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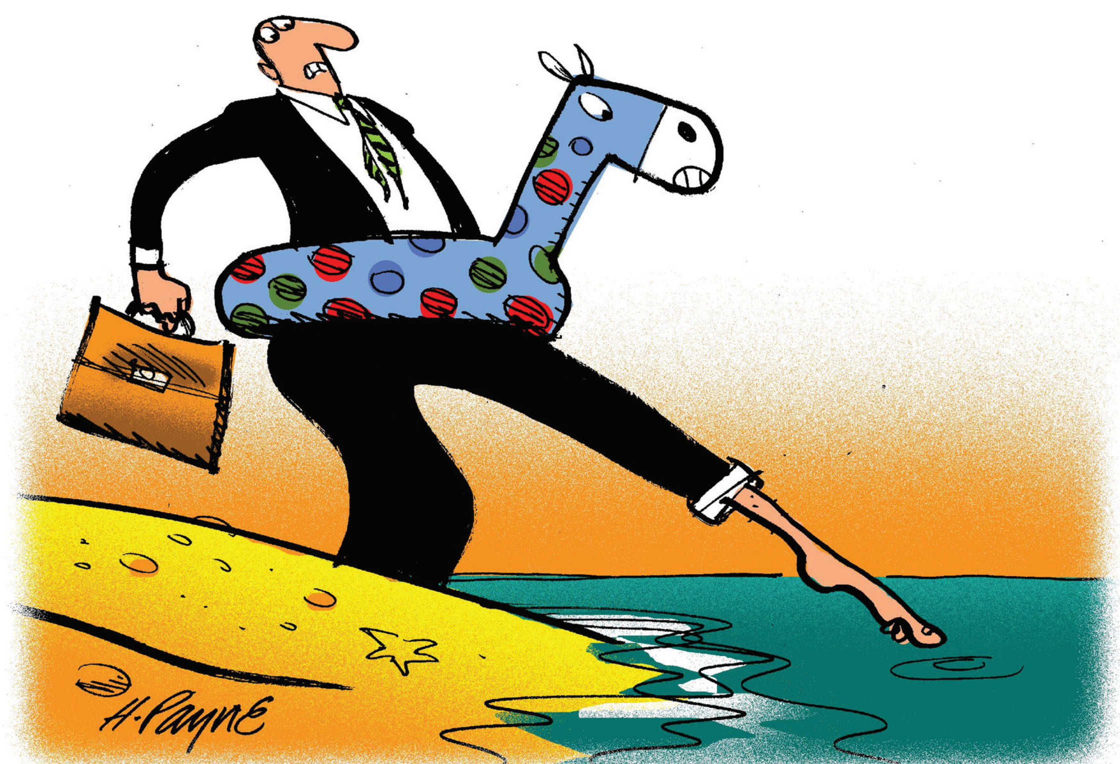

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The Limits of Water Quality Criteria

A rising tide of acidity is overwhelming the global ocean. Estuaries and near-shore waters fall under the jurisdiction of states and the federal government, mandating treatment under the Clean Water Act, but criteria for action are uncertain and unclear

Ryan Kelly is a Fellow at Stanford University's Center for Ocean Solutions. He holds a Ph.D. in Ecology, Evolution, and Environmental Biology from Columbia University and a J.D. from U.C. Berkeley's Boalt Hall. His work focuses on ocean acidification, environmental monitoring, and public resources management.

Meg Caldwell serves as the Executive Director for the Center for Ocean Solutions. She also directs the Environmental and Natural Resources Law & Policy Program at Stanford Law School, where her teaching focuses on the use of science in environmental and marine resource policy development and implementation.

Since the beginning of the industrial revolution, the global ocean has absorbed a third of the carbon dioxide emissions from fossil fuels, transforming it into carbonic acid. The acidity of the marine environment has increased by roughly a third since 1750, changing chemical processes vital to life, including shell and coral formation and the growth of bony structures in fish. This massive change in ocean chemistry is a growing water quality problem that focuses attention on the surprisingly difficult business of determining whether and how a particular water quality standard has been violated. Such attention brings with it a larger question of whether water quality criteria are legally sufficient under the CWA if they are difficult or impossible to test as a practical matter, and highlights the changing role of the act as it is used to combat a new class of water pollution.

State laws vary, but the federal Clean Water Act includes as "waters of the United States" territorial seas, out to three miles from shore, and a contiguous zone that spans from three to twelve miles off shore. The CWA protects water quality through technology-based standards for effluent and water quality standards for receiving waters. These water quality standards, in turn, consist of narrative descriptions of the designated uses of a state's waterbodies and numeric or narrative water quality criteria that set minimum thresholds necessary to protect the designated uses. The two sets of standards interact when technology-based standards are insufficient to maintain a baseline level of water quality in the receiving waters. A waterbody that violates applicable water quality standards joins the state's list of impaired waters, and agencies must work to clean it up.

