A bird's-eye view: firm costs and the limits of habitat protection

Atreya Dey

University of Cambridge

Abstract

The U.S. Endangered Species Act protects the habitats of threatened species by designating spatially explicit areas that restrict the operations of nearby firms. Using geographic designations under the Act, I show that these protections are associated with greater operating costs and lower profits for firms with facilities only within a few kilometers of the area. However, I provide causal evidence that these facilities reduce bird populations—a proxy for local ecology—over a much wider area, with effects detected up to 18 km away. Protections do not undo the damage, as bird populations near designated habitat recover only partially. Costs rise with the concentration of polluting activity near protected habitat and coincide with greater regulatory scrutiny, increased employment, and reductions in the most toxic pollutants. In addition, voluntary disclosures and biodiversity ratings provide little information about this exposure, limiting the scope for market-based incentives to reduce ecological harm.

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1 Introduction

Industrial activity creates firm value but can degrade the ecosystems around it. Indeed, an estimated $5 trillion in private finance annually supports activities that directly harm nature,[1] with substantial ecological, financial, and welfare consequences (Bilal et al., 2026; Giglio et al., 2024). Governments have responded by restricting activity in ecologically important areas, including habitats essential to species conservation. A concern, however, is that environmental regulation can impose adjustment costs (Greenstone, 2002; Greenstone et al., 2012; Walker, 2013; Xie, 2026), while its environmental benefits depend on policy design and implementation (Greenstone and Jack, 2015). This paper measures this trade-off for the U.S. Endangered Species Act's (ESA) critical habitat policy which applies conservation obligations to particular locations. It asks (i) how far industrial facilities damage the ecosystems around them, and (ii) how much the protection of those ecosystems costs the firms nearby. Credible answers to both questions are of interest to policy makers, firm managers, and investors alike (Dimson et al., 2026).

Each question raises its own empirical challenge. For (i), the ecological consequences of industrial activity are multidimensional and location-specific (Giglio et al., 2024).[2] Firms clear land, extract resources, and release pollutants—three of the five drivers of global biodiversity loss (Jaureguiberry et al., 2022). These activities can affect ecosystems beyond facility boundaries, making it difficult to determine how large these effects are and how far they extend. For (ii), conservation policies and regulations apply to particular geographies (Akbari et al., 2026), while firms may operate facilities across many locations or just outside those boundaries. Establishing the private costs of protection therefore requires estimating how regulatory exposure at individual facilities affects firm-wide operating costs.

Beyond these measurement problems, it is unclear ex ante whether place-based regula-

[1] This estimate comes from the United Nations Environment Programme, *State of Finance for Nature 2023*. The report traces private financial flows that fund economic activity driving biodiversity loss, including habitat conversion, water and soil pollution, and unsustainable extraction of natural resources.

[2] Greenhouse-gas emissions, by contrast, can be expressed in tons of CO_2 equivalent and aggregated across locations.

tion imposes material costs on firms or alters their production and investment decisions. In practice, firms trade off the costs of expenditure to reduce environmental impact and the legal liabilities of noncompliance (Xu and Kim, 2022). Regulation tied to a location may change this trade-off by requiring extra conditions on the operations there. Firms complying through recurring expenditures on labor or monitoring should see operating costs increase (Shapiro and Walker, 2018) and margins fall—even when production is maintained. If regulation instead spurs innovations that improve production efficiency, these gains may offset compliance costs over time (Porter and van der Linde, 1995; Xie, 2026). Firms facing new requirements might invest in cleaner processes or shift production to other plants. The cost response, therefore, should be largest when the regulated facilities account for more production and financing or capacity constraints limit adjustment.

This paper measures the spatial reach of industrial facilities' ecological impacts and the costs firms bear when nearby habitats are protected. For the first question, I combine facility locations from the Toxics Release Inventory (TRI) with bird observations from a citizen science platform and use satellite-implied construction dates in a staggered difference-in-differences design. The idea is that a new facility clears land and begins releasing pollutants, which should reduce nearby bird abundance and species richness—two observable proxies for the condition of the local ecosystem. The distance at which the decline fades should approximate the reach of the facility's effect. Estimating that distance is important for understanding whether place-based regulation overlaps with the areas affected by industrial activity (Currie et al., 2015; Akbari et al., 2026; Chen et al., 2026). For the second question, I match critical-habitat areas to TRI facilities and their parent firms. Obligations are highly heterogeneous across species and sites, so whether they are large enough to appear in firm-level operating costs and profitability remains unanswered.

I exploit the construction of new industrial facilities to show that nearby bird populations decrease and that the decline fades with distance. The bird data is obtained from eBird, the world's largest database of bird observations where volunteer birdwatchers record the

species and number of birds they detect. Birds are useful indicators of ecosystem health as they are widespread, readily detected, extensively observed, and sensitive to environmental change (Fraixedas et al., 2020). Within 18 km of a new facility, I find that bird abundance (the number of birds) falls by 6–9% and species richness (the number of species) by 3–5%. The effects begin at construction, persist thereafter, and attenuate with distance, with no differential pre-trends.[3] On the intensive margin, higher toxic releases are associated with lower nearby bird abundance, and lead concentrations increase near new facilities.

Having shown that industrial activity negatively affects the local ecology, I next explore the effects of habitat protection on firms by using spatio-temporal variation in critical-habitat designations. This ESA policy is the primary federal framework for protecting threatened and endangered species in the country. A component of the Act is the designation of critical habitat, which imposes spatially explicit protections on areas considered important to species conservation. Once an area is designated, federal agencies must ensure that any action they authorize or carry out does not destroy or adversely modify it. The requirement extends to private firms through the federal permits and approvals their projects need, and it applies to activities outside the designated boundary that may affect the habitat inside it. If these obligations bind, designation near a facility should raise that facility's cost of operating.

To illustrate the costs of habitat protection and how regulatory requirements differ across locations, consider two firms: Duke Energy Florida, a utility, and Koppers, a wood-treatment company headquartered in Pennsylvania. The habitat conservation plan for Duke Energy Florida's DeBary solar project committed $462,000 in contributions for Florida scrub-jay and indigo-snake conservation. The U.S. Fish and Wildlife Service (FWS) incorporated these commitments as mandatory conditions for the project to go forward. In addition, it required that any land clearing take place outside the scrub-jay nesting season and that an observer be present on site while clearing occurs. Koppers, on the other hand, has recurring

[3]Placebo tests using randomized construction dates produce effects centered on zero, and displacement tests find no offsetting increase in birds outside the impact area. The results are also robust to alternative control groups and observer-effort adjustments, and the frequency of eBird surveys does not decline after construction.

requirements during facility operations. For its Salem facility, the FWS requires specialist fish surveys before each dredging event and a survey report within 30 days.[4]

I present cross-sectional evidence that critical habitats are associated with greater operating costs of firms with facilities nearby. In a sample of about 12,300 firm-years, roughly 400 firms have a facility inside or within 3 km of a designated boundary. Compared with firms in the same industry and year, these firms have cost of goods sold (COGS) as a share of sales that is 1.42 percentage points higher. By contrast, firms with facilities 3 to 18 km from a boundary have operating costs no different from those of unexposed firms. This spatial divergence—between an ecological footprint that extends roughly 18 km and a regulatory burden that falls within a much closer radius—is the primary result of the paper.[5]

Firm proximity to habitats may be endogenous. Therefore, I compare changes in operating costs and profitability around new designations between newly exposed firms and matched control firms, repeating the comparison at successive distances from the designated boundary. Again, I find that the response is concentrated among firms with a facility within 3 km of designated habitat ("exposed facilities"). For these firms, designation is associated with an increase in the ratio of COGS to sales by 1.53 percentage points, driven by the numerator. At the treated sample's median predesignation sales of $2.05 billion, that is roughly $31 million a year in additional costs. Operating margins, defined as operating income divided by sales, fall by 1.81 percentage points over the same period. As a placebo test, I conduct a triple difference separating protected-area designations (Akbari et al., 2026)—which generally impose no new regulatory obligations on neighboring firms—from critical habitats. Indeed, I find significant increases in costs and declines in profitability only follow-

[4]These selected cases illustrate project-specific ESA obligations rather than costs attributable specifically to critical-habitat designation. For many requirements, as in the Koppers case, the documents specify what must be done without reporting its dollar cost.

[5]The ecological estimates measure how far a new facility's effect on bird populations extends, while the financial estimates measure how close an existing facility must be to designated habitat for its parent firm's costs to rise. Both effects concern the same landscapes. Among new facilities with mapped critical habitat nearby, bird abundance declines by 13–19% at radii of 8 to 17 km, with significant effects up to about 19 km (Internet Appendix Figure IA.6). The ecological footprint near protected habitat is therefore at least as wide as elsewhere and extends well beyond the 3-km range over which firms' costs rise.

ing critical-habitat designation. Overall, this pattern is consistent with recurring compliance costs rather than an innovation offset or a firm-wide contraction in output.

If designation raises liability at exposed plants, the cost response should scale with the firm's pollution there and be stronger where leverage is high. For firms with more than one-quarter of their TRI releases at exposed facilities, COGS/Sales increases by 3.66 percentage points, compared with 0.92 percentage points for firms below this threshold. This gap is about 5 percentage points larger among high-leverage firms.

Conservation obligations can require additional labor, as the specialist fish surveys required at Koppers' Salem facility illustrate. Employment does not change on average across firms. However, the estimated increase after designation is approximately 26% for firms with one TRI-reporting facility and is smaller as the number of facilities operated increases. Presumably, hiring at one site is a larger share of a small firm's workforce, so the same response is easier to detect at firms with fewer plants. Firm-level data cannot show, however, whether this hiring occurs at the exposed site (Giroud and Mueller, 2015).

I investigate the adjustments underlying these firm-wide financial effects. Comparing 178 exposed facilities with facilities of matched control firms, I find that designation increases informal and formal enforcement activity by the Environmental Protection Agency (EPA) and local environmental regulators by roughly 7.1% and 4.5%, respectively. Greater enforcement is consistent with a higher expected cost of noncompliance, which firms weigh against compliance spending. I do not find evidence that facilities report more source-reduction activity, such as process modifications or changes in operating practices, or that their total toxic releases fall. However, the composition of releases shifts toward less toxic chemicals.

Finally, I examine whether habitat protection improves ecological outcomes and whether disclosure provides an alternative disciplining channel by allowing investors to identify environmentally harmful firms. Applying a similar identification strategy to bird outcomes, I find suggestive evidence of approximately 5% higher bird abundance within roughly 5 km of designated habitats. In addition, voluntary ESG reporting, 10-K disclosures (Giglio et al.,

2026), and biodiversity footprint scores used in prior literature (Garel et al., 2024) largely do not identify the firms in proximity to these ecologically sensitive areas.

This paper relates to the financial literature on environmental pressures and firm behavior. Akey and Appel (2021) study a Supreme Court decision that reduced parent companies' responsibility for their subsidiaries' environmental cleanup costs. They find that subsidiaries subsequently increase pollution and reduce investment in abatement. Bellon (2025) examines a reform that reduced lenders' exposure to cleanup costs associated with borrowers' collateral, showing how environmental liability affects loan terms and borrowers' incentives to control pollution. Chen (2025) studies a reform that shields buyers of contaminated properties from liability for past pollution. Duchin et al. (2025) document the sale of pollutive assets to firms facing weaker environmental pressures. In each of these settings environmental scrutiny affects firms through liability rules and changes in asset ownership. I instead show how geographically targeted regulation affects firms' costs and profitability.

Other studies examine how pollution regulation affects productivity (Berman and Bui, 2001; Greenstone et al., 2012), industrial activity (Greenstone, 2002), and workers' earnings (Walker, 2013). He et al. (2020) show that differences in enforcement upstream and downstream of water-monitoring stations in China lead to differences in firm productivity and emissions. More directly related, Frank et al. (2025) examine how species protection under the ESA affects land markets. They find limited capitalization of its economic impacts into land values overall, although effects vary across species and locations. Small changes in land prices do not, however, rule out higher operating costs for nearby firms.

Akbari et al. (2026) and Chen et al. (2026)—two concurrent and related papers—use facilities' proximity to geographically defined ecosystems to study toxic releases, regulatory scrutiny, and parent firms' outcomes. The first important difference concerns how exposure is measured. The spatial extent of a facility's impact is itself an empirical object, and I estimate it using observed bird populations. Akbari et al. (2026) adopt a 30-km radius, which Chen

et al. (2026) follow, and that distance defines exposure in their empirical tests.[6] Instead, I find a spatial mismatch where the ecological effects of a facility reach roughly 18 km, while the regulatory burden falls on firms within 3 km of a habitat. This distinction matters for assigning treatment as a 30-km definition classifies many more facilities as exposed. About 76% of these facilities lie more than 3 km from a designated habitat, beyond the distance at which I find higher costs.

The financial consequences I find also diverge from these papers. Akbari et al. (2026) study protected-area designations and document lower establishment sales and employment, along with lower profitability at parent firms. Chen et al. (2026) study critical-habitat designations and find that exposed plants shift releases from on-site disposal to off-site transfers. The facility-level results in this paper provide little evidence of production reallocation, with no significant increase in other plants' output, TRI nonreporting by exposed facilities, or sales to other public firms. I show that a small set of public firms bear economically material operating costs after designation and only scale back their most toxic pollutants. The larger cost effects relative to other protected-area designations are consistent with binding regulatory constraints on nearby firms. My findings complement Xu and Kim (2022) by showing that greater enforcement is associated with higher operating costs and increased hiring, alongside a decrease in toxic releases.

From a policy standpoint, the implications of these results differ materially. Industrial activity's ecological effects extend broadly, while regulatory interventions concentrate their costs and benefits within a smaller radius. This inequality suggests that early intervention, before industrialization, could limit ecological harm at lower economic cost. Market-based channels to discipline firms also remain partial, and their measurement noisy (Avramov et al., 2022). Investor pressure can discipline firms when environmental harm is publicly recorded (Bisetti et al., 2026), but that requires information identifying the responsible firms. The

[6] Akbari et al. evaluate buffers from 5 to 50 km and select 30 km using the observed pollution response, dispersion considerations, and statistical power. They study protected areas in the World Database on Protected Areas, whose U.S. records come from PAD-US; Chen et al. study ESA critical-habitat designations.

information investors currently use—ESG scores, 10-K text, and voluntary disclosure—does not identify the firms that burden the environment or that bear the costs of regulation. Stricter reporting standards could therefore complement habitat protection as an additional channel to target brown firms (Dimson et al., 2026; Pedersen, 2026).

The remainder of the paper proceeds as follows. Section 2 describes critical-habitat designation under the Endangered Species Act. Section 3 describes the data. Section 4 estimates the ecological effects of new industrial facilities. Section 5 examines how habitat protection affects firms' operating costs, and Section 6 examines responses at the exposed facilities. Section 7 studies bird populations near designated habitat and whether disclosures identify exposed firms. Section 8 concludes.

2 Institutional Background

2.1 The Endangered Species Act

Congress enacted the Endangered Species Act (ESA) in 1973 to conserve species at risk of extinction and the ecosystems on which they depend. The U.S. Fish and Wildlife Service (FWS) generally administers the Act for terrestrial and freshwater species, while NOAA Fisheries supervises it for other marine species. The Act restricts "take," including harming, harassing, capturing, or killing protected wildlife. "Incidental take" results from an otherwise lawful activity, such as construction or facility operation.

Species listing and habitat designation are distinct decisions. Under Section 4, the responsible agency determines whether a species is endangered or threatened using the best available scientific and commercial data, without considering economic costs. Critical habitat comprises occupied areas with features essential to conservation and, when necessary, essential unoccupied areas. Unlike listing, designation requires consideration of economic and other relevant impacts. Section 4(b)(2) allows an area to be excluded when the benefits

of exclusion exceed those of inclusion, unless exclusion would result in extinction.[7]

Designations proceed through notice-and-comment rulemaking. The agency publishes a proposed rule, considers comments, and issues a final rule in the *Federal Register* specifying the habitat boundary and effective date. I date designation events to final-rule publication, although proposals and litigation may lead firms to respond earlier. Economic exclusions also mean that habitat boundaries cannot be presumed random (Frank et al., 2025).

2.2 How habitat protection affects firms

Compliance requirements vary with firms' activities, the species affected, and the federal authorizations their projects require. Section 7 requires federal agencies to ensure that actions they authorize, fund, or carry out are unlikely to jeopardize listed species or destroy or adversely modify designated critical habitat. It can therefore apply when a firm seeks a federal permit or funding, such as an Army Corps of Engineers permit for dredging. If the action may affect listed species or designated habitat, the permitting agency consults with FWS or NOAA Fisheries. Projects outside a habitat boundary can also require consultation when their effects reach protected habitat.

If the wildlife agency agrees in writing that a project is unlikely to adversely affect listed species or critical habitat, consultation can end without formal review. Otherwise, formal consultation assesses whether the project would jeopardize the species or impair habitat needed for its conservation. To obtain authorization, firms may have to change project design or restrict when work takes place. They may also face continuing monitoring requirements. Separately, Section 10 provides a route to incidental-take authorization through a habitat conservation plan specifying measures to minimize and mitigate the activity's effects. These requirements can arise from species protection even without critical-habitat designation.

These obligations can require equipment changes, operating restrictions, mitigation pur-

[7] 16 U.S.C. §§ 1532(5), 1533(a)–(b). Designation does not transfer ownership, establish a refuge, or impose a general prohibition on private land use. The FWS provides further guidance on critical-habitat designation and its regulatory implications (https://www.fws.gov/project/critical-habitat).

chases, and continuing surveys and monitoring. For example, Exelon proposed operating limits and monitoring at Eddystone after evaluating cooling-water investments. Grandin Sand Mine funds surveys and mitigation from its operating budget. Project-level requirements are difficult to document systematically because the relevant records are not consistently available and often omit associated expenditures. Appendix A.1 provides selected examples of these ESA requirements.

Habitat protection sits alongside existing environmental programs. The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) regulates point-source pollutant discharges, while the Resource Conservation and Recovery Act (RCRA) regulates hazardous-waste management. EPA and state authorities enforce these obligations. EPA-issued permits can provide a federal connection for ESA consultation; state-issued NPDES permits do not automatically do so. Designation does not automatically change existing permits. Adjustments may involve new conditions, project changes, or compliance with existing obligations.

3 Data

I describe the data in five parts, covering industrial facilities and their construction dates, bird abundance and species richness, habitat protection, financial outcomes, and regulatory activity and facility adjustments. Section 7.2 describes additional data on voluntary disclosure from CDP (formerly the Carbon Disclosure Project), biodiversity discussion in 10-K filings from Giglio et al. (2026), and commercial biodiversity measures from Iceberg Data Lab. The ecological analyses use annual observations around facilities and protected habitat, while the financial analysis follows publicly traded parent firms around new habitat designations. Table A.1 defines the variables.

3.1 Industrial facilities and pollution releases

I begin with the precise geographic location of industrial facilities, which I obtain from the TRI. Established by the Emergency Planning and Community Right-to-Know Act of 1986, the TRI provides a public registry of facility-level industrial activity in the U.S., containing annual reports from facilities in covered industries that meet reporting requirements for listed toxic chemicals.[8] Annual reports identify each facility's location, parent company, and reported releases. The stable facility identifier allows me to follow a site over time even when its reported name or parent company changes.

I match the parent companies reported in TRI to Compustat identifiers to construct an annual facility–firm ownership panel. This linkage assigns geographic exposure and pollution releases to the firm operating the facility in the relevant year. For the designation analysis, I fill gaps between ownership observations when the same parent appears on both sides of the gap, but do not extend ownership beyond the last observed link. Changes in the set of facilities associated with a firm can therefore reflect changes in ownership as well as TRI reporting coverage. The resulting facility counts measure a firm's TRI-reporting footprint, rather than its complete set of establishments.

A facility's first TRI report may come years after construction. I therefore use annual satellite-based land-cover data from the National Land Cover Database (NLCD) to identify physical development near each facility (U.S. Geological Survey, 2024). The construction measure detects discrete increases in impervious surfaces, such as rooftops and pavement, within 500 meters of the reported facility coordinates. These dates anchor the analysis of industrial construction and nearby bird populations. NLCD also provides measures of development in the surrounding landscape, which I use to account for changes in local urbanization.

I measure pollution using annual TRI releases, aggregating chemical-level quantities to

[8]Data documentation: U.S. Environmental Protection Agency, *Reporting for TRI Facilities*, accessed September 26, 2026.

the facility and parent-firm levels. I express reported quantities in pounds after converting records reported in other mass units. Total releases include on-site releases and reported off-site disposal. This measure captures the mass of reported pollution, without weighting chemicals by toxicity or ecological damage. Missing facility reports are not treated as zero releases.

3.2 Bird abundance and species richness

To quantify the ecological context of these facilities, I use bird populations, which provide a location-specific indicator of ecosystem health that can be compared across places and over time (Fraixedas et al., 2020). I examine bird abundance and species richness, two standard, complementary biodiversity measures. Abundance counts the individual birds, while species richness counts distinct species. Together, they distinguish changes in population counts from changes in the variety of species observed. Figure 1 maps county-level bird abundance and the locations of industrial facilities.

The data come from eBird, a citizen-science platform operated by the Cornell Lab of Ornithology (Sullivan et al., 2009). I use structured checklists from the eBird Basic Dataset.[9] For each checklist, volunteer observers record the species and number of birds detected, survey duration, distance traveled, and location. I construct time-varying ecological measures from checklists recorded in each year rather than backfilling earlier years from a recent abundance map. Facility-years without nearby checklists are treated as missing. The same principle applies to locations around designated habitat, where an absence of checklists is not interpreted as an absence of birds.

Raw checklist totals reflect observer effort and timing as much as underlying bird populations, so I adapt the effort-adjustment approach of Hogan et al. (2025) to account for these differences. At the individual checklist level, I partial out the number of observation hours, the number of observers, and hour-of-day and state-by-month fixed effects from

[9]The eBird Basic Dataset and accompanying sampling-event data are available through https://ebird.org/data/download.

log total bird counts. The residual captures within-state relative abundance after removing predictable variation in detectability. The state-by-month fixed effects absorb cross-state differences in biodiversity, so the adjusted abundance measure captures local deviations from each state's seasonal average rather than absolute ecological levels. I apply an analogous adjustment to species richness. In the habitat analysis, I estimate the adjustment using observations before the proposal and observations at unprotected comparison locations, then apply the estimated coefficients to the remaining checklists.

3.3 Critical habitat and geographic exposure

I obtain critical-habitat boundaries from the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). The spatial files identify the areas covered by habitat designations and the species associated with them (U.S. Fish and Wildlife Service, 2026; National Marine Fisheries Service, 2026). For the firm analysis, I combine FWS habitat polygons with NMFS polygons and river segments for freshwater and other marine species. I match these geographic records to designation dates and Federal Register rule information. The ecological analysis uses the FWS habitat polygons for which the bird observations and proposal dates can be linked. Figure 2 shows the geography of designated habitat and facilities within 30 km of it.

For each TRI facility, I calculate the shortest distance to designated habitat, assigning a distance of zero to facilities inside a habitat polygon. Combining these distances with annual ownership links identifies the firms operating facilities near each designation. The primary specification defines exposure as operating at least one facility inside or within 3 km of newly designated habitat. I repeat the construction at other distances to assess the geographic reach of the financial response. Proximity measures potential exposure to habitat protection, rather than establishing that every nearby facility faces the same legal obligation.

I use the final-rule publication year in all designation analyses. A firm becomes newly

exposed when habitat is designated near a facility it already operates. Acquiring a facility near previously designated habitat is not treated as a new designation event.

