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Managing Regulatory Risk in Today's Offshore Industry

By Alex Loureiro, Ph.D., *Senior Consultant*

Simply complying with environmental regulations is no longer enough. Building defensible environmental studies, strengthening regulatory and stakeholder credibility, and moving from project-level compliance to portfolio-level resilience are requirements for success in today's offshore industry.

For many offshore companies, the largest environmental risks are not scientific or engineering problems. Technical risks determine whether a project can be designed, built, and operated safely: whether the design is robust, equipment and materials are available, resources are sufficiently characterized, data and models are reliable, hardware and software perform as intended, and teams can work safely and effectively in the proposed environment. Nontechnical risks sit outside of engineering and project management but can still determine whether a project succeeds. They include permitting, environmental and social concerns, socioeconomic effects, stakeholder relationships, and regulatory credibility.

Both kinds of risks require robust scientific analysis. Nontechnical risk management also requires stakeholder engagement, relationship-building, careful communication, and a clear understanding of regulatory requirements and decision-making. Technical risk analysis answers the question: can it be done? Addressing nontechnical risk answers an equally important one: should it be done, and under what conditions?

Offshore companies are well acquainted with risk management. Capital expenditure, construction, market volatility, and operational safety are built into planning from the outset. These risks are not always easy to manage, but they are often visible enough to predict. Financial margins can be tested against changing market conditions; construction schedules can account for material availability; and safety risks can be evaluated against prior incidents and near-misses.

Nontechnical risk is less predictable. It can surface through a permit challenge, court decision, supplemental environmental review, change in agency interpretation, stakeholder campaign, or surge in public attention. The consequences may range from minor disruption to complete suspension of a project that has already absorbed significant capital. Yet most companies still treat environmental, social, stakeholder, and regulatory risk as project-specific compliance issues rather than as business risks to be managed across a portfolio.

Historically, nontechnical risk was a hurdle to clear on the way to a permit or authorization. As offshore operations expand into more complex regulatory, ecological, social, and socioeconomic contexts, it has become a business challenge. Schedule uncertainty, unplanned data collection, litigation exposure, delayed investment, portfolio reprioritization, stakeholder opposition, and reputational impacts are hard to predict and harder to price. Without an early look at whether a project should proceed, and under what conditions, companies are vulnerable to delays, added costs, and reputational damage with direct business implications.

Invisible Until Expensive

The cost of nontechnical risk is often measured only after it becomes visible: a missed construction window, an extended survey program, an unexpected additional mitigation, a delayed investment decision, or a legal challenge that requires agencies to revisit assumptions or findings. By then, the issue is no longer environmental compliance alone; it is a question of schedule, capital, stakeholder relationships, public reputation, or several of these at once.

Mitigation requirements that emerge late can be especially costly. In Humboldt Bay, a proposed land-based fish farm designed screening for its seawater intake, which would draw 12 million gallons per day, to meet National Marine Fisheries Service (NMFS) criteria for salmonids. Regulators remained concerned about entrainment, in which smaller organisms such as zooplankton and the eggs and larvae of fish and invertebrates are drawn into the intake. The State of California required the applicant to purchase and restore tidal marsh as mitigation, an unanticipated cost with direct project implications. The applicant then proposed finer screening to reduce entrainment further, but the additional design cost did not eliminate the mitigation expectation. Uncertainty cannot always be eliminated. Unresolved or poorly messaged uncertainty, however, can become a costly obligation.

Thoughtfully considered adaptive management can help minimize nontechnical risk. At a wave energy test center, deployment of novel technology where various types of wave energy converted would be tested triggered concerns due to high uncertainty around electromagnetic fields (EMF). This uncertainty was addressed with models that estimated EMF emissions, followed by targeted magnetic-field monitoring for up to eight converter types to validate and improve those models. This approach gave NMFS a credible way to address uncertainty while giving project proponents a clear pathway to reduce expensive monitoring over time. While more expensive to conduct this modeling and monitoring up front, this adaptive approach likely resulted in substantial cost savings over the life of the project.

