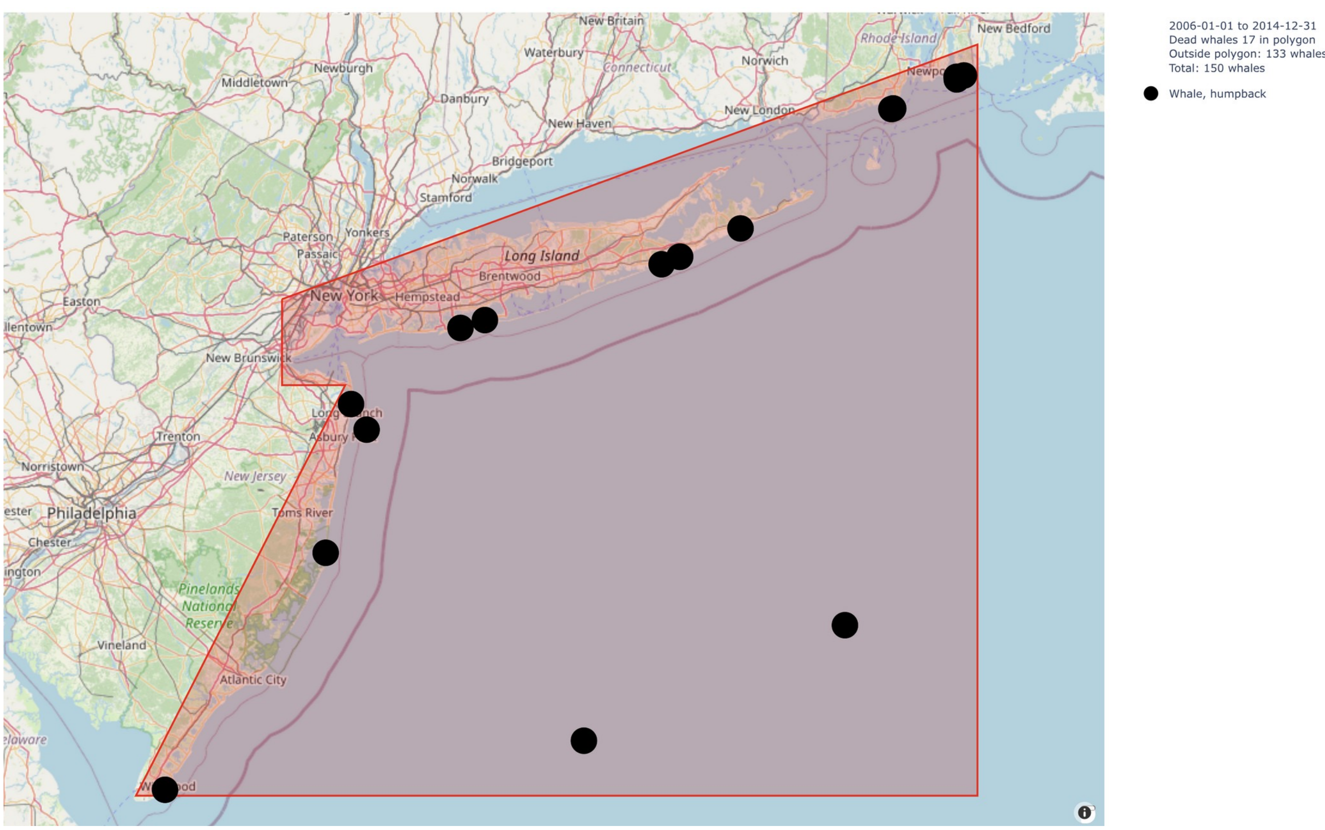


Image-7: Dead Big whales in Empire wind polygon from 2006-2014. Total inside the polygon 16.

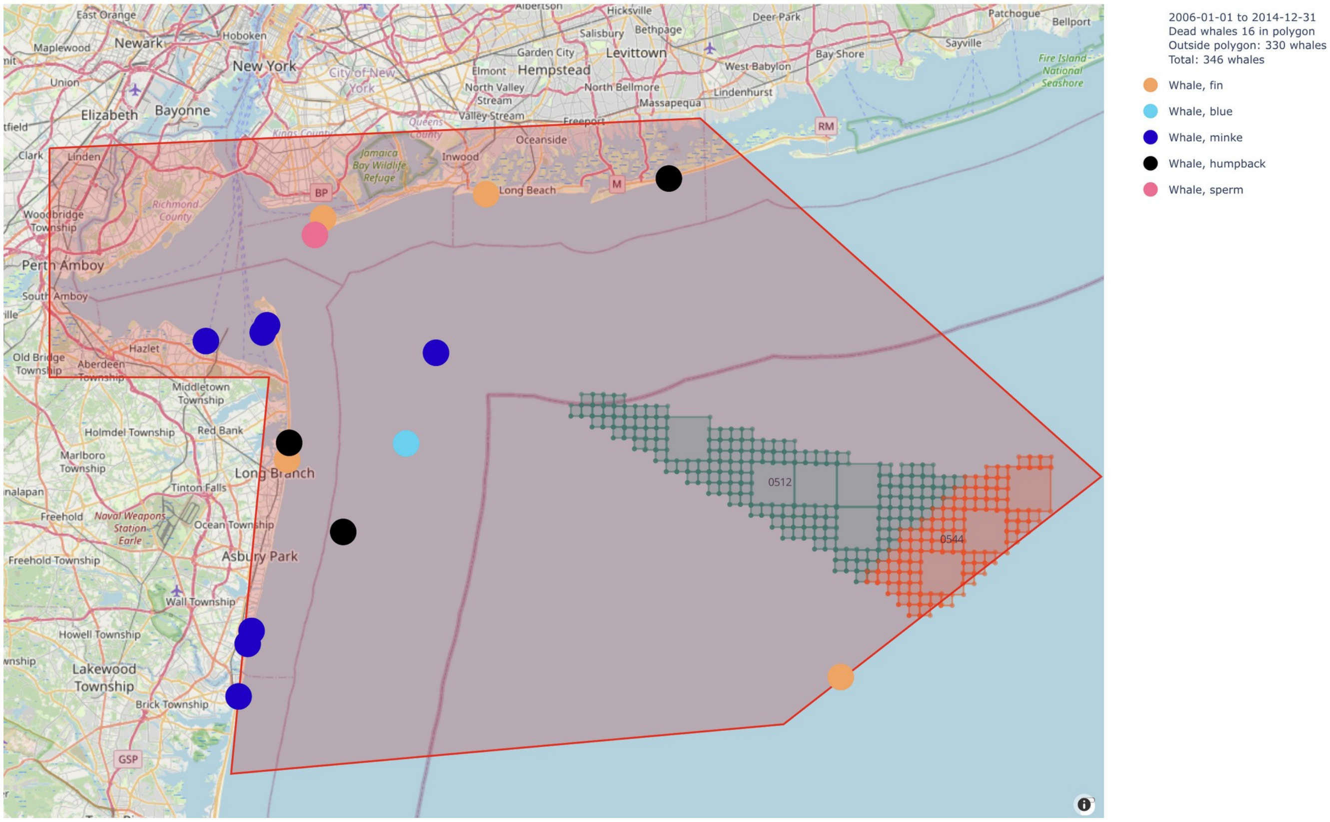
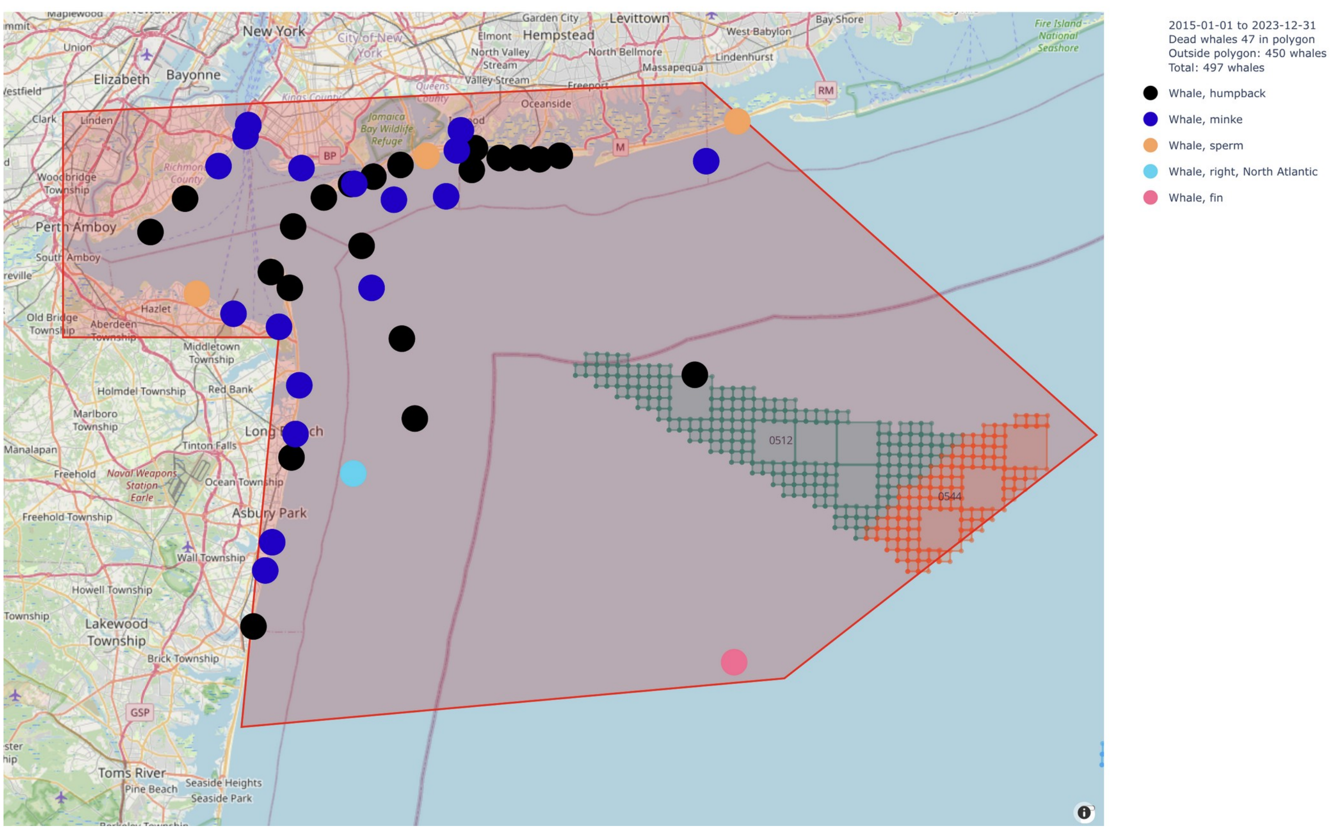


Image-8: Dead whales in Empire wind polygon from 2015-2023. Total inside the polygon 47 .



Critically, this increase in whale mortalities aligns with the period when NOAA declared Unusual Mortality Events (UMEs) for humpback, minke, and right whales (2016–2018), directly correlating with intensified OSW sonar surveying and construction activities.

Despite these clear temporal correlations, NOAA has consistently claimed offshore wind activities are unrelated to whale mortalities, attributing the increase instead to heightened ship traffic during the COVID-19 pandemic(see NOAA). NOAA cites a 40% human interaction rate for examined whale deaths but fails to clearly specify actual ship strike numbers, which upon detailed examination constitute a far smaller portion of the deaths.

Our analysis decisively counters NOAA's assertions by demonstrating heuristically, visually, and statistically that whale mortalities closely track the intensity of OSW sonar surveys—increasing sharply with intensified OSW activities and decreasing correspondingly when these activities are scaled back. This comprehensive evidence compellingly identifies offshore wind activities—not general maritime traffic—as the primary factor responsible for the recent spike in whale mortalities.

These figures underscore a notably higher increase within regions directly impacted by intense OSW sonar activities compared to the overall East Coast increase, suggesting that sonar activity from OSW operations has played a critical role in this heightened mortality.

Section 3: Heuristic Proof of Offshore Wind (OSW) as the Primary Cause of Whale Deaths in the Central Region

We conducted a rigorous comparative analysis across three distinct geographic regions—Central, South, and North—to evaluate the impact of Offshore Wind (OSW) activities versus general maritime traffic on humpback whale mortalities. Utilizing data from the LUNA system to quantify OSW and general ship traffic, we compared humpback whale death rates before significant OSW activities (2006–2014) and after their initiation (2015–2023).

Regional Comparative Analysis

The findings demonstrate a striking correlation between whale mortalities and OSW activity:

Central Region:

- Intensive OSW activities
- Annual whale mortalities increased dramatically from 1.78 to 9.69 deaths/year (5.45-fold increase)
- Mortality rate peaked in 2023 at 21 deaths/year (11.8-fold increase), coinciding with maximum OSW traffic

South Region:

- Moderate OSW activities, approximately half the intensity of the Central Region
- Slight increase from 1.98 to 4.50 deaths/year (2.27-fold increase), despite 20% higher general maritime traffic
- Lower mortality increase contradicts the assumption of general maritime traffic as the primary cause

North Region (Control):

- No OSW activities, serving as a natural control region
- Stable mortality rate (approximately 3.5 deaths/year) before and after OSW initiation elsewhere
- Indicates general maritime traffic alone is insufficient to cause observed mortality spikes

Table-2: Humpback Dead whales in Central , South and North regions from 2006-2014 and 2015-2023.

Region	2006–2014 Deaths/year	2015–2024 Deaths/year	Change Factor	Statistical Significance	OSW Traffic (miles/year)	General Traffic >80m (miles/year)
Central	1.78	9.69	5.45x	Yes / Strong	58,895	1,800,359
Central-2023	1.78	21.00	11.8x	Yes / Very Strong	171,440	1,973,891
South	1.98	4.50	2.27x	Yes / Weak	20,520	2,138,830
North (Control)	3.89	3.50	0.90x	No / None	0	383,548

Within the Empire Wind polygon in the Central Region, the impact is even more pronounced:

Table-3: Humpback Dead whales in Empire Wind polygon from 2006-2014 and 2015-2023

Region	2006–2014 Deaths	2015–2023 Deaths	Change Factor
All Big Whales	16	47	2.94x
Humpback Whales	3	23	7.7x

This significant increase (7.7-fold) in a smaller, intensively surveyed area highlights the clear impact of OSW vessel activity.

Refutation of NOAA’s Generalized Approach

NOAA broadly attributes increased whale mortalities to human interactions, primarily general ship strikes, without precise attribution(see NOAA). Our data clearly demonstrates whale mortalities directly correlate with OSW activity intensity, refuting NOAA's generalized claims. Specifically:

- Whale deaths rise and fall directly in proportion to OSW activity.
- No significant mortality increase in regions without OSW activities (North Region).

Conclusion: Strong Causative Evidence

This comprehensive analysis conclusively establishes offshore wind (OSW) activities as the primary factor driving recent increases in humpback whale mortalities, supported by:

- High statistical significance across multiple analytical periods.
- Strong predictive correlation between OSW activity intensity and whale mortalities.
- Clear regional disparities, discounting general maritime traffic as the primary cause.

The pronounced mortality increases in OSW-intensive regions compared to control regions provide compelling evidence warranting immediate regulatory reconsideration. NOAA’s generalized UME approach inadequately addresses these findings. Establishing regional-specific Unusual Mortality Events (UMEs) would enhance accuracy in identifying causative factors and improve targeted mitigation strategies, crucial for protecting marine mammal populations from the documented impacts of OSW development.

Section 4: LUNA Monthly Survey, General Ship Traffic, and Whale Death Data for the Central Region.

This section presents standardized monthly data for offshore wind survey activity, general ship traffic (for vessels exceeding **80 meters)**, and humpback whale deaths within the Central Region. These datasets form the basis for subsequent analyses examining correlations and trends.

- **Table-4** lists monthly humpback whale death counts from 2015 through 2024, highlighting key findings:
    - The highest number of whale deaths occurred in 2023.

- October consistently shows the highest cumulative whale deaths across all recorded years.
- A total of 98 humpback whale deaths were documented over the 10-year span.
- Despite the high total, monthly data appear sparse due to:
  1. Whales dying primarily when both whales and multiple OSW survey vessels are simultaneously present, which varies monthly.
  2. NOAA's estimation that only about 20% of whale deaths are actually documented, suggesting significant underreporting.

- **Table-5** provides detailed monthly OSW survey traffic (in miles) for the Central Region. The highest OSW survey traffic aligns notably with the peak whale mortality in 2023, supporting the potential relationship between survey intensity and whale fatalities.

- **Table-6** includes monthly general ship traffic data specifically for vessels over 80 meters in length, based on NOAA's identification of these vessels as the primary threat for ship strikes (Thorne and Wiley, p. 2). By limiting our analysis to this vessel category, we align precisely with NOAA's criteria for assessing ship-strike risks.

- **Image-9** shows the tracks of sonar survey vessels during august of 2023 in the Empire wind polygon. *DEEP HELDER (blue color) and BROOKS MCCALL (orange color)* **t**raversed a total of 4167 miles for Empire wind project alone in August of 2023.

The data presented in these structured tables offer critical insights into offshore wind survey patterns, general vessel traffic, and whale mortality trends, enabling rigorous statistical and causal analysis.