3.4 Financial data and firm characteristics

I obtain accounting information from the Compustat quarterly files and link it to TRI parent companies using the annual ownership panel. I obtain stock-market data from CRSP to construct market equity for book-to-market and Tobin's q. The main outcomes of interest are cost of goods sold relative to sales and operating profitability. I construct annual flow variables by summing quarterly observations within each calendar year, requiring four reported quarters for the relevant accounting items. Annual ratios use the sums of the numerator and denominator, rather than the average of quarterly ratios. The variables are

$$\begin{aligned} \text{COGS/Sales}_{i,t} &= 100 \times \frac{\text{Cost of Goods Sold}_{i,t}}{\text{Sales}_{i,t}}, \\ \text{Operating Margin}_{i,t} &= 100 \times \frac{\text{Operating Income Before D\&A}_{i,t}}{\text{Sales}_{i,t}}. \end{aligned} \tag{1}$$

Both are expressed in percentage points. Measuring operating income before depreciation and amortization separates the operating-margin outcome from changes in depreciation charges. I also construct selling, general, and administrative expenses relative to sales.

The baseline set of firm characteristics includes log total assets, log book-to-market equity, return on assets, leverage, and tangibility. Return on assets is annual net income divided by year-end assets, leverage is short- and long-term debt divided by assets, and tangibility is net property, plant, and equipment divided by assets. Balance-sheet measures use the calendar year's final quarter. I winsorize the accounting flow ratios, return on assets, and log book-to-market at the first and ninety-ninth percentiles within calendar year before restricting the data to the geographic analysis sample. I classify firms using SIC codes according to the Fama–French 12 industries.

Employment comes from Compustat's annual employee count. I express this measure as

the log number of employees, treating missing and nonpositive values as missing. Employment is reported for the consolidated firm, while the facility count comes from the firm's U.S. TRI records. The employment analysis therefore measures changes in the parent's total workforce rather than staffing at a particular exposed plant. I also use a market-based distress measure derived from an approximation to distance to default (Bharath and Shumway, 2008). I express distress as one minus the within-year percentile rank of distance to default, so that higher values indicate greater distress.

To measure how much of a firm's pollution-generating activity is exposed, I calculate the share of its predesignation TRI releases attributable to facilities exposed by the event's designation. The numerator sums releases at those facilities over event years -6 through -4, and the denominator sums releases at all of the firm's TRI facilities over the same years. The share is defined when total releases are positive. I use the same predesignation window to measure the firm's average number of TRI facilities and financial distress. These characteristics are fixed before designation. The release share measures the concentration of reported pollution, rather than the share of sales, employment, or production at the exposed facilities.

The within firm empirical analysis uses 155 treated firms across 19 designation-year cohorts between 1993 and 2023. The underlying annual panel spans 1988–2025. The COGS/Sales estimation sample contains 22,014 firm–cohort–year observations from 835 distinct firms, including matched controls. A control firm can contribute to more than one cohort, so these observations are not unique firm-years. Sample sizes differ across accounting outcomes because the required items are not available for every firm and year. The matching procedure and event windows are described later.

3.5 Regulatory activity and facility adjustments

I draw on additional datasets to probe the mechanisms through which firms realize these ecological costs.

First, I obtain enforcement records from the EPA's Enforcement and Compliance History Online (ECHO) database.[10] I match these records to TRI facilities using facility identifiers and the Facility Registry Service. The records report the timing of enforcement cases and assessed penalties across environmental programs. I measure inspections separately from informal and formal enforcement actions. Coverage varies across outcomes, so I distinguish facility-years with no recorded action from those outside the relevant program coverage. These measures capture general environmental regulatory activity rather than ESA-specific enforcement.

Second, to examine pollution-control practices, I use the source-reduction information reported in TRI.[11] These records identify activities such as process modifications and changes in operating practices intended to reduce pollution at its source. I construct indicators of reported adoption and examine them alongside annual facility releases. The source-reduction indicators measure reported practices rather than their dollar costs or the full set of conservation measures a facility may undertake.

Third, I use changes in the TRI–Compustat ownership links to identify transfers of facilities between publicly traded parent firms. A facility's disappearance from TRI reporting alone is not classified as a sale. Because the ownership linkage is to publicly traded firms, this measure does not capture all transfers to private buyers. For the facility analyses, I identify exposed plants and comparison plants from the predesignation ownership records, allowing subsequent outcomes to be followed at a fixed set of sites.

4 Ecological Effects of Industrial Facilities

To measure firms' ecological footprints, I examine ecological outcomes near their industrial facilities. This approach differs from proprietary footprint measures (Garel et al., 2024)

[10] Data documentation: U.S. Environmental Protection Agency, *Enforcement and Compliance History Online (ECHO): About the Data*, accessed September 22, 2026.

[11] Data documentation: U.S. Environmental Protection Agency, *TRI Source Reduction Reporting*, accessed September 22, 2026.

that infer biodiversity loss from firms' reported activities rather than observing ecological outcomes near their operations. The spatial extent of industrial impact is itself an empirical object, while Chen et al. (2026) use a 30-km exposure radius. I use local bird populations as a proxy for ecological condition because they respond to habitat disturbance and pollution, and citizen-science surveys provide dense spatial coverage (Fraixedas et al., 2020). Simply comparing bird populations across space is not sufficient, because facilities locate in places that differ systematically from non-facility areas. I therefore use a staggered difference-in-differences design that varies the treatment radius from 5 to 24 km and measures the effect of new TRI facility construction on local bird populations.

A central challenge is that a facility's construction date may precede its first regulatory filing by several years. I therefore extract construction dates directly from satellite imagery. Using annual data from the National Land Cover Database (NLCD), I pinpoint the year of construction by detecting discrete jumps in impervious surfaces (new rooftops and pavement) within a 500-meter radius of each facility's reported coordinates. This approach anchors the analysis to the physical construction date—average impervious surface growth spikes at the detected construction year and is near zero in surrounding years (Internet Appendix Figure IA.1). Visual inspection of high-resolution aerial imagery confirms that these statistical jumps correspond to physical land clearing and infrastructure development (Figure 3).

To isolate a facility's causal effect from broader regional trends, my design compares changes in bird populations across two concentric rings. The inner, "treated" ring, spanning from 1 to X km, captures the area of direct impact. An outer, "control" ring, from $X + 1$ to 30 km, is a contemporaneous benchmark for what would have happened in the absence of the facility. I vary the treatment threshold X from 5 to 24 km, which tests for spatial attenuation of the effect. Any spillover contamination of the control ring at the boundary becomes observable as X widens. For each facility f, ring $u \in \{\text{inner}, \text{outer}\}$, and year t, the outcome $Y_{f,u,t}$ is log effort-adjusted bird abundance or the log number of species. The

following equation describes the difference-in-differences (DiD) logic.

$$Y_{f,u,t} \;=\; \text{Facility-Ring FE}_{f,u} + \text{Year FE}_t + \beta \cdot \text{Inner}_u \times \text{Post}_{f,t} + X'_{f,t}\gamma + \varepsilon_{f,u,t}, \qquad (2)$$

where Inner_u indicates the inner ring and $\text{Post}_{f,t}$ indicates years at or after the facility's satellite-inferred construction year $\hat{T}_f$. The vector $X_{f,t}$ contains time-varying controls for observer effort and local urbanization. The dynamic event-study version replaces $\text{Post}_{f,t}$ with a full set of event-time indicators, one for each year relative to construction. Following the default in Callaway and Sant'Anna (2021), post-construction coefficients measure changes relative to the year before construction, and each pre-construction coefficient measures the change from the preceding year.

I estimate the specification with the staggered DiD estimator of Callaway and Sant'Anna (2021), which is robust to the bias that affects two-way fixed effects under heterogeneous treatment timing. The control set comprises all outer-ring observations (never treated) and inner-ring observations from facilities not yet constructed at t (not yet treated). I cluster standard errors at the facility level. The urbanization control in all specifications uses impervious surface growth in a fixed 15–30-km band around the facility, which proxies for regional development trends without absorbing the facility's own physical footprint. The identification assumption is that bird populations in the inner ring would have trended similarly to those in the outer ring in the absence of facility construction; not that facility locations are randomly assigned.

Figure 4 presents the estimated difference-in-differences at every integer threshold from 5 to 24 km and plots the average treatment effect on the treated (ATT). Both abundance and richness show negative effects that generally attenuate as the treatment ring expands to encompass less-affected areas. The abundance effect is statistically significant up to 18 km and attenuates beyond. Richness follows the same spatial pattern at roughly half the magnitude. This spatial pattern is consistent with a site-specific externality that dissipates

with distance from the facility.

The distance-threshold analysis indicates that the ecological response extends beyond 14 km, with statistically significant abundance estimates through approximately 18 km. Table 2 reports the DiD estimates for the 1–14-km treatment ring across four progressively controlled specifications. This comparison provides the detailed estimates of magnitude and robustness within the broader range examined in Figure 4. For each specification, I report the pre-construction average ($e < 0$) as a diagnostic for parallel trends, and the post-construction average ($e \geq 0$) as the main causal estimate. Bird abundance decreases by 6% to 9% relative to the outer control ring (Panel A). Species richness falls by 3% to 5%—roughly half the abundance decline (Panel B). Panel C reports that the post-period average remains similar when the control group is restricted to never-treated outer-ring observations. Figure 5 shows the event-time path and shows that the decline begins at the time of construction and persists through the post-treatment window.[12]

Facilities also release chemicals that may have heterogeneous effects on biodiversity. Estimating the causal effects of these releases is difficult because release volumes are not plausibly exogenous. Internet Appendix Figure IA.3 uses facility fixed effects to show that, within a given facility over time, years with higher reported TRI releases are associated with lower nearby bird abundance. This associational evidence suggests that ecological degradation persists as an ongoing byproduct of industrial activity rather than only a one-time consequence of initial land use. Evidence on ambient pollution complements these findings. Internet Appendix Figure IA.4 shows that TRI facilities measurably increase local lead concentrations in ambient water by 1.7 to 2.3 μg/L within 5 to 10 km, with effects that attenuate with distance. Internet Appendix Figure IA.5 confirms that the lead contamination effect lies outside the placebo distribution.

[12] A concern with citizen science data is that facility construction may alter where birders choose to survey, independently of ecological change. I test this by replacing the abundance outcome with log(checklist count+ 1) and re-estimating the primary specification. The ATT on checklist density ranges from -0.025 to -0.027 across specifications and is statistically indistinguishable from zero. These results do not indicate systematic changes in checklist density.

I test for four identification threats that could plausibly explain this pattern in the absence of a real facility effect. First, the decline could reflect pre-existing differences in ring trends or anticipatory behavior, rather than the facility itself. The dynamic event-study pre-period coefficients are small and statistically indistinguishable from zero, providing no evidence of differential trends or anticipatory responses. Sager and Singer (2025) show that differential trends related to baseline pollution can bias environmental-policy DiD estimates. An analogous concern here is that baseline bird abundance predicts subsequent trends; the pre-period tests provide a diagnostic but do not rule out this concern. Second, to discount the possibility of control-ring contamination, a displacement test finds no offsetting increase in bird populations in the rings immediately surrounding the impact zone (Internet Appendix Figure IA.2). The losses in the near-field are not offset by gains farther out, providing no evidence of contamination from outward displacement. Third, for treatment-timing exogeneity, a randomization inference exercise permutes facility construction dates 1,000 times at each distance threshold (Figure 6). The placebo ATTs cluster around zero at every threshold, while the actual abundance estimates remain significant through 18 km, outside the 5th percentile of the placebo distribution. Richness follows the same pattern. Facility construction timing rather than ring geometry therefore drives the result.

Fourth, the decline could reflect changes in where or how intensively birders survey rather than changes in bird populations. Adding controls for the number of observers and survey hours leaves the post-construction ATT at -9.2% (column (4) of Table 2). I also test directly whether survey activity changes after construction by using checklist counts, reported observer counts, and survey hours as outcomes, each measured as the log of one plus activity. This test uses the 1–14-km treatment ring and the 15–30-km control ring. Ring-years without checklists enter as zeros, allowing the test to capture the abandonment of survey locations. Internet Appendix Table IA.1 reports no statistically significant average post-construction change in any of the three measures. For observer counts, the estimates are -0.011 and -0.013 log points without and with the urbanization control, respectively.

These results provide no evidence of a systematic decline in survey activity accompanying the measured decline in bird populations.

I also repeat the distance-threshold analysis separately for facilities with and without mapped critical habitat nearby. Internet Appendix Figure IA.6 shows that the estimated decline in bird abundance is more negative near mapped critical habitat for thresholds above 6 km, and remains statistically significant up to about 19 km, compared with about 17 km for facilities without nearby habitat. Declines also occur among facilities without nearby mapped habitat. This exercise assesses the construction results across ecological settings, with habitat proximity defined independently of whether designation preceded construction.

Together, these results provide evidence that industrial facilities reduce nearby bird abundance and species richness. The distance-threshold estimates for bird abundance remain negative and statistically significant for treatment radii up to approximately 18 km. The declines attenuate with distance, persist through the post-treatment window, survive placebo tests on facility timing and ring geometry, and coincide with elevated chemical contamination of the surrounding environment.

5 Habitat Protection and Firm Operating Costs

Having documented that the ecological effects of industrial activity extend roughly 18 km from facilities, I next examine whether firms' operating costs also vary with proximity to designated critical habitat. I first examine these associations across alternative distance ranges. I then use the timing of new designations to compare changes in costs, profitability, Tobin's q, and capital expenditure between newly exposed firms and matched control firms.

5.1 Between-firm spatial associations

To examine the association between habitat proximity and firms' operating costs, I estimate the following regression separately for distance thresholds of $r = 1, 2, 3, 4$, and 5 km:

$$Y_{it} = \beta \, \text{Near}_{it} + \gamma \, \text{Outer}_{it} + \text{Controls}_{it} + \text{Fixed effects} + \varepsilon_{it}, \tag{3}$$

where i indexes firms, t indexes calendar years, and Y_{it} is annual COGS/Sales in percentage points. Near_{it} equals one if firm i owns at least one linked TRI facility inside or within r km of designated critical habitat in year t, and zero otherwise. Outer_{it} equals one if the firm owns at least one linked facility more than r and up to 18 km from its nearest designated habitat in year t, and zero otherwise. A firm can have both types of exposure if it owns facilities in both distance bands. The reference group comprises firm-years with neither type of exposure.

I measure each facility's distance to the nearest FWS or NMFS critical habitat whose final designation rule has been published by year t. Distance is measured from the facility's coordinates to the mapped habitat, with facilities inside habitat polygons assigned a distance of zero. Controls include lagged firm size, Tobin's q, leverage, capital expenditures, tangibility, profitability, and contemporaneous log TRI releases. Industry-by-year and headquarters-state-by-year fixed effects account for common industry conditions and time-varying conditions shared by firms headquartered in the same state. Standard errors are clustered by firm. The coefficient β measures the difference in annual cost ratios associated with near-habitat exposure, holding outer-band exposure and the included controls and fixed effects constant. Because facility locations and ownership are not randomly assigned, the coefficients describe conditional associations rather than the causal effect of designation.

Table 3 reports the results. In column (3), firms with facilities inside or within 3 km of designated habitat have COGS/Sales that is 1.42 percentage points higher, conditional on outer-band exposure and the included controls and fixed effects. The estimate is significant

at the 5% level and corresponds to $1.42 more in COGS per $100 of sales. The coefficient on exposure between 3 and 18 km is smaller, at 0.28 percentage points. Overall, the coefficient is larger if a firm has any facility closer to the habitat and loses significance after the 3-km threshold. All five specifications use the same 12,332 firm-years from 1,177 firms.

5.2 Within-firm changes following habitat designation

Persistent differences in production technology or facility location could contribute to the spatial associations even after conditioning on observed characteristics. To alleviate concerns of these persistent differences, I study changes following new habitat designations near facilities that firms owned before designation. I compare changes in operating costs, profitability, Tobin's q, and capital expenditures between newly exposed firms and matched control firms.

Exploiting habitat designation as exogenous variation in regulatory exposure raises two main identification challenges. First, habitat designation takes economic impacts into account (Frank et al., 2025), so exposure depends on existing industrial activity and anticipated development. Figure 7 shows an apparent discontinuity in predesignation facility density at the eventual habitat boundary, with fewer facilities immediately inside than outside. Frank et al. (2025) document the same pattern in land markets: transactions are roughly six times less frequent just inside critical-habitat boundaries than just outside, before designation. Because these facilities began reporting before designation, the spatial difference cannot be attributed to the final rule alone. Second, firms may respond to proposed protection before the final designation. Figure 8 shows that, among the 170 linked FWS final rules, the median interval between proposal and final publication is approximately 396 days, and 81.8% were finalized within two years. This delay gives firms time to adjust investment or operations before the event date used in the regressions. This anticipation may affect both the timing and magnitude of the estimated changes if the reference period includes a response to proposed protection.

To alleviate some of these concerns, I restrict exposure to facilities owned before des-

ignation and compare changes within firms. I also use matching and entropy balancing to improve comparability on observable characteristics (Hainmueller, 2012). Table 4 reports balance before matching, after matching, and after weighting. Before matching, treated firms are larger and report higher releases than eligible controls. Matching reduces these differences, and entropy balancing brings the absolute standardized differences below 0.02 for all six targeted characteristics. These adjustments do not eliminate selection related to unobserved changes in firms' operating conditions. To address anticipatory effects, I use years -6 to -4 as the reference period and examine years -3 to -1 separately. I therefore interpret the estimates as changes associated with designation, without claiming that they isolate its causal effect. Using only new habitat designations reduces the treated sample from roughly 400 to 155 firms.

I select the 20 nearest eligible controls for each treated firm-event using Mahalanobis distance (Rubin, 1980). Matching uses COGS/Sales, log assets, return on assets, log TRI releases, tangibility, and log book-to-market, averaged over years -6 to -4. I then apply entropy balancing to the matched controls to improve balance in the means of these characteristics. Using the matched sample and entropy weights, I estimate a stacked difference-in-differences specification (Cengiz et al., 2019). For each firm i, designation cohort c, and year t, the following equation describes the estimation.

$$\begin{aligned} Y_{i,c,t} \;&= \text{Firm-Cohort FE}_{i,c} + \text{Cohort-Year FE}_{c,t} + \text{Industry-Year FE}_{j,t} + \text{State-Year FE}_{s,t} \\ &\quad + \beta \cdot \text{Designated}_{i,c} \times \text{Post}_{c,t} + \pi \cdot \text{Designated}_{i,c} \times \text{Pre}_{c,t} + \varepsilon_{i,c,t}, \end{aligned} \tag{4}$$

where j and s denote the firm's industry and headquarters state. $\text{Designated}_{i,c}$ indicates the newly exposed firm in cohort c, and its matched controls form the comparison group. $\text{Post}_{c,t}$ indicates event years 0 to 5 and $\text{Pre}_{c,t}$ indicates event years -3 to -1. Years -6 to -4 form the reference period, so β measures the average change over years 0 to 5 and π absorbs any anticipatory adjustment. Observations are weighted by the entropy-balancing weights. The

dynamic event-study version replaces $\text{Post}_{c,t}$ and $\text{Pre}_{c,t}$ with a full set of event-time indicators for years -3 to 5. Standard errors are clustered by firm.

Table 5 reports changes in firm outcomes following habitat designation. Panel A presents pooled estimates for years 0 through 5 relative to the reference period of years -6 to -4 and Panel B reports the yearly estimates. In column (1), COGS/Sales increases by 1.53 percentage points relative to matched controls. The estimate is significant at the 5% level and corresponds to approximately \$1.53 more in production costs per \$100 of sales. Column (3) shows a similar decline in operating profitability. Operating margin before depreciation and amortization (profits) falls by 1.81 percentage points. In contrast, the estimates for SG&A/Sales and sales are not significant. Columns (4) and (5) separate the ratio into its components. Log sales rises by 6.1 log points and is not significant, while log COGS rises by 8.4 log points, significant at the 10% level. The cost increase therefore outpaces sales, and the higher ratio does not reflect lower sales spread over fixed costs. In Panel B, the coefficients for years -3 to -1 do not provide evidence of differential predesignation trends.

If higher operating costs are expected to persist, they should reduce the value of future profits. To the extent that these costs also lower the expected marginal return to capital, q theory predicts weaker investment incentives (Hayashi, 1982). Table 6 examines firm valuation and capital expenditures following designation. In column (1), Tobin's q declines by 0.117, significant at the 10% level. This decline is consistent with lower expected profitability, although average q does not directly measure the marginal return to investment. Columns (2) and (3) report negative but insignificant changes in capital expenditures scaled by lagged sales and assets, respectively. The estimates therefore provide suggestive evidence of lower firm valuation, but do not establish a reduction in capital investment.

For robustness, I test whether the results depend on the number of matched controls or the matching criteria. Table A.2 varies the number of controls per treated firm-event from 5 to 50, re-estimating the entropy weights in each specification. The COGS/Sales estimate ranges from 1.53 to 1.82 percentage points and is significant at the 5% level except with

five controls, where it is significant at the 10% level. The predesignation coefficients are jointly insignificant throughout. Table A.3 replaces the matching distance with rank-based Mahalanobis distance; the COGS/Sales estimate remains similar at 1.44 percentage points and remains significant at the 5% level. Because the baseline matching does not require control firms to operate near habitat, Table A.4 adds exact matching on whether a firm owned a linked TRI facility more than 3 and up to 30 km from already-designated habitat during years -6 to -4. The results remain statistically similar, with the pre-trend coefficients individually and jointly insignificant.

I conduct a placebo test using other protected-area designations (Akbari et al., 2026), which generally enforce fewer obligations on neighboring firms and instead restricts land use within their boundaries. Internet Appendix IA.5 presents the triple-difference estimates. I find no significant change in costs or profitability under these other designations, and the differences relative to critical-habitat designation are statistically significant. These findings are consistent with regulatory constraints on firms exposed to critical habitat rather than a general effect of protecting nearby land.

Next, I use alternative definitions of spatial exposure. For the between-firm analysis, Table A.5 replaces the any-facility indicators with portfolio exposure shares and varies the outer distance bands. The near-habitat coefficient remains positive and similar across specifications. Finally, Table A.6 presents results testing whether designations affect facilities more than 5 km away. Both the cost and profitability estimates are smaller and insignificant.

I also examine whether local economic conditions account for the estimated changes in costs and profitability. Frank et al. (2025) provide evidence that critical-habitat boundaries are drawn to limit effects on land values. Table A.7 adds contemporaneous county income, unemployment, population density and growth, and farm and manufacturing employment shares. On the same sample, the COGS/Sales and operating-margin estimates remain magnitudinally and statistically similar.

5.3 Heterogeneity in firm responses to designation

Firm-wide cost increases should be larger when facilities exposed to critical-habitats account for more of the firm's activity. I examine this prediction using the predesignation concentration of TRI releases at exposed facilities and the number of TRI facilities a firm operates.

I measure this concentration as total releases at exposed facilities divided by total releases across the firm's linked TRI facilities, summing both over years -6 to -4. I divide treated firms into two groups at each concentration cutoff of 10%, 25%, and 50%, and compare changes in COGS/Sales and profitability between the groups. Each threshold defines a separate comparison between firms with higher and lower concentrations of releases at exposed facilities.

Table 7 shows that cost increases associated with designation are larger when exposed facilities account for a greater share of the firm's predesignation TRI releases. For firms with more than 25% of releases at exposed facilities, COGS/Sales rises by 2.74 percentage points more than for other treated firms, a difference significant at the 5% level. I find the same pattern at the 10% and 50% thresholds for both COGS/Sales and profits.

If designation increases staffing needs at exposed facilities, the proportional change in firm-wide employment should be larger when the firm operates fewer facilities. I examine this prediction in Table 9, using the firm's number of linked TRI facilities denoted by n. Column (1) reports a non significant average employment increase of 0.069 log points relative to matched controls. In column (2), I interact Designated $\times$ Post with $1/n$. The interaction coefficient is 0.522 and significant at the 1% level, indicating larger employment increases among firms with fewer TRI facilities. Together, these coefficients imply an increase of 0.470 log points for a firm with one linked facility. Column (3) adds contemporaneous county economic controls and the interaction coefficient remains significant at the 5% level. With these controls, the implied increase for a firm with one linked facility is 0.229 log points, or approximately 26%.