The Credibility Gap

Decision-makers must determine not only whether the technical work is sound, but also whether it is sufficient to support decisions that regulators, courts, investors, communities, and other stakeholders can understand and trust. When studies do not connect technical analysis to regulatory requirements and stakeholder concerns, they create a credibility gap even when the underlying work is rigorous.

These gaps commonly stem from shortcomings in communication, engagement, and implementation rather than from just the scientific analysis. Examples:

- When findings are technically accurate but not clearly connected to regulatory decisions or stakeholder concerns, communication issues between project proponents, regulators, communities, and other stakeholders are created.
- When limitations, assumptions, or data gaps are acknowledged but not translated into their practical implications, this can lead to unfounded or unmerited concern.
- When the analytical record is hard for reviewers outside the original team to understand, test, and defend, the rigor of the underlying work fails to translate to the audiences who need this information.

Regulatory credibility is established from connecting technical analysis, engagement, and decision-making in a way that can be understood and defended. That requires the underlying science itself to be strong and the communication of that information to be clear, concise, appropriately translated for the audience, and responsive to the concerns and processes that shape the decision.

Building Defensible Environmental Studies

Closing the credibility gap starts with study design, but it does not end there. **The most effective environmental studies for offshore projects are organized around decisions.** This does not mean compromising scientific independence or tailoring conclusions to a desired outcome, but rather that every step of the process is informed by the decisions that must be made later, the concerns that decision-makers and stakeholders are likely to raise, and the implications of those decisions. Put plainly: **So what?**

A decision focus also gives project teams a basis for constructively pushing back on study protocols that may satisfy a baseline requirement but do not materially improve agency decision-making. Work that ends up in a binder on a shelf creates cost without reducing risk. Better study design starts with asking what information regulators need to make and defend a decision, then working with agencies to develop methods that produce it. Traditional seabird baseline protocols, for example, often rely on quarterly at-sea observer monitoring. Those surveys reveal little about bird activity in inclement weather, at nighttime, or about whether birds fly within the rotor-swept zone, the area swept by turbine blades. Observer data may be more valuable when used to support and validate remote methods that assess passage rates, flight height, and other decision-relevant metrics.

Before collecting data, project teams must identify regulatory triggers, decision criteria, agency expectations, likely challenges, the stakeholders whose concerns may affect the decision, and what those concerns are. Tailoring study design around these sensitivities keeps the scientific work focused on the most important questions. Uncertainty should be characterized, quantified where possible, and connected to its implications transparently. Conceptual models linking sources, stressors, exposure pathways, receptors, and outcomes can help readers follow the analytical process. Most importantly, project proponents must build a defensible record by documenting assumptions, alternatives considered, data limitations, analytical choices, engagement steps, and how concerns were heard and addressed.

Legal and regulatory challenges often focus less on whether the engineering can be completed or whether individual findings are technically valid, and more on whether the analysis was complete, transparent, responsive to relevant concerns, and properly connected to the decision. A record that explains not only the study and the findings, but also ***why* the study was appropriate to inform the specific regulatory decision** is critical to preempting confusion or challenges later in the regulatory process.

Project-Level Risk Management to Portfolio-Level Resilience

Most environmental risk management still happens on a project-by-project, or in some cases region-by-region basis, but the drivers of regulatory scrutiny rarely remain isolated. Similar assumptions, data gaps, stakeholder concerns, and agency interpretations often occur across assets, regions, and business lines. Regulators making similar decisions across jurisdictions communicate with each other; stakeholders can reach other stakeholders globally via both traditional and social media. Concerns that are ostensibly specific to one jurisdiction are likely to arise in another, perhaps in a slightly different form.

Companies benefit by considering nontechnical risk on a portfolio basis rather than a project one. Questions to inform this approach might include:

- What data gaps are we seeing across multiple projects?
- Which projects rely on similar permitting assumptions?
- Which regulations or agency interpretations are changing most rapidly?

- Which assets face similar stakeholder concerns?
- Where can we enhance monitoring, baseline studies, regulatory strategy, stakeholder engagement, or relationship-building to reduce risk across multiple projects rather than one permit application?