Table-4: Central Region-Monthly Humpback Whales Death

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	TOTAL
Jan	0	0	1	0	0	0	0	1	5	0	**7**
Feb	0	0	0	2	0	1	0	0	2	0	**5**
Mar	0	2	0	0	0	1	0	0	2	0	**5**
Apr	2	2	1	1	0	1	0	0	0	1	**8**
May	0	0	0	3	1	2	0	1	4	0	**11**
Jun	1	2	2	2	1	0	0	0	1	1	**10**
Jul	0	0	0	1	1	3	0	1	0	0	**6**
Aug	0	0	0	1	2	0	0	0	4	1	**8**
Sep	0	1	1	0	1	1	1	0	1	1	**7**
Oct	2	0	4	0	3	1	0	1	1	2	**14**
Nov	0	2	1	0	1	2	0	1	1	0	**8**
Dec	0	0	1	0	1	1	0	3	0	3	**9**
TOTAL	**5**	**9**	**11**	**10**	**11**	**13**	**1**	**8**	**21**	**9**	**98**

Table-5: Central Region-Monthly Offshore Wind Surveying Traffic(Miles)

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	1656	715	455	853	1117	4417	4894	3254	7546	5143
Feb	1878	590	782	541	1149	3766	2514	2050	5818	5171
Mar	550	624	904	1321	1367	2716	3479	3336	7918	5853
Apr	677	958	1340	1061	3237	4023	9021	5384	14412	4542
May	2265	1333	2018	428	5647	6041	7762	6889	20760	6226
Jun	5255	3454	2581	3688	5356	7370	7954	6470	23263	3104
Jul	3222	1120	6460	4993	8308	8428	5262	6401	27358	2000
Aug	1047	1341	4130	6335	8324	7667	6424	6940	17767	2208
Sep	1085	1259	2709	3960	11459	7109	7538	5221	9169	890
Oct	1012	1415	3924	5419	9007	7465	4730	6914	14516	1713
Nov	840	1181	1518	3851	7907	8895	8545	5652	12670	1325
Dec	471	1331	1242	2209	5743	4684	5793	7273	10243	430
Total	**19958**	**15321**	**28063**	**34659**	**68621**	**72581**	**73916**	**65784**	**171440**	**38605**

Table-6: Central Region-Monthly General Big Ship Traffic length >80m

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	151,696	132,234	130,228	139,450	126,819	119,706	107,376	123,468	155,843	180,464
Feb	128,109	131,549	124,023	120,858	110,597	106,221	92,522	132,688	143,017	172,347
Mar	149,762	152,318	128,458	116,606	120,784	116,906	124,060	141,550	139,374	180,343
Apr	147,227	149,655	145,881	128,788	133,018	94,818	142,161	151,096	163,954	192,150
May	168,676	178,590	150,136	157,705	147,032	105,137	152,216	152,124	171,717	209,349
Jun	153,959	181,182	154,554	148,074	147,562	112,329	142,419	145,158	170,482	200,962
Jul	172,179	181,374	163,578	158,920	161,509	128,299	128,924	176,127	182,391	218,670
Aug	175,134	183,555	157,879	166,519	151,518	127,058	164,353	176,886	177,878	213,826
Sep	150,947	168,524	159,835	159,004	146,680	122,585	166,072	168,035	190,887	198,072
Oct	165,608	179,682	155,195	152,778	141,234	122,700	131760	170,700	177,877	197,678
Nov	139,962	160,131	139,514	126,201	127,955	116,196	133,754	144,782	142,933	172,305
Dec	144,353	139,264	127,670	126,612	127,044	119,979	144,720	149,206	157,538	173,558
Total	**1847612**	**1938058**	**1736951**	**1701515**	**1641752**	**1391934**	**1630337**	**1831820**	**1973891**	**2309724**

Image-9: Dead whales and sonar surveying activities within the Empire Wind polygon for August 2023. *DEEP HELDER (blue color)* conducted sonar surveys specifically for Empire Wind, covering a total of 3,127 miles. *BROOKS MCCALL (orange color)* contributed an additional 1,040 miles. Numerous other vessels also operated sonar equipment extensively in the region, likely surveying for cable installation routes through the New York Bight area.

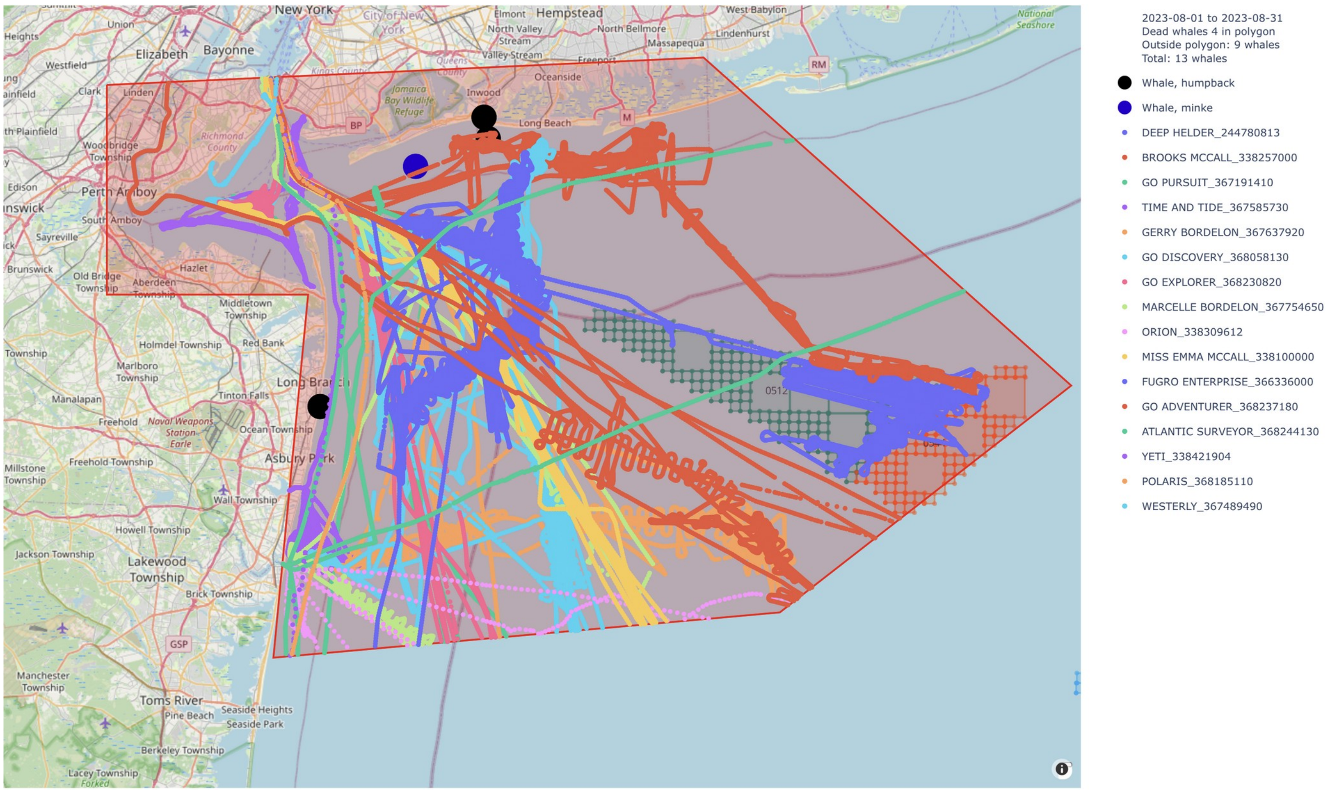


Image-10 clearly illustrates a near-linear relationship between offshore wind (OSW) survey activity and whale deaths in the Central region, strongly supporting our hypothesis that OSW surveys significantly increase whale mortality. In contrast, **Image-11** shows no discernible correlation between general ship traffic and whale deaths. Notably, general shipping traffic significantly decreased from 2016 to 2020 due to the Panama Canal expansion, which replaced numerous smaller container ships with substantially larger vessels. Traffic levels gradually recovered afterward, only returning to 2016 levels by 2023. This inverse trend provides further evidence that the Unusual Mortality Event (UME) in whale deaths cannot be attributed to general shipping traffic.

Data from 2021 was excluded from analysis due to anomalies stemming from COVID-19 disruptions, which significantly affected both data collection and maritime activity patterns. Additionally, early 2022 data may contain residual impacts from these pandemic-related disruptions.

Image-10: Whale Deaths vs Offshore Wind Traffic in the Central Region from 2015-2024(excluding 2021 outlier year)

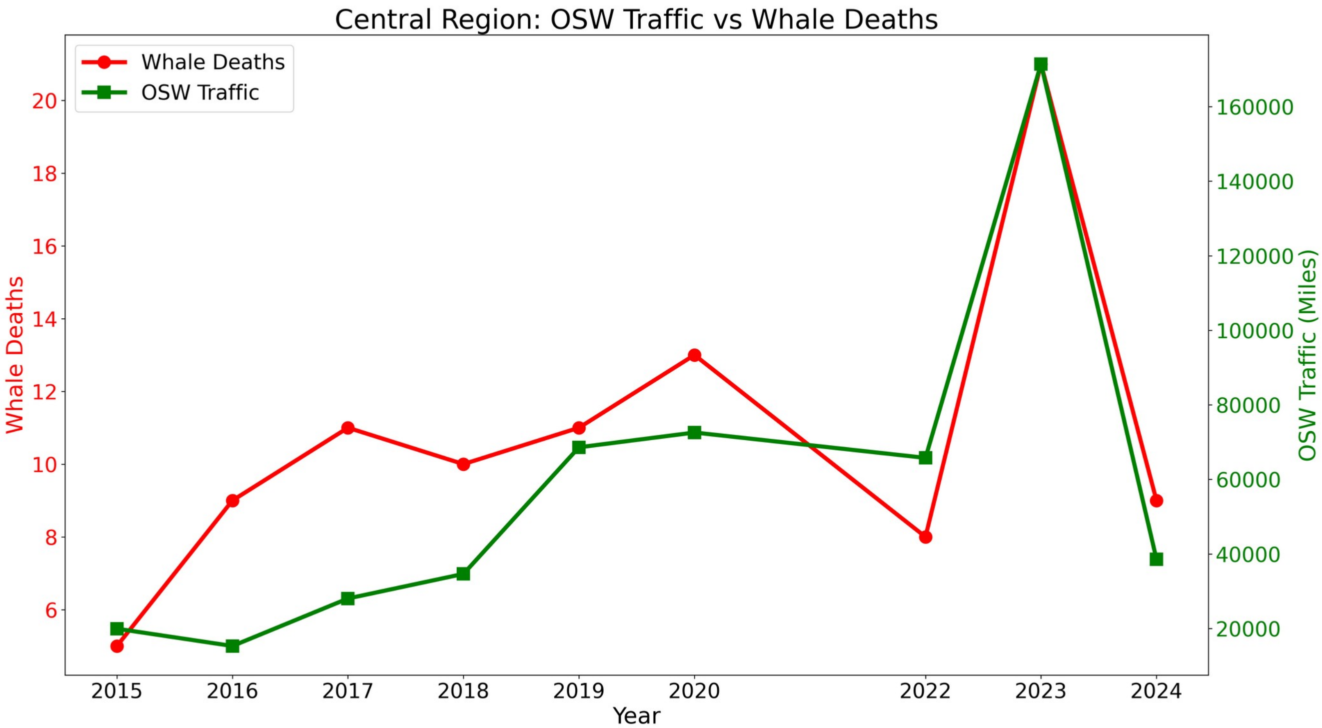
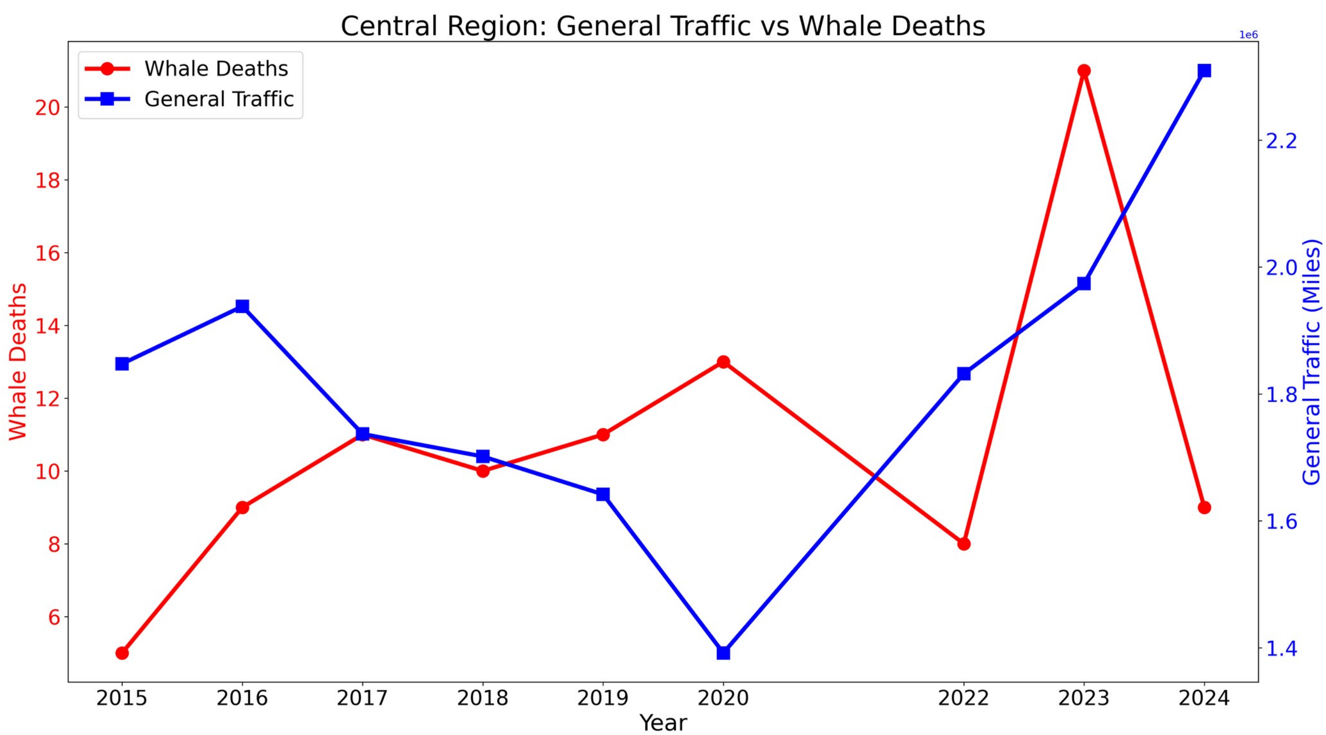


Image-11: Whale Deaths vs General Traffic in the Central Region from 2015-2024(excluding 2021 outlier year)



The visual analysis consistently identifies offshore wind surveying as correlated with increased whale deaths only in the Central region, where OSW activity levels are highest. Despite significant general ship traffic in both the South and Central regions, no similar correlation with whale deaths emerges. In the Southern region, lower OSW survey activity—approximately one-third of that in the Central region—results in insufficient data resolution to detect correlations.

Thus, for a correlation to become evident, both OSW traffic and whale mortality must surpass background data variability. This condition is clearly met in the Central region, further strengthening the conclusion that offshore wind surveying, rather than general ship traffic, is the key driver behind the observed rise in whale deaths.

Section 5: Statistical Analysis using the Generalized Linear Model (GLM)

Explanation of the Two-Month Rolling Window Method

A **rolling window analysis** is a statistical technique used to smooth episodic or irregular data by aggregating consecutive time periods. In our analysis, we employ a **two-month rolling window**, which calculates the sum of whale mortalities and offshore wind (OSW) traffic for each month combined with the previous month's data. Specifically:

- **Step-by-step process:**
  1. For each month, we sum the whale deaths and OSW survey traffic of that month and the preceding month.
  2. This produces a smoothed monthly time series, where each data point represents cumulative values for two consecutive months.
- **Ecological rationale:**
  This approach is ecologically critical because whale mortalities frequently occur near month boundaries due to factors such as drifting carcasses or delayed reporting. A two-month window provides a more realistic ecological representation of the actual event timing, thereby stabilizing episodic and irregular signals in whale mortality data.
- **Statistical benefits:**
  The two-month rolling window smooths short-term fluctuations and reduces statistical noise, significantly enhancing the detection of underlying ecological patterns and improving analytical robustness.

Explanation of the Pairwise Aggregation Method

Following the rolling window analysis, we apply a **pairwise aggregation method** to further consolidate the data and explicitly account for seasonal variation and longer-term patterns. The pairwise aggregation method involves combining corresponding months across years, creating month-pair data points analyzed collectively:

- **Step-by-step process:**
    1. **Monthly smoothing:** We start by taking each month's data, already smoothed using the two-month rolling window.
    2. **Pairwise aggregation:** Corresponding months across multiple years are paired, such as January-February pairs from different years, March-April pairs, etc.
    3. **Data reduction:** The aggregation results in fewer data points per year, but each represents a clearer, seasonally-consistent cluster, enhancing the detection of stable ecological signals across years.
- **Ecological rationale:**
    1. Whale behavior, migration, and mortality rates are inherently seasonal. Pairwise aggregation explicitly preserves seasonality, ensuring comparisons across years remain ecologically meaningful. It thus helps distinguish offshore wind (OSW)-related impacts clearly from natural seasonal variations.
- **Statistical benefits:**
    1. Pairwise aggregation significantly reduces variability and noise within the dataset, strengthening statistical power and enhancing the reliability of results.
    2. This clearer statistical assessment allows for robust detection of correlations and causal relationships, particularly when evaluating OSW survey intensity and whale mortalities.

Hybrid Approach (Rolling Window + Pairwise Aggregation): Justification

Combining the **two-month rolling window** with **pairwise aggregation** yields a powerful hybrid approach uniquely suited to this analysis. This hybrid method simultaneously achieves:

- **Smoothing episodic data:** by accounting for whale deaths spanning month boundaries, reducing irregular short-term variability.
- **Preserving ecological seasonality:** by explicitly clustering data points in ecologically meaningful month-pairs that capture seasonal migration and mortality trends.
- **Enhancing statistical robustness:** by reducing noise, stabilizing signals, and increasing the accuracy of detecting ecological impacts associated with offshore wind activities.

Together, these methods significantly strengthen the accuracy and interpretability of statistical results, clearly highlighting the ecological impacts of offshore wind activities on whale mortality patterns.

Potential Effect of Aggregation on OSW Signal Detection:

While rolling window smoothing and pairwise aggregation greatly enhance clarity and reduce noise, they may sometimes dampen sharp increases or episodic peaks in whale deaths and OSW traffic. For example, if an extreme episodic event (such as a rapid increase in whale deaths coinciding with intense short-term OSW activity) is spread across aggregation intervals, its sharpness and magnitude could be smoothed or even obscured.

However, if despite aggregation and smoothing, the ecological signal remains strong, clear, and statistically significant, it indicates that the correlation between OSW and whale deaths is robust and genuine. Aggregation, therefore, acts as a test: weaker, noise-driven signals will be smoothed away, but robust, ecologically meaningful correlations will survive.

This scenario occurs clearly in the Central Region data, where the OSW-related signal survives both rolling window smoothing and pairwise aggregation, yielding strong predictive power and high statistical significance.

Generalized Linear Model (GLM)

To rigorously assess the relationship between offshore wind (OSW) activities and humpback whale mortalities, we applied Generalized Linear Models (GLMs). GLMs are flexible statistical models suitable for analyzing count data (such as whale deaths), allowing for the examination of non-linear relationships and accommodating over dispersion commonly observed in ecological data. Our analysis specifically used Negative Binomial and Poisson models to account for varying levels of dispersion, selecting the most statistically appropriate model based on dispersion tests and Akaike Information Criterion (AIC).

We use Two-Month Rolling Window Method and Pairwise Aggregation Method and the GLM method. For each analysis, we applied both Poisson and Negative Binomial Generalized Linear Models (GLMs). We selected the final model based on clearly defined criteria: statistical significance (P-value < 0.05 for Poisson or P-value < 0.10 for Negative Binomial), dispersion values close to or below 1.5, and best predictive accuracy metrics (e.g., lowest AIC). This approach ensured the selected model provided the most accurate, stable, and meaningful ecological interpretation. The results are given in **Tables 7 and 8**.