Firms with limited access to external finance may be less able to adjust to higher operat-

ing costs (Giroud and Mueller, 2015). Consistent with this, Xie (2026) finds that employment declines after the 1990 Clean Air Act Amendments are concentrated in industries dependent on external finance. Xu and Kim (2022) show that financially constrained firms release more toxic pollution, trading lower abatement spending against potential legal liabilities. These firms may therefore face greater compliance costs when regulation tightens. I examine whether the concentration pattern differs with predesignation leverage. Table 8 splits firms at the within-cohort median of predesignation debt to assets. The difference in cost increases between high- and low-concentration firms is approximately 5 percentage points larger among high-leverage firms.The corresponding profitability estimates are negative but not statistically significant.

The cost and employment results suggest that additional staffing contributes to higher operating costs, with hiring more apparent at firms with fewer facilities. Investment does not decline significantly, inconsistent with q theory. I also find no significant decline in sales, unlike Derrien et al. (2025), who show that salient negative ESG news reduces sales.

6 Facility-Level Responses to Habitat Designation

In this section, I investigate the regulatory activity and operating adjustments at the same facilities that define firms' exposure in the firm-level analysis.[13] If the higher operating costs reflect compliance-related adjustments, designation may be accompanied by changes in enforcement, permit requirements, or operating practices at these facilities. Facilities may leave and later reenter TRI reporting, so the available sample varies across years and outcomes.

I estimate facility-level changes with the same matched stacked design. For each facility

[13] I do not expand the sample to all TRI facilities. The sample includes only the facilities owned by the firms in the prior empirical tests.

f, designation cohort c, and year t, the following equation describes the estimation.

$$\begin{aligned} Y_{f,c,t} \;&= \text{Facility-Cohort FE}_{f,c} + \text{Cohort-Year FE}_{c,t} + \text{Industry-Year FE}_{k,t} \\ &\quad + \text{State-Year FE}_{s,t} + \beta \cdot \text{Exposed}_{f,c} \times \text{Post}_{c,t} + \pi \cdot \text{Exposed}_{f,c} \times \text{Pre}_{c,t} \\ &\quad + \beta^S \cdot \text{Sibling}_{f,c} \times \text{Post}_{c,t} + \pi^S \cdot \text{Sibling}_{f,c} \times \text{Pre}_{c,t} + \varepsilon_{f,c,t}, \end{aligned} \tag{5}$$

where k and s denote the facility's three-digit NAICS industry and state. $\text{Exposed}_{f,c}$ indicates a facility inside or within 3 km of the new designation, and $\text{Sibling}_{f,c}$ indicates the exposed firm's other facilities owned before designation. Facilities of matched control firms form the comparison group. I estimate separate effects for the exposed firm's other facilities, which may also adjust operations or compliance after designation. $\text{Post}_{c,t}$, $\text{Pre}_{c,t}$, and the reference period are defined as in equation (4). Each firm's entropy-balancing weight is divided equally across its facilities. The coefficient β measures the change at exposed facilities, and β^S the change at the firm's other facilities. Standard errors are clustered by firm.

6.1 Regulatory activity

To measure regulatory activity, I obtain enforcement records from the EPA's Enforcement and Compliance History Online (ECHO) database.[14] These records detail case timing and assessed penalties, allowing me to follow regulatory activity at individual facilities around designation.

The outcomes cover different stages of the regulatory process. I use facility-year counts of inspections, which assess compliance with environmental requirements, and informal enforcement actions, including warning letters and notices of violation that identify potential or observed noncompliance and seek corrective action. I also count formal enforcement actions, such as administrative orders and judicial cases, through which regulators seek enforceable remedies or penalties.

[14]Data documentation: U.S. Environmental Protection Agency, *Enforcement and Compliance History Online (ECHO): About the Data*, accessed September 22, 2026.

Table 10 presents pooled and yearly results testing whether these outcomes change following designation relative to facilities belonging to matched control firms. Enforcement actions are infrequent: informal actions occur in 7 percent of facility-years in the sample and formal actions in 11 percent. Panel A shows increases in informal and formal enforcement actions at exposed facilities relative to facilities belonging to matched control firms, of 0.071 and 0.045 log points. The inspection coefficient is 0.021 and statistically insignificant. Because the enforcement outcomes are sparse, I interpret these results as suggestive evidence of increased regulatory enforcement and compliance following designation.

6.2 Permit requirements and reissuance

Higher operating costs may also reflect changes in permit requirements. I use discharge monitoring reports and permit-version records from the EPA's Integrated Compliance Information System to examine this possibility.[15] I restrict the sample to facilities holding an individual National Pollutant Discharge Elimination System (NPDES) permit before designation. The first measure captures newly recorded requirements, i.e., whether a discharge monitoring report records a limit for a particular pollutant at an outfall—the point where a facility discharges wastewater into a water body. The second indicates whether a renewed discharge permit takes effect during the year, potentially updating the facility's discharge limits, monitoring requirements, or other permit conditions.

Table 11 shows that the probability of a newly recorded requirement increases by 11.83 percentage points following designation, significant at the 1% level. The reissuance estimate is 3.76 percentage points and statistically insignificant. These estimates draw on only 23 and 29 exposed facility-events, respectively, and the requirements measure depends on consecutive years of reporting. I therefore interpret the increase in recorded requirements as suggestive evidence of a compliance-related adjustment in this sample.

[15]Data documentation: U.S. Environmental Protection Agency, *Enforcement and Compliance History Online (ECHO): About the Data*, accessed September 22, 2026.

6.3 Source-reduction activities and toxic releases

Firms may also respond through pollution prevention or reduction. Indeed, Akbari et al. (2026) and Chen et al. (2026) both show that on-site toxic releases fall when a facility is within 30 km of protected areas or critical habitat, respectively. However, Akbari et al. (2026) report no change in reported source-reduction activity, which includes process changes that reduce the amount of a chemical entering the waste stream before recycling or treatment.

Similarly, I use data from the EPA's TRI to identify facilities that report source-reduction activities, including process changes, input substitutions, and waste reduction.[16] These indicators measure reported adoption rather than the amount spent on these activities. Table 12 reports pooled and yearly estimates for the three source-reduction indicators using the stacked difference-in-differences estimator. Overall, the estimates are indistinguishable from zero, indicating that facilities do not report changes in operating practices after critical-habitat designation. Regulation could in principle induce process innovations that offset compliance costs (Porter and van der Linde, 1995; Xie, 2026). Source-reduction activities are the closest TRI measure of such process changes, and they show no response. Together with operating margins that continue to decline through year 5, this provides no evidence of an innovation offset within the event window.

To understand whether facilities reduce aggregate chemical pollution, I use total reported TRI releases in pounds at each facility. Total releases include on-site releases and reported off-site disposal, aggregated across chemicals. Missing facility reports are not treated as zero releases. Once again, I compare changes in reported practices and releases between exposed facilities and facilities belonging to matched control firms.

The first three columns of Table 13 report a negative but insignificant relationship between designation and chemical releases. In columns (4)–(6) I instead examine the composition of chemical releases rather than their quantity. I weight each chemical's on-site releases

[16] Data documentation: U.S. Environmental Protection Agency, *TRI Source Reduction Reporting*, accessed September 22, 2026.

in pounds by the toxicity weights of the EPA's Risk-Screening Environmental Indicators (RSEI) model, which quantify the chronic inhalation and oral toxicity of each chemical. I apply the inhalation weight to releases to air and the oral weight to releases to water and land. The dependent variable is the log of these toxicity-weighted releases divided by the on-site pounds of the same chemicals and release routes—the average toxicity of a pound released. This significantly falls by 1.22 to 1.48 log points, while the corresponding pounds do not change. However, the decline begins before the final rule, suggesting anticipatory effects.

Firm-wide sales do not fall after designation (Table 5), but this could mask lower output at exposed facilities offset by higher output at the firm's other plants. Using a cumulative production index constructed from TRI production ratios, I find no significant increase in output at sibling facilities (Internet Appendix Table IA.2). Although output at exposed facilities declines after designation, significant predesignation differences between exposed and control facilities prevent attributing this decline to designation. I also find no significant increase in the likelihood that exposed facilities stop reporting to TRI or are transferred to another publicly traded parent firm (Internet Appendix Table IA.3).

7 Habitat Protection and the Information Role of Disclosure

Finally, I investigate whether habitat designation is associated with improvements in local bird abundance and species richness. These outcomes provide evidence on the ecological changes accompanying the firm and facility responses documented above.

I also ask whether firms' biodiversity disclosures reflect their operations in or near designated habitats. Disclosure, either voluntary or mandatory, could complement habitat protection by helping investors and other stakeholders identify exposed firms and monitor their responses (Dimson et al., 2026). This information may be used to help inform fi-

nancing decisions that link firms' cost of capital to their environmental impacts (Pedersen, 2026)—creating a market-based incentive to reduce that harm.[17]

7.1 Ecological outcomes following designation

Similar to Section 4, I use local bird populations as a proxy for ecological condition and test whether they recover after critical-habitat designation. To isolate changes near designated habitat from broader regional trends, my design compares changes in bird populations across two areas. The inner, "treated" area includes the habitat interior and locations up to X km outside its boundary. An outer, "control" area, more than $X + 1$ and up to 30 km from the boundary and outside designated habitat, provides a contemporaneous benchmark for what would have happened in the absence of protection. I estimate the specification with the staggered DiD estimator of Callaway and Sant'Anna (2021), using 1-km grid cells by year and dating treatment to final-rule publication. The sample contains 46 designations, with observations from six years before to ten years after publication. The sample is not restricted to locations near TRI facilities. I control for seasonal survey coverage, observer counts, survey hours, and NLCD impervious-surface growth, and cluster standard errors at the designation level.

Table 14 reports the estimates for the habitat interior and for thresholds of 1, 2, 5, 10, and 18 km. For each specification, I report the pre-period average over years -6 to -2, the post-period average over years 0 to 10, and the difference between the two. Panel A reports post-minus-pre increases in bird abundance of 0.040–0.059 log points (approximately 4–6%) for the habitat interior and thresholds up to 5 km, all significant at the 5% level. The difference is smaller and significant only at the 10% level at 10 km, and insignificant at 18 km. The estimates suggest a larger response near the habitat boundary, although they do not establish a sharp boundary for the response. Panel B reports the corresponding estimates for species richness which are small and statistically insignificant.

[17] In a model of carbon pricing, Pedersen (2026) shows how green finance can address unpriced environmental damage when financing costs can be linked to firms' future emissions.

An important concern is that the positive differences could reflect ecological changes that began before final designation. The post-period abundance averages are statistically insignificant in every column, while the pre-period averages are negative and significant at thresholds of 2 km and above. The improvement relative to the earlier pre-period therefore does not establish a new increase beginning at final-rule publication. The estimates may therefore reflect responses before the final rule or other differential changes preceding designation. In sum, the results provide only suggestive evidence of an improvement in bird abundance relative to the earlier pre-period.

7.2 Disclosure of biodiversity-sensitive operations

I next ask whether corporate disclosure and commercial biodiversity measures identify firms with operations near designated habitat. I relate each measure to whether a firm owns a facility within 1, 3, or 18 km of critical habitat, controlling for firm characteristics, pollution releases, and facility count.

I begin with CDP's biodiversity questionnaire, using responses from 2022–2025. The five indicators record whether firms report operations near biodiversity-sensitive areas, monitor biodiversity, take biodiversity-related actions, make public commitments, or voluntarily publish biodiversity information. Among respondents, Table 15 shows that firms with a facility within 3 km of critical habitat are 12.69 percentage points more likely to report operations near biodiversity-sensitive areas, significant at the 10% level. The corresponding estimates at 1 and 18 km are positive but insignificant. Habitat proximity is not significantly associated with the other four indicators at any distance. Moreover, 43% of yes-or-no responses from firms with facilities within 3 km report no operations near biodiversity-sensitive areas.[18]

Next, I also investigate biodiversity discussion in mandatory 10-K filings using the measures of Giglio et al. (2026). Internet Appendix Tables IA.9–IA.11 report positive but in-

[18]This share is 64 of 149 firm-year responses, excluding missing answers and "Not assessed." CDP's definition of biodiversity-sensitive areas is broader than designated critical habitat and does not use the distance thresholds in this analysis.

significant associations between habitat proximity and both biodiversity mentions and discussion of biodiversity regulation. At 3 km, the estimates are 1.62 and 1.07 percentage points, respectively. These estimates provide limited evidence that the filing-based measures distinguish firms operating near designated habitat.

Lastly, I exploit the corporate biodiversity footprint (CBF) developed by Iceberg Data Lab and used by Garel et al. (2024). CBF estimates biodiversity loss associated with firms' activities, including pollution, land use, and greenhouse-gas emissions. Columns (1)–(3) of Internet Appendix Tables IA.12–IA.14 report positive but insignificant associations with habitat proximity at 1 and 3 km, whether the footprint is measured in absolute terms or scaled by assets or sales. The estimates at 18 km are also insignificant. Columns (4)–(5) examine biodiversity dependency. Revenue dependency is 4.83 index points higher among firms with a facility within 1 km of critical habitat, significant at the 10% level. The results do not provide evidence that these measures capture proximity to designated habitat.

8 Conclusion

Biodiversity loss is emerging as the next environmental externality, after carbon emissions, for financial markets and governments to address. Yet protecting biodiversity requires that ecological damage be measured, attributed to firms, and linked to the locations where protection can limit that damage. Carbon emissions provide a benchmark because they can be expressed in common units, whereas biodiversity depends on local ecosystem conditions and is multidimensional. I address this problem by estimating how industrial facilities affect nearby bird populations and how critical-habitat designation affects the firms operating near protected areas. I find that the ecological effects of industrial activity extend roughly 18 km, while the operating-cost response to habitat protection is concentrated among firms with facilities within 3 km of designated habitat. Higher costs coincide with greater regulatory activity, while the evidence of ecological improvement following designation remains

suggestive. Voluntary reporting, mandatory filings, and commercial biodiversity measures provide limited information about which firms operate near these protected areas. The results therefore show how geographically targeted conservation concentrates private costs within a narrower area than the ecological effects of industrial activity.

One limitation of my analysis is that it does not establish whether the benefits of habitat protection exceed its social costs. Answering this question requires valuing the ecological changes and accounting for costs and benefits beyond the firms studied here. For instance, Bilal et al. (2026) evaluate biodiversity loss within a welfare framework that incorporates the intrinsic value of animal life. My estimates document changes in bird populations, operating costs, and profitability, but do not express these changes in a common welfare measure. They can therefore inform an assessment of conservation policy, but cannot determine the optimal level of protection. Another constraint is that I lack the detailed facility-level data available in Giroud and Mueller (2015) and Akbari et al. (2026), limiting my ability to identify the reallocation of labor and capital within firms.

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Figures

Figure 1: Bird abundance and the location of industrial facilities

County-level bird abundance and industrial facility locations. Counties are shaded by the geometric mean number of birds reported per eBird checklist from 2010 through 2024; darker shades denote higher abundance. Black points mark facilities in the Environmental Protection Agency's Toxics Release Inventory.

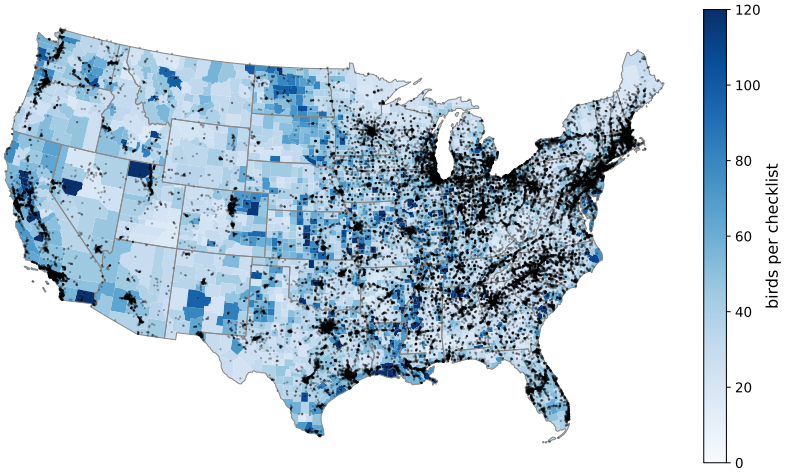


Figure 2: Critical habitat and nearby industrial facilities

Critical habitat and nearby Toxics Release Inventory facilities in the contiguous United States. Blue areas show final U.S. Fish and Wildlife Service habitat polygons. Orange areas and lines show National Marine Fisheries Service habitat for the salmon, steelhead, eulachon, and sturgeon species covered by the study's spatial data. Black points mark facilities within 30 km of designated habitat. Facility coordinates use the last available TRI report. The map combines the September 2026 FWS display layer with archived NMFS layers and does not reconstruct habitat boundaries at each historical designation date.

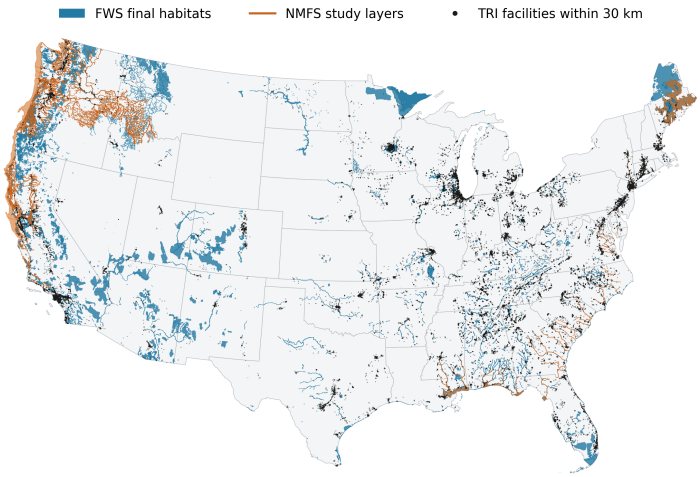


Figure 3: Visual validation of satellite-inferred construction dates

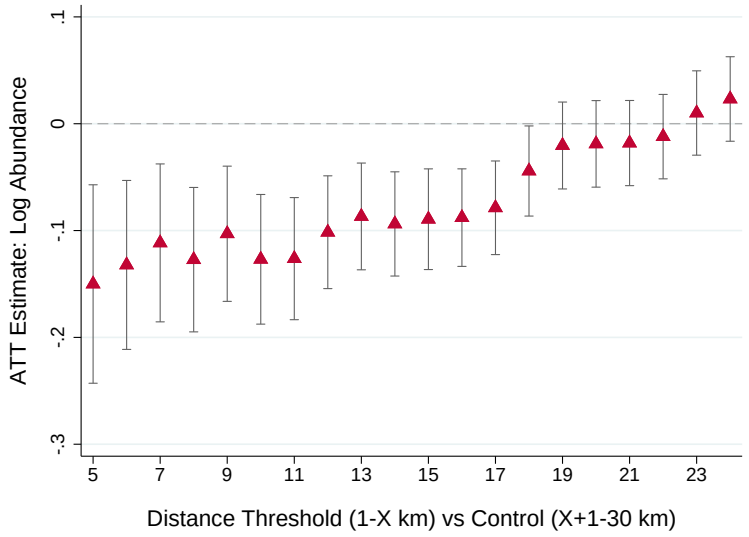
High-resolution (∼1 m) aerial imagery from the USDA National Agriculture Imagery Program before and after the construction year detected from National Land Cover Database impervious-surface growth. Images are aligned to the same grid measuring 1.8 km × 1.8 km centered on the facility's Toxics Release Inventory coordinates. The site changes from a South Carolina field in 2011 to a tire manufacturing plant by 2015, consistent with a satellite-inferred construction year of approximately 2013.



Figure 4: Ecological impact across distance thresholds

Callaway–Sant'Anna staggered difference-in-differences estimates of the effect of Toxics Release Inventory facility construction on nearby bird populations, varying the treatment-control boundary from 5 to 24 km. For each threshold X, the treated ring spans $(1, X]$ km and the control ring spans $(X+1, 30]$ km. Controls include seasonal coverage, National Land Cover Database impervious-surface growth, observer-hours, and observer counts. Bars show 95% confidence intervals clustered by facility. Panel (a) reports log bird abundance; Panel (b) reports log species richness.

(a) Abundance



(b) Richness

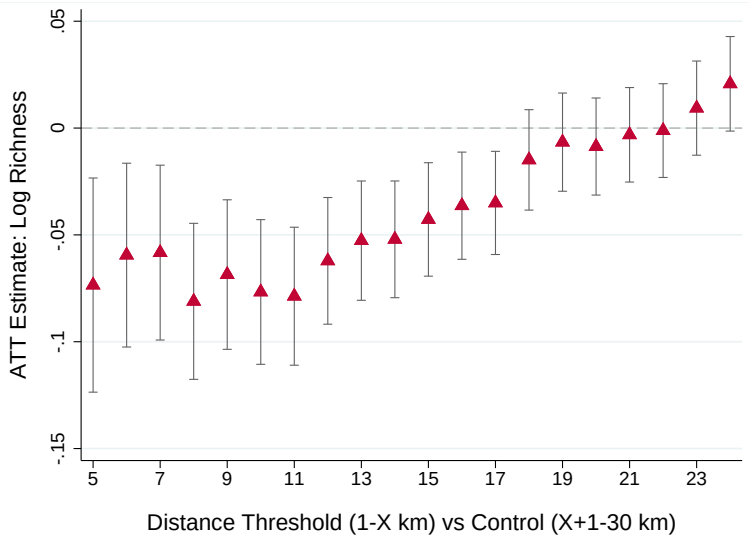
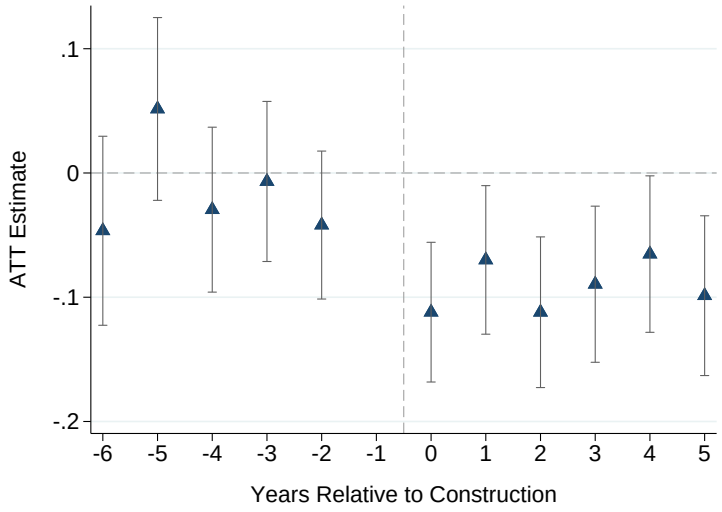


Figure 5: Ecological impact of industrial facility construction

Event-study estimates of the effect of Toxics Release Inventory facility construction on nearby bird populations. Each panel plots Callaway–Sant'Anna staggered difference-in-differences estimates by event year, with 95% confidence intervals clustered by facility. Treatment sites lie 1–14 km from the facility; control sites lie 15–30 km away. Controls include seasonal coverage, National Land Cover Database impervious-surface growth, observer-hours, and observer counts. The dashed vertical line separates the last pre-construction year ($t = -1$) from the construction year ($t = 0$). Panel (a) reports log bird abundance; Panel (b) reports log species richness.