Closing the Gap

Four capabilities matter most for organizations working in this environment, and Integral's value lies in helping clients apply them before uncertainty becomes a project-level obstacle:

- **Risk anticipation:** Anticipating nontechnical risk and monitoring emerging scientific, regulatory, policy, social, and stakeholder developments allows project proponents to act before they become project constraints, rather than waiting for an unfavorable decision or court challenge.
- **Study defensibility:** Study designs that are tailored to directly informing regulatory decision-making, addressing relevant environmental and social concerns, and documenting how assumptions and uncertainties were considered hold up better against external scrutiny.
- **Stakeholder and regulatory engagement:** Early, deliberate engagement helps project teams understand concerns, build relationships, clarify regulatory expectations, and demonstrate that issues have been heard and addressed before they harden into opposition or litigation risk.
- **Portfolio-level intelligence:** Identifying common risk drivers across assets, programs, and investments can help companies prioritize the nontechnical risks most likely to pose threats to project success.

Integral helps clients navigate the intersection of science, permitting, stakeholder expectations, and agency decision-making. Our personnel bring practical experience anticipating regulatory and environmental challenges, developing study designs that support defensible decisions, engaging agencies and stakeholders before concerns harden into barriers, and translating uncertainty into clear options for project teams. This allows clients to address issues earlier, reduce late-stage surprises, and keep projects moving through complex permitting environments.

Conclusion

The primary question is no longer whether a study is technically rigorous, whether the project can be built, or whether minimum regulatory requirements have been met. Successful organizations must also ask whether the scientific work supports a defensible decision in the face of evolving policy, public perception, stakeholder concern, socioeconomic, and legal challenges. They build regulatory credibility by doing ***the right science for the decision***, engaging the right stakeholders proactively, and managing risk across the full portfolio.

Moving from compliance to defensibility to credibility builds portfolio-level resilience. Integral helps companies connect technical analysis, regulatory strategy, stakeholder engagement, and decision-making across portfolios so that environmental work supports both permits and project outcomes. By anticipating permitting, mitigation, and engagement challenges early, building robust science around the decisions that agencies must make, and managing uncertainty before it becomes expensive, clients can reduce the likelihood of late-stage challenges, avoid unnecessary or duplicative studies, manage mitigation expectations, and improve offshore project efficiency.

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Reliably Measuring Low-Level Persistent Organic Contaminants in Surface Water

By Greg Cotten, *Senior Scientist*
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To understand the full picture of a site, sediment practitioners must consider the presence, sources, and pathways of persistent organic pollutants (POPs) in submerged sediment; surface sediment and water; biota; and drainage basins. Legacy contaminants, often at the heart of sediment cleanups, can cause long-term effects across every linkage in the food web. POPs are stable chemicals that can resist degradation for decades and even centuries, can travel far from their sources, and often occur at very low concentrations. Those ultra-low levels are hard to quantify confidently with traditional sampling and analytical methods. Understanding their nature and extent requires specialized sampling techniques and technologies.

Traditional surface water sampling involves filling a container with a sample of water (often 2 liters) and analyzing it for POPs dissolved in the water and bound to particles within that sample. Because POPs are hydrophobic and have low solubility, very few molecules may be present in a typical sample, making detection with standard analytical tools difficult. Further, a grab sample, or even a composite of grab samples, represents only a relatively limited spatial and temporal window.

Traditional water sampling is often insufficient for detecting and characterizing these contaminants because the analyst is working with a relatively small volume of water to characterize potentially widespread, low-level contamination. Enter high-volume, long-duration sampling technologies as an additional tool in the investigator's toolbox. These systems use pumps to actively and precisely move a known quantity of water through solid absorptive media, concentrating the POPs in a large volume of water within the sampling device.



Glass fiber filter (left) for solid phase analysis. Stainless steel column (right) contains resin beads for dissolved phase extraction.



Plastic absorptive resin beads for dissolved fraction sampling.