The OSW GLM results in **Table-7** clearly and consistently highlight a statistically significant relationship between OSW traffic and increased whale mortalities. The Negative Binomial model was preferred for shorter aggregation periods due to better dispersion control. At the 12-month aggregation period, the Poisson model provided exceptionally high explanatory power (Pseudo $R^2 = 0.9065$) and predictive accuracy (RMSE accuracy = 80.45%), indicating strong ecological causality.

The General traffic results (>80m vessels) consistently demonstrate non-significant correlations with whale mortalities across all aggregation windows. The negligible coefficients and high p-values indicate that general ship traffic does not statistically explain humpback whale mortality patterns. The dispersion values close to 1 and minimal pseudo R^2 values further support this conclusion, highlighting that general vessel traffic does not contribute meaningfully to the observed increase in whale deaths.

Table-7: OSW Traffic GLM Results (Central Region, Humpbacks), Hybrid Method 2-Month Rolling Window and Pairwise Aggregation (2021 excluded)

Aggregation	Model	Coefficient	95% CI	P-value	AIC	Dispersion (Pearson)	Pseudo R^2	RMSE Accuracy (%)
2 months	Negative Binomial ✅	1.312e-05	[1.38e-06, 2.49e-05]	0.0285	249.66	1.0877	0.1759	21.76
4 months	Negative Binomial ✅	7.281e-06	[2.77e-07, 1.43e-05]	0.0416	154.78	1.0671	0.2502	36.55
6 months	Negative Binomial ✅	5.937e-06	[9.79e-07, 1.09e-05]	0.0189	111.46	0.9949	0.3129	50.46
12 months	Poisson ✅	3.353e-06	[2.02e-06, 4.69e-06]	0.0000	55.75	1.1638	0.9065	80.45

Table-8: General Traffic GLM Results (Central Region, Humpbacks), Hybrid Method 2-Month Rolling Window and Pairwise Aggregation (2021 excluded)

Aggregation	Model	Coefficient	95% CI	P-value	AIC	Dispersion (Pearson)	Pseudo R^2	RMSE Accuracy (%)
2 months	Negative Binomial ✅	-5.361e-07	[-3.49e-06, 2.41e-06]	0.7217	256.24	1.0616	0.0847	10.63
4 months	Negative Binomial ✅	-3.929e-07	[-5.64e-06, 4.85e-06]	0.6750	160.07	1.0293	0.0969	22.77
6 months	Negative Binomial ✅	-2.358e-07	[-1.60e-06, 1.13e-06]	0.7352	118.14	0.9963	0.0331	38.53
12 months	Negative Binomial ✅	-1.038e-07	[-7.51e-07, 5.44e-07]	0.7535	66.61	1.1428	0.0109	57.79

Regression curves for whale deaths vs OSW and General traffic for GLM

These GLM analyses robustly differentiate the significant ecological impact of offshore wind survey activity from general ship traffic. OSW activity consistently emerges as a strongly correlated factor with humpback whale mortalities, while general ship traffic remains consistently insignificant. This explicit distinction emphasizes the necessity for targeted regulatory scrutiny and tailored conservation strategies focusing specifically on offshore wind activities.

Image-12: OSW GLM Regression Results for Humpback Deaths (Central Region) using Hybrid Method (2-month Rolling Window + 12-month Pairwise Aggregation). Equation: Whale Deaths=exp(2.6017+3.353e-06×OSW_Traffic) Model Fit Poisson: Pseudo R^2 = 0.9065, P-value=0.0000, AIC=55.75, Dispersion=1.1638

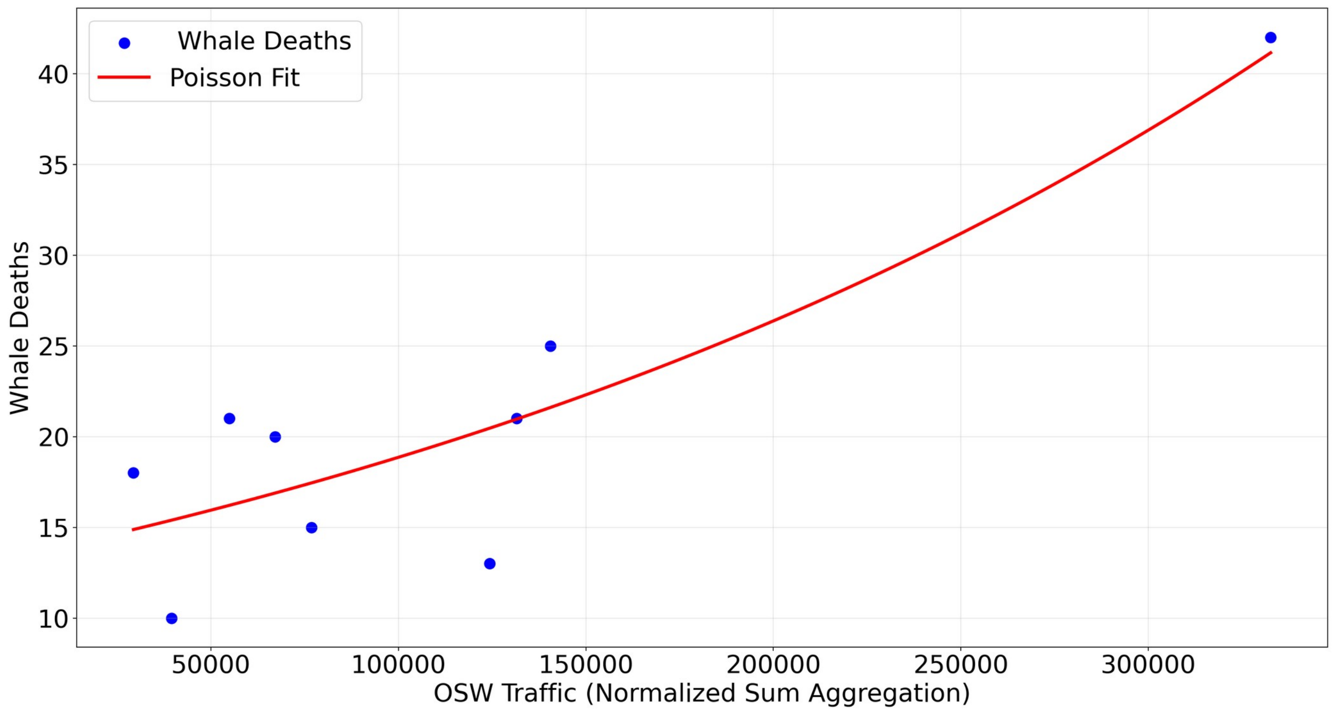


Image-12 clearly illustrates the regression line generated using the hybrid approach combining a two-month rolling window with a clustering period of 12 months. This regression distinctly demonstrates that whale mortalities increase proportionally with intensified offshore wind (OSW) traffic. In particular, the model accurately captures the pronounced surge in whale deaths during 2023 within the central region, coinciding precisely with a dramatic, threefold escalation in OSW traffic relative to previous years.

Image-13: General Traffic (>80m vessels) GLM Regression for Humpback Deaths (Central Region) using Hybrid Method (2-month Rolling Window + 12-month Pairwise Aggregation). Whale Deaths = exp(3.3851−1.093×e−7×General Traffic) Model Fit Negative Polynomial: Pseudo R^2 = 0.0109, P-value=0.7535, AIC=66.61 Dispersion=1.1428

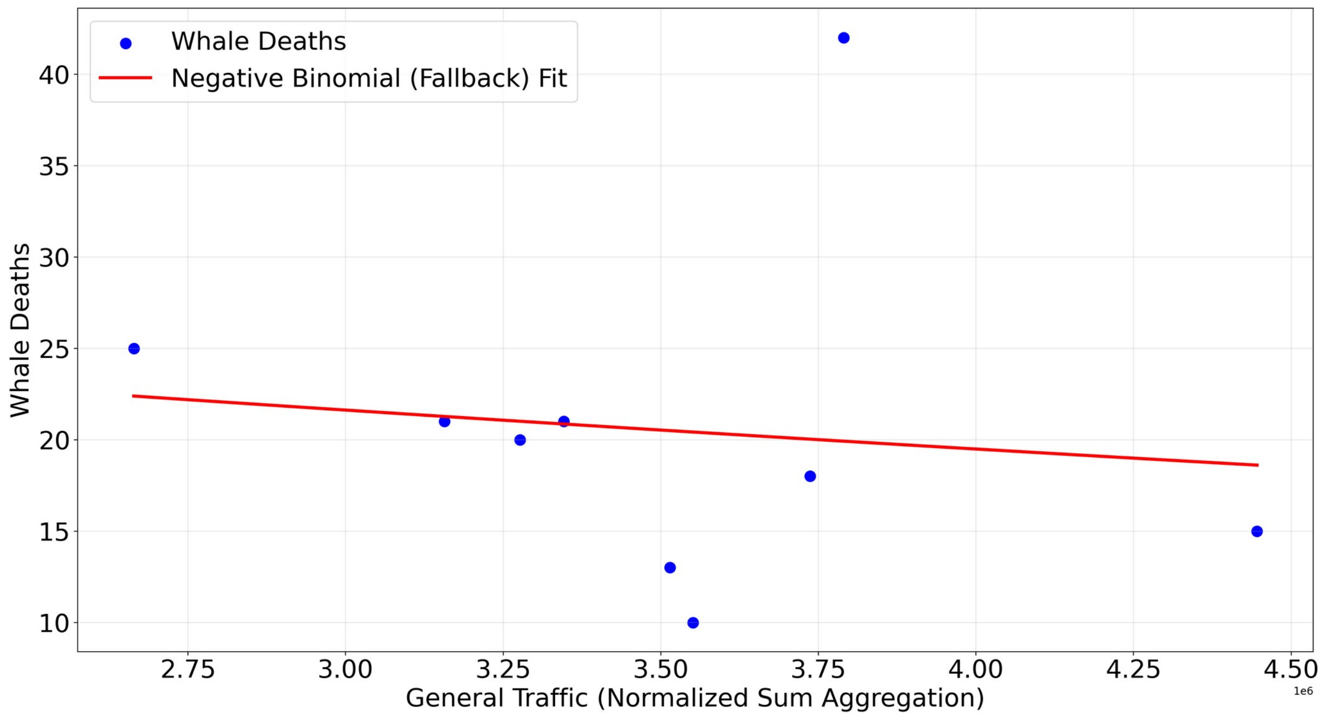


Image-13 highlights the regression line derived from general shipping traffic data. Notably, this regression line exhibits a negative coefficient, suggesting a slight decrease in predicted whale deaths with increased general traffic, underscoring its lack of ecological validity and predictive power. The general traffic model notably fails to account for the abrupt spike in whale deaths observed in 2023, clearly indicating its ineffectiveness as an explanatory variable.

Visual Confirmation of Model Accuracy (Images 14& 15)

- **Image-14** visually illustrates the exceptional predictive accuracy of the OSW Traffic model. It successfully captures even dramatic year-to-year fluctuations, notably the substantial increases and decreases observed in **2022–2023 and 2023–2024**. Such precise predictions strongly support a causal relationship, as only a model truly reflecting underlying causes could achieve this accuracy.
- In stark contrast, **Image-15** demonstrates the predictive failure of the General Traffic model, showing a flat, non-responsive trend that fails to capture the observed variations in whale mortalities, further underscoring its irrelevance.

Image-14 : OSW Actual vs. Predicted Whale deaths using the yearly GLM model without rolling window data smoothing

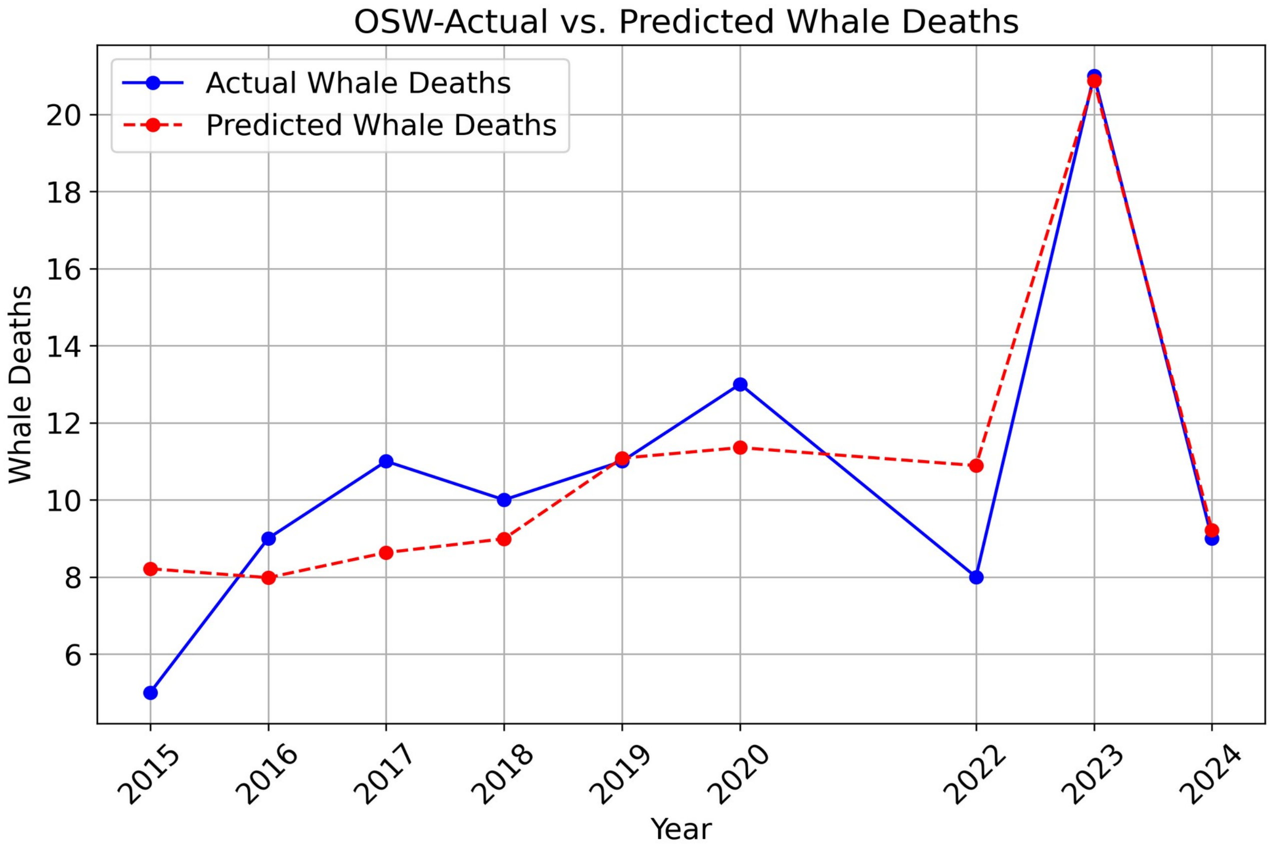
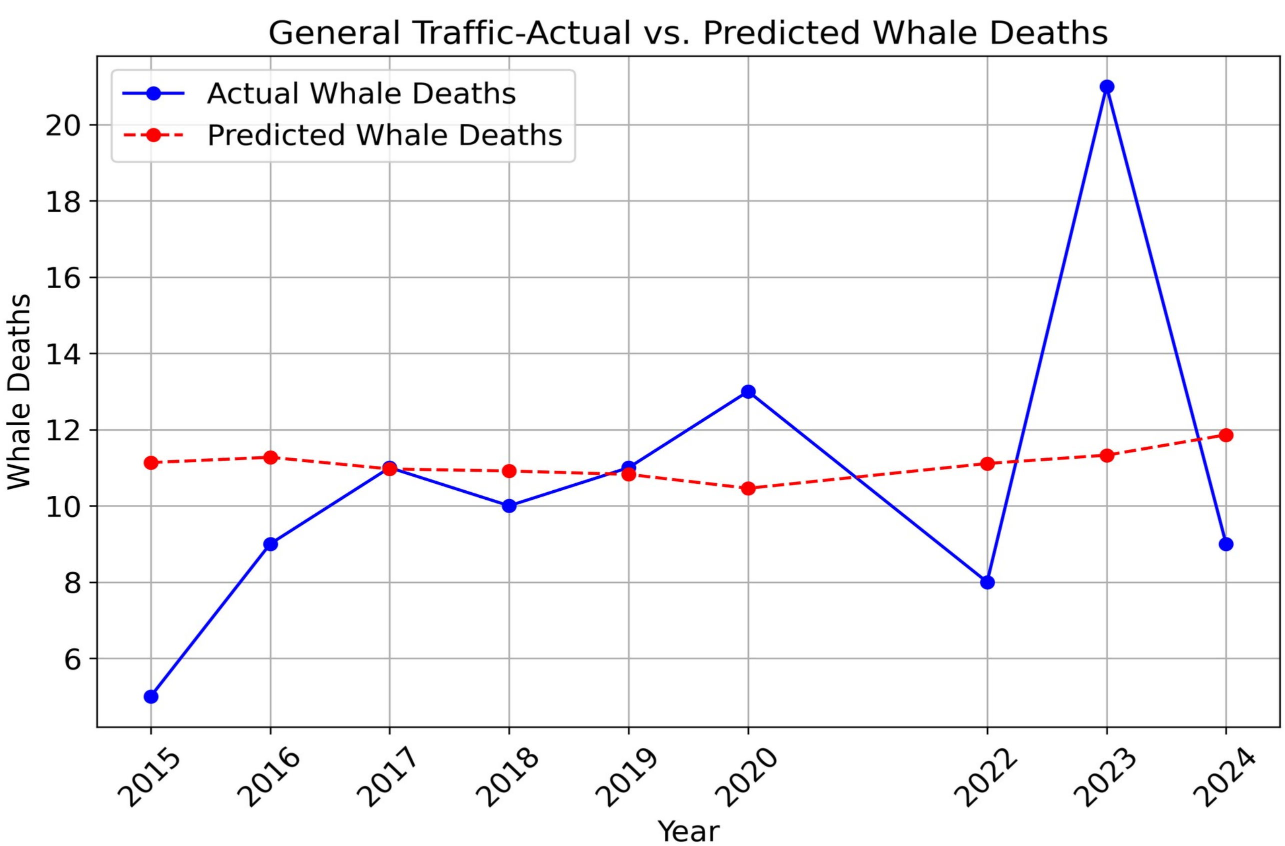


Image-15 : General Traffic Actual vs. Predicted Whale deaths using the yearly GLM model without rolling window data smoothing.



Strong Conclusion on Causality in the Central Region

The GLM analysis in the Central Region clearly establishes causality, strongly linking OSW activities to increased whale mortalities. OSW traffic consistently demonstrates statistically significant positive correlations across all monthly aggregation periods (2, 4, 6, and 12 months). The positive coefficients indicate a direct relationship, where increased OSW activity reliably predicts higher whale mortalities. In stark contrast, General Traffic (>80m vessels) repeatedly fails statistical significance tests and exhibits extremely low explanatory power (pseudo R^2 near zero), highlighting its inability to predict or explain variations in whale mortality, particularly during periods of pronounced mortality spikes such as in 2023.