(a) Abundance



(b) Richness

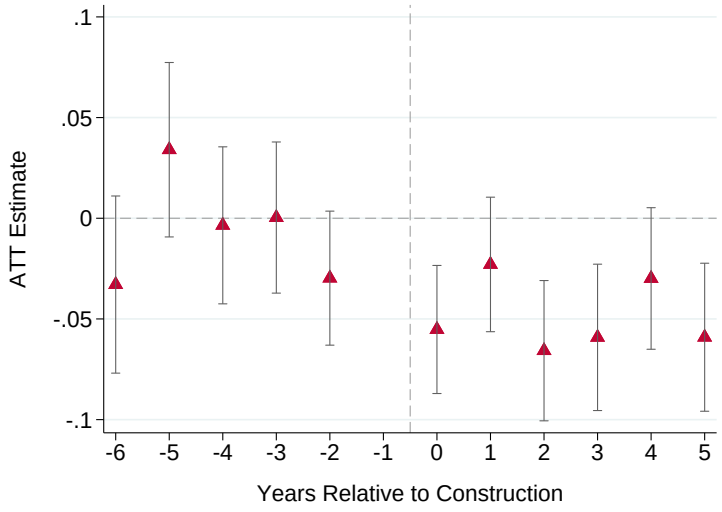
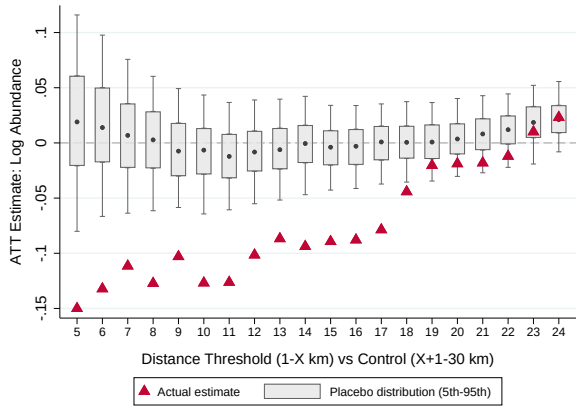


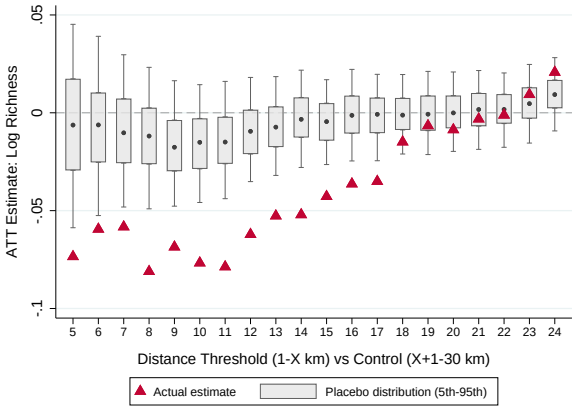
Figure 6: Placebo distributions with actual estimates

Placebo distributions from 1,000 permutations of facility construction years in the staggered difference-in-differences design. For each threshold X, the treated ring spans $(1, X]$ km and the control ring spans $(X+1, 30]$ km. Gray boxes show the 25th–75th percentiles of placebo estimates, whiskers show the 5th–95th percentiles, dots mark placebo medians, and red triangles mark the actual estimates. Panels (a)–(b) plot average treatment effect estimates; panels (c)–(d) plot z-statistics, with dashed lines at ± 1.96.

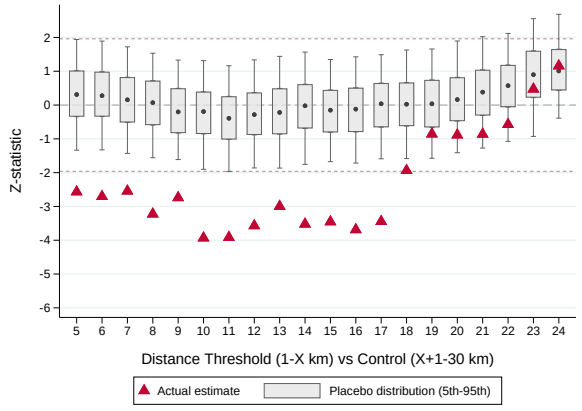
(a) Abundance ATT estimates



(b) Richness ATT estimates



(c) Abundance z-statistics



(d) Richness z-statistics

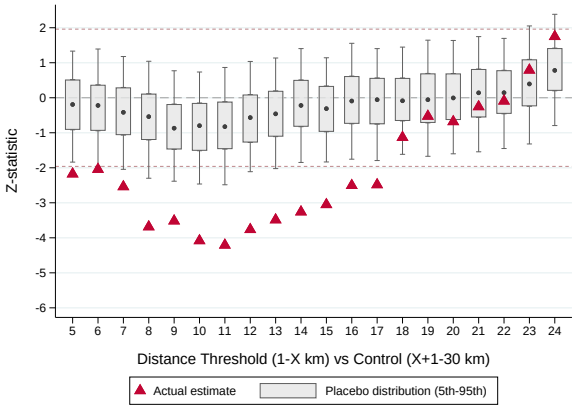


Figure 7: Facility presence before critical-habitat designation

This figure plots TRI facilities per 1,000 grid cells against signed distance to the boundary of each cell's assigned critical-habitat designation. The underlying grid consists of 1-km × 1-km cells. Facilities are counted if their first TRI reporting year precedes the designation year; continued reporting in the immediately preceding year is not required. Red triangles show mean facility counts, scaled by 1,000, in 1-km distance bins and are plotted at bin midpoints. Gray intervals span two standard errors on either side of each mean, with standard errors clustered by designation. Negative distances indicate locations inside the habitat boundary, and positive distances indicate locations outside it. The dashed vertical line marks the boundary. The figure describes predesignation spatial differences rather than effects of designation.

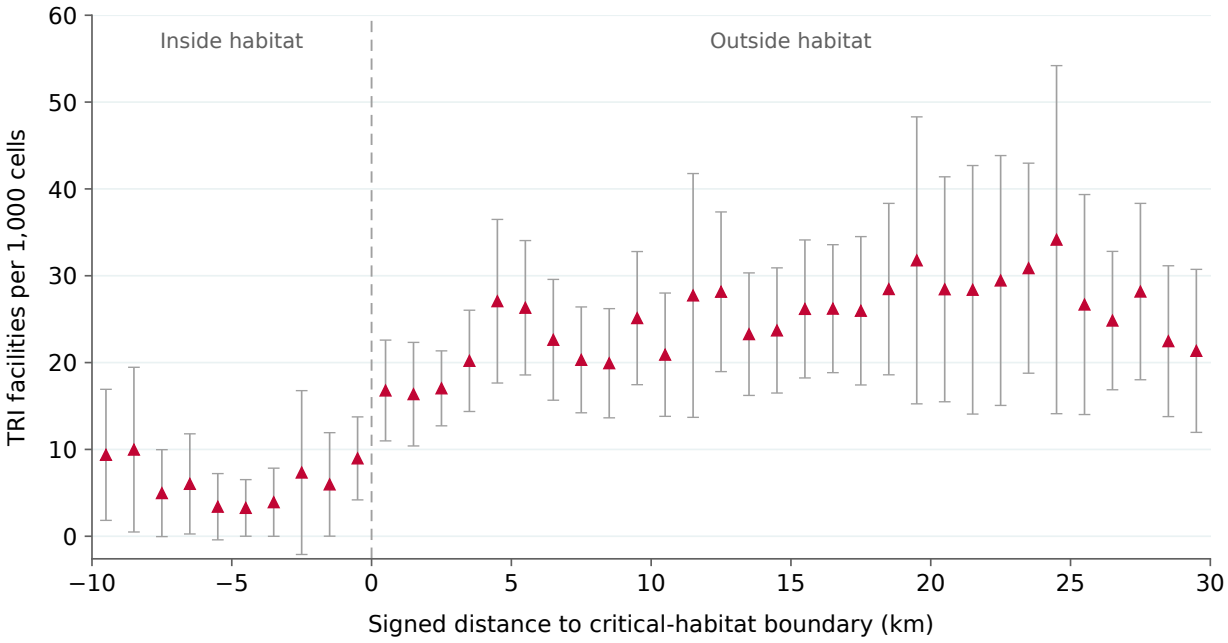
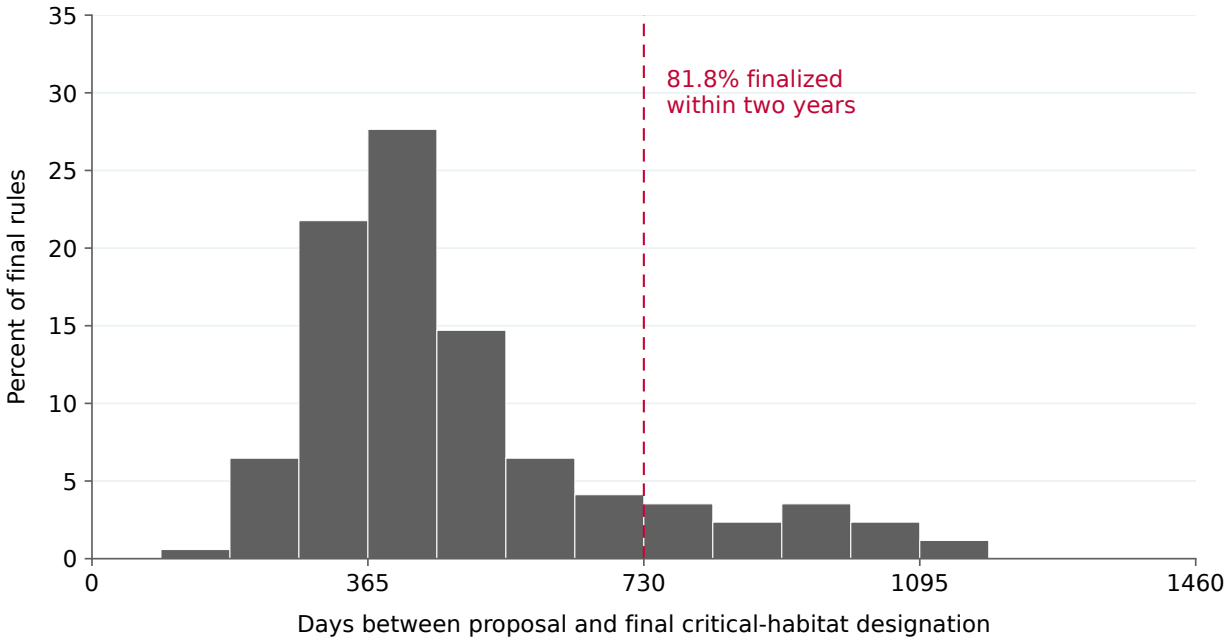


Figure 8: Time between proposed and final critical-habitat designation

This figure shows the number of days between publication of the first operative critical-habitat proposal and publication of the final rule. The sample contains 170 distinct final rules published during 1999–2026 that are linked to the FWS habitat inventory and have a proposed rule matched with high confidence. Each final rule receives equal weight, including rules covering multiple species; the sample includes habitat revisions and is not restricted to the firm-estimation sample. Bars show percentages of all 170 rules in bins of approximately three months (91.25 days). The displayed distribution excludes durations above the 95th percentile (1,154.6 days), omitting nine rules without renormalizing the percentages. The dashed line marks 730 days; 81.8% of all 170 rules were finalized within this interval. The median duration is 395.5 days. The distribution is conditional on an observed final rule and a linked proposal date; it excludes proposals that never reached final designation.



Tables

Table 1: Summary statistics

This table reports descriptive statistics for the ecological analysis (Panel A), between-firm comparisons (Panel B), and firm- and facility-level designation analyses (Panels C and D). Variable definitions and sample construction are described in Section 3. Ratios are winsorized at the 1st and 99th percentiles within calendar year; other continuous variables at the 1st and 99th percentiles.

	Mean	SD	p5	p25	Median	p75	p95	N
Panel A: Facility-ring-years, construction analysis								
Log abundance (effort-adjusted)	2.57	1.10	0.77	1.91	2.54	3.21	4.49	58,489
Checklists	154.58	515.28	1.00	4.00	13.00	56.00	755.00	58,489
Observers	265.38	844.78	1.00	6.00	26.00	109.00	1348.00	58,489
Observation hours	197.93	585.48	1.00	6.08	23.00	94.08	1046.85	58,489
Months with checklists	6.32	4.14	1.00	2.00	6.00	11.00	12.00	58,489
Urbanization growth (NLCD)	0.02	0.04	-0.02	0.00	0.01	0.02	0.08	57,830
Panel B: Firm-years, between-firm sample								
COGS/Sales (%)	67.96	15.84	36.39	59.96	70.42	79.20	89.41	12,332
SG&A/Sales (%)	16.73	11.72	0.00	8.37	14.52	23.24	39.61	12,332
Operating margin (%)	10.46	8.40	-1.06	5.45	9.66	14.92	25.14	12,332
Log total assets	7.66	1.84	4.63	6.36	7.63	8.94	10.70	12,332
Tobin's q	1.75	0.96	0.91	1.17	1.46	1.98	3.58	12,332
Leverage	0.27	0.16	0.00	0.16	0.27	0.37	0.56	12,332
Investment rate (I/K)	0.21	0.27	0.02	0.07	0.13	0.23	0.76	12,332
Tangibility (PPE/A)	0.32	0.18	0.08	0.17	0.28	0.42	0.70	12,332
ROA (%)	9.84	27.77	-28.96	3.30	12.07	21.68	41.80	12,332
Log TRI releases	10.87	3.98	1.07	9.25	11.54	13.55	16.06	12,332
Number of TRI facilities	10.92	13.60	1.00	3.00	6.00	13.00	42.00	12,332
Facility within 3 km of habitat	0.28	0.45	0.00	0.00	0.00	1.00	1.00	12,332
Facility 3–18 km from habitat	0.47	0.50	0.00	0.00	0.00	1.00	1.00	12,332
Panel C: Firm-cohort-years, designation analysis								
COGS/Sales (%)	69.12	14.97	41.00	61.92	70.88	78.87	88.68	22,014
SG&A/Sales (%)	15.91	12.01	0.00	7.83	14.33	22.06	37.83	22,014
Operating margin (%)	10.00	11.48	-0.59	5.46	9.35	14.56	24.59	21,958
Log sales	7.41	1.44	5.00	6.42	7.43	8.38	9.80	22,014
Log total assets	7.49	1.65	4.78	6.31	7.45	8.63	10.35	22,014
Return on assets (%)	4.29	7.96	-7.02	2.00	4.73	7.98	13.96	22,005
Log book-to-market	-0.66	0.67	-1.81	-1.06	-0.62	-0.22	0.33	21,751
Tangibility (PPE/A)	0.32	0.20	0.08	0.18	0.28	0.42	0.74	22,012
Log TRI releases	10.63	3.92	0.41	9.12	11.29	13.23	15.73	20,385
Log number of TRI facilities	1.45	1.00	0.00	0.69	1.39	2.20	3.14	20,495
Panel D: Facility-event-years, facility analysis								
Inspections	1.27	2.36	0.00	0.00	0.00	2.00	6.00	145,975
Informal enforcement actions	0.16	0.66	0.00	0.00	0.00	0.00	2.00	145,975
Formal enforcement actions	0.16	0.49	0.00	0.00	0.00	0.00	1.00	145,975
Any penalty	0.03	0.18	0.00	0.00	0.00	0.00	0.00	145,975
Source-reduction activity reported	0.20	0.40	0.00	0.00	0.00	0.00	1.00	122,274
$\ln(1 + \text{TRI releases})$	7.97	4.29	0.00	5.51	9.06	11.11	13.89	133,769

Table 2: Ecological impact: progressive controls

This table reports staggered difference-in-differences estimates of the effect of Toxics Release Inventory facility construction on local bird populations. The estimator is Callaway and Sant'Anna (2021), using doubly robust inverse probability tilting. Treated observations are facility-ring-years in the inner ring (1–14 km); controls are outer-ring observations (15–30 km) and inner-ring observations for facilities not yet constructed. Panel C restricts the control group to never-treated outer-ring observations. Outcomes are log adjusted bird abundance and log adjusted species richness. Columns progressively add controls for seasonal coverage, National Land Cover Database urbanization growth, and observer effort. The post-period average summarizes event-study coefficients for event years 0 to +5; the pre-period average summarizes coefficients for event years −5 to −1 and serves as a diagnostic for differential trends or anticipation. Standard errors are clustered by facility; z-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

	(1)	(2)	(3)	(4)
Panel A: Log Abundance				
Post-period average	-0.064^{***}	-0.074^{***}	-0.074^{***}	-0.092^{***}
	(−2.66)	(−2.94)	(−2.92)	(−3.68)
Pre-period average	−0.034	−0.027	−0.024	−0.010
	(−1.49)	(−1.13)	(−1.01)	(−0.42)
Panel B: Log Species Richness				
Post-period average	-0.032^{**}	-0.039^{***}	-0.040^{***}	-0.050^{***}
	(−2.38)	(−2.77)	(−2.84)	(−3.59)
Pre-period average	-0.022^{*}	−0.016	−0.016	−0.006
	(−1.69)	(−1.20)	(−1.20)	(−0.42)
Panel C: Robustness — never-treated controls only				
Abundance: post-period average	-0.060^{**}	-0.071^{***}	-0.069^{***}	-0.089^{***}
	(−2.56)	(−2.80)	(−2.73)	(−3.57)
Richness: post-period average	-0.031^{**}	-0.038^{***}	-0.037^{***}	-0.048^{***}
	(−2.35)	(−2.70)	(−2.62)	(−3.45)
Coverage (month indicators)	×	✓	✓	✓
Urbanization (NLCD growth)	×	×	✓	✓
Effort (observers, hours)	×	×	×	✓
Observations	58,489	58,489	57,911	57,906
Facilities (clusters)	3,583	3,583	3,583	3,583

Table 3: Firm operating costs and distance to critical habitat

This table reports between-firm OLS regressions using combined FWS and NMFS critical-habitat exposure. Annual COGS/Sales equals 100 times the sum of quarterly COGS divided by the sum of quarterly sales, requiring four usable quarters. The dependent variable and continuous accounting controls are winsorized at the 1st and 99th percentiles within calendar year. Firm controls are lagged one year and include size, Tobin's q, leverage, capital expenditures, tangibility, and profitability. Log TRI releases is contemporaneous. The near and outer indicators enter jointly. The omitted category comprises firm-years with no facility within 18 km of designated habitat. The complete-case sample is held fixed across radii and also requires the accounting outcomes used in the companion analysis. Exposed firms counts distinct firms with positive near-band exposure in the estimation sample. Parentheses report firm-clustered standard errors. The standard error of the near-minus-outer contrast uses the estimated covariance of the two coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (percentage points)				
	(1)	(2)	(3)	(4)	(5)
Exposure radius r	1 km	2 km	3 km	4 km	5 km
Any facility inside or within r	2.695***	2.151***	1.416**	0.369	0.438
	(0.783)	(0.729)	(0.698)	(0.657)	(0.672)
Any facility in $(r, 18]$ km	0.139	0.073	0.278	0.812	0.690
	(0.600)	(0.604)	(0.595)	(0.610)	(0.621)
Near minus outer band	2.557**	2.079**	1.138	-0.444	-0.252
	(1.001)	(0.987)	(0.976)	(0.965)	(1.005)
Lagged firm controls	Yes	Yes	Yes	Yes	Yes
Log TRI releases	Yes	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes	Yes
Exposed firms	264	345	396	432	451
Firms	1,177	1,177	1,177	1,177	1,177
Observations	12,332	12,332	12,332	12,332	12,332
R^2	0.576	0.575	0.574	0.573	0.573

Table 4: Firm characteristics before and after matching and entropy balancing

This table compares predesignation characteristics of treated and control firms in the combined FWS and NMFS 3-km design. Characteristics are averaged over years −6 to −4. All columns hold fixed the 155 treated firm-events retained by the baseline design. Column (1) compares them with all 8,148 eligible control firm-events in the same 19 cohorts, before nearest-neighbor selection or entropy balancing. Controls must have nonmissing values for the six matching targets. Column (2) uses the retained matched control sample with equal weights, and column (3) applies its entropy-balancing weights. Matching selects $K = 20$ nearest neighbors for each treated firm-event. Differences are treated minus control means. Column (4) divides the weighted difference by the pooled standard deviation of treated and unweighted matched controls. The six targets enter matching and entropy balancing; the remaining characteristics are untargeted diagnostics. Significance markers use tests from regressions of each characteristic on treatment status with cohort fixed effects and firm-clustered standard errors; column (3) additionally uses entropy weights. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Difference before matching (1)	Difference after matching (2)	Difference after entropy balancing (3)	Standardized difference after entropy balancing (4)
Matching and entropy-balancing targets				
Predesignation COGS/Sales	+1.414	+0.197	-0.027	-0.002
Log assets	+0.797***	+0.474***	-0.008	-0.005
Return on assets	+0.848*	-0.019	+0.105	+0.018
Log TRI releases	+2.449***	+0.758***	+0.004	+0.001
Tangibility	+0.023	+0.012	+0.003	+0.013
Log book-to-market	-0.075*	-0.093*	-0.009	-0.014
Untargeted diagnostics				
Tobin's q	+0.041	+0.109	+0.013	+0.014
Leverage	+0.024	+0.017	+0.013	+0.083
Profitability	+0.004***	+0.002*	+0.002	+0.123

Table 5: Firm outcomes following critical-habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates for firms newly exposed to FWS or NMFS critical-habitat designation within 3 km of a previously owned facility. Panel A reports the pooled effect over years 0–5. Panel B reports a separate event-study regression with annual treatment interactions. Both specifications use years -6 to -4 as the reference period. Matching selects the $K = 20$ nearest controls in the same designation year on six predesignation characteristics. Entropy balancing then reweights the matched controls within each designation year and industry cell that has at least ten matched controls, and within the designation year otherwise. Parentheses report standard errors clustered by firm. Sample counts apply to both panels. R^2 is reported for Panel A. Operating margin is measured before depreciation and amortization. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	SG&A/Sales (pp) (2)	Op. margin (pp, before D&A) (3)	Log sales (log pts) (4)	Log COGS (log pts) (5)
Panel A. Pooled estimate					
Designated × Post	1.528**	0.535	-1.812**	0.061	0.084*
	(0.656)	(0.458)	(0.766)	(0.044)	(0.047)
Panel B. Yearly estimates					
Designated × Year −3	-0.397	0.127	0.096	0.012	0.002
	(0.459)	(0.312)	(0.571)	(0.023)	(0.024)
Designated × Year −2	-0.029	0.207	-0.049	0.006	-0.002
	(0.561)	(0.397)	(0.716)	(0.028)	(0.031)
Designated × Year −1	0.052	0.064	0.008	0.026	0.022
	(0.547)	(0.349)	(0.637)	(0.030)	(0.031)
Designated × Year 0	0.749	-0.036	-0.499	0.048	0.059
	(0.604)	(0.387)	(0.674)	(0.035)	(0.037)
Designated × Year +1	1.162*	0.492	-1.569**	0.024	0.043
	(0.660)	(0.426)	(0.737)	(0.039)	(0.042)
Designated × Year +2	2.667***	0.174	-2.535***	0.060	0.099*
	(0.899)	(0.488)	(0.868)	(0.048)	(0.052)
Designated × Year +3	1.802**	0.963	-2.519**	0.057	0.086
	(0.853)	(0.593)	(1.021)	(0.055)	(0.057)
Designated × Year +4	1.731**	1.058	-2.386**	0.099*	0.127**
	(0.844)	(0.672)	(1.013)	(0.060)	(0.062)
Designated × Year +5	1.457	1.139	-2.101**	0.117*	0.138**
	(0.888)	(0.713)	(1.070)	(0.063)	(0.066)
Matching controls	Yes	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes	Yes
State × year FE	Yes	Yes	Yes	Yes	Yes
Treated firm-events	155	155	155	155	155
R^2 (pooled)	0.912	0.945	0.845	0.979	0.977
Observations	22,014	22,014	20,541	22,014	22,014
Firms	835	835	826	835	835