This is the long and arduous process of assigning and implementing a Total Maximum Daily Load level for the offending pollutant in the waterbody — which can take many years and millions of dollars, as demonstrated by the recent multi-state Chesapeake Bay TMDL to limit nitrogen, phosphorous, and sediment inputs to the bay. A TMDL requires an agency to allocate the total acceptable pollutant load among point and nonpoint sources, and it then functions as a roadmap for a state to rehabilitate the impaired waterbody. Because sources of the CO_2 that drives acidification are widespread and disparate, it is difficult to apply technology-based standards; therefore, the water quality–based TMDL is a better match for the emerging challenge of ocean acidification.

The appeal of numeric water-quality criteria lies in their simplicity. Numeric criteria are neatly defined bright lines; when a waterbody violates a clear mathematical threshold for pollution, the TMDL process is supposed to follow automatically. At least in principle, this results in uniform minimum water quality nationally.

It is in the context of water quality criteria that ocean acidification has become a fascinating test case for the CWA. On the one hand, the statute clearly applies and is a central tool for this and other water quality issues in the estuarine and marine waters of the United States. But on the other hand, ocean acidification is a challenge of a different tempo and mode than those the 92nd Congress envisioned when revising the water pollution system in 1972. Ocean acidification is slower, more subtle, and more diffuse, but just as detrimental to the goal of healthy, fishable waters the act demands.

In absorbing a third of anthropogenic CO_2 emissions, the oceans are a critical buffer against more rapid climate change, but in the bargain this process creates a water quality problem on a truly enormous scale — and the problem is getting worse at an accelerating pace. Ocean acidification is therefore a large-scale water quality issue with important ecological and economic implications. The fact that an air pollutant is the root cause of the problem (and thus that sources are manifold and global) does not diminish the utility of the CWA for mitigating the harm to marine waters: because pH (the measure of acidity) is a pollutant under the CWA, a key tool for mitigating the change is the nation's foundational water quality statute. The national recommended water quality criterion for pH in marine waters sets the acceptable threshold at 0.2 pH units outside the naturally occurring range of variation, with outer limits of 6.5 at the low (more acidic) end to 8.5 or 9 on the high (alkaline) end. Each state has its own criteria that generally match the federal recommendations closely (although importantly some states, such as Hawaii, do not tie the marine pH criterion to a "natural" range). A waterbody is impaired for pH if it exceeds the applicable state or federal threshold.

The federal CWA and its state implementations in effect presume that waterbodies meet the relevant standards. To trigger the mandatory TMDL process, then, a state must find that one or more of its waterbodies violates an applicable water quality standard based upon reasonable evidence. Failure to do so, given the appropriate evidence, would be the failure to perform a nondiscretionary duty, which may give rise to a citizen suit against the federal Environmental Protection Agency for approval of the state's list of impaired waters. As global ocean pH has continued to drop, the marine water quality criteria have become a logical focal point for applying the CWA to help ameliorate the problem. Numeric criteria seem to be the most easily tested standards, clear targets because of the bright lines they represent.

In an attempt to force action to address the increasingly apparent problem of ocean acidification, the nonprofit Center for Biological Diversity sued EPA for certifying Washington State's 2008 list of impaired state waters. The complaint alleged that, because Washington had failed to list coastal ocean waters as impaired for pH (i.e., the waters were more acidic than was permissible, as a consequence of human-generated pollution), EPA had violated the CWA by approving the state's list. More specifically, the claim was that EPA's approval was arbitrary and capricious in light of evidence about increasing ocean acidity worldwide. The parties settled, with EPA ultimately determining that states should list waters impaired by ocean acidification, but simultaneously noting the lack of data supporting such listings for most states. Further evidence of acidifying marine waters — this time more specific to Washington's geographic area — failed to convince the state's Department of Ecology that a listing was merited. In a separate but related filing in 2010, EPA declined to change the federal water quality criterion for marine pH, citing insufficient data to support such a change, especially in light of the large natural pH fluctuations known from some coastal environments. No state has yet listed its marine waters as impaired for pH.

The heart of this dispute — and the future disputes that will inevitably arise as agencies struggle to apply the CWA to a rising tide of acidity — may not be whether the available data demonstrate impairment for pH in Washington or elsewhere. Rather, the issue may be a mismatch between the water quality criteria and what's knowable. New data are generally unlikely to demonstrate that any state's waters violate the pH standard because of the way the water quality criterion itself is structured.

There are at least two reasons for this mismatch, one technical, one historical. Showing that a waterbody is more than 0.2 pH units outside of its "natural" range requires being able both to document the present-day pH with specificity (a technical hurdle), and to put that measurement in the context of its historical variation (the more significant hurdle).