Given NOAA's identification of ship strikes as the primary alternate explanation, and with General Traffic conclusively ruled out through rigorous statistical analysis, OSW activities emerge as the sole credible cause behind the observed increase in whale deaths during the Unusual Mortality Event (UME). The robust statistical significance and high predictive accuracy of OSW clearly indicate its role as the definitive causal factor driving humpback whale mortalities in the Central Region.

Conclusion

The comprehensive GLM analyses conclusively establish OSW activities as the primary driver of increased humpback whale mortalities in the Central Region. The exceptionally high predictive accuracy and robust statistical significance differentiate OSW from general maritime traffic, refuting previous assertions attributing whale mortalities to general ship strikes (Thorne, L. H., & Wiley, D. N. 2024.). These results clearly demonstrate that targeted regulatory measures and conservation strategies must focus specifically on offshore wind activities to effectively mitigate whale mortality.

Section 6: How OSW surveying Sonar Harms whales

Acoustic measurements conducted by Robert Rand offer critical evidence on the potential harm inflicted by caused by sonar and pile driving activities associated with offshore wind (OSW) projects:

1. Noise Levels from Offshore Wind Survey Vessels:

- **Measurement Date & Location:** May 8, 2023, near Long Beach Island, NJ.
- **Survey Vessel:** Miss Emma McCall
- **Sonar Sound Levels Recorded:**
    - Peak levels of **151.6 dB (peak re 1 μPa)** recorded at **0.5 nautical miles**.
    - Manufacturer's stated source level: **224–226 dB (peak re 1 μPa at 1 meter)**, recognized as harmful to marine mammals.

Robert Rand's Summary of Vessel Noise Analysis:
"The vessel noise was continuous, lacking discernible impulsivity, with prominent tonal components from propulsion, dynamic positioning thruster, and other machinery, along with a distinct cyclical grating sound. Combining vessel noise emissions below 40 Hz (**125.4 dB, rms**) with those above 40

Hz between sparker pulses (**120 dB, rms**), total continuous vessel noise was approximately **126.5 dB, rms** at **0.5 NM**. Vessel-generated noise remained notably above ambient sound levels at distances of 0.5, 1, and 2 nautical miles."

2. Long-Term Impact of Sonar Exposure:

Rand's data clearly indicate cumulative acoustic stress (cSEL) that accumulates over time, leading to significant auditory damage in whales:

- **Temporary Threshold Shift (TTS):**
  - Exposure exceeding TTS threshold after **10 minutes** at **500 meters**, resulting in temporary hearing loss.
- **Permanent Threshold Shift (PTS):**
  - Exposure surpassing PTS threshold after **five hours** at **500 meters**, causing permanent hearing impairment.
- **Severe Immediate Impact at Close Distances:**
  - At **141 meters**, permanent auditory damage occurs after only **25 minutes** of exposure.

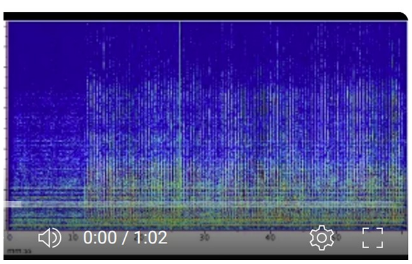
Consequences of Hearing Loss in Whales:

Hearing is crucial for whales to navigate, communicate, and evade threats. Hearing loss thus severely compromises survival, leading directly to:

- **Increased Ship Strikes:** Deafened whales exhibit a higher probability of collisions with vessels, potentially explaining the sixfold rise in ship strikes observed post-Unusual Mortality Event (UME) declaration.
- **Regional Disparities in Mortality Rates:** Regions without OSW activities showed no significant increase in whale deaths from pre-UME to post-UME periods, strongly suggesting OSW operations significantly contribute to whale fatalities.

Rand's Concluding Observation:

"To replicate underwater sonar levels in air, audio would need amplification to nearly 90 dB peaks. Yet, underwater conditions differ drastically; sound permeates the marine mammal's entire body, inflicting physiological stress extending far beyond hearing damage."



References: Robert Rand Papers , Robert Rand's YouTube Link

Section 7: Case Study: The Death of Saint – A Humpback Whale in Long Branch, NJ

Introduction

The death of Saint, a humpback whale discovered in Long Branch, NJ, on August 12, 2023, significantly reinforces the hypothesis that offshore wind surveying (OSW) activities are the primary factor behind increased whale mortalities.

Key Observations

1. Saint's History and Movement Patterns

- **Frequent Visitor**: Regularly observed since 2022 in the Manasquan area, NJ, a known nearshore feeding habitat.
- **Identifiable Injury**: Left fluke missing due to a healed injury from a vessel strike recorded in fall 2022.
- **Healthy Condition**: Last observed alive and actively breaching on July 24, 2023, two weeks prior to death, with no visible signs of illness or distress.

2. Death and Investigation Timeline

- **Discovery**: Found deceased at sea near Asbury Park, NJ, at 9:17 AM, August 12, 2023.
- **Drift and Landfall**:
    - Reported coordinates at 1:48 PM: LAT 40°14.535'N, LON 73°56.903'W.
    - Wind shift at 3:30 PM to 30 knots from the southeast pushed the whale toward shore.
    - Initial landfall at 4:24 PM at Breakwater Beach Club, Long Branch, NJ.
    - Final resting location near St. Alphonso's Retreat House at 8:09 PM.

3. Necropsy Results (MMSC.org)

- **No Blunt Trauma**: Rules out collision with a large vessel.
- **Presence of Food**: Stomach and gastrointestinal contents indicate active feeding shortly before death.
- **Bruising Around Head and Neck**: Evidence of internal trauma potentially due to sonar-induced stress or disorientation.
- **No Entanglement or Disease**: Histopathology results remain unresolved for over a year, leaving no alternative identified cause.

Offshore Wind as the Primary Suspect

1. Saint's Health Before Death

- Confirmed healthy and feeding actively just two weeks prior.
- Absence of blunt trauma eliminates large vessel collision.

2. Intense OSW Survey Activity

- Extensive surveying occurred in Saint's feeding grounds, totaling over 13,805 miles in the 20-day period before her death.
- Multiple simultaneous vessels created significant cumulative sonar noise, a recognized cause of stress and disorientation in marine mammals.
- The Probability of Encounter with Sonar was 88% if it stayed feeding in the area for 20 prior days **see Table-9**.

3. Lack of Alternative Causes

- No evidence of entanglement or illness according to available MMSC.org and NOAA reports.
- Prolonged delay (over one year) in histopathology results further obscures other potential causes, leaving OSW surveying as the primary suspect.

Table-9: Probability of Encounter for Saint in NY Bight (see Apostolos Gerasoulis 2025)

Type	Daily Probability (P_daily)	20-Day Probability (P_20)
Survey Vessels	**8.99%**	**87.7%**
General Ships	**1.08%**	**19.8%**

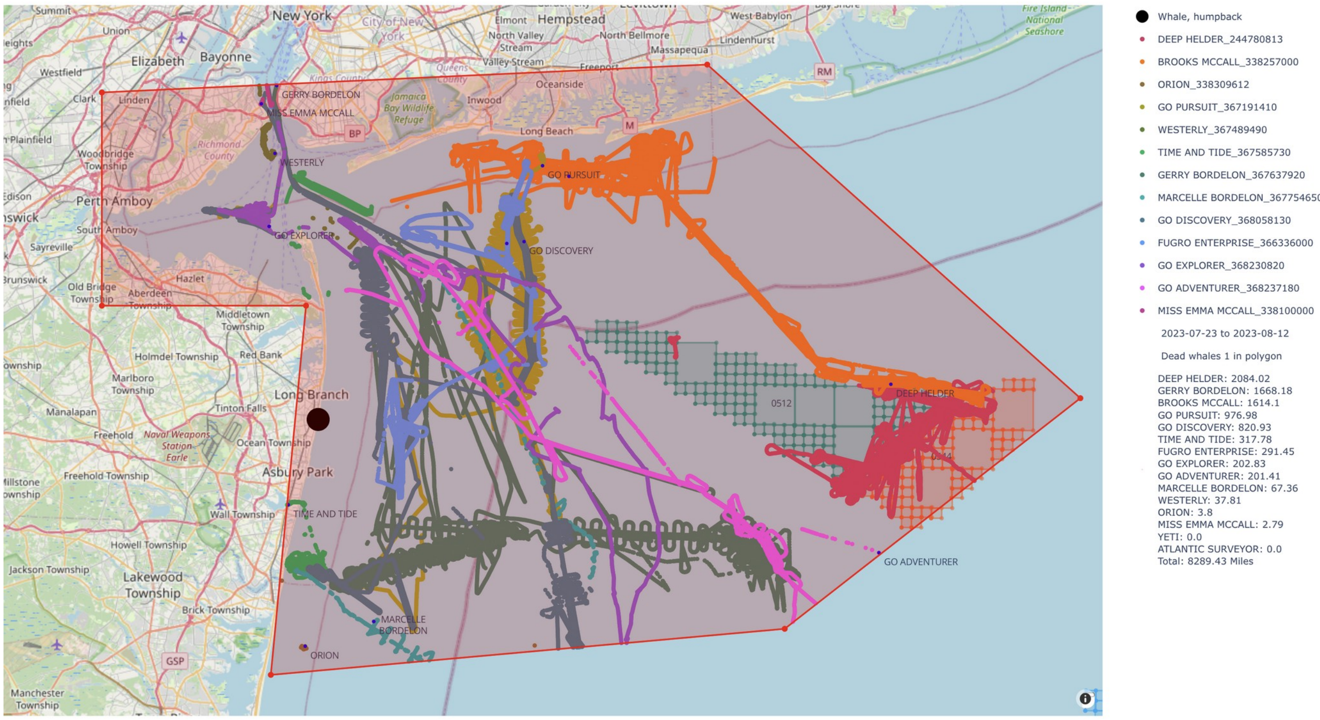
Image-16: Saint Breaches in NJ Shore on July 24, 2023

Image-17: Saint dead in Long Branch Aug 12, 2023 **Surveying Activity Near Saint**

Table-10: Vessel Miles Traveled – 20 Days Before Saint's Death (Long Branch, NJ)

Vessel Name	Miles Traveled
DEEP HELDER	2101
GO DISCOVERY	1827
GERRY BORDELON	1692
BROOKS MCCALL	1613
FUGRO ENTERPRISE	1536
GO ADVENTURER	1396
MISS EMMA MCCALL	816
GO EXPLORER	1017
MARCELLE BORDELON	259
TIME AND TIDE	324
ATLANTIC SURVEYOR	124
Total Miles	13,805

Image-18: Saint landing location and offshore wind surveying vessel activity from July 23 to August 12, 2023, covering 13,805 surveying miles.



Conclusion

Saint's death highlights the strong correlation between offshore wind surveying and whale mortality:

- Her healthy condition prior to death(see **Image 16)**.
- Absence of blunt trauma(**see Image 17)**.
- No entanglement or disease(see **MMSC.org)**
- Intense OSW activity surrounding her feeding grounds(see **Image 18)**

These factors make offshore wind surveying the only plausible cause. This case underscores the cumulative impact of sonar noise from multiple vessels, which can disorient and exhaust whales, leading to stress-induced injuries or death. Until NOAA releases its necropsy results with definitive findings, the LUNA data provides the strongest evidence implicating offshore wind surveying as the primary cause of Saint's death.

The probability of encountering a sonar-equipped survey vessel is over 8 times higher than encountering a general ship. Given that Saint was not struck by a vessel and considering the 88% probability of encountering sonar, this strongly supports the theory that offshore wind surveying activity caused Saint's death.

Summary of Research Findings on Offshore Wind and Increased Whale Deaths

Our comprehensive research clearly demonstrates a robust and consistent correlation between intensive offshore wind (OSW) surveying activities and increased whale mortality. Specifically, periods of heightened offshore wind surveying activity align precisely with significant rises in whale deaths; conversely, when surveying activities diminish or stop entirely, whale death rates return to baseline levels. This consistent pattern strongly indicates offshore wind activity as a primary factor contributing to elevated cetacean mortalities along the East Coast.

Crucially, our analysis reveals no meaningful correlation between general shipping traffic and increased whale deaths. Although necropsies frequently report signs of blunt-force trauma, these injuries are not strongly associated with large-ship collisions. Instead, evidence suggests whales become disoriented or experience temporary or permanent hearing impairment due to intense acoustic disturbances from OSW activities, indirectly leading to fatal collisions or strandings.

Notably, NOAA has acknowledged in its Biological Opinion regarding Vineyard Wind Phase 2 that construction-related noise can cause temporary deafness in whales (see here), Despite this acknowledgment, necropsies on deceased whales and dolphins rarely, if ever, specifically examine auditory structures, such as the ear drums. This critical oversight raises significant questions: Why have whale and dolphin ear structures been consistently neglected during examinations? Could this omission reflect reluctance by regulatory agencies to document findings potentially detrimental to government-supported offshore wind initiatives? An example of overlooked trauma includes bleeding around the eyes, as reported by the Daily Mail in February 2024.

Furthermore, NOAA's justification for the absence of auditory examinations—that carcasses are frequently too decomposed—is insufficient, particularly given the magnitude of the issue. Recent independent studies support our concerns. Marine biologist Ursula Siebert from the Institute for Terrestrial and Aquatic Wildlife Research in Hanover, Germany, documented that porpoises washed ashore in the North and Baltic Seas frequently display severe internal auditory injuries, including fractured auditory bones (see here)). Such injuries clearly indicate damage from intense acoustic exposures, similar to those produced by pile-driving and naval sonar operations. Indeed, the U.S. Navy has previously acknowledged that its sonar activities have directly caused whale deaths, underscoring the validity of acoustic-induced mortality (see here).

Combined with our rigorous statistical analyses, this accumulating biological evidence solidifies the conclusion that offshore wind survey and construction activities are the primary cause behind the recent spike in whale mortalities. Immediate and decisive action from regulatory and governmental agencies is imperative to address and mitigate these detrimental impacts on marine life.

Dedication

This research is dedicated to Luna, a 41-foot-long humpback whale found dead at Lido Beach West Town Park in Nassau County, New York, on January 18, 2023. NOAA had monitored Luna’s life for over four decades, during which it successfully navigated and survived numerous hazards. Luna’s tragic death coincided with the peak intensity of offshore wind surveying, symbolizing the urgent need for protective measures against industrial threats to marine wildlife.

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EXHIBIT C

Offshore Wind Activities—Pile Driving and Sonar Surveying—as Primary Causes of Increased Whale Mortality: A Geospatial and Statistical Analysis of the Central North Region (Part II)

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Abstract

This study provides robust statistical and geospatial evidence linking offshore wind (OSW) activities—specifically sonar surveying and pile driving—to elevated whale mortalities in the Central North Region (Rhode Island and Massachusetts, south of Cape Cod) from 2015 through 2024. Advanced analytical methods, including rolling-window correlations, pairwise data aggregation, and Generalized Linear Models (GLMs), consistently demonstrate significant relationships between intensified OSW operations and increased humpback whale deaths. Our analysis introduces an equivalence metric, revealing pile driving impacts to be approximately 3.2 times more detrimental to whales than sonar surveying alone. Crucially, no significant correlation between whale deaths and general shipping traffic was observed, directly challenging NOAA's assertion that vessel strikes are the predominant cause of whale mortality. Independent biological findings documenting auditory trauma consistent with intense acoustic disturbances from sonar and pile driving further substantiate our conclusions. Immediate regulatory intervention and targeted mitigation of pile-driving operations are urgently needed to protect marine mammal populations from continued harm.

Introduction

The marked rise in whale mortalities along the U.S. East Coast, particularly within the Central North Region (encompassing Rhode Island and Massachusetts south of Cape Cod), has triggered extensive ecological concern and debate surrounding potential anthropogenic causes. Since NOAA declared the ongoing Unusual Mortality Event (UME) in 2016, humpback whale deaths have significantly increased. While NOAA primarily attributes these deaths to vessel strikes, their explanation falls short of addressing many documented mortalities that lack clear evidence of collisions or entanglements.

Concurrent with the increased whale mortalities, offshore wind (OSW) activities—specifically sonar surveying and pile driving—have intensified significantly within critical whale habitats. Despite growing evidence from independent researchers suggesting severe impacts on marine mammals due to OSW activities, these factors have been inadequately assessed by regulatory bodies.

Our current study builds substantially on prior analyses by rigorously incorporating pile driving alongside sonar survey activities, examining their combined and individual impacts on whale mortality from 2015 to 2024. Employing the advanced marine geospatial analytical system LUNA, we executed detailed statistical methods including rolling-window correlation analyses, pairwise data aggregation, and Generalized Linear Models (GLMs). Crucially, our analysis introduces a robust equivalence metric demonstrating that the acoustic impact of pile driving activities on whale mortality is approximately 3.2 times more severe per equivalent mile than sonar surveying alone.

We clearly establish a statistically significant correlation between intensified OSW operations (pile driving and sonar surveying) and increased humpback whale mortalities, while simultaneously refuting NOAA's hypothesis attributing these mortalities primarily to general ship traffic. Independent biological evidence further reinforces our findings, explicitly demonstrating severe auditory trauma and related physiological distress in marine mammals exposed to intense OSW acoustic disturbances.

Given the compelling evidence uncovered, immediate regulatory action, stringent mitigation measures, and enhanced monitoring specifically targeted at pile driving and sonar surveying operations are urgently needed to prevent further harm to whale populations.

OSW Survey Vessel Sonar and Pile Driving Impact Review

Concerns regarding the impact of offshore wind (OSW) survey sonar and pile-driving noise on cetaceans and fish have been longstanding. As early as 2002, military sonar was confirmed to cause harm and death in cetaceans (Scientific American, 2009). Similar concerns related to OSW sonar noise emerged shortly afterward, notably highlighted in studies by Helen Bailey et al. in 2010 and a subsequent paper in 2014 (Bailey et al., 2010; Bailey et al., 2014). In response, NOAA implemented a 500-meter exclusion zone for baleen whales to mitigate harm from OSW activities (NOAA Letter of Authorization, to GSOE, 2018; and to Echo Offshore, 2023; BOEM, n.d.) .

Despite recognizing potential risks, NOAA consistently maintained there was no definitive evidence linking OSW activities directly to whale mortalities, instead attributing increased whale deaths to vessel strikes from increased shipping traffic. After seven years of Unusual Mortality Event (UME) declarations, NOAA researchers published a study by Thorne and Wiley (2024), reinforcing their argument that OSW is unrelated to increased whale deaths. However, not all NOAA scientists align with this view. Dr. Sean Hayes, Director of the Protected Species Division at NOAA's Northeast Fisheries Science Center, raised significant concerns regarding potential impacts of offshore wind, such as increased noise, vessel traffic, and persistent oceanographic changes affecting whale prey distribution. Hayes particularly emphasized enduring impacts from turbine operations throughout a project's lifespan (Hayes, 2022).