Table 6: Firm valuation and capital expenditure following critical-habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates for firm valuation and capital expenditure following FWS or NMFS critical-habitat designation within 3 km of a previously owned facility. Tobin's q is measured at calendar year-end. Capital expenditure is the fiscal-year total, assigned to the calendar year in which that fiscal year ends. Investment ratios divide this total by prior-fiscal-year sales or assets, are expressed in percent, and are winsorized at the 1st and 99th percentiles within year. Panel A pools years 0–5; Panel B reports annual estimates from a separate event-study regression. Both use years −6 to −4 as the reference period. Matching selects 20 controls using six predesignation characteristics; samples and weights are identical across columns and to the baseline cost estimates. Sample counts apply to both panels; R^2 refers to Panel A. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Tobin's q (ratio) (1)	CapEx/Lagged sales (pp) (2)	CapEx/Lagged assets (pp) (3)
Panel A. Pooled estimate			
Designated × Post	-0.117*	-0.127	-0.458
	(0.070)	(0.682)	(0.415)
Panel B. Yearly estimates			
Designated × Year −3	-0.010	-0.344	-0.466
	(0.056)	(0.589)	(0.368)
Designated × Year −2	0.013	-0.413	-0.862**
	(0.059)	(0.583)	(0.381)
Designated × Year −1	-0.070	0.023	-0.363
	(0.062)	(0.628)	(0.439)
Designated × Year 0	-0.086	-0.368	-0.650
	(0.070)	(0.687)	(0.452)
Designated × Year +1	-0.147**	-0.387	-0.662
	(0.064)	(0.695)	(0.442)
Designated × Year +2	-0.120*	0.221	-0.215
	(0.073)	(0.752)	(0.468)
Designated × Year +3	-0.109	-0.604	-0.500
	(0.073)	(0.798)	(0.483)
Designated × Year +4	-0.099	0.384	-0.328
	(0.090)	(0.783)	(0.442)
Designated × Year +5	-0.166	0.483	-0.118
	(0.102)	(0.858)	(0.495)
Matching controls	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes
State × year FE	Yes	Yes	Yes
Treated firm-events	155	155	155
R^2 (pooled)	0.807	0.845	0.745
Observations	22,002	21,036	21,036
Firms	835	832	832

Table 7: Firm responses to designation by concentration of exposed TRI releases

This table reports matched, entropy-weighted stacked difference-in-differences estimates by the predesignation share of TRI releases attributable to exposed facilities. The share equals total releases at exposed facilities divided by total releases across the firm's linked TRI facilities, summing both over years −6 to −4. It measures the concentration of releases, not the share of production, sales, assets, or employment exposed to designation. High and Low identify treated firms with shares above and at or below the indicated threshold, respectively. Each column reports a separate regression. Post comprises years 0–5; the reference period is years −6 to −4. Each regression also includes separate interactions for the two treated groups during years −3 to −1, which are not reported. High minus Low reports the difference between the groups' postdesignation estimates. Matching uses 20 controls per treated firm-event and the six baseline characteristics described in the text. Both outcomes are expressed in percentage points. Parentheses report firm-clustered standard errors, including for the High-minus-Low contrast. The threshold groups overlap. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	A. COGS/Sales			B. Operating margin before D&A		
	(1)	(2)	(3)	(4)	(5)	(6)
Concentration threshold	$> 10\%$	$> 25\%$	$> 50\%$	$> 10\%$	$> 25\%$	$> 50\%$
Low × Post	0.757	0.920	1.047	-1.143	-1.089	-1.263*
	(0.750)	(0.695)	(0.664)	(0.811)	(0.769)	(0.731)
High × Post	3.120***	3.662***	4.689***	-3.215***	-4.343***	-5.209***
	(0.949)	(1.083)	(1.327)	(1.190)	(1.317)	(1.748)
High − Low	2.363**	2.742**	3.642***	-2.072*	-3.254***	-3.947**
	(1.049)	(1.079)	(1.271)	(1.175)	(1.200)	(1.570)
Matching and entropy weighting	Yes	Yes	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes	Yes	Yes
High-concentration firms	55	37	25	55	37	25
Observations	21,969	21,969	21,969	20,498	20,498	20,498
Firms	832	832	832	823	823	823
R^2	0.909	0.909	0.909	0.845	0.845	0.845

Table 8: Firm responses to designation by leverage and concentration of exposed TRI releases

This table reports matched, entropy-weighted stacked difference-in-differences estimates by leverage and the concentration of predesignation TRI releases at exposed facilities, defined in Table 7. Both outcomes are in percentage points. Leverage is short- and long-term debt divided by assets, averaged over fiscal years in event years −6 to −4 ending before the proposal. Treated and control firms are split at the median leverage within each designation cohort. Each column includes treatment interactions for the four leverage–concentration groups and separate cohort-by-year fixed effects for each leverage group. The first two rows compare high- and low-leverage firms within each concentration group; High − Low concentration is the difference between these contrasts. Post pools years 0–5 relative to years −6 to −4. Group interactions for years −3 to −1 are included but not reported; the corresponding contrasts are insignificant at the 10% level. Leverage is one of seven financial-constraint measures examined; the other results are not reported. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	A. COGS/Sales			B. Operating margin before D&A		
	(1)	(2)	(3)	(4)	(5)	(6)
Concentration threshold	> 10%	> 25%	> 50%	> 10%	> 25%	> 50%
High minus low leverage × Post						
Low concentration	-2.992**	-2.528**	-2.364*	2.054	1.663	1.794
	(1.359)	(1.281)	(1.231)	(1.460)	(1.448)	(1.378)
High concentration	2.058	2.421	2.806	-0.036	0.665	0.170
	(1.793)	(2.098)	(2.501)	(2.559)	(2.621)	(3.437)
High − Low concentration	5.049**	4.949**	5.170**	-2.090	-0.999	-1.625
	(1.989)	(2.157)	(2.455)	(2.519)	(2.429)	(3.095)
Matching and entropy weighting	Yes	Yes	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort × leverage × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes	Yes	Yes
High-concentration firms: high / low leverage	28 / 27	17 / 20	13 / 12	28 / 27	17 / 20	13 / 12
Low-concentration firms: high / low leverage	45 / 51	56 / 58	60 / 66	45 / 51	56 / 58	60 / 66
Observations	21,957	21,957	21,957	20,486	20,486	20,486
Firms	831	831	831	822	822	822
R^2	0.912	0.912	0.912	0.850	0.850	0.850

Table 9: Firm employment following designation by predesignation plant count

This table reports matched, entropy-weighted stacked difference-in-differences estimates for log firm employment following FWS or NMFS critical-habitat designation within 3 km of a previously owned facility. Employment is measured using Compustat annual employees. Post comprises years 0–5, and the reference period is years −6 to −4. Column (1) reports the pooled estimate. Columns (2) and (3) allow the estimate to vary with $1/n$, where n is the number of the firm's linked TRI facilities averaged over years −6 to −4. A separate treatment interaction for years −3 to −1 is included in all columns and is also interacted with $1/n$ in columns (2) and (3); these terms are not displayed. Column (3) adds contemporaneous county income, unemployment, population density and growth, and farm and manufacturing employment shares, using observations with complete county data. Matching uses $K = 20$ controls and six predesignation characteristics; the original matching and entropy weights are retained. Parentheses report standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Log employment		
	(1)	(2)	(3)
Designated × Post	0.069	-0.052	-0.076
	(0.048)	(0.058)	(0.059)
Designated × Post × $1/n$		0.522***	0.305**
		(0.170)	(0.150)
Log per-capita personal income			-0.156
			(0.168)
Unemployment rate (pp)			0.006
			(0.012)
Population density (1,000/km^2)			-0.042
			(0.050)
Population growth (pp)			0.018
			(0.012)
Farm employment share (pp)			-0.011
			(0.021)
Manufacturing employment share (pp)			0.007
			(0.005)
Firm × cohort FE	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes
Treated firm-events	155	155	154
Observations	21,789	21,789	18,063
Firms	831	831	787
R^2	0.973	0.974	0.977

Table 10: Regulatory activity at facilities following habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates comparing facilities within 3 km of new FWS or NMFS habitat designations with matched control-firm facilities. Outcomes are ln(1 + annual count) of inspections, informal actions, and formal actions. Inspections cover water, air, and hazardous waste; informal actions cover water and air; formal actions cover air and hazardous waste. These are not necessarily ESA cases. Panel A pools years 0–5; Panel B reports annual estimates, both relative to years −6 to −4. Panel B includes the predesignation estimates for years −3 to −1. Interactions for the exposed firm's other facilities (Sibling$_{f,c}$ in equation (5)) are included but not displayed. Matching uses 20 controls and six baseline characteristics; entropy weights are allocated across facilities. Sample counts refer to Panel A. Parentheses report firm-clustered standard errors. Facility counts are facility–firm-event combinations. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Inspections (1)	Informal actions (2)	Formal actions (3)
Panel A. Pooled estimates			
Exposed × Post	0.021	0.071**	0.045**
	(0.039)	(0.031)	(0.022)
Panel B. Yearly estimates			
Exposed × Year −3	0.039	-0.022	0.016
	(0.031)	(0.036)	(0.026)
Exposed × Year −2	-0.013	0.011	0.054
	(0.047)	(0.034)	(0.033)
Exposed × Year −1	0.064	-0.060*	-0.001
	(0.045)	(0.034)	(0.034)
Exposed × Year 0	0.029	0.017	0.028
	(0.041)	(0.029)	(0.028)
Exposed × Year +1	0.024	0.072	0.043
	(0.049)	(0.045)	(0.043)
Exposed × Year +2	-0.026	0.105**	0.060*
	(0.053)	(0.048)	(0.033)
Exposed × Year +3	0.085	0.065	0.066
	(0.065)	(0.048)	(0.049)
Exposed × Year +4	0.012	0.122**	0.058*
	(0.058)	(0.057)	(0.035)
Exposed × Year +5	0.002	0.086**	0.012
	(0.058)	(0.042)	(0.035)
Matching and entropy weighting	Yes	Yes	Yes
Facility × firm-event FE	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes
State × year FE	Yes	Yes	Yes
Exposed facility-events	178	178	178
Control facility-events	12,772	12,772	12,772
Firm clusters	795	795	795
Observations	145,975	145,975	145,975

Table 11: Permit requirements and reissuance following habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates comparing facilities within 3 km of new FWS or NMFS habitat designations with matched control-firm facilities. The sample comprises facilities holding individual NPDES permits before designation. Both dependent variables are binary indicators, equal to one when the event described below occurs and zero otherwise. Column (1) indicates a newly recorded limited outfall–parameter pair, requiring discharge reports in consecutive years; it does not measure tighter numerical limits. Column (2) indicates permit reissuance: a subsequent version with a term of at least three years and a changed expiration date. Estimates are in percentage points. Post covers years 0–5 relative to years −6 to −4. Predesignation interactions for years −3 to −1 are included but not displayed. Interactions for the exposed firm's other facilities ($\text{Sibling}_{f,c}$ in equation (5)) are included but not displayed. Matching uses 20 controls and six baseline characteristics; entropy weights are allocated across facilities. Parentheses report firm-clustered standard errors. Facility counts are facility–firm-event combinations. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Newly recorded requirement (pp) (1)	Reissuance (pp) (2)
Exposed × Post	11.834***	3.764
	(3.747)	(4.873)
Matching and entropy weighting	Yes	Yes
Facility × firm-event FE	Yes	Yes
Cohort × year FE	Yes	Yes
Industry × year FE	No	No
State × year FE	No	No
Exposed facility-events	23	29
Control facility-events	1,324	1,655
Firm clusters	270	331
Observations	12,261	19,771

Table 12: Source-reduction activities following habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates comparing facilities within 3 km of new FWS or NMFS habitat designations with matched control-firm facilities. Outcomes are binary indicators for reported source reduction, process modifications, and operating-practice changes. Each equals one when the activity is reported and zero otherwise. Estimates are in percentage points. Panel A pools years 0–5; Panel B reports annual estimates, both relative to years −6 to −4. Predesignation interactions for years −3 to −1 are included but not displayed. Interactions for the exposed firm's other facilities ($\text{Sibling}_{f,c}$ in equation (5)) are included but not displayed. Matching uses 20 controls and six baseline characteristics; entropy weights are allocated across facilities. Missing source-reduction information is excluded, not coded as zero. Sample counts refer to Panel A. Parentheses report firm-clustered standard errors. Facility counts are facility–firm-event combinations. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Any source-reduction activity (1)	Process modifications (2)	Operating practices (3)
Panel A. Pooled estimates			
Exposed × Post	-0.492	-2.234	-1.052
	(3.306)	(3.072)	(2.106)
Panel B. Yearly estimates			
Exposed × Year −3	-1.749	-3.125	-1.864
	(5.183)	(4.105)	(3.435)
Exposed × Year −2	3.058	0.520	-5.281
	(4.226)	(3.996)	(3.215)
Exposed × Year −1	-1.649	-0.239	2.427
	(4.729)	(3.948)	(3.330)
Exposed × Year 0	5.556	-0.731	-1.529
	(4.204)	(3.785)	(3.517)
Exposed × Year +1	-3.022	-1.968	-2.553
	(4.678)	(3.729)	(2.617)
Exposed × Year +2	-7.086*	-3.589	0.997
	(3.866)	(3.252)	(3.960)
Exposed × Year +3	-1.474	-4.755	0.053
	(4.901)	(3.741)	(3.265)
Exposed × Year +4	6.502	2.604	0.944
	(5.475)	(4.149)	(3.100)
Exposed × Year +5	-4.255	-3.960	-1.961
	(4.429)	(3.766)	(2.426)
Matching and entropy weighting	Yes	Yes	Yes
Facility × firm-event FE	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes
State × year FE	Yes	Yes	Yes
Exposed facility-events	178	178	178
Control facility-events	12,295	12,295	12,295
Firm clusters	785	785	785
Observations	124,276	124,276	124,276

Table 13: Toxic releases following habitat designation

This table reports matched, entropy-weighted stacked difference-in-differences estimates comparing facilities within 3 km of new FWS or NMFS habitat designations with matched control-firm facilities. Columns (1)–(3) report ln(1 + total releases in pounds), including on-site releases and off-site disposal. Columns (4)–(6) report the log of toxicity-weighted on-site pounds divided by pounds of the same chemicals and release routes. EPA RSEI version 2.3.12 supplies inhalation weights for air and oral weights for water and land. The weights measure chronic human-health toxicity, not ecological harm or population exposure. Chemical–route combinations with positive weights account for 80% of on-site pounds; other combinations are excluded from both sums. Total releases retain reported zeros; the toxicity measure requires positive weighted releases. Missing reports are excluded. Post pools years 0–5 relative to years −6 to −4. Matching uses 20 controls and six baseline characteristics, with entropy weights allocated across facilities. Predesignation interactions for years −3 to −1 are included but not displayed. Interactions for the exposed firm's other facilities (Sibling$_{f,c}$ in equation (5)) are included but not displayed. Samples and weights are fixed within each outcome; facility counts are facility–firm-event combinations. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	ln(1 + total TRI releases in pounds)			ln(toxicity-weighted pounds per pound)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exposed × Post	-0.068	-0.151	-0.113	-1.476***	-1.301***	-1.218***
	(0.211)	(0.162)	(0.193)	(0.477)	(0.287)	(0.254)
Matching and entropy weighting	Yes	Yes	Yes	Yes	Yes	Yes
Facility × firm-event FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year FE	No	Yes	Yes	No	Yes	Yes
State × year FE	No	No	Yes	No	No	Yes
R^2	0.877	0.886	0.895	0.845	0.859	0.879
Exposed facility-events	181	181	181	165	165	165
Firm clusters	793	793	793	765	765	765
Observations	146,304	146,304	146,304	116,209	116,209	116,209

Table 14: Bird abundance and richness around final critical-habitat designations

This table reports Callaway and Sant'Anna (2021) estimates of bird outcomes around 46 critical-habitat designations, with treatment dated to final-rule publication. The estimator is doubly robust with not-yet-treated controls. Observations are 1-km grid cells by year from six years before to ten years after the final rule. In each column, treated cells include the habitat interior and cells up to X km outside the designated boundary; comparison cells lie more than $X+1$ and up to 30 km away. Outcomes are effort-adjusted log bird abundance and log species richness. The post-period average summarizes event-study coefficients for event years 0 to +10; the pre-period average summarizes coefficients for event years −6 to −2; both are measured relative to event year −1. The pre-period average serves as a diagnostic for differential trends or anticipation. Post − Pre is the difference between the two averages, tested with a Wald test. Standard errors are clustered by designation; z-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Threshold X	(1) Interior	(2) ≤1 km	(3) ≤2 km	(4) ≤5 km	(5) ≤10 km	(6) ≤18 km
Panel A: Log Abundance						
Post-period average	0.024	0.025	0.012	0.003	−0.016	−0.013
	(1.23)	(1.46)	(0.74)	(0.16)	(−1.06)	(−0.94)
Pre-period average	−0.035	−0.027	−0.038**	−0.037**	−0.044***	−0.037***
	(−1.34)	(−1.35)	(−2.00)	(−2.18)	(−3.28)	(−3.05)
Post − Pre	0.059**	0.052***	0.050***	0.040**	0.028*	0.024
	(2.34)	(2.66)	(2.72)	(2.28)	(1.74)	(1.64)
Panel B: Log Species Richness						
Post-period average	−0.000	−0.002	−0.009	−0.010	−0.017*	−0.016**
	(−0.04)	(−0.22)	(−0.96)	(−0.96)	(−1.74)	(−2.10)
Pre-period average	−0.003	−0.011	−0.016*	−0.018**	−0.020***	−0.023***
	(−0.17)	(−1.04)	(−1.72)	(−2.21)	(−2.59)	(−3.00)
Post − Pre	0.002	0.009	0.007	0.008	0.003	0.007
	(0.14)	(0.71)	(0.58)	(0.63)	(0.24)	(0.67)
Coverage (month indicators)	✓	✓	✓	✓	✓	✓
Urbanization (NLCD growth)	✓	✓	✓	✓	✓	✓
Effort (observers, hours)	✓	✓	✓	✓	✓	✓
Treated cell-years	47,104	79,372	104,225	173,001	284,492	467,897
Comparison cell-years	634,745	609,892	586,950	519,009	406,238	223,609
Designations (clusters)	46	46	46	46	46	46

Table 15: Biodiversity disclosure and habitat proximity

This table reports linear probability regressions of CDP responses on whether a firm owns any linked TRI facility within the indicated distance of designated FWS or NMFS critical habitat. Each exposure row reports separate regressions at a cumulative distance threshold. Estimates are in percentage points. Column (1) compares "Yes" with "No", excluding "Not assessed"; other columns indicate affirmative responses. Missing answers are excluded. CDP waves 2022–2025 are aligned with the preceding year's exposure and controls; the proximity item is unavailable in 2022. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. Industry and year fixed effects enter separately. Firm counts include exposed and unexposed firms in each outcome's estimation sample; samples are fixed across the three radii. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Near biodiversity-sensitive areas	(2) Monitors biodiversity	(3) Actions	(4) Public commitments	(5) Voluntary disclosure
Any facility within 1 km	11.88	-4.01	-6.20	-1.34	-5.28
	(8.25)	(5.17)	(6.00)	(5.46)	(4.91)
Any facility within 3 km	12.69*	2.51	-3.31	-6.48	-6.54
	(7.18)	(4.68)	(5.34)	(5.06)	(4.75)
Any facility within 18 km	9.57	5.13	1.27	-0.67	5.69
	(8.56)	(5.26)	(5.94)	(5.18)	(5.39)
Firm controls	Yes	Yes	Yes	Yes	Yes
Log plant count	Yes	Yes	Yes	Yes	Yes
Industry and year FE	Yes	Yes	Yes	Yes	Yes
Distinct firms in sample	157	283	284	294	303
R^2: 1 km	0.299	0.214	0.223	0.156	0.147
R^2: 3 km	0.303	0.213	0.221	0.159	0.148
R^2: 18 km	0.296	0.214	0.220	0.155	0.146
Firm-year observations	322	817	810	878	952

Appendix

A.1 Illustrative conservation requirements

These cases illustrate how requirements under the Endangered Species Act can restrict operations, require continuing work, and create mitigation commitments. They describe selected company projects, not costs attributable specifically to critical-habitat designation.[19]

A.1.1 Operating restrictions and monitoring

Exelon's Eddystone Generating Station in Pennsylvania illustrates how operating limits can substitute for investment in equipment. The firm's 2019 permit application compared cooling-water investments with estimated capital costs of $7.1–227.6 million. It instead proposed keeping average capacity utilization below 8% over 24 months and restricting water-pump use to essential operations. The conservation plan also specifies monthly monitoring reports from April through July and an annual report.[20]

The Grandin Sand Mine in Florida illustrates the continuing use of resources. Its conservation plan provides for wildlife surveys throughout the mine's life and mitigation credits before clearing. Florida Rock Industries, a Vulcan Materials subsidiary, identifies the mine's annual operating budget as the source of funding for surveys, permitting, wildlife relocation, and required credits.[21]

Koppers' Salem plant in Virginia faces both operating limits and recurring survey requirements. FWS approval is required to increase water-intake screen size or intake velocity beyond specified limits. Before each dredging event, the firm must hire an approved fish

[19]Eddystone is in the treated group; the other examples concern projects undertaken elsewhere by sample firms.

[20]Exelon, *Eddystone Incidental Take Permit Application and Conservation Plan*, June 21, 2019, pp. 48, 52–59; NMFS opinion OPR-2019-03367, pp. 13–14, 73; permit No. 23148, issued July 6, 2020. The opinion describes the plan's commitments as binding through the permit. The capital estimates concern alternatives not adopted. Some operating procedures predate the permit, and the documents do not establish whether the utilization limit reduced output.

[21]Kleinfelder for Florida Rock Industries, *Grandin Sand Mine HCP Amendment*, September 9, 2020, docket FWS-R4-ES-2021-0072-0004, § 6, p. 29. An operating-budget funding source does not establish financial-statement classification.

surveyor and submit a report within 30 days.[22]

A.1.2 Mitigation commitments

Duke Energy Florida's DeBary solar project illustrates a direct financial commitment. Its habitat conservation plan proposed approximately $412,000 for Florida scrub-jay conservation and $50,000 for indigo-snake conservation. The 2019 biological opinion made these measures mandatory, bringing the total commitment to approximately $462,000.[23]

American Electric Power's Talawanda–McAlester transmission-line project in Oklahoma provides evidence of implementation. Its permit required 7.9 acres of conservation-bank credits for the American burying beetle, and the biological opinion reports that AEP purchased 7.9 credits. The purchase price is not reported.[24]

A.1.3 A fee waiver

Some projects qualify for fee waivers. For FMC's injection-well project in Wyoming, FWS waived the water-depletion fee under a provision for water depletions of no more than 100 acre-feet. The waiver applies to this fee, not to all compliance costs.[25]

A.2 Supporting spatial evidence

I examine how the between-firm spatial associations vary with portfolio exposure and the outer distance bands, and how the designation estimates vary with the number of matched controls.

[22]FWS opinion on Corps permit NAO-2002-2580, Koppers Salem intake, May 21, 2014, ECOS document 15868143, pp. 2, 9–10. The limits are one-millimeter screen mesh and intake velocity of 0.25 feet per second.

[23]Duke Energy Florida, *DeBary Solar Power Plant Habitat Conservation Plan*, November 15, 2018, docket FWS-R4-ES-2019-0047-0004, PDF pp. 24, 27, 29, 31; FWS opinion, June 19, 2019, ECOS document 13841791, PDF pp. 2, 5, 7–8. The exact commitment is $462,296.30. The opinion incorporates the plan's measures as non-discretionary terms; the issued permit and evidence of payment were not located.

[24]AEP Oklahoma Transmission Company, permit TE01909C-0, effective November 18, 2016, Condition R, p. 5; FWS opinion FWS/R2/ES/2016-F-1251, ECOS document 11707951, PDF p. 5. The units follow the documents. The purchase is agency-reported; no independent payment record was located.