The solid media consists of a particle filter and a plastic resin column. The latter sorbs contaminants that are small enough to pass through the glass fiber filter. Because POPs adhere to plastics, plastic filters, and resins within the sampling device efficiently extract these chemicals from water. The filter and resin target different groups of POPs in the water: those associated with suspended particles and those dissolved within the water matrix, respectively.

The mass of compounds trapped on each material is analyzed separately and, in combination with the volume of water that passed through the media, can be used to calculate the concentration present in that water. Concentrating target analytes for extraction and measurement allows for significantly lower detection limits and greater confidence in quantifying contaminant concentrations. Sample representativeness relative to the environment being studied also increases with increasing sample volume.

Sample representativeness relative to the fluctuating stressor levels experienced by biota over one or more seasons also increases with sample collection duration. These sampling devices can be deployed over extended periods in dynamic systems, tracking the influence of short-term variabilities as well as longer trends.

Sample collection rate, controlled by the collection device, can be programmed to coincide with the behavior of the water body. In river systems, the river's flow rate can be monitored, and sample frequency can be proportional to flow allowing the filter and resin to capture dissolved POPs in proportion to the movement of contaminant mass through the system. Modelers can then use these data to calculate the mass of contaminants transported through the system over the sampling period.

From the risk assessor's perspective, the sampling protocol can also provide a better representation of the exposure conditions experienced by organisms bioaccumulating contaminants in these environments.

For 25 years, Integral (formerly Kinnetic Environmental) has been inventing, testing, and developing technology—from hardware to software—to continually improve deployment flexibility, data quality, resiliency, and efficiency at every level. These systems can be configured for location, duration, volume, and sampling rate. Robust enclosures allow independent monitoring in publicly accessible and remote locations such as river levees. The systems can be integrated with existing facilities, like flow meters at water treatment plants, to provide flow-weighted POP data for calculating facility contaminant loads from a determined sampling duration.

Open-water samplers are submerged and programmed to pump water at specified intervals, producing an integrated sample over the target duration. Adjusting pump and sample frequency variables allow for customizable deployment periods, from hours to weeks, so a representative sample can be captured across a broad range of conditions and interests.

Case Study: West Virginia

On a river in West Virginia, water analysis of dioxins was used to examine the effectiveness of a sediment cap under both high- and low-flow conditions. A hydrologic study was used to select transect locations where collected samples would be representative of conditions in the river. The sampling device's position and depth were maintained using live-boating.

Each sample was developed by passing 240 liters of water continuously through the media over an 8-hour period. A nearby U.S. Geological Survey river gauge provided flow-rate data, allowing contaminant concentrations to be converted to loads.



Live-boating on West Virginia river maintaining pinpoint location while sampling at prescribed depths based on previous hydrological study.

Case Study: Central Coast Long-Term Environmental Assessment Network (CCLEAN); Monterey Bay Area Governments, California

Integral has monitored the sources, loads, and effects of contaminants discharged into the Monterey Bay Marine Sanctuary since 2001. The mission of the project is to safeguard the beneficial uses of Monterey Bay's waters as defined by California regulations. Data are generated through the monitoring of the Bay's rivers, water treatment facility effluents, and receiving ocean waters, as well as the collection of coastal filter feeders (*Mytilus californianus*).

The study uses several high-volume, long-duration sampler configurations, including ocean moorings, river samplers, and effluent-installed devices, in five water treatment facilities. Across the ocean, river, and treatment-facility systems, absorbent POP resin filters collect contaminants from 250+ liters of water drawn through each device, producing an integrated 30-day contaminant concentration for each sample.

The river and treatment facility samplers are programmed for flow-weighted collection, allowing calculation of contaminant loads entering the Bay. The program covers 30 days during the dry season and 30 days during the wet season in every year since 2001. That long record makes it possible to examine trends and identify changes in contaminant sources and transport over time.

As with any broad-scale study, multiple sampling programs help refine the conceptual site model. Water grab and composite sampling are also performed to analyze per- and polyfluoroalkyl substances (PFAS), nutrients, current-use pesticides, and bacteria. Mussel samples are collected for bacteria and organic pollutants. Together, these efforts have identified major POP contributors to Monterey Bay and informed targeted interventions and regulatory actions. Regional collaboration among the various cities and agencies is critical to this comprehensive, coordinated effort.