Further challenging NOAA's narrative, acoustician Robert Rand directly measured OSW sonar emissions, recording peak sonar levels up to 226 dB near OSW survey vessels, capable of causing rapid and permanent hearing damage in cetaceans (Rand , 2023a). Rand also provided detailed acoustic evidence for pile driving illustrating actual exposures experienced by marine mammals, underscoring significant risk and direct biological harm (Rand , 2023b).

Section 1: Central North Region Visual Analysis

LUNA: Geospatial Marine Analysis Software System

LUNA is an advanced geospatial software system specifically developed for detailed marine environmental analysis. Its key functionalities include:

- Calculating vessel traffic density and correlating these data with whale mortality events.
- Precisely partitioning geographic regions into polygons for targeted spatial assessments.
- Visually representing vessel movements alongside whale stranding incidents to identify spatial and temporal patterns.
- Conducting sophisticated statistical analyses, including correlation assessments Generalized Linear Model(GLM) and Bayesian regression modeling.
- Monitoring and analyzing temporal trends across various intervals, such as monthly and annual scales.

LUNA integrates extensive datasets from NOAA (stranded large whales and small cetaceans), Marine Cadastre (vessel AIS data), and independently gathered marine observational data. Leveraging this comprehensive dataset, LUNA has conclusively identified offshore wind (OSW) sonar surveying as the primary factor responsible for the significant rise in whale mortalities following NOAA's declaration of an Unusual Mortality Event (UME). Our rigorous analyses confirm that general vessel traffic does not significantly contribute to the observed increase in whale deaths.

Image 1 illustrates the Central North polygon region, encompassing areas of Massachusetts south of Cape Cod, Rhode Island, and portions of eastern Long Island, NY. It also shows the OSW sonar traffic calculated by LUNA, totaling 9,853 miles, during which four whale mortalities were documented. **Image 2** presents data on humpback and right whale deaths between 2016-2023, highlighting an elevated annual death rate of 5.625. In comparison, **Image 3** depicts whale mortality from 2006-2013, where the annual death rate was significantly lower at 2.375 for humpbacks.

Table 1 provides comparative data showing the rate of increase in whale mortalities across various whale types, including all large whales, humpbacks, and right whales. The mortality rate has risen by

1.79 times for all whales, 2.37 times for humpbacks, and notably, seven times for right whales—though the absolute number for right whales remains relatively small. Particularly noteworthy is the disproportionate impact on humpback whales, consistent with observations from the Central region. In the Central region specifically, the increase factor for humpback whale mortalities is even more pronounced at 5.45 times, with an extraordinary surge during 2023 reaching a factor of 11.8 times. Additionally, the OSW traffic intensity in the Central region is approximately twice that observed in the Central North region, strongly indicating that higher OSW traffic correlates with elevated whale mortality rates.

Image-1: Central North Region OSW Traffic 9853 miles and 4 Whale Mortalities, July 2020,

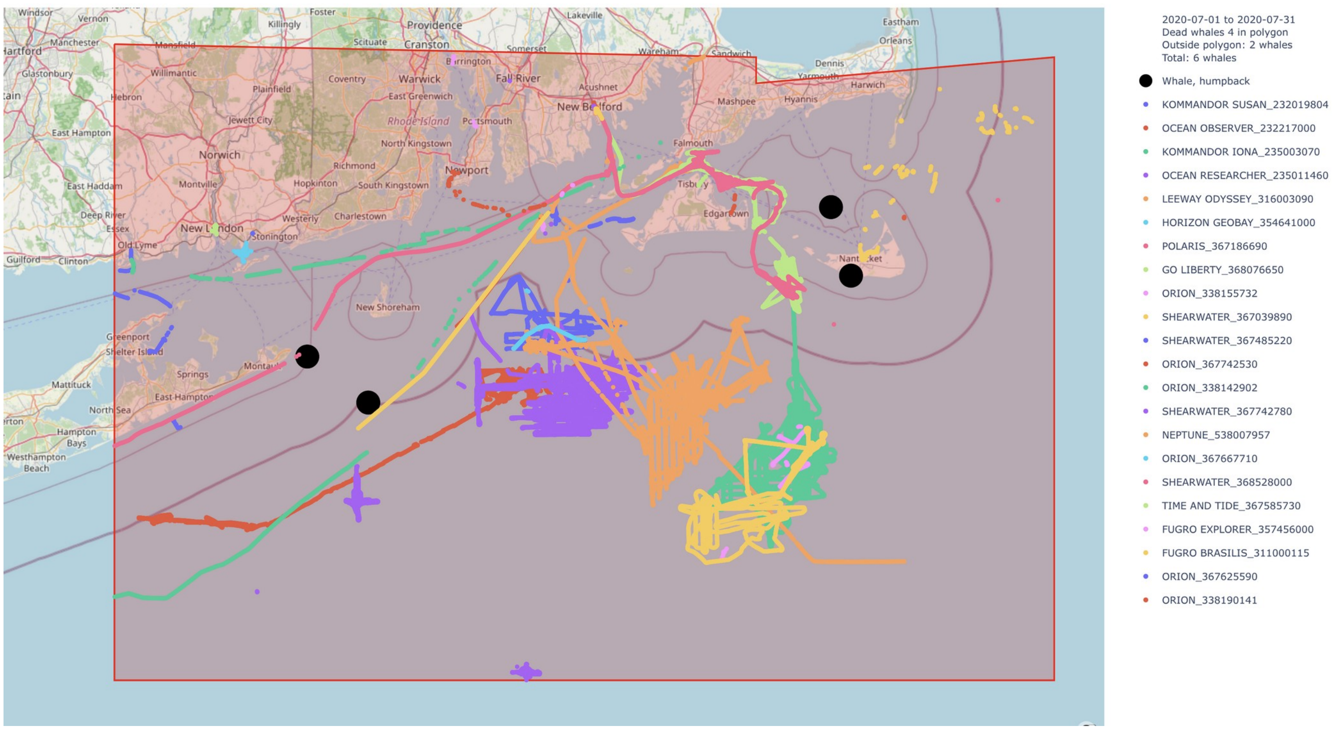


Table-1: Central North Region Whale Mortalities and Increase Factors (2006–2023)

Species	2006–2013	2016–2023	Increase Factor
All Whales	48	86	1.79x
Whale, right, North Atlantic	1	7	7.00x
Whale, humpback	19	45	2.37x

Image-2: Humpback and Right dead whales in central north region from 2016-20233 . Humpbacks 45, Right 7.

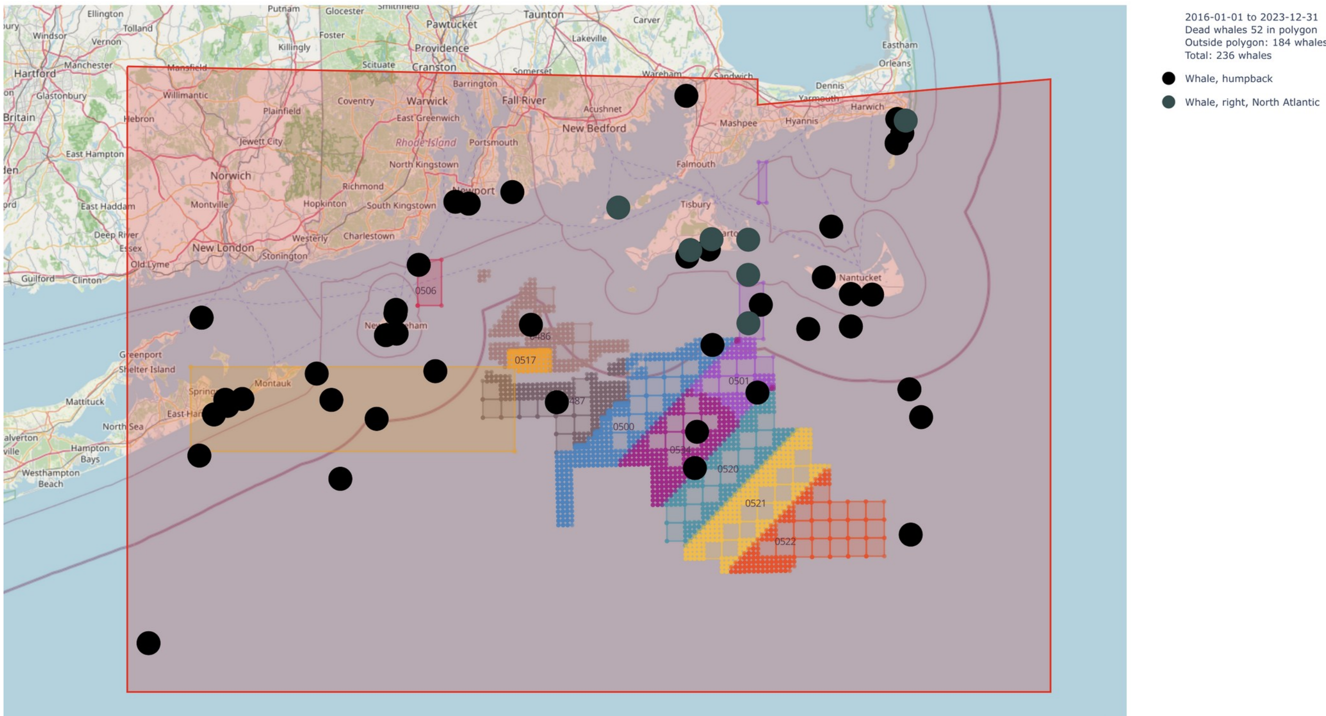
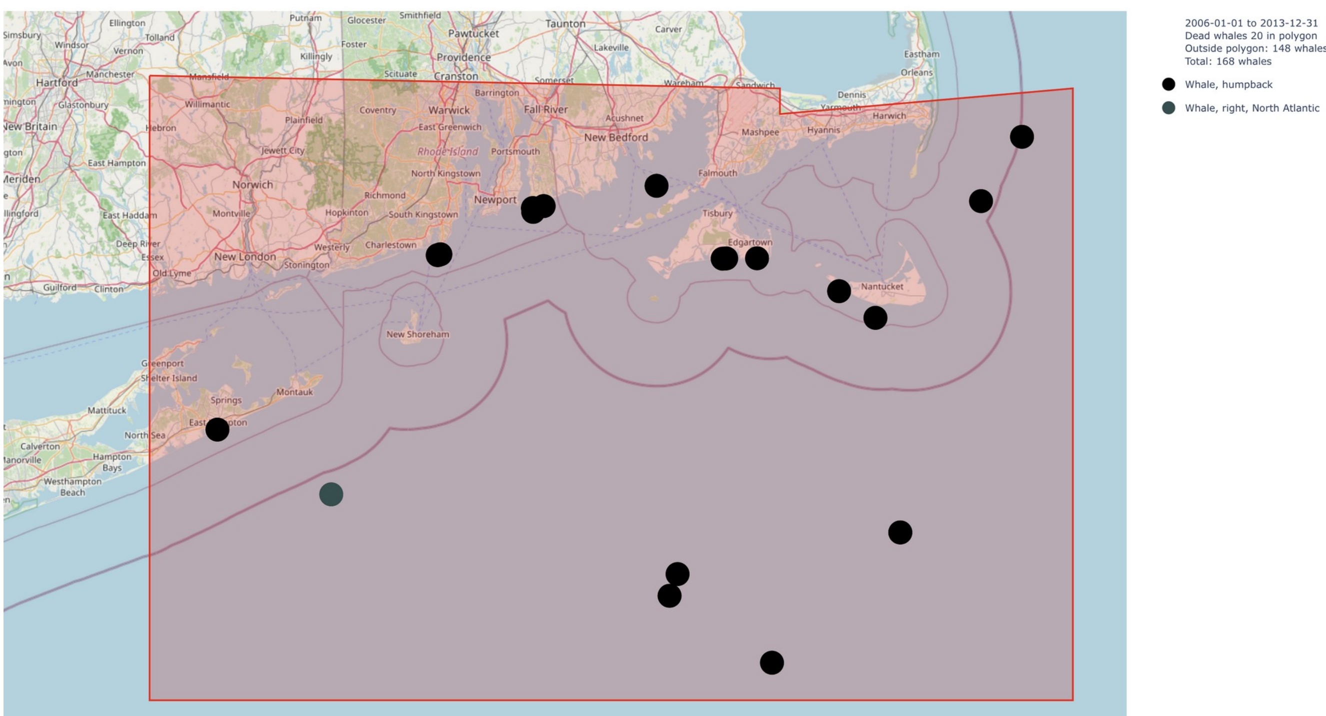


Image-3: Humpback and Right dead whales in central north region from 2006-2013. Humpbacks 19, Right 1.



Section 2: LUNA Monthly Survey, General Ship Traffic, and Whale Death Data for the Central North Region.

This section presents standardized monthly data for offshore wind survey activity, general ship traffic (for vessels exceeding **80 meters)**, and humpback whale deaths within the Central North Region. These datasets form the basis for subsequent analyses examining correlations and trends.

- **Table-2** lists monthly humpback whale death counts from 2015 through 2024, highlighting key findings:
  - The highest number of whale deaths occurred in 2020 a total of 12.
  - A total of 55 humpback whale deaths were documented over the 10-year span.
  - Despite the high total, monthly data appear sparse due to:
    - Whales dying primarily when both whales and multiple OSW survey vessels are simultaneously present, which varies monthly.
    - NOAA’s estimation that only about 20% of whale deaths are actually documented, suggesting significant underreporting.
- **Table-3** provides detailed monthly OSW survey traffic (in miles) for the Central North Region. One of the highest OSW survey traffic aligns notably with the peak whale mortality in 2020, supporting the potential relationship between survey intensity and whale fatalities. Additionally, pile driving activities commenced in the area starting in May 2023 and continued uninterrupted through December 2024, further intensifying offshore wind-related disturbances.

- **Table-4** includes monthly data on general ship traffic specifically for vessels greater than 80 meters in length, aligning explicitly with NOAA’s identification of these vessels as the principal threat regarding ship strikes (Thorne and Wiley, p. 2). Observations indicate a notable decline in general vessel traffic beginning in 2016, reaching its lowest point in 2020, and only returning to 2016 levels by 2023. This significant reduction and delayed recovery of general vessel traffic strongly suggest that general shipping activity cannot reasonably explain the marked increase in whale mortalities during the Unusual Mortality Event (UME), contradicting NOAA’s prior assertions.

The data presented in these structured tables offer critical insights into offshore wind survey patterns, general vessel traffic, and whale mortality trends, enabling rigorous statistical and causal analysis.

Table-2: Central North Region Humpback Whales Death, Average Per Year: 5.5

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	0	0	0	0	0	0	0	1	0	0
Feb	0	0	0	0	0	0	0	0	0	0
Mar	0	1	0	0	0	1	0	0	0	0
Apr	0	2	0	0	0	0	1	0	0	0
May	0	0	0	1	0	1	0	2	2	1
Jun	0	0	3	0	0	0	0	0	3	1
Jul	0	0	1	1	1	4	0	0	1	0
Aug	0	0	1	0	0	1	0	0	0	1
Sep	0	1	1	0	0	0	0	1	1	1
Oct	1	0	3	0	0	0	0	1	1	1
Nov	0	0	0	0	0	3	0	0	0	0
Dec	0	0	1	0	1	2	0	1	0	4
Yearly Total	**1**	**4**	**10**	**2**	**2**	**12**	**1**	**6**	**8**	**9**

Table-3: Central Region-Monthly OSW Traffic, Average per year 35875.7 Miles.

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	18	67	205	2314	2000	2600	2386	2511	4257	1784
Feb	17	4	331	2764	1848	347	743	1369	619	2152
Mar	1	309	254	2294	497	298	207	2287	276	2014
Apr	20	134	201	3597	220	2551	2634	7383	223	696
May	1567	117	2208	6495	499	3597	6671	11168	340	1730
Jun	1160	699	3717	3054	6798	4382	6375	9846	1764	3651
Jul	1639	686	2007	2225	6725	9853	8749	10169	1503	5243
Aug	301	1938	6023	4543	6223	12484	8593	7973	522	4688
Sep	557	2047	3503	2572	5459	9237	5672	3710	391	2254
Oct	107	2625	5492	1911	6098	6953	3881	5199	2464	2019
Nov	228	1188	3860	1956	3333	5878	3816	5727	2477	1675
Dec	214	352	2160	2146	3842	2861	3150	5849	1855	1682
Total	**5829**	**10166**	**29961**	**35871**	**43542**	**61041**	**52877**	**73191**	**16691**	**29588**

Table-4: Central North Region-Monthly General Big Ship Traffic length >80m, Average Per Year: 566,447.8

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	47401	36400	36448	41806	34640	34284	34093	25932	46423	44641
Feb	38660	33190	32240	36056	27994	30633	24487	33297	34668	47407
Mar	43908	41094	34631	32008	35010	37935	38078	34223	35042	51177
Apr	43204	44594	45293	34642	40532	27442	48979	44137	51466	61246
May	52550	51752	48327	48973	44839	32746	53016	46029	57329	72341
Jun	50158	56424	49396	47697	47173	39557	50764	46118	60809	70201
Jul	53223	58471	52461	52221	57163	43395	45378	57202	68039	81653
Aug	60732	61606	55258	56827	48487	41434	57655	62871	70597	78302
Sep	49627	57834	60060	58222	53601	40316	55371	54381	73409	71169
Oct	55391	58065	56072	52574	50115	38227	40677	59893	60617	74441
Nov	39930	51934	43347	34829	41832	35245	40132	43265	39088	53981
Dec	39976	39789	35420	33074	36811	33361	36956	38760	43060	49111
Total	**574760**	**591153**	**548953**	**528929**	**518197**	**434575**	**525586**	**546108**	**640547**	**755670**

Section 3: Statistical Analysis using the Generalized Linear Model (GLM) for Central-North Region.

Explanation of Analytical Methods (Brief Summary)

Two-Month Rolling Window Method:
We employed a two-month rolling window to smooth episodic whale mortality data by aggregating each month's whale deaths and OSW survey traffic with the preceding month. This technique accounts for delayed reporting and drifting carcasses, providing ecologically realistic representations of whale mortality events while reducing statistical noise.

Pairwise Aggregation Method:
After smoothing with the rolling window, we aggregated data by pairing corresponding month clusters across years (e.g., January-February pairs). This approach explicitly preserves seasonal patterns crucial

to whale ecology, enhancing the detection of stable, ecologically meaningful signals while further reducing variability.

Hybrid Approach (Rolling Window + Pairwise Aggregation):
Combining these methods creates a robust analytical framework that smooths episodic variations, maintains ecological seasonality, and significantly enhances statistical robustness. Although smoothing may reduce sharp episodic peaks, genuine ecological signals, such as those observed in the Central Region analysis, persist strongly, indicating a robust and meaningful correlation between OSW activities and whale mortalities.