[25]FWS memorandum, *FMC Corporation Sodium Solution Liquor Injection Well Project*, July 3, 2012, 06E13000/WY12F0244, ECOS document 553191, p. 2.

The any-facility indicators in the main analysis distinguish firms with nearby facilities from firms without such facilities, but do not measure how much of a firm's facility portfolio is exposed. In Table A.5, I instead measure exposure as the share of linked TRI facilities near designated habitat, using combined FWS and NMFS geography. I average quarterly shares across the year, with exposure beginning in the designation's publication quarter. Each facility is assigned to its nearest designated habitat, and the denominator includes all linked facilities. In column (4), a 10-percentage-point larger share within 3 km is associated with 0.284 percentage points higher COGS/Sales, conditional on the shares in the outer bands and the other controls. This estimate is imprecise, although the inner-minus-$(3, 18]$ contrast has $p = 0.061$. All four columns use 12,354 firm-years from 1,179 firms.

Appendix Tables

Table A.1: Variable definitions

Variable definitions and data sources. Timing and transformations follow the relevant specifications.

Variable	Definition
Panel A: Ecological variables	
ln(bird abundance)	Natural log of bird counts adjusted for observation effort and timing, averaged across checklists within each facility-ring-year or habitat-cell-year. Source: eBird.
Species richness	Number of distinct bird species observed, expressed in logs in the ecological regressions. Source: eBird.
Construction year	Year of a discrete increase in impervious surface within 500 meters of a TRI facility. Source: NLCD, TRI.
Urbanization growth	Annual log change in impervious surface in the 15–30-km ring around a facility. Habitat regressions use local impervious-surface growth. Source: NLCD.
Survey coverage and effort	Checklist counts, months surveyed, observer counts, and observation hours, aggregated to the geographic unit and year. Source: eBird.
Lead concentration	Median of routine ambient lead measurements at a monitoring station in a year, in micrograms per liter. Source: Water Quality Portal.
Panel B: Habitat exposure variables	
Habitat proximity	Equal to one if a firm owns a linked TRI facility within the stated distance of designated habitat. Facilities inside a habitat polygon have distance zero. Source: FWS, NMFS, TRI.
Designation year	Year of final-rule publication. Firm exposure requires designation near a previously owned facility; acquisition near existing habitat does not constitute a new designation. Source: Federal Register, FWS, NMFS, TRI.
Portfolio exposure share	Share of linked TRI facilities in the stated distance band around designated habitat, averaged across quarters within the year. Source: FWS, NMFS, TRI.
Predesignation release share	TRI releases at facilities exposed by the event's designation divided by releases at all of the firm's TRI facilities, summed over event years -6 to -4. Defined for positive total releases. Source: TRI, FWS, NMFS.
Number of TRI facilities	Number of TRI-reporting facilities linked to the firm in a year. Predesignation plant count averages this number over event years -6 to -4. Source: TRI.
Panel C: Firm outcomes and characteristics	
COGS/Sales	Cost of goods sold divided by net sales, multiplied by 100. Annual flows sum four calendar quarters. Source: Compustat.
SG&A/Sales	Selling, general, and administrative expenses divided by net sales, multiplied by 100. Annual flows sum four calendar quarters. Source: Compustat.

Continued on next page

Table A.1 continued from previous page

Variable	Definition
Operating margin	Operating income before depreciation and amortization divided by sales, multiplied by 100, in the designation analysis. The between-firm analysis uses income after depreciation and amortization. Source: Compustat.
Log sales	Natural log of annual sales, in millions of dollars. Source: Compustat.
Log COGS	Natural log of annual cost of goods sold, in millions of dollars. Annual flows sum four calendar quarters. Source: Compustat.
Log total assets	Natural log of total assets, in millions of dollars. Annual balance-sheet measures use the calendar year's final quarter. Source: Compustat.
Log book-to-market	ln(book equity/market equity). Source: Compustat, CRSP.
ROA	Annual net income divided by year-end assets, multiplied by 100, in the designation analysis. The between-firm control is annualized quarterly income before extraordinary items divided by lagged assets. Source: Compustat.
Leverage	Short- and long-term debt divided by total assets. Source: Compustat.
Tangibility	Net property, plant, and equipment divided by total assets. Disclosure regressions use its natural log. Source: Compustat.
Tobin's q	(Total Assets − Common Equity + Market Equity)/Total Assets. The designation analysis measures q at calendar year-end. Source: Compustat, CRSP.
Investment rate (I/K)	Capital expenditures divided by lagged net property, plant, and equipment, used in the between-firm analysis. Source: Compustat.
Capital-expenditure ratios	Fiscal-year capital expenditure divided by prior-fiscal-year sales or assets, multiplied by 100, assigned to the calendar year in which the fiscal year ends. Source: Compustat.
Log employment	Natural log of the consolidated firm's annual employee count. Missing and nonpositive counts are excluded. Source: Compustat.
Financial distress	One minus the within-year percentile rank of distance to default, approximated following Bharath and Shumway (2008). Higher values indicate greater distress. Source: Compustat, CRSP.
County controls	Per-capita personal income, unemployment, population density and growth, and farm and manufacturing employment shares, aggregated across the counties of a firm's TRI facilities. Source: BEA, BLS, Census.
Panel D: Pollution and regulatory outcomes	
Total TRI releases	On-site releases and reported off-site disposal, in pounds, summed across chemicals. Facility regressions use ln(1 + releases). Missing reports are excluded. Source: TRI.
Toxicity per pound	Log of toxicity-weighted on-site pounds divided by pounds of the same chemicals and release routes. Air releases use inhalation weights; water and land releases use oral weights. Weights measure chronic human-health toxicity. Source: TRI, EPA RSEI.
Inspections	Count of environmental inspections of a facility in a year. Regressions use ln(1 + count). Source: EPA ECHO.

Continued on next page

Table A.1 continued from previous page

Variable	Definition
Enforcement actions	Annual counts of informal actions, such as warning letters, and formal actions, such as administrative orders or judicial cases. Regressions use ln(1 + count). Source: EPA ECHO.
Penalty indicator	Equal to one if a facility receives a monetary penalty in a year. Source: EPA ECHO.
Source-reduction indicators	Equal to one if a facility reports any source-reduction activity, process modifications, or operating-practice changes, respectively. Missing information is excluded. Source: TRI.
New permit requirement	Equal to one if discharge reports record a newly limited outfall–pollutant pair, requiring reports in consecutive years. Source: EPA ICIS-NPDES.
Permit reissuance	Equal to one if a subsequent permit version takes effect with a term of at least three years and a changed expiration date. Source: EPA ICIS-NPDES.
Panel E: Disclosure and commercial biodiversity measures	
CDP disclosure	Indicators for reported operations near biodiversity-sensitive areas, monitoring, actions, public commitments, and voluntary biodiversity reporting. Missing answers are excluded; the proximity item compares Yes with No and excludes Not assessed. Source: CDP.
10-K biodiversity disclosure	Indicators for biodiversity mentions and discussion of biodiversity regulation in 10-K filings, following Giglio et al. (2026). Missing filings or scores are excluded. Source: SEC EDGAR.
Corporate biodiversity footprint	Log of the sign-reversed corporate biodiversity footprint (CBF), in absolute terms or using vendor measures per unit of assets or sales. Higher values indicate greater estimated damage. Source: Iceberg Data Lab.
Biodiversity dependency	High-dependency and revenue-dependency indices, each on a 0–100 scale. Source: Iceberg Data Lab.

Table A.2: Designation estimates and the number of matched controls

This table reports matched, entropy-weighted stacked difference-in-differences estimates for COGS/Sales in percentage points in the combined FWS and NMFS 3-km design. Columns vary the number of Mahalanobis nearest neighbors selected per treated firm-event. Entropy weights are re-estimated at each value of K using the same six predesignation characteristics averaged over years -6 to -4. The pooled estimate covers years 0–5 relative to years -6 to -4. The retained treated sample can vary with weighting support. Pre-period joint p reports the joint test of the year -3, -2, and -1 coefficients in a separate annual event-study regression. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (percentage points)				
	(1)	(2)	(3)	(4)	(5)
Matched controls per treated firm-event	$K = 5$	$K = 10$	$K = 20$	$K = 30$	$K = 50$
Designated × Post	1.691*	1.683**	1.528**	1.818***	1.721**
	(0.994)	(0.773)	(0.656)	(0.671)	(0.672)
Matching controls	Yes	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes	Yes
Industry/state × year FE	Yes	Yes	Yes	Yes	Yes
Pre-period joint p	0.600	0.854	0.673	0.294	0.395
Control effective sample size	323	500	661	746	688
Treated firm-events	153	152	155	152	152
Observations	8,454	13,779	22,014	26,846	35,362
Firms	498	680	835	909	1,004
R^2	0.924	0.921	0.912	0.915	0.914

Table A.3: Firm outcomes following designation: rank-based matching

This table replaces the Mahalanobis matching distance in Table 5 with Rosenbaum's (2010, Section 8.3) rank-based Mahalanobis distance. Each of the six matching characteristics is replaced by its average rank across the eligible firm-event matching sample; the rank covariance matrix is adjusted for ties. The 20 nearest eligible controls are selected within each designation cohort. Entropy balancing continues to target the means of the original, untransformed characteristics. The exposure definition, reference period, and fixed effects follow Table 5; the selected controls, entropy weights, and retained treated events can change. Designated × Post pools years 0–5 relative to years −6 to −4. A separate treatment interaction for years −3 to −1 is included but not displayed. The pre-period joint p-value tests the three annual predesignation coefficients in the corresponding event-study specification. Operating margin is measured before depreciation and amortization, as in Table 5. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	SG&A/Sales (pp) (2)	Op. margin (pp, before D&A) (3)	Log sales (log pts) (4)
Designated × Post	1.435**	0.665	-2.047***	0.046
	(0.684)	(0.449)	(0.725)	(0.044)
Entropy balancing	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes
Pre-period joint p	0.681	0.626	0.701	0.852
Treated firm-events	152	152	152	152
Observations	21,782	21,782	20,355	21,782
Firms	838	838	827	838
R^2	0.917	0.946	0.842	0.980

Table A.4: Firm outcomes following designation: controls with facilities near designated habitat

This table repeats columns (1) and (3) of Table 5, adding exact matching on whether the firm owned a linked TRI facility more than 3 and up to 30 km from already-designated FWS or NMFS critical habitat during years −6 to −4. Control firms therefore share the treated firms' predesignation proximity to habitat but do not become newly exposed within 3 km. Panel A reports the pooled effect over years 0–5. Panel B reports a separate event-study regression with annual treatment interactions. Both specifications use years −6 to −4 as the reference period. Matching otherwise uses $K = 20$ controls and the six predesignation characteristics of the baseline design, followed by entropy balancing. Two treated firm-events that cannot be balanced in the baseline design are balanced here, so the treated sample is a superset of the baseline sample. Parentheses report standard errors clustered by firm. Sample counts apply to both panels; R^2 is reported for Panel A. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	Op. margin (pp, before D&A) (2)
Panel A. Pooled estimate		
Designated × Post	2.242**	-1.964***
	(1.130)	(0.707)
Panel B. Yearly estimates		
Designated × Year −3	-0.067	0.228
	(0.758)	(0.602)
Designated × Year −2	0.409	0.041
	(0.908)	(0.683)
Designated × Year −1	0.820	-0.288
	(0.775)	(0.631)
Designated × Year 0	1.159	-0.499
	(0.892)	(0.653)
Designated × Year +1	1.747*	-1.360**
	(1.056)	(0.688)
Designated × Year +2	2.862**	-2.627***
	(1.259)	(0.881)
Designated × Year +3	3.318**	-3.183***
	(1.444)	(1.070)
Designated × Year +4	2.621*	-2.462**
	(1.426)	(1.018)
Designated × Year +5	2.397*	-2.518***
	(1.395)	(0.931)
Matching controls	Yes	Yes
Firm × cohort FE	Yes	Yes
Cohort × year FE	Yes	Yes
Industry × year FE	Yes	Yes
State × year FE	Yes	Yes
Treated firm-events	157	157
R^2 (pooled)	0.913	0.846
Observations	20,338	19,018
Firms	783	774

Table A.5: Portfolio exposure and COGS/sales: FWS and NMFS, 3-km inner band

This table reports between-firm OLS regressions of annual COGS/Sales, expressed in percentage points, on the shares of a firm's linked TRI facilities near designated FWS or NMFS critical habitat. Shares range from zero to one and average quarterly exposure within each year, with exposure beginning in the designation's publication quarter. Each facility is assigned to its nearest designated habitat and counted in one distance band per quarter; the denominator includes all linked TRI facilities. Columns (1)–(3) include the share inside or within 3 km and the indicated outer-band share. Column (4) includes separate shares for $(3, 18]$ and $(18, 30]$ km. The omitted category comprises facilities beyond the outermost distance cutoff, including those with no designated habitat nearby. All columns include firm controls, log TRI releases, industry-by-year fixed effects, and headquarters-state-by-year fixed effects. The sample is held fixed across columns. Parentheses report firm-clustered standard errors; standard errors for coefficient differences use the estimated covariance between coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)
Share inside or within 3 km	2.996	2.940	2.816	2.838
	(2.364)	(2.372)	(2.366)	(2.357)
Share in (3,10] km	-2.762			
	(2.647)			
Share in (3,14] km		-2.382		
		(2.265)		
Share in (3,30] km			-1.495	
			(1.399)	
Share in (3,18] km				-2.366
				(1.854)
Share in (18,30] km				-0.362
				(2.247)
Inner − adjacent outer band	5.759*	5.322*	4.311	5.205*
	(3.343)	(3.014)	(2.623)	(2.775)
Inner − (18,30] km				3.200
				(3.264)
Firm controls	Yes	Yes	Yes	Yes
Log TRI releases	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes
Firm FE	No	No	No	No
Observations	12,354	12,354	12,354	12,354
Firms	1,179	1,179	1,179	1,179
Adjusted R^2	0.518	0.518	0.518	0.518

Table A.6: Firm outcomes following designation, by distance to newly designated habitat

This table reports matched, entropy-weighted stacked difference-in-differences estimates of the pooled effect over years 0–5 for firms grouped by the distance between critical habitat and the facilities they owned before designation. Distance is the minimum, over facilities owned in the three years before designation, of the distance to habitat published in the firm's designation. Columns (1) and (4) are the baseline design: firms with a facility within 3 km. Columns (2)–(3) and (5)–(6) include only firms whose nearest facility lies more than 5 km and at most 10 or 18 km from the newly designated habitat. Each distance group is a separate design with its own treated firms, matched controls, entropy weights and designation timing, so the table does not test whether the coefficients differ across columns. All specifications use years -6 to -4 as the reference period and match on $K = 20$ controls and six predesignation characteristics. Parentheses report standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	A. COGS/Sales (pp)			B. Op. margin before D&A (pp)		
Habitat distance group	0–3 km	5–10 km	5–18 km	0–3 km	5–10 km	5–18 km
	(1)	(2)	(3)	(4)	(5)	(6)
Designated × Post	1.528**	0.117	0.483	-1.812**	1.002	0.901
	(0.656)	(0.775)	(0.856)	(0.766)	(0.843)	(0.745)
Firm × cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry/state × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Treated firm-events	155	64	130	155	64	128
Observations	22,014	10,472	20,426	20,541	9,596	18,762
Firms	835	550	739	826	531	717
R^2	0.912	0.942	0.916	0.845	0.864	0.849

Table A.7: Firm outcomes following designation: county economic controls

This table adds contemporaneous county economic controls to the matched, entropy-weighted stacked difference-in-differences specification in Table 5. All six controls enter jointly, and each outcome uses observations with complete county data. The designation coefficient pools years 0–5 relative to years −6 to −4; a separate treatment interaction for years −3 to −1 is included but not displayed. The original $K = 20$ matching and entropy weights are retained. County variables are existing firm-year aggregates across reporting TRI facilities, constructed from BEA, BLS, and Census data. Unemployment, population growth, and employment shares are in percentage points; population density is in thousands of persons per square kilometer. Missing controls are not imputed. County conditions and facility composition can respond to designation, so this specification is a sensitivity check. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	SG&A/Sales (pp) (2)	Op. margin (pp, before D&A) (3)	Log sales (log pts) (4)
Designated × Post	1.156**	0.559	-2.022***	-0.009
	(0.587)	(0.447)	(0.699)	(0.046)
Log per-capita personal income	-1.777	-0.059	0.711	-0.154
	(2.630)	(1.249)	(2.822)	(0.154)
Unemployment rate (pp)	-0.214	-0.010	0.178	-0.002
	(0.182)	(0.100)	(0.174)	(0.012)
Population density (1,000/km^2)	-0.142	0.445	-0.176	-0.025
	(0.433)	(0.310)	(0.360)	(0.041)
Population growth (pp)	0.079	-0.207	0.153	0.017
	(0.197)	(0.137)	(0.237)	(0.013)
Farm employment share (pp)	0.148	-0.001	-0.259	-0.011
	(0.175)	(0.101)	(0.228)	(0.021)
Manufacturing employment share (pp)	-0.031	-0.054	0.087	0.009*
	(0.056)	(0.034)	(0.056)	(0.005)
Matching weights	Yes	Yes	Yes	Yes
Firm × cohort FE	Yes	Yes	Yes	Yes
Cohort × year FE	Yes	Yes	Yes	Yes
Industry × year FE	Yes	Yes	Yes	Yes
HQ state × year FE	Yes	Yes	Yes	Yes
Treated firm-events	154	154	154	154
Observations	18,238	18,238	17,080	18,238
Firms	794	794	779	794
R^2	0.936	0.959	0.874	0.982

Internet Appendix

IA.1 eBird effort adjustment methodology

Section 3.2 summarizes the effort-adjustment procedure used to construct bird abundance measures from eBird checklists. I provide the full specification here.

The unit of observation is the eBird checklist. I keep complete checklists under structured protocols (Traveling, Stationary, Area) and deduplicate shared group outings. For each checklist i, I sum species counts to obtain total birds and take the log,

$$y_i = \log(\text{TotalBirds}_i + 1). \tag{6}$$

I then partial out observer effort and predictable detectability by estimating

$$y_i = \beta_1 \,\text{Hours}_i + \beta_2 \,\text{Observers}_i + \delta_h + \gamma_{s,m} + \varepsilon_i, \tag{7}$$

where δ_h is an hour-of-day fixed effect and $\gamma_{s,m}$ is a state-by-month fixed effect. The residual $\hat{\varepsilon}_i$ is the effort-adjusted log abundance for checklist i. Because the model includes no local fixed effects below the state level, $\hat{\varepsilon}_i$ retains all within-state spatial variation in bird populations. In a biologically rich area the average residual is positive, and in a degraded area it is negative.

For each facility f in year t, I average the residuals across all checklists within the ring and exponentiate to obtain the facility-level abundance measure.

$$\text{BirdAbundance}_{ft} = \exp\left(\frac{1}{N_{ft}} \sum_{i=1}^{N_{ft}} \hat{\varepsilon}_i\right), \tag{8}$$

where N_{ft} is the number of checklists in the 15–30-km control ring around facility f in year t. Facility-years with no checklists are treated as missing. Coverage grows from approximately 7,600 checklists per year in the mid-1980s to over 6.5 million by 2024, so the fraction of

missing facility-years declines over the sample.

Effort-adjusted abundance is a first-step residual used as the dependent variable in subsequent regressions, so I include the first-step regressors in those specifications to address the coefficient-bias concern documented by Chen et al. (2018). The first stage is estimated at the checklist level, while the second stage is aggregated to the facility-ring-year level. I include aggregated versions of the first-stage regressors (observer counts, birding hours, and month-of-year indicators) as controls in the difference-in-differences specifications of Section 4. Table 2 shows that the core results are robust regardless of whether these controls are included (comparing columns 1 and 4).

IA.2 Ecological validation checks

The staggered difference-in-differences design in Section 4 anchors the causal estimates to satellite-inferred construction dates rather than to the delayed administrative event of a facility's first TRI filing. Two identification concerns require direct validation. First, the construction dates must be correctly identified. Second, the bird abundance decline must reflect genuine ecological damage rather than spatial displacement.

Construction date detection. A facility's true construction year often precedes its first regulatory filing by several years, so I extract construction timing directly from satellite imagery. The National Land Cover Database (NLCD) reports the fraction of each 30-meter pixel covered by impervious surfaces such as pavement, concrete, and rooftops. For each facility, I sum impervious area within a 500-meter buffer of the TRI-reported coordinates, compute annual log growth rates, and flag the year of maximum growth as the inferred construction date, restricting to pre-reporting years so the algorithm captures the true buildup. I retain facilities where the inferred date falls within three years before the first TRI report, which focuses the analysis on new facilities rather than legacy sites. Figure IA.1 validates this procedure across all facilities. By construction, average impervious surface growth peaks

at the detected year (year 0); it is near zero in the surrounding years, so built-up area jumps in a single year rather than accumulating gradually, consistent with a discrete construction event.

Displacement test. The bird abundance decline documented in Section 4 could reflect spatial displacement rather than genuine ecological damage. If birds flee the impact zone, abundance should rise in rings just outside it. I test for this pattern using a staggered difference-in-differences design in which the treated unit is a series of 5-km sliding rings at increasing distances from the facility rather than the inner circle. For each start distance $X \in \{5, \ldots, 20\}$, I define the treated ring as $[X, X+5]$ km and use the far edge $[25, 30]$ km as a stable reference group, keeping the same construction-year cohort assignment and event window $[-6, +5]$ as in the main specification. The Callaway and Sant'Anna (2021) estimator is applied with doubly-robust imputation and facility-level clustering.

Figure IA.2 shows that bird abundance declines significantly in rings out to approximately 15 km, with peak damage of -10.1% at 6–11 km. No ring shows a significant positive effect at any distance. The losses in the near-field are not offset by gains farther out, providing no evidence of spatial reshuffling. The smooth monotonic attenuation with distance is consistent with genuine ecological degradation from a site-specific source.

Observer selection test. Citizen-science data raise the concern that facility construction may change where birders choose to survey independently of ecological conditions. Table IA.1 re-estimates the primary staggered difference-in-differences specification using the numbers of checklists, observers, and survey hours as outcomes. Facility construction has no statistically significant effect on any measure of observer activity, with or without controls for urbanization growth. The pre-construction estimates are also indistinguishable from zero. These results therefore provide evidence that observer sorting does not explain the decline in bird abundance.

Table IA.1: Observer activity around facility construction

This table re-estimates the staggered difference-in-differences design using observer activity as the outcome. Treated observations are facility-ring-years within 1–14 km of a TRI facility; controls are observations in the 15–30-km ring and not-yet-treated inner-ring observations. Panels A, B, and C report checklist counts, reported observer counts, and survey hours, respectively. Each outcome is measured as $\log(1 + \text{activity})$. Ring-years without checklists are coded as zero. Within each panel, column (2) controls for NLCD urbanization growth; observer-effort controls are omitted because they are outcomes. Post ATT averages event years 0 to +5; Pre ATT averages event years −5 to −1. Estimates use the Callaway–Sant'Anna doubly robust estimator, with standard errors clustered by facility. z-statistics are in parentheses.

	Panel A Checklists		*Panel B* Observers		*Panel C* Survey hours	
	(1)	(2)	(1)	(2)	(1)	(2)
Post ATT	-0.025	-0.027	-0.011	-0.013	-0.017	-0.018
	(-1.26)	(-1.32)	(-0.49)	(-0.55)	(-0.73)	(-0.78)
Pre ATT	-0.005	-0.001	-0.014	-0.010	-0.019	-0.014
	(-0.28)	(-0.03)	(-0.66)	(-0.44)	(-0.91)	(-0.68)
Urbanization	No	Yes	No	Yes	No	Yes
Observations	70,076	69,239	70,076	69,239	70,076	69,239
Facilities	3,606	3,606	3,606	3,606	3,606	3,606

Figure IA.1: NLCD validation of satellite-inferred construction dates

Average growth in impervious surface area within 500 meters of Toxics Release Inventory facility coordinates, measured annually from the National Land Cover Database. The x-axis plots years relative to the satellite-inferred construction date, with year 0 defined as the largest discrete jump in built-up area. Error bars show 95% confidence intervals. $N = 3{,}583$ facilities.