Overall, POP loading to the Bay was found to be greater from rivers than from treatment facilities, indicating the need for targeted sampling and management in these rivers. After some flood events, samplers have shown unique signatures of DDT and related compounds, suggesting that these pesticides may have been stored in sediment and soil and were then mobilized by heavy precipitation and floodwaters. DDT's effects on bird shell failure persists, and tracing environmental reservoirs of this banned chemical remains critical to recovery efforts.

These studies also offer insight into how more frequent flooding linked to climate change affects ecosystems and food webs. High-volume sampling data show that DDT concentrations in the Pajaro River have not declined over time, and nearshore ocean waters still regularly exceed water quality objectives. Although levels are approximately 5 percent lower than in 1985, chemical distributions remain similar over time, providing insight into sources and pathways.

CCLEAN has also shown that Monterey Bay ocean water has exceeded water quality objectives for polychlorinated biphenyls (PCBs) in at least one integrated 30-day sample every year since 2001.

This highlights a persistent water-quality issue in the Bay that would have been very difficult to elucidate using traditional sampling methods alone.

Case Study: Washington State Department of Ecology

Lastly, the Washington State Department of Ecology is tracing a significant POP issue in the state's surface waters and has been consulting with us to develop its own system for extensive in-house processing and a statewide monitoring program. Scaling this technology statewide allows for consistent, highly representative data collection with a reasonable level of effort and cost.

Once deployed, these devices can operate independently for a range of durations and sampling rates at multiple locations throughout a watershed. They can also reduce the need to send field staff into the field during storm events or other episodic flow conditions, when identifying contaminant presence, transport, and loads may be particularly important.

Closing

Protecting the health of our water resources requires an understanding of aquatic stressors that can affect biota at very low levels and persist well beyond the time and place they were released. High-volume, long-duration water sampling devices provide researchers a way to connect the dots between offshore contamination, watershed sources, and ongoing transport pathways. By integrating contaminant concentrations over larger volumes and longer periods, these technologies provide detection and quantification capabilities that can complement—and in some applications, significantly improve upon—traditional surface water grab sampling.

Authors

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Dr. Alex Loureiro is a marine biologist with a decade of experience specializing in marine mammal protection, offshore energy, and environmental regulatory strategy. Her work focuses on supporting clients navigating complex regulatory frameworks and assessing potential environmental impacts to support responsible project development. Prior to joining Integral Consulting, Dr. Loureiro served as Scientific Director at EnerGeo Alliance, where she led initiatives related to the interaction of offshore energy activities with marine life. She worked closely with industry, regulatory, and scientific stakeholders to develop best practices for environmental impact assessment, support compliance with U.S. regulations such as the Endangered Species Act and Marine Mammal Protection Act, and contribute to international policy discussions.

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GREG COTTEN, *Senior Scientist*

As a project manager, Mr. Cotten has more than 25 years of experience in the environmental field. He manages field efforts for dry- and wet-weather water quality, oceanographic research, and aquatic biological surveys, and he is responsible for data submittals and other reporting tasks. He designs and oversees protected species and marine mammal monitoring programs. Mr. Cotten also directs the development, fabrication, and maintenance of instrument assemblies and has participated heavily in sediment quality investigations. He also holds a current scientific collecting permit for the Monterey Bay National Marine Sanctuary.

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SEAN NOBLE, *Senior Scientist*

Mr. Sean Noble has more than 5 years of experience supporting multiple water quality, stormwater, and sediment coring projects. He has performed stormwater and dry-weather sampling in various environments, such as estuaries, streams, and channels, and within structural best management practices (BMPs), such as permeable pavement, bioretention areas, and media filters. He is also responsible for database management, the development of programming tools, statistical analyses, hardware troubleshooting and calibration, automated sampler development and programming, GIS work, environmental modeling, and document preparation.

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