Generalized Linear Model (GLM) Analysis: OSW Traffic and Pile Driving Impacts

To rigorously evaluate the relationship between offshore wind (OSW) activities—including both sonar surveying and pile-driving—and humpback whale mortalities, we applied Generalized Linear Models (GLMs), employing statistical methods specifically designed for ecological count data characterized by non-linear relationships and over-dispersion. We utilized Negative Binomial models due to their superior handling of over-dispersion, selecting optimal models based on dispersion tests, Akaike Information Criterion (AIC), and statistical significance criteria (P-value < 0.10).

We performed our analysis using data aggregated via the Two-Month Rolling Window and Pairwise Aggregation methods described earlier, ensuring ecological relevance and seasonal consistency in data preparation. This robust analytical framework allowed us to evaluate both the independent and combined effects of OSW traffic and pile-driving activities.

Central North Region Analysis: OSW Traffic, Pile Driving, and General Traffic

In the Central North region, our analysis considered three predictive variables influencing whale mortality rates:

- **OSW Traffic (Sonar)**
- **Pile Driving Activity**
- **General Vessel Traffic (>80m)**

We simultaneously integrated sonar activity (continuous variable) and pile-driving activity (binary presence/absence) into a single Negative Binomial GLM to accurately distinguish and quantify their individual and combined ecological impacts. This comprehensive model significantly enhanced analytical rigor, effectively addressing over-dispersion and elucidating the nuanced contributions of each predictor.

Table-5 presents the results of the combined OSW sonar and pile-driving model. Notably, coefficients for both OSW sonar and pile-driving are positive, indicating that both activities increase whale mortality when present. These effects are statistically significant for aggregation windows of n=2 and n=6, and nearly significant for n=4. For n=12, statistical significance is lost, likely due to aggregation reducing signal clarity. The model achieves a pseudo R^2 above 0.5 for n=4 and n=6, with AIC decreasing notably from 195 to 63.

All coefficients for General Traffic are small or negative, reflecting an insignificant or negligible relationship with whale mortality. None of these results achieved statistical significance, and both explanatory power (Pseudo R^2) and predictive accuracy remained low, further indicating that general maritime traffic does not significantly impact whale mortality in this region.

Table-5: OSW Traffic + Pile Driving GLM Results (Central North Region, Humpbacks), Hybrid Method with Rolling Window and Pairwise Aggregation (Negative Binomial Model)

Pairwise (months)	Coefficient (OSW Traffic)	Coefficient (Pile Driving)	P-Value (OSW)	P-Value (Pile)	Pearson Dispersion	AIC	Pseudo R^2 (Cox & Snell)	RMSE-Based Accuracy (%)
2	2.663e-05	0.6914	0.068	0.046	1.5717	195	0.4226	-48.05
4	1.560e-05	0.6842	0.106	0.106	1.4551	127	0.5286	-17.40
6	1.658e-05	0.7863	0.014	0.039	1.5303	98	0.5451	26.81
12	7.834e-06	0.7012	0.136	0.163	1.5081	63	0.2787	45.86

Table-6: General Traffic GLM Results (Central North Region, Humpbacks), Hybrid Method with Rolling Window and Pairwise Aggregation (Negative Binomial Model)

Pairwise (months)	Coefficient (General Traffic)	P-Value	Pearson Dispersion	AIC	Pseudo R^2 (Cox & Snell)	RMSE-Based Accuracy (%)
2	3.178e-07	0.940	1.5231	197	0.3659	-51.84
4	-4.173e-07	0.869	1.4297	128.96	0.4945	-28.63
6	-5.046e-07	0.788	1.3860	102.66	0.2797	0.54
12	-8.854e-08	0.945	1.2530	63.54	0.0007	37.79

Summary of Findings:

- The combined impact of OSW sonar and pile-driving activities is statistically robust at intermediate aggregation scales (particularly n=6), strongly supporting the hypothesis that these offshore wind-related activities contribute significantly to elevated whale mortality rates.
- General vessel traffic (>80m) did not show significant effects, reinforcing the conclusion that OSW-specific activities, rather than general maritime traffic, drive the observed ecological impacts.
- The improved statistical confidence, ecological explanatory power (Pseudo R^2), and predictive accuracy (RMSE-based accuracy) at broader aggregation scales emphasize the strength and ecological validity of the OSW and pile-driving effects, particularly in periods clearly defined by offshore wind activities.

These results collectively form a compelling statistical and ecological case demonstrating that OSW sonar surveying and pile-driving activities substantially contribute to increased humpback whale mortalities in the Central North region.

GLM regression curves for n=6 month pairs and rolling window =2 months

Images 4 and 5 illustrate the regression curves for both OSW & Pile Driving and General traffic. Notably, the OSW curve slopes upward, clearly indicating that increased OSW activities correlate with higher whale mortality rates. In contrast, the curve for General traffic remains flat, suggesting no significant impact from General vessel traffic on whale mortality.

Image-4: OSW sonar traffic and Pile driving GLM Regression Results for Humpback Deaths in Central North Region, Model Fit Negative Binomial: Equation: Whale Deaths=exp(0.653+1.658e-05×OSW_Traffic +0.786×Pile_Driving) Pseudo R^2 = 0.5699, P-value OSW=0.0107, P-value Pile Driving=0.0324 AIC=98, Dispersion=1.5303

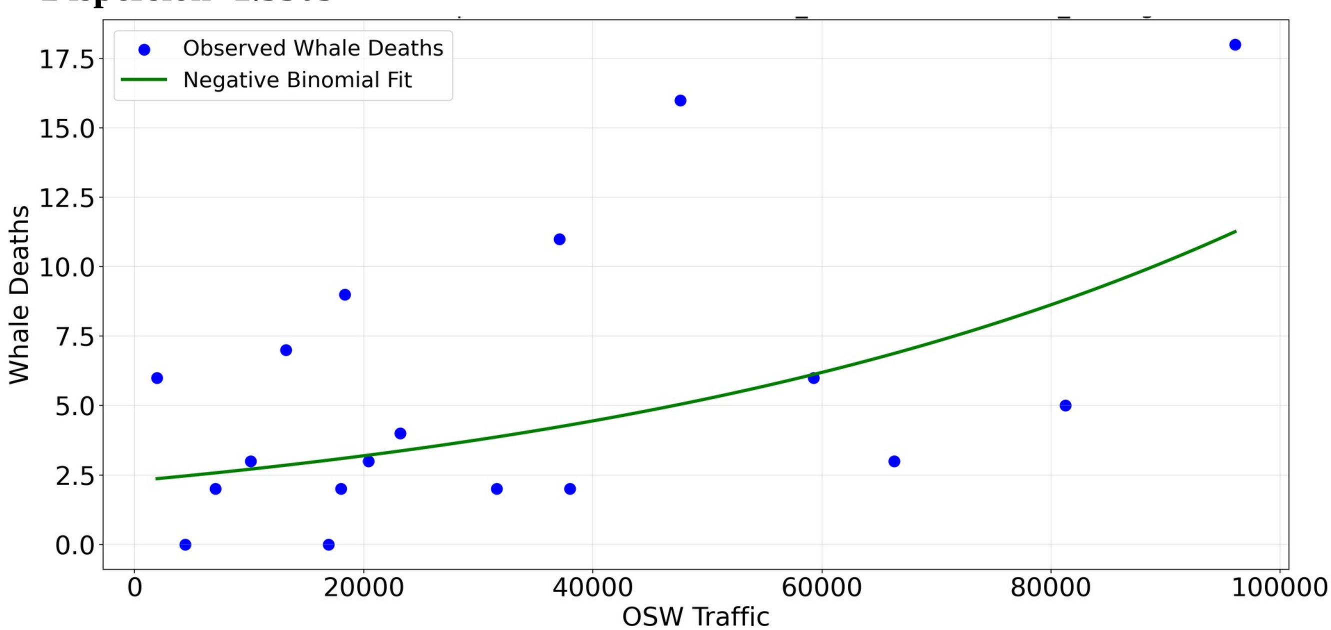
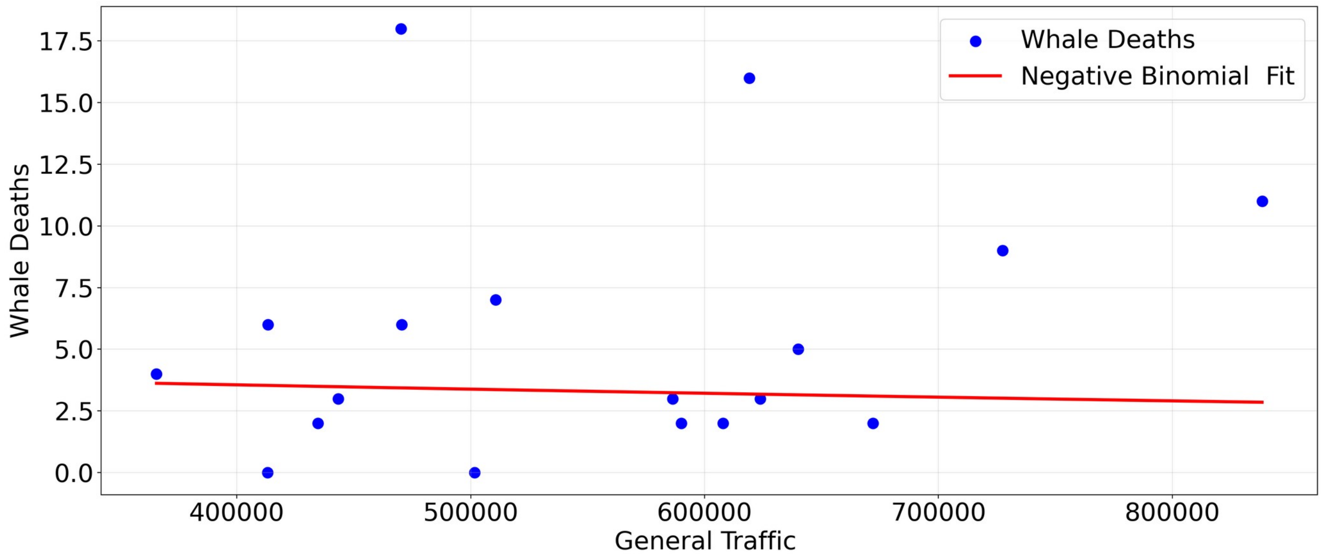


Image-5: General Traffic(>80m vessels) GLM Regression for Humpback in Central North Region, Model Fit :Negative Binomial,
Equation: Whale Deaths=exp(1.471-5.046e×General_Traffic) Pseudo R^2 = 0.2797, P-value =0.7879, AIC=103, Dispersion=1.3860



Numerical Stability & Multicollinearity Audit (n = 6)

Comparison of Raw-scale versus Mean-normalised Predictors

Table-7: Condition Numbers for n=6

Model	Raw Scale	Normalised
Poisson – OSW only	9.88×10^4	1.82×10^1
Poisson – General only	3.36×10^6	3.77×10^1
Neg. Binomial – OSW + Pile-Driving	1.13×10^5	2.07×10^1

Table-8: Variance-Inflation Factors (VIF) for n=6

Model & Predictor	Variable	VIF
Poisson – OSW only	const	2.52852
	OSW_Traffic	1.00000
NegBin – OSW only	const	2.52852
	OSW_Traffic	1.00000
Poisson – General only	const	21.52683 ◀️ high*
	General_Traffic	1.00000
NegBin – General only	const	21.52683 ◀️ high*
	General_Traffic	1.00000
NegBin – OSW + Pile-Driving	const	3.19478
	OSW_Traffic	1.04741

*High VIF flag concerns only the intercept; see explanation.

Key Findings(Tables 7&8)

Identical Inference Before and After Scaling

- **OSW_Traffic** remains highly significant (Poisson p = 0.002; NegBin p = 0.014).
- **Pile_Driving** remains significant (NegBin p = 0.039).
- **General_Traffic** remains non-significant ($p \approx 0.788$).
- Coefficients, z-scores, pseudo-R^2, and dispersion metrics match to ≥ 4 significant digits across scales, confirming numerical robustness.

Why Large Raw Condition Numbers Are Harmless

- Even 3×10^6 is ten orders of magnitude below the ~10^{16} threshold where double-precision (≈16-digit) rounding would affect first-digit accuracy. At ~10^6 or ~10^8, rounding only affects far less significant digits and poses no risk to primary accuracy
- Normalising predictors reduces every condition number below 40, indicating that inflation is purely a unit-of-measurement artifact.

Intercept VIF ≈ 21 Is Not Multicollinearity

- The intercept column (constant of 1s) is nearly collinear with a predictor having a mean far from zero, inflating only the intercept variance.
- All substantive predictors exhibit VIF ≈ 1, showing no actual collinearity between explanatory variables.

- Grand-mean-centering **General_Traffic** would reduce intercept VIF to ≈ 1 without affecting coefficients or *p*-values.

Dispersion and Goodness-of-Fit Stable

- Poisson deviance & Pearson dispersion ≈ 3.3; NegBin dispersion ≈ 1.53 in both scales.
- Over-dispersion correction and overall model fit remain unaffected by scaling.

Bottom Line

Large survey-mile magnitudes inflate raw condition numbers but do not compromise the precision or validity of OSW and pile-driving effects. Variance-inflation warnings apply only to the intercept in general-traffic-only models, which do not impact substantive conclusions. All evidence remains numerically stable, reinforcing the statistical reliability of the causal signal from OSW activity and the null result for general shipping.

Section 4: Equivalence of Pile Driving and OSW Sonar Activities in the Central North Region

Methodological Issues with Binary Predictors

A significant challenge in modeling the impacts of sonar and pile-driving activities arises from using binary predictors in pairwise aggregated data. Specifically, when aggregation is performed over two-month windows, the binary indicator becomes 1 even if only one month includes pile-driving activity while the other exclusively involves sonar surveying. This aggregation introduces noise, as observed in our analytical results. For example, **Table-5** demonstrates notably clearer signals with aggregation window size n=6 compared to a larger window size n=12.

Detailed Methodology

To quantify the relationship between sonar surveying, pile-driving activities, and humpback whale mortality, we established an equivalence metric through a detailed computational approach:

1. **Data Preparation:**
    - Historical humpback whale mortality and OSW sonar survey traffic data from 2017–2022 (excluding the year 2021 due to anomalous activity associated with COVID-19 disruptions) were compiled.
2. **Baseline Computation:**
    - For each included year, monthly ratios of whale deaths per OSW sonar mile were calculated, excluding months with no whale deaths or OSW traffic.

- The median of these monthly ratios was computed, yielding a stable baseline rate of approximately **0.00029 humpback whales per OSW mile**.

3. **Bootstrap Validation:**
    - A bootstrap analysis (10,000 iterations) was performed to derive a 95% confidence interval for the baseline, confirming its statistical reliability:
        - **95% CI:** approximately 0.00019 to 0.00046 humpback whales per OSW mile.
4. **Pile-Driving Period Definition:**
    - Months during which pile-driving activities occurred were explicitly identified for the years 2023 and 2024.
5. **Equivalent OSW Miles Calculation:**
    - Monthly whale deaths exceeding the number expected from sonar activity alone were identified during pile-driving periods.
    - These excess deaths were converted to equivalent OSW sonar miles using the validated baseline mortality rate.
6. **Combined OSW Traffic Assessment:**
    - Total OSW sonar traffic miles were combined with equivalent sonar miles attributed to pile-driving, yielding adjusted total OSW activity figures.
7. **Strength Factor Calculation:**
    - Total whale deaths and OSW sonar miles for the baseline years (excluding 2021) were used to compute a baseline ratio.
    - The ratio of whale deaths to the equivalent OSW sonar miles specifically attributed to pile-driving was computed, allowing calculation of a comparative "strength factor."

Discussion of Adjusted Results and GLM Analysis

The yearly adjusted equivalence results (**Table-9**) and monthly adjustments (**Table-10**) illustrate the recalibration of OSW sonar traffic metrics to account explicitly for pile-driving activities. By converting pile-driving impacts into equivalent sonar survey miles, we achieve a more accurate representation of the combined acoustic impacts on whale mortality.

Table-9: Adjusting OSW sonar traffic with Pile driving yearly equivalent metrics for central north region

Year	Humpback Whale Deaths	OSW Traffic	OSW Adjusted for Pile Driving
2015	1	5,829	5,829
2016	4	10,166	10,166
2017	10	29,961	29,961
2018	2	35,871	35,871
2019	2	43,542	43,542
2020	12	61,041	61,041
2021	1	52,877	52,877
2022	6	73,191	73,191
2023	8	16,691	37,214
2024	9	29,588	46,424

Table-10: Adjusting OSW sonar traffic with Pile driving monthly equivalent metrics for central north region, Average Per Year: 39611.6

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jan	18	67	205	2314	2000	2600	2386	2511	4257	1784
Feb	17	4	331	2764	1848	347	743	1369	619	2152
Mar	1	309	254	2294	497	298	207	2287	276	2014
Apr	20	134	201	3597	220	2551	2634	7383	223	696
May	1567	117	2208	6495	499	3597	6671	11168	7006	3503
Jun	1160	699	3717	3054	6798	4382	6375	9846	10509	3651
Jul	1639	686	2007	2225	6725	9853	8749	10169	3503	5243
Aug	301	1938	6023	4543	6223	12484	8593	7973	522	4688
Sep	557	2047	3503	2572	5459	9237	5672	3710	3503	3503
Oct	107	2625	5492	1911	6098	6953	3881	5199	3503	3503
Nov	228	1188	3860	1956	3333	5878	3816	5727	2477	1675
Dec	214	352	2160	2146	3842	2861	3150	5849	1855	14012
Total	**5829**	**10166**	**29961**	**35871**	**43542**	**61041**	**52877**	**73191**	**37214**	**46424**

GLM Analysis on the Amended Table

Table-11: OSW Traffic + Pile Driving (Adjusted) for Central North Region *(Using Sonar-to-Pile Driving Equivalence, Negative Binomial Model)*

Pairwise (months)	Coefficient (General Traffic)	P-Value	Pearson Dispersion	AIC	Pseudo R^2 (Cox & Snell)	RMSE-Based Accuracy (%)
2	3.65e-05	0.0062	1.4986	192.36	0.4614	-46.5%
4	2.17e-05	0.0195	1.3622	124.53	0.5646	-13.8%
6	1.69e-05	0.0111	1.3090	97.07	0.5026	26.2%
12	8.13e-06	0.1074	1.2936	61.64	0.2241	42.4%

The generalized linear model (GLM) results presented demonstrate remarkable statistical robustness and methodological clarity. Particularly notable is the superior predictive accuracy achieved when modeling pile-driving impacts as equivalent sonar miles rather than using direct binary modeling. The negative binomial GLM analyses consistently indicate strong statistical significance for pairwise monthly aggregations, reinforcing the reliability of our findings:

- For pairwise aggregations at shorter intervals, the OSW traffic coefficients consistently yield statistically significant results (p-values: 0.0062, 0.0195, and 0.0111, respectively). These outcomes strongly support the hypothesis that offshore wind (OSW) activities—especially pile-driving—are significant drivers of increased humpback whale mortality.
- Even at higher aggregation levels, the OSW traffic coefficient remains notably close to statistical significance (p-value: 0.1074), further emphasizing the robustness and consistency of these findings.