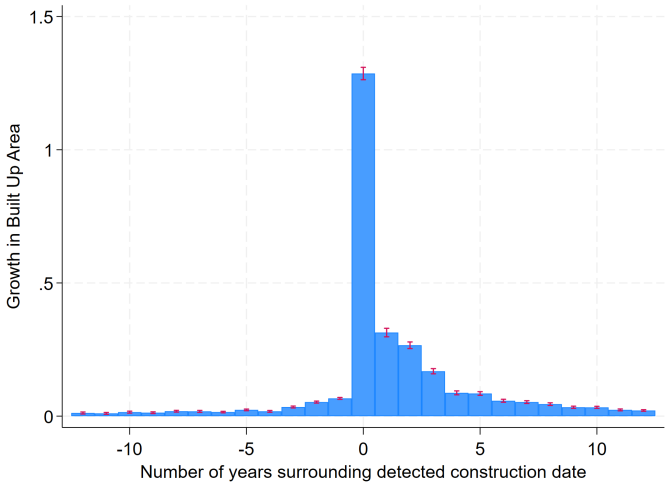
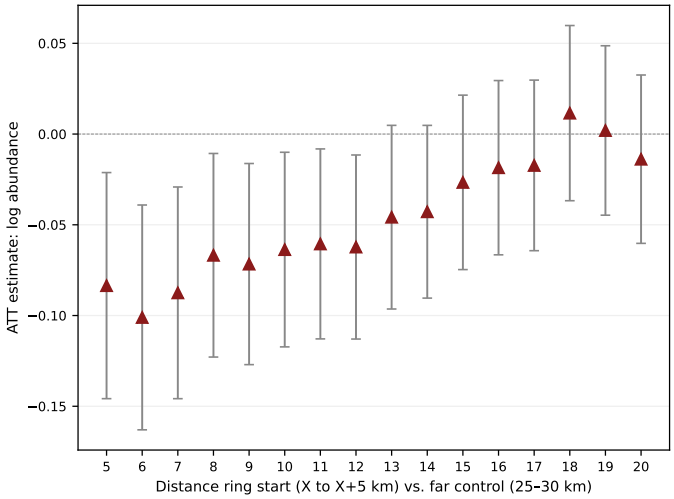


Figure IA.2: Spatial attenuation of ecological decline

Callaway–Sant'Anna staggered difference-in-differences estimates of the effect of Toxics Release Inventory facility construction on log bird abundance in 5-km-wide sliding rings at increasing distances from the facility. Each ring is compared with a 25–30-km control ring. Controls include month-of-year indicators, observer counts, birding effort, and urbanization growth. Error bars show 95% confidence intervals clustered by facility. $N = 3{,}623$ facilities with construction year ≥ 1990; event window $[-6, +5]$ years.

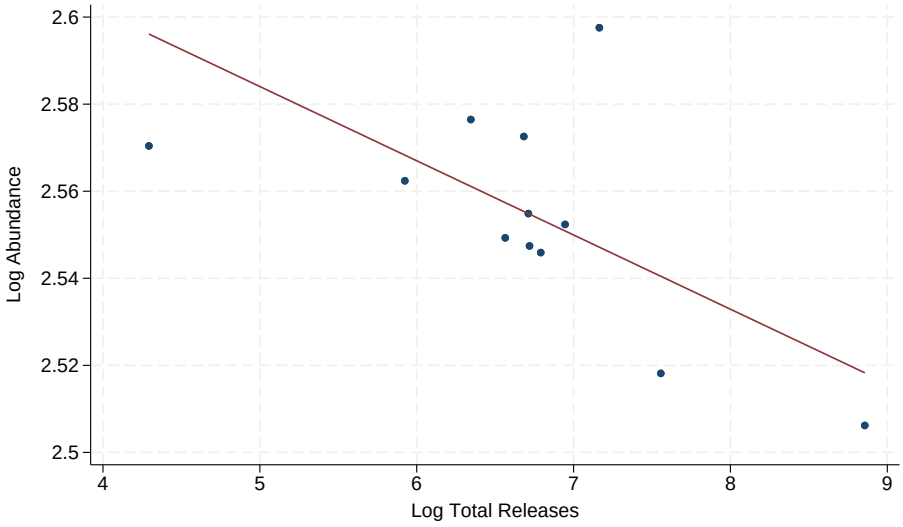


IA.3 Within-facility and pathway evidence

Three further pieces of evidence support the ecological-validation strategy. First, a within-facility dose-response test shows that years with higher toxic releases are associated with lower bird abundance at the same site (IA Figure IA.3). Second, ambient water-quality monitoring shows elevated lead concentrations near TRI facilities (IA Figure IA.4). Third, randomization inference indicates that the lead effects are correctly timed rather than artifacts of generic trends (IA Figure IA.5).

Figure IA.3: Within-facility dose-response in bird abundance

Binscatter of log effort-adjusted bird abundance on log total toxic releases within the 1–14-km ring around Toxics Release Inventory facilities, absorbing facility fixed effects. Each point is one of twelve equal-sized bins of the within-facility distribution of log releases, averaging approximately 1,975 facility-year observations per bin. The fitted line applies the within-facility regression coefficient to the bin means. The vertical axis is zoomed to the range of conditional means.



Lead contamination pathway. I obtain ambient water-quality data from the Water Quality Portal (WQP), a public repository maintained jointly by the U.S. Geological Survey, the Environmental Protection Agency, and the National Water Quality Monitoring Council, which compiles sampling results submitted by federal, state, tribal, and local governments, academic institutions, nongovernmental organizations, and private contributors. I query the WQP for all monitoring stations reporting the characteristic "Lead" between January 1985 and December 2024, retaining stations with at least five sampling activities and five recorded results, and then download the underlying measurement records for those stations. Separately, I take the coordinates of every TRI facility outside the U.S. island territories and compute the distance to each lead monitoring station within 30 km, yielding 4.2 million facility–station pairs across 61,899 facilities and 49,704 stations.

I retain samples collected under a routine monitoring protocol from ground water, surface water, estuarine, and unspecified water media, which excludes industrial effluent and wastewater. I convert milligrams per liter to micrograms per liter and drop the 0.8% of records reported in other units, such as milligrams per kilogram, which measure sediment or tissue rather than water. Of 409,822 raw lead results, 320,182 survive these screens. For each station-year I take the median concentration across samples to reduce sensitivity to extreme observations, giving 63,736 station-year observations at 14,549 stations from 1984 to 2023.

I then apply the ring-based staggered difference-in-differences design of Section 4 to these data, replacing bird abundance with median lead concentration and varying the treatment threshold from 5 to 24 km. The unit of observation is a facility–station pair: stations between 1 and X km of a facility are treated at that facility's satellite-inferred construction year, and stations between $X + 1$ and 30 km serve as never-treated controls.[26] I restrict the sample to facilities constructed in 1990 or later and to the event window $[-6, +5]$. The estimation panel contains 72,091 station-year observations across 26,384 facility–station pairs, 5,746 stations,

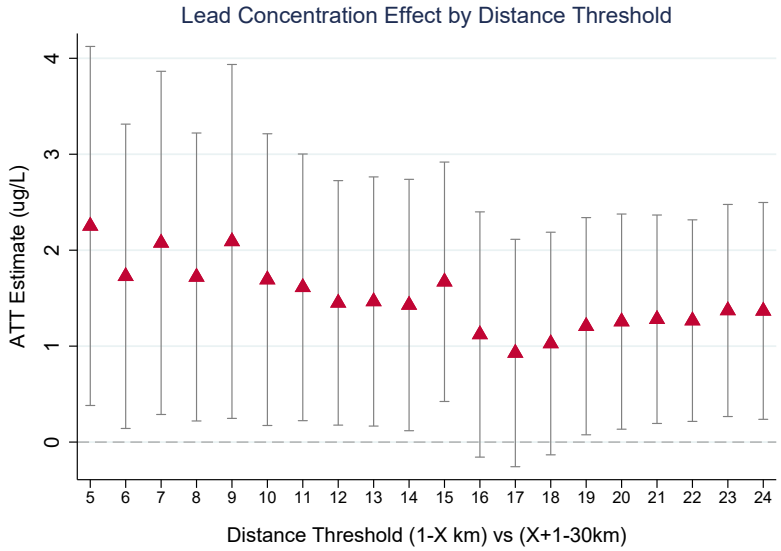
[26]Monitoring stations are shared across nearby facilities: 64% of stations in the estimation panel fall within 30 km of more than one facility. Standard errors are clustered at the facility level.

and 2,566 facilities. Because monitoring coverage is far sparser than eBird coverage, the specification includes no additional covariates.

IA Figure IA.4 reports the results. Lead concentrations increase by 1.7 to 2.3 μg/L within 5 to 10 km of a new facility, decline to roughly 1 μg/L at 16 to 18 km, and settle near 1.2 to 1.4 μg/L for thresholds above 19 km. Confidence intervals are wide at tight thresholds, reflecting sparse monitoring coverage, but the point estimates are positive across all 20 distance cutoffs. The profile declines only modestly as the treated ring widens, and the control ring thins as it retreats toward 30 km, so the wider thresholds are harder to interpret; unlike the bird estimates, the lead results establish that concentrations are elevated near facilities without independently localizing the effect to a particular radius. Elevated lead near new facilities is consistent with a chemical pathway through which industrial operations degrade the surrounding environment, though the analysis does not establish that lead contamination is the mechanism behind the measured decline in bird populations.

Figure IA.4: Lead concentration by distance from facility

Staggered difference-in-differences estimates of the effect of Toxics Release Inventory facility construction on ambient water lead concentrations (μg/L), varying the treatment-control boundary from 5 to 24 km. For each threshold X, the treated ring spans $(1, X]$ km and the control ring spans $(X{+}1, 30]$ km. Estimates use the Callaway–Sant'Anna doubly robust estimator with not-yet-treated controls. Error bars show 95% confidence intervals clustered by facility.



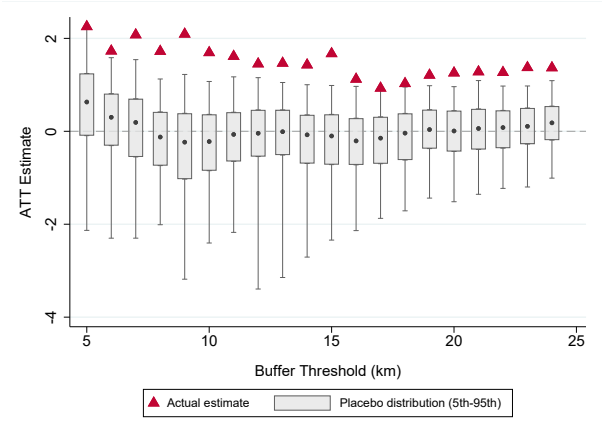
Lead placebo tests. To confirm that the lead estimates reflect the timing of facility construction rather than time trends, I permute construction years across facilities, holding the ring geometry and the sample fixed, and re-estimate the staggered DiD at each distance threshold. Each iteration reassigns the observed distribution of construction years at random, preserving cross-sectional heterogeneity in monitoring coverage, distance, and facility characteristics while breaking any systematic alignment between construction and subsequent lead dynamics.

IA Figure IA.5 reports the result. The actual z-statistic exceeds 2 at 17 of the 20 thresholds, and the actual estimate lies above the 95th percentile of the permuted distribution at most cutoffs. The permuted distribution is not centered at zero at the tightest thresholds—its median is approximately 0.6 μg/L at 5 km, declining toward zero as the treated ring widens—so the relevant comparison is the position of the actual estimate within the permuted distribution rather than its distance from zero. Measured that way, the effect remains outside the null across most of the range. Permuted cohorts do not reproduce the observed pattern.

Figure IA.5: Randomization inference for lead concentration effects

Placebo distributions from 1,000 permutations of facility construction years in the lead-concentration difference-in-differences design. For each threshold X, the treated ring spans $(1, X]$ km from a Toxics Release Inventory facility and the control ring spans $(X+1, 30]$ km. Gray boxes show the 25th–75th percentiles of placebo estimates; whiskers show the 5th–95th percentiles; dots mark placebo medians; red triangles mark the actual estimates. Panel (a) plots average treatment effect estimates in μg/L; Panel (b) plots z-statistics, with dashed lines at ± 1.96.

(a) ATT estimates (μg/L)



(b) z-statistics

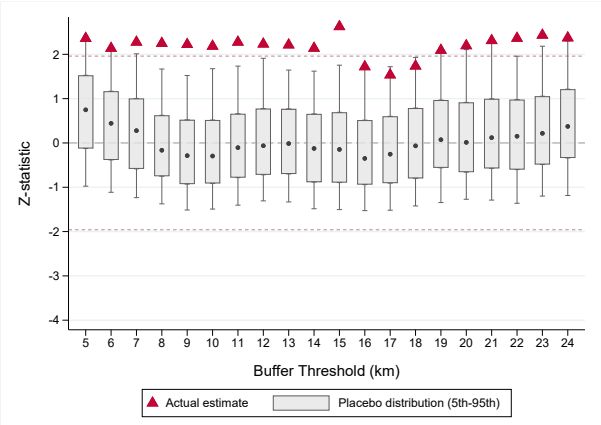
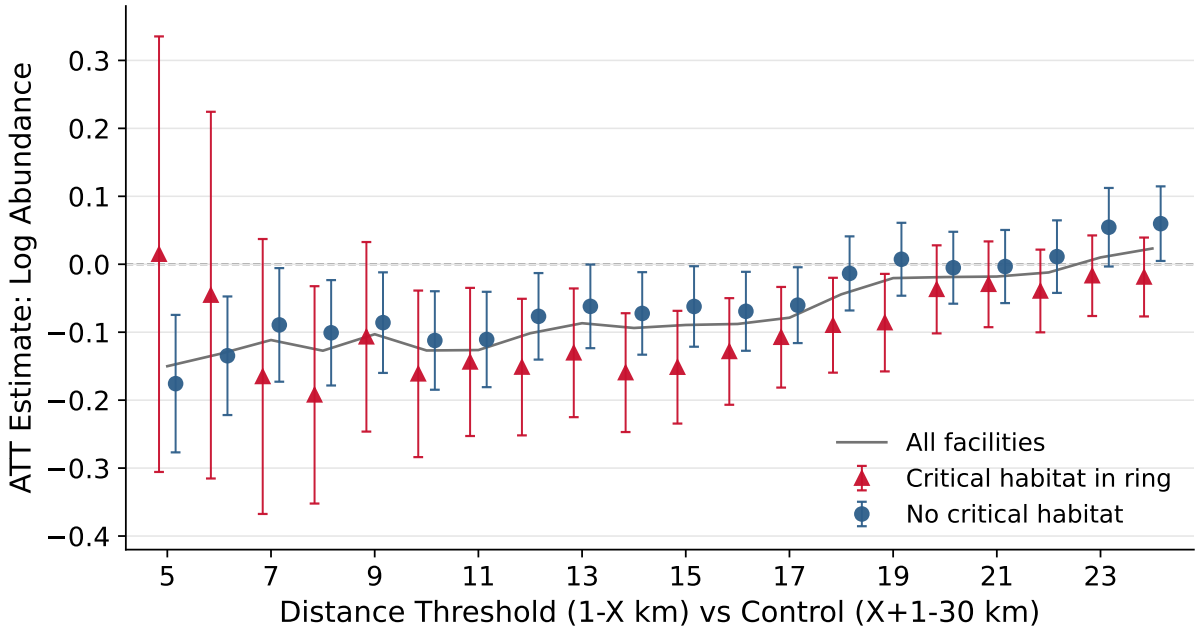


Figure IA.6: Ecological impact by proximity to critical habitat

Callaway–Sant'Anna staggered difference-in-differences estimates of the effect of TRI facility construction on log effort-adjusted bird abundance, varying the distance threshold X from 5 to 24 km. Bird observations in the ring spanning $(1, X]$ km are compared with those in the ring spanning $(X + 1, 30]$ km and with not-yet-treated observations. Red triangles report estimates for facilities with mapped critical habitat within X km; blue circles report estimates for facilities without mapped critical habitat within that distance. The gray line reports the pooled estimate. Habitat proximity uses FWS spatial records, regardless of whether designation preceded facility construction, and group membership can change with X. Controls include seasonal checklist coverage, NLCD impervious-surface growth, observer counts, and survey hours. Bars show 95% confidence intervals clustered by facility. The figure assesses the construction results across habitat-proximity groups; it does not estimate the effect of habitat designation.



IA.4 Facility production after designation

Table IA.2 examines whether firms shift production from exposed facilities to their other facilities after designation. I measure output with the cumulative production ratio used by Akey and Appel (2021) and Duchin et al. (2025). In column (2), output at the firm's other facilities does not rise after designation. The pooled estimate is small and not significant, and the predesignation coefficients are jointly insignificant. In column (1), output at exposed facilities falls by about 17 log points, significant at the 5% level. However, the predesignation coefficients are jointly significant, so the decline cannot be attributed to designation.

Table IA.3 examines whether exposed facilities stop reporting to TRI or are transferred to another publicly traded parent. In column (1), the estimated change in the probability of no TRI report over the following three years is -0.3 percentage points. In column (2), exposed facilities are 1.7 percentage points more likely than controls to have been transferred during the postdesignation period. Neither estimate is statistically significant. These measures do not distinguish plant closures from other reasons for nonreporting and do not capture transfers to private buyers.

Table IA.2: Cumulative output at exposed and sibling facilities

This table reports matched, entropy-weighted stacked difference-in-differences estimates for facilities within 3 km of new FWS or NMFS habitat designations (exposed) and their firms' other facilities owned before designation (siblings), relative to matched control-firm facilities. The dependent variable is the log of a cumulative production index constructed from annual TRI production ratios following Akey and Appel (2021) and Duchin et al. (2025). Each facility–chemical series starts at one in its first reported year and is multiplied by subsequent annual ratios. Missing ratios and ratios outside $(0, 3]$ are replaced with one. Unreported years contribute no growth. Panel A pools years 0–5, while Panel B reports annual estimates. Each panel estimates exposed and sibling effects jointly, relative to years -6 to -4. Observations are facility–chemical–years. Each facility's weight is divided by the number of chemicals it reports over the event window. The pre-period test jointly tests whether the coefficients for years -3 through -1 equal zero. Parentheses report standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Exposed facilities (1)	Sibling facilities (2)
Panel A. Pooled estimate		
Designation × Post	-0.168**	-0.035
	(0.082)	(0.038)
Panel B. Yearly estimates		
Designation × Year −3	-0.055	-0.045**
	(0.041)	(0.022)
Designation × Year −2	-0.087*	-0.060**
	(0.045)	(0.026)
Designation × Year −1	0.025	-0.063**
	(0.058)	(0.031)
Designation × Year 0	-0.155*	-0.053
	(0.088)	(0.034)
Designation × Year +1	-0.159*	-0.035
	(0.089)	(0.036)
Designation × Year +2	-0.165*	-0.033
	(0.093)	(0.040)
Designation × Year +3	-0.167*	-0.034
	(0.090)	(0.043)
Designation × Year +4	-0.187*	-0.036
	(0.105)	(0.049)
Designation × Year +5	-0.155	-0.003
	(0.113)	(0.052)
Pre-period joint p-value	0.002	0.153
Facility-chemical × firm-event FE	Yes	Yes
Cohort × year FE	Yes	Yes
Chemical × year FE	Yes	Yes
Industry × year FE	Yes	Yes
State × year FE	Yes	Yes
Facilities	181	1,922
R^2 (pooled)	0.925	0.925
Observations	594,199	594,199

Table IA.3: Reporting cessation and ownership transfer at exposed facilities

This table reports matched, entropy-weighted stacked difference-in-differences estimates comparing facilities within 3 km of new FWS or NMFS habitat designations with matched control-firm facilities. Both dependent variables are binary (0/1) indicators. In column (1), the outcome equals one if a facility files no TRI report in any of the following three years and zero otherwise. Post comprises years 0–5, and years −6 to −4 are the reference period. In column (2), the outcome equals one once a different publicly traded parent is reported for the facility and zero otherwise. Because ownership is fixed at the latest owner in years −3 to −1, column (2) compares exposed and control facilities in years 0–5. Each regression includes separate interactions for the exposed firm's other facilities, which are not reported. Parentheses report standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Stops reporting to TRI (1)	Transferred to public parent (2)
Exposed × Post	-0.003	0.017
	(0.020)	(0.019)
Facility × firm-event FE	Yes	No
Cohort × year FE	Yes	Yes
Industry × year FE	Yes	Yes
State × year FE	Yes	Yes
Exposed facility-events	181	183
Control facility-events	13,120	13,510
Firm clusters	793	797
Observations	143,094	92,096

IA.5 Critical habitat versus other protected areas

Figure IA.7 compares critical habitat with other protected areas. Critical habitat often follows rivers and coastlines or spans species' ranges, whereas other protected areas are mostly discrete parcels.

The two forms of protection impose different obligations on nearby firms. Section 7 of the Endangered Species Act requires federal agencies to consult with wildlife agencies when their actions may affect designated habitat. This requirement can extend to private facilities seeking federal permits or funding. Designation does not change land ownership or directly restrict private activities without federal involvement. Other protected areas, such as parks and conservation easements, generally restrict use of the protected land itself and bind its owner or manager. Neighboring facilities usually face no new obligations.[27] If costs arise from obligations on nearby operators, the response should therefore be larger after critical-habitat designation.

Table IA.4 repeats the main design for other protected areas. Exposure begins with the first designation within 3 km of a previously owned facility, using sites with a designation year in the World Database on Protected Areas (WDPA). I retain the ownership and matching rules from Table 5 and stack the two designs, interacting all fixed effects with the design. The triple-difference coefficient measures the difference between the two designation effects.

Panel A shows no significant change in COGS/Sales or operating margin following other protected-area designations. Relative to these designations, critical-habitat designation is associated with higher COGS/Sales and lower operating margins. Both differences are about 2.5 percentage points in magnitude and statistically significant. The differences remain significant after excluding protected-area events near critical habitat (Table IA.5). These findings are consistent with the higher operating costs arising from additional regulatory obligations on nearby firms.

[27] An exception is the Clean Air Act, which requires new or modified major sources that may affect certain national parks and wilderness areas to assess their air-quality impacts. Few protected areas near sample facilities fall in this category. Section 9 species protections apply regardless of critical-habitat designation.

Figure IA.7: Critical habitat and other protected areas in the contiguous United States

Blue areas are final FWS critical-habitat designations and NMFS critical habitat for salmon, steelhead, eulachon, and sturgeon. Orange areas are protected areas on land or the coast in the World Database on Protected Areas. Critical habitat is drawn on top where the two overlap. Boundaries are simplified for display and are not the boundaries used in estimation.