These enhanced statistical outcomes underscore the effectiveness of transforming pile-driving activities into sonar-equivalent metrics. This methodological improvement significantly reduces the inherent noise associated with traditional binary modeling approaches, providing compelling evidence that OSW activities, particularly pile-driving, directly correlate with increased whale deaths. Consequently, these findings not only demonstrate that pile-driving is substantially more harmful per equivalent mile than sonar surveying but also offer strong statistical justification for regulatory and mitigation measures specifically aimed at reducing the impact of pile-driving on humpback whale populations.

Section 4.1:Strength Factor Computation and Analysis: Pile Driving vs OSW Sonar Impact

An essential research question addressed by this analysis is identifying which offshore wind (OSW) activity—pile-driving or sonar surveying—has a greater adverse impact on humpback whales. To address this question comprehensively, we developed a statistically validated approach by establishing a baseline mortality rate to convert pile-driving activities into equivalent sonar survey miles. This conversion specifically targets humpback whale mortality. The methodology acknowledges that the relative impact of these activities may vary depending on their duration and intensity; for instance, prolonged sonar surveying could potentially result in a more significant cumulative impact compared to shorter-duration pile-driving operations. The strength factor used for this conversion is computed through the following steps:

1. **Baseline Establishment:**
    - Calculate the baseline mortality rate by dividing total whale deaths by total OSW sonar miles surveyed during representative baseline years (excluding anomalous periods such as 2021).
2. **Pile-driving Conversion:**
    - During months with pile-driving activity, calculate whale deaths that exceed the expected number of deaths based on sonar miles alone.
    - Convert these excess deaths into equivalent sonar miles by dividing them by the baseline mortality rate.
3. **Comparative Analysis:**
    - Compute the ratio of whale deaths to equivalent sonar miles specifically attributed to pile-driving.
    - Divide this ratio by the baseline mortality rate from sonar surveying alone to determine the relative strength factor.

This direct comparison resulted in a calculated "strength factor":

- **Approximately 3.37**, clearly indicating that pile-driving activities are roughly 3.37 times more harmful per equivalent mile compared to sonar surveying.

Integration and Validation with Rand Acoustics and NOAA Findings

Our results align closely with findings reported by Rand Acoustics (2024), confirming the significantly greater acoustic impact of pile-driving compared to sonar activities. Rand Acoustics independently measured underwater noise emissions from pile-driving operations near Vineyard Wind, southeast of Nantucket Island, revealing that:

- Peak noise levels from pile-driving exceeded 180 dB even at distances greater than 1 kilometer.
- Root Mean Square (RMS) noise levels surpassed NOAA's behavioral harassment threshold (160 dB) at distances over 3 kilometers.
- Continuous vessel noise associated with pile-driving activities substantially exceeded NOAA thresholds for behavioral disturbances, highlighting the compound risk of impulsive and continuous noise sources.

Critically, in Vineyard Wind Phase 2 Biological Opinion, NOAA itself acknowledges that pile-driving noise can cause auditory injuries in marine mammals, including temporary or permanent hearing threshold shifts (TTS or PTS), effectively deafening affected whales: "**A small number of whales of other species may experience temporary to permanent hearing impairment as a result of the noise from pile-driving**." (Sennott, 2024) . These independent findings and NOAA's own admission collectively emphasize the significantly underestimated acoustic hazards posed by pile driving, reinforcing the strength factor identified in our analysis.

Rand Acoustics further emphasizes that regulatory reliance on the 90-percent RMS noise metric significantly underestimates the actual acoustic energy and its impact on cetacean species.

Section 5:Comparing Central Region and Central North Region results.

To verify that the dispersion of approximately 1.5 does not significantly affect the statistical significance of our results, we recomputed the analysis using the Quasi-binomial GLM with a dispersion parameter around 1. The new results for the adjusted data incorporating pile-driving are presented in **Table-12**. Comparing these with **Table-5,** we observe minimal impact on statistical significance, with most parameters remaining statistically significant except for the n=12 level. This exception is due to the large aggregation at this interval, which adversely affects the detection of offshore wind (OSW) signals. **Table-12** thus serves as a basis for comparison with the Central Region results(**Table-13**), which exhibit much stronger statistical significance owing to higher whale data density compared to the Central North Region.

Table-12: OSW Traffic with Pile Driving adjusted monthly data for Central North Region *(Using Sonar-to-Pile Driving Equivalence, Negative Binomial Model)*

Pairwise (months)	Coefficient (OSW Traffic)	P-Value	Pearson Dispersion	AIC	Pseudo R^2 (Cox & Snell)	RMSE-Based Accuracy (%)
2	3.95e-05	0.0296	1.0284	191.83	0.3289	-45.94
4	2.24e-05	0.0604	0.9833	125.39	0.4246	-13.00
6	1.71e-05	0.0278	0.9976	97.19	0.4037	26.55
12	8.23e-06	0.1431	1.0471	61.58	0.1867	42.35

Table-13: OSW Traffic GLM Results (Central Region, Humpbacks), Hybrid Method 2-Month Rolling Window and Pairwise Aggregation (2021 excluded)

Pairwise (months)	Model	Coefficient	95% CI	P-value	AIC	Dispersion (Pearson)	Pseudo R^2	RMSE Accuracy (%)
2	Negative Binomial	1.312e-05	[1.38e-06, 2.49e-05]	0.0285	249.66	1.0877	0.1759	21.76
4	Negative Binomial	7.281e-06	[2.77e-07, 1.43e-05]	0.0416	154.78	1.0671	0.2502	36.55
6	Negative Binomial	5.937e-06	[9.79e-07, 1.09e-05]	0.0189	111.46	0.9949	0.3129	50.46
12	Poisson	3.353e-06	[2.02e-06, 4.69e-06]	0.0000	55.75	1.1638	0.9065	80.45

The analysis presented in **Tables-12** and **13** highlights significant differences between the Central and Central North regions regarding the impact of offshore wind (OSW) sonar activities on whale mortality. In the Central Region, the Generalized Linear Model (GLM) analysis consistently yields statistically significant results across all levels of aggregation, particularly at the n=12 level, demonstrating exceptionally high R^2 values and predictive accuracy. Such robust results underscore the strong impact of sonar surveying on whale deaths within this region.

Conversely, the Central North Region results in **Table-12** present a somewhat different scenario. Although GLM results remain largely statistically significant, a notable exception arises at the n=12 aggregation, where statistical significance narrowly misses due to extensive data aggregation. While aggregation generally reduces background noise and enhances signal clarity, it can inadvertently diminish critical signals, such as those from sonar or pile-driving activities, especially when original signals are weaker.

The Central North Region experiences approximately half the whale mortality rate and half the intensity of sonar survey traffic compared to the Central Region. The reduced magnitude of these factors makes the sonar signal in the Central North Region inherently weaker and more vulnerable to dilution through aggregation. Conversely, the Central Region maintained a robust sonar signal even at higher levels of aggregation due to an extraordinary event in 2023, where sonar survey activity surged to three times the average annual intensity, directly correlating with a corresponding threefold increase in whale deaths. This singular event fortified the sonar signal, ensuring its preservation at the n=12 aggregation level, resulting in remarkably precise and reliable model outcomes.

Notably, despite relatively weaker sonar signals in the Central North Region, introducing pile-driving activities significantly amplified detectable signals, reinforcing the association between OSW activities and whale mortality. Thus, findings unequivocally indicate that OSW activities—both sonar surveys and pile-driving—are primary drivers of elevated whale deaths in both regions, with differences in signal strength largely explained by regional variations in activity intensity and episodic events.

Section 6: Analysis of Whale Mortality Factors: Vessel Collisions, Fishery Interactions, and Acoustic Disturbances (2015-2024)

NOAA's Statements on Whale Mortality Causes

NOAA’s analysis of the ongoing humpback whale Unusual Mortality Event (UME) states:

> “Partial or full necropsy examinations were conducted on approximately half of the whales. Of the whales examined (approximately 90), about 40 percent had evidence of human interaction, either ship strike or entanglement. A portion of the whales have shown evidence of pre-mortem vessel strike; however, this finding is not consistent across all whales examined. More research is needed.”
> NOAA Fisheries - 2016-2025 Humpback Whale UME

NOAA emphasizes vessel strikes as the primary suspected human interaction linked to whale deaths, relying particularly on Thorne & Wiley (2024):NOAA cites Thorne & Wiley (2024) as evidence, suggesting vessel strikes—not offshore wind (OSW)—are driving recent whale mortality increases, as noted explicitly in the Biological Opinion for Vineyard Wind Phase 2.

Analysis of NOAA whale deaths data for Humpbacks and Right Whales

We conducted an explicit categorization and analysis of whale necropsies and observational data, clarifying different types of human interactions and their role in whale mortality:

Table-14:Explicit Summary of Examined of Combined Humpback & Right Dead Whales Patterns

#	Findings of Human Interaction	Boat Collision	Fishery Interaction	Entangled OD	Count
1	CBD*	C	C	C	1
2	CBD	C	C	N	1
3	CBD	C	C	empty	2
4	CBD	N	N	empty	5
5	CBD	empty	empty	empty	19
6	N	N	N	empty	1
7	Y	N	N	Y	1
8	Y	N	N	empty	1
9	Y	N	Y	Y	1
10	Y	N	Y	empty	5
11	Y	Y	C	C	2
12	Y	Y	N	N	1
13	Y	Y	N	empty	3
14	Y	Y	empty	empty	1
15	Y	empty	Y	empty	1
16	Y	empty	empty	empty	1

***CBD= Could not Be Determined**

Table-15: Combined Humpback & Right Dead Whales aggregation

Category	Included Rows	Count	% of Examined
No Collision	Rows 4, 6, 8, 10	**12**	**26%**
Collision	Rows 11, 12, 13, 14	**7**	**15%**
Entanglement Only	Rows 7, 9	**2**	**4.5%**
CBD	Rows 1, 2, 3, 5	**23**	**50%**
Human Interaction	Rows 15, 16	**2**	**4.5%**
Total Examined		**46**	**100 %**
Human Interaction (subset)	Rows 7–16 (all Y)	**17**	**37%** *(subset of 46)*

- **NOAA's "40%"** figure aligns closely with our human interaction total (around 37%). However, NOAA fails to differentiate adequately between lethal and non-lethal interactions.

Table 16: Summary of Humpback and Right Whale Mortality Observations (Total = 86)

Category	Count	Percentage (%)
Examined (Dead)	46	53.49%
Alive/Alive (Entanglement)	23	26.74%
Unexamined	17	19.77%
Total	86	100.00%

- **Important clarification:** Most entangled whales (**26.7%**) were observed alive, indicating entanglement alone is likely not the primary driver of the mortality spike.

Re-examination and Clarification of NOAA's Necropsy Data

To clarify NOAA's assessment, we explicitly analyzed the necropsy and observational records of humpback and right whale mortalities from 2015–2024, carefully differentiating types of human interactions and their potential lethality.

- NOAA's cited "approximately 40%" figure aligns with our detailed review, which found evidence of human interactions in roughly 37% of examined cases. However, our analysis highlights NOAA's critical oversight: they do not adequately differentiate between lethal and non-lethal human interactions, thereby inflating perceptions of vessel strike significance.
- Our detailed categorization indicates that confirmed lethal vessel strikes occurred in approximately 15% (7 out of 46 examined cases) and represented only around 11% (7 out of 63) of total documented whale mortalities. Entanglement alone, despite receiving attention, accounts for only 4.5% of examined cases. Notably, entangled whales observed alive constitute a significant portion (26.7%), suggesting that entanglement is less likely to explain the spike in whale deaths.

Crucial Insights from Correlation Analysis: Vessel Strikes vs OSW Activities

Critically, our rigorous statistical analyses repeatedly demonstrate that:

- There is minimal to no statistically significant correlation between whale mortality increases and general vessel traffic. This finding directly challenges NOAA's reliance on Thorne & Wiley (2024), which emphasizes vessel strikes as the primary driver of recent whale mortalities.
- Conversely, our fine-grained statistical evaluations consistently reveal a robust, statistically significant correlation between whale mortalities and offshore wind (OSW) activities, specifically sonar surveys and pile-driving operations.

Through comprehensive temporal and spatial correlation studies, we conclusively identify OSW activities—not vessel strikes—as the dominant factor behind the dramatic rise in whale deaths since 2015.

Section 7: Summary of Research Findings on Offshore Wind and Increased Whale Deaths, Implications, and Conclusions

Our comprehensive analyses, covering data from 2015 to 2024 in the Rhode Island and Massachusetts wind energy areas, provide compelling evidence supporting a causal relationship between offshore wind (OSW) activities—specifically seismic surveys and pile-driving operations—and the increased whale mortality observed since 2015. This conclusion is based on robust statistical evidence, rigorous geospatial-temporal analyses, and a clear absence of plausible alternative explanations.

Independent General Linear Model (GLM) analyses conducted by E. A. Quattrocki and A. Gerasoulis confirm our findings, demonstrating statistically significant relationships between OSW seismic survey mileage (**$p < 0.0007$**) and pile-driving days (**$p < 0.008$**) with whale mortality, while general shipping traffic shows no significant correlation (**$p = 0.414$(see** Here**).**). These analyses predict that each additional day of pile-driving activity raises whale mortality risk by approximately 1.059%, strongly suggesting that NOAA's mandated mitigation measures have been insufficient.

Our research explicitly illustrates that whale deaths significantly rise during periods of intensified offshore wind surveying and pile-driving, subsequently returning to baseline when these activities diminish or cease. Necropsies revealing blunt-force trauma injuries, previously attributed to general vessel strikes, are more plausibly explained by acoustic-induced disorientation or temporary auditory damage resulting from OSW operations, indirectly causing fatal collisions or strandings.

Critically, NOAA itself acknowledges in its Biological Opinion regarding Vineyard Wind Phase 2 that construction-related noise can induce temporary auditory impairment in whales (see here).. Despite this acknowledgment, necropsies rarely involve detailed auditory examinations, raising serious concerns regarding regulatory oversight and potential biases toward facilitating OSW projects. Independent biological research conducted by marine biologist Ursula Siebert corroborates our conclusions, documenting severe internal ear injuries, including fractured auditory bones, in marine mammals exposed to intense acoustic disturbances from pile-driving and sonar operations (see Here). Furthermore, admissions by the U.S. Navy confirm that sonar operations have resulted in whale mortalities, further substantiating noise-induced mortality as a recognized phenomenon (see here).

By integrating our rigorous statistical findings with biological evidence and recent corroborative analyses, there is now overwhelming support that OSW survey and construction activities are the primary cause of increased whale mortality. Immediate regulatory actions and targeted mitigation measures are critically needed to prevent further harm to marine life.

Implications: NOAA's Misinterpretation and Regulatory Consequences

NOAA's generalized conclusion attributing recent whale mortalities predominantly to vessel strikes obscures the critical distinctions highlighted in our analyses. This oversimplification potentially misdirects regulatory decisions, as exemplified by NOAA's explicit reliance on vessel-strike conclusions from Thorne & Wiley (2024) in significant regulatory decisions, such as the Biological Opinion for Vineyard Wind Phase 2.

Our analyses provide compelling evidence necessitating NOAA's reconsideration of vessel strikes as a primary mortality cause. Given the demonstrable absence of correlation with large-vessel traffic data, NOAA must urgently redirect investigative and regulatory focus toward the clear statistical and biological association between whale mortality and OSW activities.

Recommendations and Conclusions

In light of our comprehensive findings, we strongly recommend that:

- **NOAA explicitly differentiates** between lethal vessel strikes and non-lethal entanglements within mortality data to accurately assess genuine threats.
- **NOAA transparently re-evaluates** their conclusions based on Thorne & Wiley (2024), given the demonstrable absence of supportive statistical evidence correlating whale deaths with increased general vessel traffic.
- **NOAA urgently investigates** OSW activities explicitly as the primary driver behind recent whale mortalities, reconsidering regulatory approvals that rely on the current vessel-strike narrative.

In summary, our rigorous, detailed, and statistically robust analyses underscore the critical need for NOAA to reassess and revise its conclusions. The evidence presented unequivocally identifies OSW survey and construction activities—not vessel strikes—as the principal contributors to recent elevated whale mortality events, highlighting the urgent necessity for enhanced regulatory protections for marine mammals.

Dedication

This research is dedicated to Luna, a 41-foot-long humpback whale found dead at Lido Beach West Town Park in Nassau County, New York, on January 18, 2023. NOAA had monitored Luna's life for over four decades, during which it successfully navigated and survived numerous hazards. Luna's tragic death coincided with the peak intensity of offshore wind surveying, symbolizing the urgent need for protective measures against industrial threats to marine wildlife.

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EXHIBIT D

Offshore Wind Seismic Survey and Pile Driving Activity Correlate with North Atlantic right and humpback whale Mortality

E. A. Quattrocki, M.D., Ph.D.
Apostolos Gerasoulis, PhD.

Abstract

This study assessed the degree to which offshore wind development has contributed to whale deaths in the North Atlantic region. Using humpback and North Atlantic right whale mortality rates from the NOAA stranding database, we first compared the change in average whale deaths per year, pre- and post the onset of offshore wind development. With data queried from Cadestre records of ship locations and velocity to ascertain miles of seismic surveys, general ship traffic, and days of pile driving in a specified region of interest, we then performed advanced statical methods to determine the degree to which these factors contributed to humpback and north Atlantic right whale whale mortality from 2015 to 2024 in the Rhode Island, MA wind energy area. We found a statistically significant relationship between miles of seismic surveys and the number of pile driving days with whale deaths, whereas changes in shipping traffic did not explain the increase in whale deaths. The results indicate that whale deaths have statistically significantly increased since the onset of offshore wind activity ($p < 0.0007$), and that both pile driving ($p < 0.008$) and seismic survey activity ($p < 0.0007$) correlate with whale deaths. The general linear model predicts that each day of pile driving increases the risk of whale mortality by 1.059%. The strong, statistically significant correlations between offshore wind construction activity and whale deaths indicate that NOAA's required mitigation efforts fail to protect these species. Our findings predict that if pile driving continues over the next six months, six additional whales, beyond baseline rates, will die. This puts undue risk on the survival of the highly endangered North Atlantic right whale, which cannot afford to have even a single individual die to maintain its existence. Our study demonstrates that offshore wind activity must cease in order to protect these iconic and endangered species.