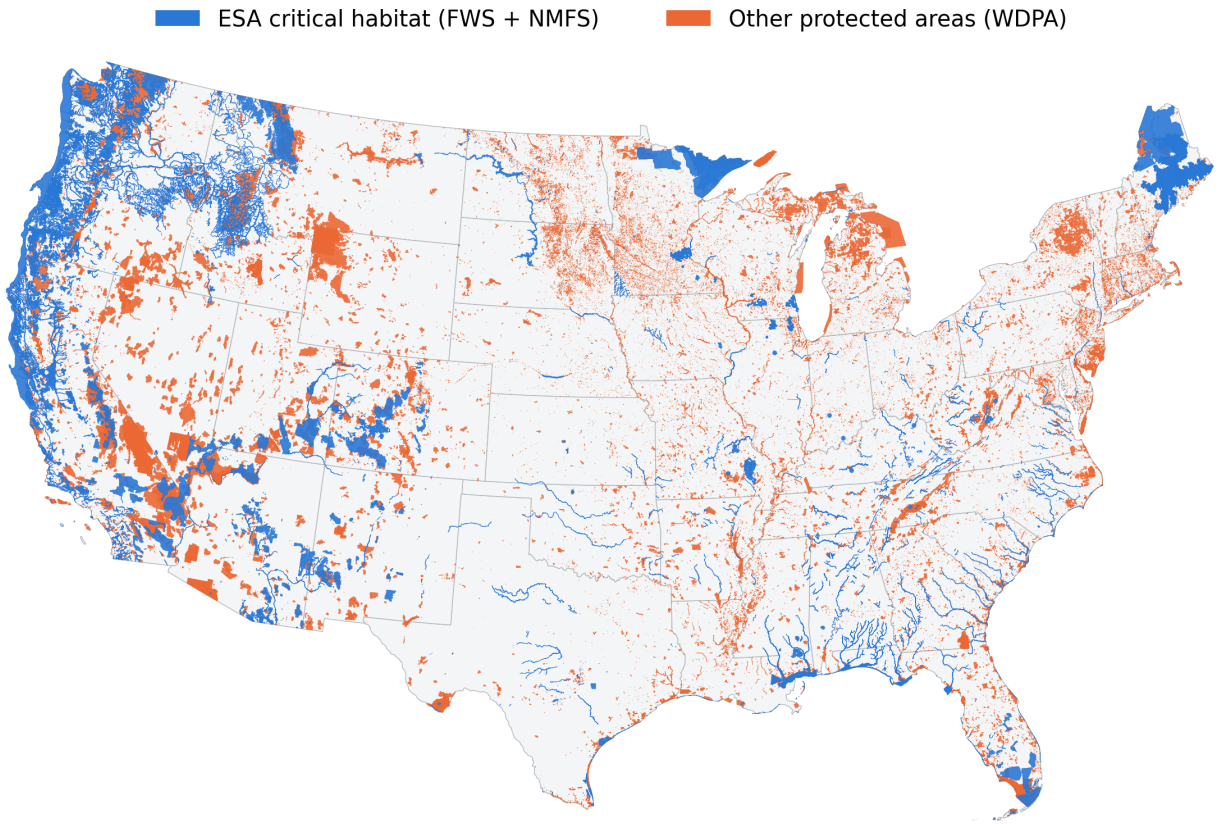


Table IA.4: Critical habitat versus other protected areas: triple difference

This table reports a triple-difference version of Table 5. The sample stacks the critical-habitat design (firms newly exposed to FWS or NMFS critical habitat within 3 km of a previously owned facility) with a parallel design in which the event is the first protected area within 3 km that is not critical habitat (WDPA sites with a designation year). Each design keeps its own matched, entropy-weighted controls ($K = 20$, six predesignation characteristics). Designated × Post is the protected-area effect. Designated × Post × Critical habitat is the difference between the critical-habitat and protected-area effects. All fixed effects are interacted with the design. In the protected-area design a control stops being eligible at its first exposure to either a protected area or critical habitat within 3 km, and treated firms exposed to critical habitat within 3 km by event year +5 are excluded. Most critical-habitat firms already had a protected area within 3 km before their event, so the triple coefficient measures the additional effect of critical habitat if the two effects are additive. Panel A reports the pooled effect over years 0–5. Panel B reports a separate regression with annual interactions. Table IA.5 repeats Panel A excluding protected-area events near critical habitat. Years −6 to −4 are the reference period. Parentheses report standard errors clustered by firm across both designs. Both dependent variables are ratios to sales, multiplied by 100. Operating margin is measured before depreciation and amortization. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	Operating margin (pp, before D&A) (2)
Panel A. Pooled estimate		
Designated × Post	-1.019	0.645
	(0.677)	(0.599)
Designated × Post × Critical habitat	2.547***	-2.457**
	(0.935)	(0.966)
Panel B. Yearly estimates of the critical-habitat difference		
Designated × Year −3 × Critical habitat	-0.280	-0.285
	(0.599)	(0.710)
Designated × Year −2 × Critical habitat	-0.440	-0.002
	(0.812)	(0.878)
Designated × Year −1 × Critical habitat	0.203	-0.454
	(0.754)	(0.821)
Designated × Year 0 × Critical habitat	1.815**	-0.990
	(0.907)	(0.891)
Designated × Year +1 × Critical habitat	2.595***	-2.031**
	(0.968)	(1.031)
Designated × Year +2 × Critical habitat	3.859***	-3.517***
	(1.190)	(1.168)
Designated × Year +3 × Critical habitat	1.864	-3.370**
	(1.316)	(1.385)
Designated × Year +4 × Critical habitat	2.749**	-2.832**
	(1.265)	(1.341)
Designated × Year +5 × Critical habitat	2.306*	-2.974**
	(1.282)	(1.337)
Matching controls	Yes	Yes
Firm × cohort × design FE	Yes	Yes
Cohort × year × design FE	Yes	Yes
Industry × year × design FE	Yes	Yes
State × year × design FE	Yes	Yes
Critical-habitat firm-events	155	155
Protected-area firm-events	77	74
R^2 (pooled)	0.920	0.861
Observations	35,372	32,660
Firms	999	982

Table IA.5: Critical habitat versus other protected areas: excluding nearby critical habitat

This table repeats the pooled triple-difference estimates in Panel A of Table IA.4. The protected-area sample additionally excludes firms with a newly exposed facility within 18 km of any critical habitat, regardless of designation date. The critical-habitat sample is unchanged. The first row reports the protected-area effect, and the second reports the difference between the critical-habitat and protected-area effects. Adding the two rows gives the critical-habitat effect. Estimates pool years 0–5 relative to years −6 to −4. Matching and fixed effects follow Table IA.4. Both dependent variables are ratios to sales, multiplied by 100. Operating margin is measured before depreciation and amortization. Observation and firm counts refer to the stacked sample. Parentheses report standard errors clustered by firm across both designs. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	COGS/Sales (pp) (1)	Operating margin (pp, before D&A) (2)
Designated × Post	-0.645	0.565
	(0.725)	(0.697)
Designated × Post × Critical habitat	2.173**	-2.377**
	(0.969)	(1.030)
Matching controls	Yes	Yes
Firm × cohort × design FE	Yes	Yes
Cohort × year × design FE	Yes	Yes
Industry × year × design FE	Yes	Yes
State × year × design FE	Yes	Yes
Critical-habitat firm-events	155	155
Protected-area firm-events	50	49
Observations	31,296	28,896
Firms	954	940

IA.6 Disclosure regressions by distance band

Table IA.6: Biodiversity disclosure and habitat proximity: 1 km

This table reports the full coefficients for the 1-km regressions summarized in Table 15. Each column is a separate linear probability regression. Dependent variables equal one for "Yes" responses to the CDP items in the column headings and zero for other answers. Missing responses are excluded, as are "Not assessed" responses in column (1). Estimates are in percentage points. Sample construction follows the main table. Industry and year fixed effects enter separately. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Near bio. areas	(2) Monitors indicators	(3) Actions	(4) Public commitments	(5) Voluntary disclosure
Any facility within 1 km	11.88	-4.01	-6.20	-1.34	-5.28
	(8.25)	(5.17)	(6.00)	(5.46)	(4.91)
ln(Assets)	10.37***	6.50***	8.69***	3.20	5.14***
	(3.60)	(2.09)	(2.20)	(1.98)	(1.81)
Leverage	28.74	4.35	-14.89	-11.04	-4.85
	(30.32)	(15.34)	(19.80)	(16.46)	(16.30)
ROA	0.00	0.05	-0.18	0.03	-0.09
	(0.15)	(0.08)	(0.12)	(0.10)	(0.10)
ln(PPE/Assets)	8.97	9.12**	14.21***	11.38***	14.30***
	(6.09)	(3.52)	(3.64)	(3.79)	(3.15)
ln(Book/Market)	-4.43	-2.04	-4.88	-0.47	-4.89
	(4.84)	(3.23)	(3.68)	(3.40)	(2.98)
TRI releases (standardized)	2.46	3.91	2.87	1.78	1.17
	(3.93)	(2.50)	(2.79)	(2.71)	(2.19)
ln(Facility count)	-6.07	0.18	-3.06	0.93	-0.91
	(4.22)	(2.83)	(3.08)	(2.89)	(2.48)
Constant	-40.70	-28.42*	-5.25	27.79	11.14
	(28.33)	(15.31)	(19.50)	(17.58)	(15.95)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Distinct firms in sample	157	283	284	294	303
R^2	0.299	0.214	0.223	0.156	0.147
Firm-year observations	322	817	810	878	952

Table IA.7: Biodiversity disclosure and habitat proximity: 3 km

This table reports the full coefficients for the 3-km regressions summarized in Table 15. Each column is a separate linear probability regression. Estimates are in percentage points; outcome definitions, response coding, and sample construction follow the main table. Industry and year fixed effects enter separately. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Near bio. areas	(2) Monitors indicators	(3) Actions	(4) Public commitments	(5) Voluntary disclosure
Any facility within 3 km	12.69*	2.51	-3.31	-6.48	-6.54
	(7.18)	(4.68)	(5.34)	(5.06)	(4.75)
ln(Assets)	10.20***	6.33***	8.51***	3.26*	4.98***
	(3.66)	(2.09)	(2.18)	(1.95)	(1.78)
Leverage	27.90	3.13	-15.61	-10.13	-4.52
	(30.77)	(15.25)	(19.64)	(16.43)	(16.03)
ROA	0.00	0.07	-0.17	0.03	-0.09
	(0.15)	(0.08)	(0.12)	(0.11)	(0.10)
ln(PPE/Assets)	8.45	9.28***	14.41***	11.36***	14.37***
	(6.22)	(3.48)	(3.64)	(3.81)	(3.14)
ln(Book/Market)	-4.49	-2.20	-4.87	-0.21	-4.70
	(4.93)	(3.23)	(3.67)	(3.40)	(2.98)
TRI releases (standardized)	2.03	3.77	2.95	2.00	1.37
	(3.97)	(2.48)	(2.78)	(2.72)	(2.19)
ln(Facility count)	-6.31	-0.98	-3.50	1.96	-0.55
	(4.32)	(2.85)	(3.08)	(2.85)	(2.54)
Constant	-41.74	-26.82*	-2.69	28.07	13.68
	(28.43)	(15.48)	(19.17)	(17.28)	(15.51)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Distinct firms in sample	157	283	284	294	303
R^2	0.303	0.213	0.221	0.159	0.148
Firm-year observations	322	817	810	878	952

Table IA.8: Biodiversity disclosure and habitat proximity: 18 km

This table reports the full coefficients for the 18-km regressions summarized in Table 15. Each column is a separate linear probability regression. Estimates are in percentage points; outcome definitions, response coding, and sample construction follow the main table. Industry and year fixed effects enter separately. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Near bio. areas	(2) Monitors indicators	(3) Actions	(4) Public commitments	(5) Voluntary disclosure
Any facility within 18 km	9.57	5.13	1.27	-0.67	5.69
	(8.56)	(5.26)	(5.94)	(5.18)	(5.39)
ln(Assets)	10.49***	6.22***	8.43***	3.18	4.90***
	(3.70)	(2.10)	(2.18)	(1.97)	(1.79)
Leverage	30.25	2.78	-16.40	-11.16	-6.22
	(30.74)	(15.12)	(19.81)	(16.48)	(16.35)
ROA	-0.02	0.07	-0.16	0.04	-0.07
	(0.15)	(0.08)	(0.12)	(0.11)	(0.10)
ln(PPE/Assets)	9.03	9.29***	14.44***	11.44***	14.52***
	(6.15)	(3.46)	(3.62)	(3.79)	(3.12)
ln(Book/Market)	-4.54	-2.40	-5.04	-0.46	-5.33*
	(4.85)	(3.26)	(3.65)	(3.40)	(2.98)
TRI releases (standardized)	2.56	3.87	2.82	1.75	1.22
	(3.96)	(2.51)	(2.79)	(2.71)	(2.19)
ln(Facility count)	-6.12	-1.42	-4.37	0.81	-2.96
	(4.41)	(2.86)	(3.09)	(2.89)	(2.60)
Constant	-45.96	-27.91*	-2.89	28.44	11.14
	(28.03)	(15.62)	(19.09)	(17.26)	(15.83)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Distinct firms in sample	157	283	284	294	303
R^2	0.296	0.214	0.220	0.155	0.146
Firm-year observations	322	817	810	878	952

Table IA.9: 10-K biodiversity disclosure and habitat proximity: 1 km

This table reports linear probability regressions of 10-K biodiversity disclosure indicators from Giglio et al. (2026) on whether a firm owns any linked TRI facility within 1 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Outcomes indicate any biodiversity mention and discussion of biodiversity regulation. Estimates are in percentage points. Missing filings or scores are excluded. Score years are aligned with the same year's exposure and controls. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. All regressions include industry-by-year fixed effects and use the same sample across radii. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Biodiversity mention	(2) Biodiversity regulation
Any facility within 1 km	1.08	0.52
	(1.34)	(1.17)
ln(Assets)	-0.05	0.08
	(0.42)	(0.37)
Leverage	3.47	3.25
	(2.82)	(2.46)
ROA	-0.00	0.00
	(0.01)	(0.01)
ln(PPE/Assets)	2.77***	2.26***
	(0.77)	(0.66)
ln(Book/Market)	1.36**	1.05*
	(0.68)	(0.60)
TRI releases (standardized)	0.44	0.10
	(0.50)	(0.44)
ln(Facility count)	-0.20	-0.19
	(0.62)	(0.58)
Constant	8.37***	5.44**
	(2.91)	(2.31)
Industry × year FE	Yes	Yes
Firms	735	735
R^2	0.111	0.116
Observations	8,237	8,237

Table IA.10: 10-K biodiversity disclosure and habitat proximity: 3 km

This table reports linear probability regressions of 10-K biodiversity disclosure indicators from Giglio et al. (2026) on whether a firm owns any linked TRI facility within 3 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Outcomes indicate any biodiversity mention and discussion of biodiversity regulation. Estimates are in percentage points. Missing filings or scores are excluded. Score years are aligned with the same year's exposure and controls. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. All regressions include industry-by-year fixed effects and use the same sample across radii. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Biodiversity mention	(2) Biodiversity regulation
Any facility within 3 km	1.62	1.07
	(1.10)	(0.96)
ln(Assets)	-0.05	0.08
	(0.41)	(0.36)
Leverage	3.46	3.23
	(2.81)	(2.44)
ROA	-0.00	0.00
	(0.01)	(0.01)
ln(PPE/Assets)	2.79***	2.27***
	(0.77)	(0.66)
ln(Book/Market)	1.33**	1.03*
	(0.67)	(0.59)
TRI releases (standardized)	0.41	0.08
	(0.50)	(0.44)
ln(Facility count)	-0.33	-0.31
	(0.63)	(0.60)
Constant	8.35***	5.46**
	(2.88)	(2.27)
Industry × year FE	Yes	Yes
Firms	735	735
R^2	0.111	0.117
Observations	8,237	8,237

Table IA.11: 10-K biodiversity disclosure and habitat proximity: 18 km

This table reports linear probability regressions of 10-K biodiversity disclosure indicators from Giglio et al. (2026) on whether a firm owns any linked TRI facility within 18 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Outcomes indicate any biodiversity mention and discussion of biodiversity regulation. Estimates are in percentage points. Missing filings or scores are excluded. Score years are aligned with the same year's exposure and controls. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. All regressions include industry-by-year fixed effects and use the same sample across radii. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) Biodiversity mention	(2) Biodiversity regulation
Any facility within 18 km	0.83	0.28
	(1.10)	(0.93)
ln(Assets)	-0.05	0.09
	(0.41)	(0.36)
Leverage	3.52	3.29
	(2.78)	(2.41)
ROA	-0.00	0.00
	(0.01)	(0.01)
ln(PPE/Assets)	2.78***	2.26***
	(0.77)	(0.66)
ln(Book/Market)	1.36**	1.05*
	(0.67)	(0.59)
TRI releases (standardized)	0.43	0.10
	(0.50)	(0.44)
ln(Facility count)	-0.21	-0.17
	(0.70)	(0.65)
Constant	8.08***	5.31**
	(2.84)	(2.24)
Industry × year FE	Yes	Yes
Firms	735	735
R^2	0.111	0.116
Observations	8,237	8,237

Table IA.12: Iceberg biodiversity measures and habitat proximity: 1 km

This table relates Iceberg Data Lab's biodiversity footprint and dependency measures to whether a firm owns any linked TRI facility within 1 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Columns (1)–(3) use the log of the sign-reversed corporate biodiversity footprint (CBF), in absolute terms and using Iceberg's measures per unit of assets and sales; coefficients and standard errors are multiplied by 100. Higher CBF indicates greater estimated damage. Columns (4)–(5) use dependency indices on a 0–100 scale. Iceberg years 2020–2024 are matched to exposure and controls in the same year; each annual vintage may not align exactly with firms' fiscal years. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. Industry and year fixed effects enter separately. Samples are fixed across radii within each outcome. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) ln(CBF) Absolute	(2) ln(CBF/Assets)	(3) ln(CBF/Sales)	(4) High-dependency score	(5) Revenue dependency
Any facility within 1 km	16.07	17.22	9.56	0.83	4.83*
	(16.87)	(17.41)	(14.39)	(0.86)	(2.49)
ln(Assets)	82.93***	-14.34**	-2.75	0.15	-0.82
	(6.00)	(6.52)	(5.25)	(0.33)	(0.93)
Leverage	-42.97	-45.49	11.66	-3.25	-18.98**
	(52.67)	(53.38)	(49.85)	(2.78)	(8.64)
ROA	0.03	0.04	-0.13	0.01	-0.00
	(0.16)	(0.16)	(0.16)	(0.01)	(0.03)
ln(PPE/Assets)	30.70**	29.02**	19.42*	2.52***	9.76***
	(12.54)	(13.02)	(11.63)	(0.62)	(1.61)
ln(Book/Market)	-5.35	-5.72	5.40	0.02	0.22
	(8.14)	(8.35)	(7.86)	(0.51)	(1.46)
TRI releases (standardized)	-6.09	-7.91	-3.73	1.11***	-0.35
	(9.86)	(10.53)	(9.14)	(0.40)	(1.02)
ln(Facility count)	27.26***	26.98***	17.91**	-0.20	-1.01
	(9.85)	(10.36)	(8.65)	(0.46)	(1.33)
Constant	-145.02***	-159.29***	-228.08***	73.57***	100.41***
	(46.88)	(51.02)	(42.70)	(2.58)	(7.18)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firms	390	353	390	389	389
R^2	0.568	0.268	0.226	0.377	0.442
Observations	1,538	1,406	1,538	1,537	1,537

Table IA.13: Iceberg biodiversity measures and habitat proximity: 3 km

This table relates Iceberg Data Lab's biodiversity footprint and dependency measures to whether a firm owns any linked TRI facility within 3 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Columns (1)–(3) use the log of the sign-reversed corporate biodiversity footprint (CBF), in absolute terms and using Iceberg's measures per unit of assets and sales; coefficients and standard errors are multiplied by 100. Higher CBF indicates greater estimated damage. Columns (4)–(5) use dependency indices on a 0–100 scale. Iceberg years 2020–2024 are matched to exposure and controls in the same year; each annual vintage may not align exactly with firms' fiscal years. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. Industry and year fixed effects enter separately. Samples are fixed across radii within each outcome. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) ln(CBF) Absolute	(2) ln(CBF/Assets)	(3) ln(CBF/Sales)	(4) High-dependency score	(5) Revenue dependency
Any facility within 3 km	11.79	14.69	8.97	-0.33	0.85
	(16.01)	(16.64)	(14.83)	(0.75)	(2.26)
ln(Assets)	83.22***	-14.17**	-2.64	0.19	-0.66
	(6.14)	(6.68)	(5.39)	(0.33)	(0.95)
Leverage	-43.77	-46.83	10.84	-3.13	-18.74**
	(52.36)	(53.03)	(49.47)	(2.76)	(8.65)
ROA	0.02	0.03	-0.13	0.01	-0.01
	(0.16)	(0.16)	(0.16)	(0.01)	(0.03)
ln(PPE/Assets)	30.65**	28.87**	19.39*	2.52***	9.75***
	(12.54)	(13.04)	(11.64)	(0.63)	(1.63)
ln(Book/Market)	-5.63	-6.11	5.11	0.06	0.30
	(8.20)	(8.41)	(7.90)	(0.51)	(1.46)
TRI releases (standardized)	-6.53	-8.37	-4.04	1.11***	-0.42
	(9.91)	(10.59)	(9.17)	(0.40)	(1.01)
ln(Facility count)	27.77***	27.01***	17.84**	0.01	-0.33
	(9.59)	(10.06)	(8.54)	(0.46)	(1.30)
Constant	-149.25***	-162.81***	-230.30***	73.21***	98.73***
	(47.48)	(51.75)	(43.49)	(2.59)	(7.35)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firms	390	353	390	389	389
R^2	0.568	0.268	0.226	0.376	0.436
Observations	1,538	1,406	1,538	1,537	1,537

Table IA.14: Iceberg biodiversity measures and habitat proximity: 18 km

This table relates Iceberg Data Lab's biodiversity footprint and dependency measures to whether a firm owns any linked TRI facility within 18 km of designated FWS or NMFS critical habitat. Each column reports a separate regression. Columns (1)–(3) use the log of the sign-reversed corporate biodiversity footprint (CBF), in absolute terms and using Iceberg's measures per unit of assets and sales; coefficients and standard errors are multiplied by 100. Higher CBF indicates greater estimated damage. Columns (4)–(5) use dependency indices on a 0–100 scale. Iceberg years 2020–2024 are matched to exposure and controls in the same year; each annual vintage may not align exactly with firms' fiscal years. Controls include log assets, leverage, ROA, log PPE/assets, log book-to-market, standardized TRI releases, and log facility count. Industry and year fixed effects enter separately. Samples are fixed across radii within each outcome. Parentheses report firm-clustered standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	(1) ln(CBF) Absolute	(2) ln(CBF/Assets)	(3) ln(CBF/Sales)	(4) High-dependency score	(5) Revenue dependency
Any facility within 18 km	-4.10	3.54	-1.04	-0.68	-0.53
	(17.49)	(18.49)	(16.43)	(0.84)	(2.29)
ln(Assets)	83.64***	-13.77**	-2.36	0.19	-0.63
	(6.06)	(6.62)	(5.32)	(0.33)	(0.95)
Leverage	-41.55	-43.77	12.47	-3.17	-18.57**
	(52.57)	(53.24)	(49.84)	(2.76)	(8.54)
ROA	0.01	0.03	-0.14	0.01	-0.01
	(0.16)	(0.16)	(0.16)	(0.01)	(0.03)
ln(PPE/Assets)	30.77**	28.94**	19.43*	2.53***	9.77***
	(12.50)	(13.01)	(11.57)	(0.63)	(1.64)
ln(Book/Market)	-4.68	-5.42	5.72	0.08	0.38
	(8.31)	(8.54)	(7.97)	(0.51)	(1.44)
TRI releases (standardized)	-6.35	-7.89	-3.84	1.08***	-0.41
	(9.82)	(10.52)	(9.06)	(0.40)	(1.02)
ln(Facility count)	30.79***	29.14***	19.77**	0.06	-0.08
	(9.82)	(10.42)	(8.63)	(0.45)	(1.25)
Constant	-149.56***	-166.64***	-231.28***	73.50***	98.79***
	(47.34)	(52.09)	(43.49)	(2.62)	(7.43)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firms	390	353	390	389	389
R^2	0.567	0.266	0.226	0.377	0.436
Observations	1,538	1,406	1,538	1,537	1,537