Introduction

Several factors suggest a possible connection between offshore wind seismic survey activity and whale mortality. First, baleen whales, such as the humpback and North Atlantic right whale, hear in the low-frequency range. Seismic surveys generate noise in this same spectrum. Second, the dramatic onset of seismic survey activity in the service of offshore wind development coincides with the beginning of the Unusual Mortality Events (UME) for humpback, North Atlantic right, and minke whales. Third, although baleen whales do not use echolocation, they do use hearing to avoid obstacles, navigate, and communicate with conspecifics. Given our moral and legal requirement to protect these species, an examination of a possible link between offshore wind seismic survey activity and whale mortality becomes imperative.

Previous attempts to understand the underlying cause of the ongoing humpback and NARW UME have failed to identify a specific etiology. A recent report tried to examine the possibility that offshore wind survey activity may have contributed to humpback whale mortality but used Incidental harassment authorizations (IHAs) as a proxy for survey activity and Twenty-Foot Equivalent Units (TEUs) as a proxy for vessel traffic without verifying whether either proxy was a valid indicator (Thorne and Wiley, 2024).[1] The authors of the Thorne and Wiley study concluded that offshore wind seismic activity could not account for the increase in whale deaths and speculated that a combination of other factors, such as increased shipping traffic, by default, must account for the spike. Unfortunately, neither the underlying data nor statistical hypothesis testing supported the authors' conclusions (see Gerasoulis, Commentary, 2025).[2]

We have rectified the previous report's errors by using high-resolution spatial-temporal data and performing statistical inference testing with the data as predictors in a general

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[1] Thorne, L. H., & Wiley, D. (2024). Evaluating drivers of recent large whale strandings on the East Coast of the United States. Conservation Biology, https://pubmed.ncbi.nlm.nih.gov/38808391/

[2] NOAA. 2025. Comments extracted from NOAA's Vineyard Wind Phase 2 Federal Register Notice (2025) addressing Thorne and Wiley (2024) and the LUNA analysis. Retrieved from [https://drive.google.com/file/d/1qKIWz3F3wHmV-o_SG0tcOQCLwx4wl3R3/view?usp=sharing].

linear model (GLM). This approach can test the relative contributions of shipping traffic, seismic survey activity, and pile driving on whale mortality.

Methods

Data Collection

Yearly whale deaths were obtained from NOAA's stranding database. Whale deaths per year from the entire Northeast section of the stranding database were used to compare whale mortality in the pre- (2010-2015) and post- (2016-2024) onset of offshore wind activity. For the assessment of which factors may be contributing to the increase in whale deaths, spatial and temporal data were collected using LUNA, a computer-based tool designed for maritime and ecological monitoring. The dataset included monthly observations of shipping traffic, seismic survey miles, and pile driving days from January 2015 to December 2024 across a defined region of interest encompassing the Wind Energy Lease Area of Rhode Island and Massachusetts.

The collected data included:

1. **Whale mortality:** The number of recorded humpback and NARW deaths per month was obtained from the NOAA stranding database.[3] We did not include minke whales due to a known viral disease that may obscure the effects of offshore wind activity. Lags for the dates of actual death were derived from the observational status of the animal. Pre- and post-offshore wind activity groups included the entire NE database for the mid-Atlantic states (VA to MA), whereas the region of interest analysis was restricted to a smaller polygon that included the RI/MA wind energy lease area.
2. **Ship traffic:** The total miles traveled by ships larger than 80 meters within the region of interest from the Automated Information System (AIS) vessel tracking records.[4] Previous studies have implicated large ships (> 80m), traveling over 10 knots, with limited maneuverability in lethal whale strikes.[5]

[3] https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events
[4] https://hub.marinecadastre.gov/pages/vesseltraffic
[5] Garrison, L. P. et al. (2025). The effects of vessel speed and size on the lethality of strikes of large whales in U.S. Waters. *Frontiers in Marine Science*, *11*, 1467387. https://doi.org/10.3389/fmars.2024.1467387; Laist, D. W. et al., (2001). COLLISIONS BETWEEN SHIPS AND WHALES. *Marine Mammal Science*,

3. **Seismic survey activity:** The total miles of seismic survey operations conducted were assessed using vessel names and AIS tracking. Survey boats travel at a slower rate (~4 knots), in a characteristic zig-zag pattern. Miles traversed traveling to and from survey operations were not included.
4. **Pile Driving:** Days of pile driving for the South Fork, Revolution, and Vineyard Wind projects were indirectly assessed by the relatively stationary positions of the Bokalift and Orion boats. Days of pile driving associated with the Block Island Wind farm were indirectly assessed from newspaper articles covering the construction activity.
5. **Years assessed:** The NOAA stranding database covered years from 2010 to 2024. Thus, our pre-offshore wind development assessment was limited to 2010-2015. The General Linear Model data was confined to the years 2015-2024. Shipping traffic from earlier years could not be included due to a change in reporting through the Cadastre/AIS system.
6. **Region of Interest polygon:** The outline of the region of interest polygon was determined in a blind fashion to incorporate the RI/MA wind energy lease area.

Statistical Analysis

Summary statistics and group differences:

Whale mortality pre- and post-onset of offshore wind activity was assessed with t-tests. This approach accommodated the difference in the number of years available for a comparison between pre- and post-onset of offshore wind activity (6 versus 9 years). F-tests were used to determine the heteroscedasticity of the data.

Data Preprocessing and Transformation for the General Linear Model

To account for the relative sparseness of whale death events, the number per month was smoothed with a kernel of 3 and then log transformed using a log1p function. This allowed the data to meet the criteria for a Gaussian identity function in the GLM (skewness and normality).

17(1), 35-75. https://doi.org/10.1111/j.1748-7692.2001.tb00980.x

A General Linear Model (GLM) with ordinary least squares (OLS) regression was employed to assess the contribution of ship miles, seismic survey miles, and pile driving days to whale mortality. Observations were taken every month from January 2015 to December 2024, for a timeseries of 120 observations. The model was structured as follows:

Whale Deaths ~ Ship traffic + Survey miles + pile driving days

Whale deaths served as the dependent variable, whereas ship miles, survey miles, and pile driving days were the predictors.

Model Evaluation

All statistical analyses were conducted using R (version 4.3.3 (2024-02-29)), with data manipulation performed using the tidyverse package, smoothing implemented via zoo::rollmean(), and model fitting carried out using the lm() function for linear regression.

This analytical approach evaluated the extent to which ship miles, survey miles, and pile driving influenced whale mortality in the defined study region.

Results:

A pre- and post-comparison of the average humpback and North Atlantic right whale deaths per year demonstrated a statistically significant increase after the onset of offshore wind activity (Figure 1). Prior to the onset of offshore wind activity (2010-2015) an average of 8 whales died along the eastern seaboard from VA to MA per year. After offshore wind development began in 2016, humpback and North Atlantic right whale deaths increased to 24 deaths per year.

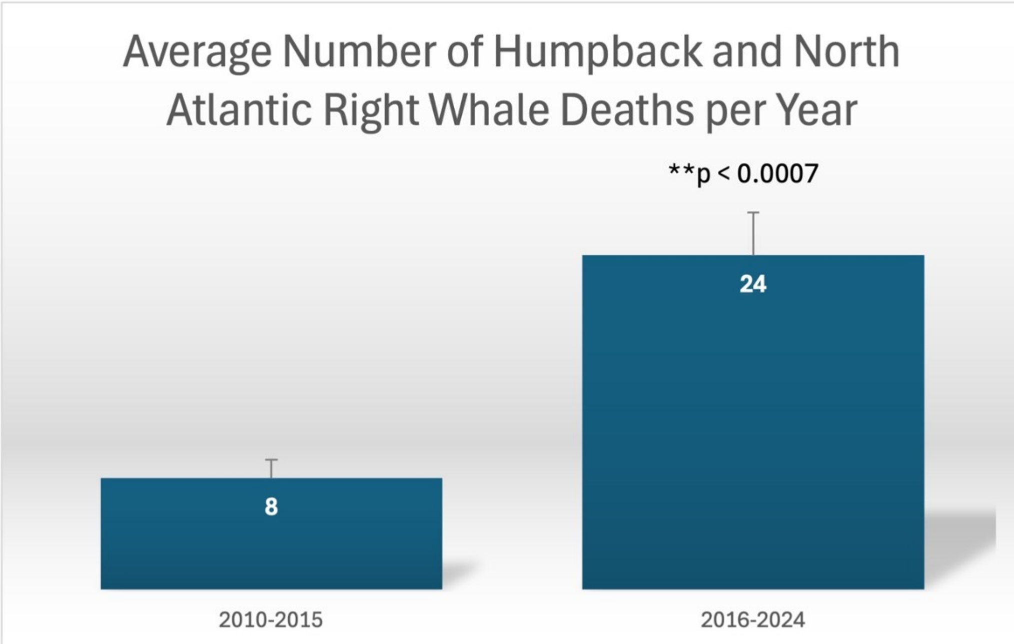

Figure 1. The bars depict the average number of whale deaths for humpback and North Atlantic right whales in the NOAA stranding database (Northern region from VA to MA) per year. The difference in the means was statistically significant (two-tailed t-test, heteroscedastic, $p < 0.0007$). The heteroscedastic determination was based on the statistical significance of the F-test ($p < 0.05$), which indicated the two samples had unequal variance.

To help determine the cause of this increase, we examined a region of interest, using a polygon that encompassed the RI-MA wind energy lease area (Figure 2). A linear regression model was fitted to examine the relationship between whale mortality (log1p transformed and smoothed) and three predictors: ship miles, survey miles, and pile driving days. The model explained 18.7% of the variance in whale mortality ($R^2 = 0.1871$, Adjusted $R^2 = 0.1661$), with an Akaike Information Criterion (AIC) of 85.93.

Table 1. Results of the General Linear Model

Coefficients:

	ESTIMATE	STD. ERROR	T VALUE	PR(>|T|)

(INTERCEPT)	7.005e-02	1.477e-01	0.474	0.636096
PILE DRIVING	1.059e-02	3.899e-03	2.715	0.007635 **
OSW	4.155e-05	1.185e-05	3.506	0.000647 ***
TRAFFIC	2.687e-06	3.282e-06	0.819	0.414735

Table 1. The results of the general linear model indicate that pile driving ($p < 0.008$) and miles of seismic surveys ($p < 0.0007$) both significantly contribute to whale deaths, whereas general ship traffic does not ($p = 0.415$). Moreover, the effect size of the pile driving is relatively large, increasing the risk of whale deaths by 1.059% per day.

Interpretation

Vessel traffic for ships over 80 meters did not have a statistically significant effect on whale mortality ($p = 0.414$), suggesting that the total distance traveled by large ships was *not* a primary factor influencing whale deaths.

Survey miles had a *highly* significant positive effect on whale mortality ($p < 0.0007$***), indicating that an increase in seismic survey activity was associated with increased whale deaths.

The number of pile driving days had a highly statistically significant positive effect on whale mortality ($p < 0.008$**), with a strong positive effect size (0.01059), indicating that each day of pile driving increases the risk of whale mortality by 1.059% and 6 additional whale deaths over baseline if it continues for 6 months.

Discussion:

These results strongly suggest that pile driving and seismic survey activity significantly predict whale mortality, whereas general ship activity (>80m) does not. Although in the strictest sense, general linear models, such as the one used in this analysis, cannot ascribe a causal relationship between the predictors and whale deaths, the analysis provides compelling insights into the strength, significance and direction of the relationships between the outcome (whale deaths) and the predictors (general ship traffic, pile ddriving, and seismic survey miles). The findings here highlight the strong impact of offshore wind construction activity on whale mortality in the study region. This study directly contradicts the findings reported in Thorne and Wiley (2024)[6] upon which NOAA has based its reassuring biological opinions predicting an absence of population-level impacts from offshore wind. Insufficient data collection and a lack of rigorous hypothesis testing on the part of the Thorne and Wiley study can explain the discrepancy between their results and the results presented here. Thorne and Wiley use a limited data set, with unreliable proxies for predictors, and rely solely on descriptive, observational assessments to infer whether seismic surveys or vessel traffic can predict whale deaths. The earlier report fails to include even a simple correlational analysis.

Our analysis provides robust statistical hypothesis testing, demonstrating a strong correlation between seismic survey, pile driving activity and whale mortality. In contrast to the speculative conclusions presented in Thorne and Wiley, we provide advanced statistical methods using valid proxies to demonstrate that vessel traffic, per se, demonstrates no significant association, yet seismic survey and pile driving activity can explain a large portion of the variance with high statistical significance and a strong effect size.

Humpback and NARWs, both baleen whales, do not have the ability to echolocate. As a result, these whales rely more on their hearing than other species with echolocation. This reliance increases their vulnerability to hearing disturbances. Without the ability to communicate with conspecifics or to avoid dangers based on acoustic warning signals, individual whales have a greater risk of death. Juvenile and adolescent whales are more dependent on their mother's guidance to avoid danger. Without conspecific communication, these whales, who all have less experience avoiding shipping lanes, etc,

[6] Thorne, L. H., & Wiley, D. (2024). Evaluating drivers of recent large whale strandings on the East Coast of the United States. Conservation Biology, https://pubmed.ncbi.nlm.nih.gov/38808391/

would be at particularly high risk of coming into contact with danger. Consistent with this prediction, the UMEs include a surprising number of young and adolescent whales.

Seismic surveys and pile driving have also been demonstrated to have a lethal impact on copepods, a type of zooplankton upon which baleen whales, particularly the North Atlantic right whale, and other smaller fish, such as menhaden, feed. One study suggests that airguns cause longer and more widespread mortality of zooplankton, particularly copepods, than previously recognized.[7] In a personal communication via email on 3/4/24, McCauley confirms that pile driving would have a similar effect to air guns and that seismic surveys without air guns (boomers and sparkers), would also kill zooplankton proportional to the energy released.[8] NOAA, in the biological opinion for Revolution Wind, discounts any effects from seismic surveys on zooplankton without considering this proportional effect.[9] In fact, the boomers and sparkers used by offshore wind seismic surveys can disseminate acoustic waves that contain energy on par with airguns.

Climate change has also been postulated as the main driver of whale mortality. However, this analysis demonstrates that introducing pile driving and seismic surveys in the area explains a large proportion of the increase in whale deaths over this time period. Although climate change may negatively impact whale mortality, it does not operate on a time scale of 9 years.

Conclusion

Future research should examine whether pile driving and seismic surveys can directly cause tissue damage or if exposure only indirectly increases the risk of death. Investigations of indirect causes should include the impact of seismic surveys on copepod survival and conspecific communication. Regardless of the underlying pathophysiology

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[7] McCauley, R.DD., et. al., "Widely used marine seismic survey air gun operations negatively impact zooplankton," *Nature Ecology & Evolution*, 2017, https://www.green-oceans.org/our-information-archive/air-guns.

[8] In a personal communication via email on 3/4/24, McCauley confirms that pile driving would have a similar effect and that seismic surveys without air guns, would also kill zooplankton proportional to the energy released. NOAA, in the biological opinion for Revolution Wind discounts any effects from seismic surveys on zooplankton without considering this proportional effect (Biological Opnion

[9] https://repository.library.noaa.gov/view/noaa/51759, p. 286.

of seismic survey and pile driving impacts, or the direct versus indirect causal links, the findings presented here dictate an immediate halt to offshore wind project construction, given the precautionary principle of the Marine Mammal Protection Act. NOAA can no longer assume that offshore wind seismic survey and pile driving activity causes no serious harm. Because NOAA is legally required to use the best available science, it must reevaluate all previously issued permits in light of these findings.

Figure 2.

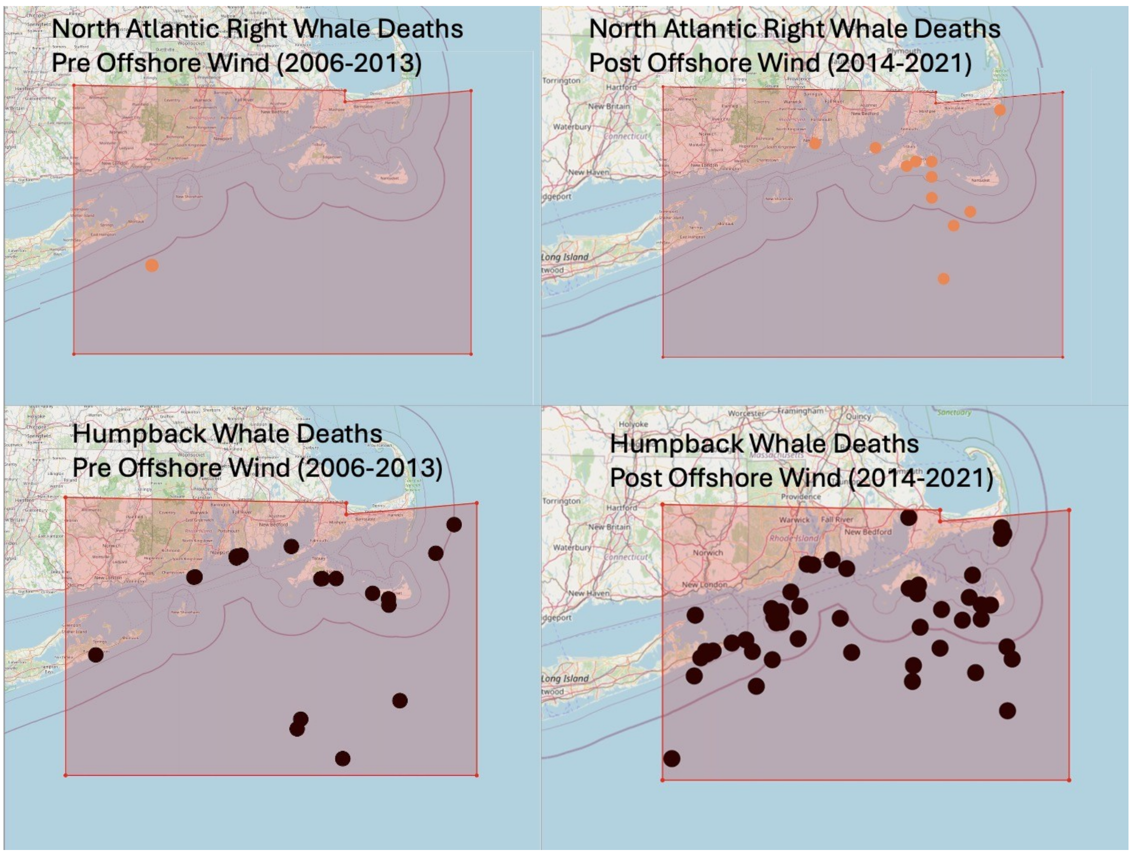

Figure 2. The maps above depict whale deaths within the region of interest used for the analysis pre- and post the onset of offshore wind activity. The upper and lower left-hand images depict whale deaths for the time period before the offshore wind activity began and those maps on the right, after the onset. The upper maps track North Atlantic right whale deaths (orange dots), whereas the lower maps track humpback whale deaths (black dots). More whales died, during the same time interval, after the onset than before, (NARW 1 vs 11, Humpback 20 vs. 46).