The technical side poses a moderate challenge for a party wishing to monitor for water quality violations. Water samples brought from the field into the lab can be tested with good accuracy and precision

The technical side poses a moderate challenge for a party wishing to monitor for water quality violations. Although pH meters are notoriously difficult to keep properly calibrated, water samples brought from the field into the lab can be tested with good accuracy and precision (to within less than a thousandth of a pH unit, for example) by a highly competent technician. However, a sampling protocol that requires bringing samples into the lab is labor-intensive and requires the relevant state or federal agency to be specifically testing marine pH on a regular basis in order to detect a violation of short or moderate duration. Moreover, competent technicians are in relatively short supply. Automated sensing equipment — pH monitoring on buoys and piers, such as exists at a handful of U.S. coastal sites — provides a more continuous stream of data that avoids the need for lab-based testing and can identify short-term departures from suitable chemical conditions. Thus if these field-based sensors were sufficiently sensitive and reliable, interested parties could simply monitor the publicly available data stream they generate, watching to ensure the water quality stayed within acceptable limits. State agencies would do the same, gathering data to support including or excluding waterbodies from their list of impaired waters.

However, most commercially available field-based pH sensors are far less sensitive than lab-based pH measurements. The common field-based sensors measure pH to within one or two tenths of a unit, such that it is difficult to establish with high confidence whether a given sample has violated the water quality criterion (i.e., beyond two tenths of a unit outside its historical range). Because the relevant standard of review is the arbitrary-and-capricious standard under the Administrative Procedure Act, higher-confidence measurements are not legally necessary to demonstrate impairment, but because the consequences of impaired water quality can be significant, developing more precise autonomous sampling is desirable as a practical matter.

The historical side of the hurdle for violating the water quality criterion is more problematic. Giving meaning to the numeric water quality criterion for marine pH often requires defining the "natural" range of pH for a specific waterbody, which in turn requires having waterbody-specific historical data of some reliable kind, a reliable reference site, or else modeling with a degree of validation that meets the relevant evidentiary standards. Of these, having site-specific historical data is the most desirable because it speaks most directly to the issue of whether the focal waterbody shows departures from its past range. Moreover, because the present day pH range for a particular waterbody can swing wildly over the course of hours, days, and weeks, long-term datasets are essential for parsing these shorter-term fluctuations from long-term trends. But historical pH data do not generally exist for a variety of reasons. As noted, pH-sensing instruments require frequent calibration, automated sensors are not as accurate as would be most useful for ocean acidification, and furthermore, marine pH is a parameter of relatively recent interest.

Reference sites — comparable waterbodies for which adequate data exist — are difficult to identify because of the considerable spatial and temporal variability of nearshore pH. But one way around the paucity of historical and present day pH data is to define the "natural" range of pH for a waterbody based on modeled chemical dynamics (where state standards allow the use of such models for water quality assessment). State agencies could develop or adapt models for marine pH, creating practically testable water quality criteria that account for natural background variation and simultaneously uncovering important relationships between pH change and its ecosystem effects.

Technical and modeling advances have made both the technical and historical hurdles more surmountable now than in the past: the precision of autonomous pH meters is improving and some historical data exist that can validate models. It is worth noting that such progress underscores how difficult demonstrating a water quality violation for marine pH would have been at the time the EPA first developed the national guidelines in the 1976 Red Book. These criteria seem better suited to guarding against discrete and severe acidic discharges of mine tailings, pulp mill effluent, and the like. That is, the standard was made with relatively easy questions in mind — discerning which streams were made highly acidic by discharges — rather than the subtler, more insidious challenge of global ocean acidification through absorption of a water pollutant.

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Supposing a party could show that a water body had violated a water quality standard for marine pH due to ocean acidification, what then? A waterbody-specific TMDL would not solve the root cause of the problem — global CO_2 emissions — but it would help within the waterbody in several smaller ways. First, it would require the relevant state agency to develop a "budget" for pH change, allocating the causal inputs among point and nonpoint sources to keep pH within the acceptable range. This work would be a significant step forward in itself, given the lack of relevant data in nearly all coastal jurisdictions. Second, the TMDL would prevent new local point sources from increasing coastal vulnerability to the global oceanic chemical change; jurisdictions may not issue discharge permits that would cause or contribute to the impairment of a waterbody. And finally, a TMDL would focus research and attention on a serious problem that, until very recently, has gotten little notice in policy circles. These are tangible, if modest, environmental benefits that result from creating a TMDL.

The practical difficulty of demonstrating a violation of the marine pH standard raises the more fundamental question of whether a standard that can't be tested or violated is legally sufficient. The purpose of the CWA — "to restore and maintain the chemical, physical, and biological integrity of the nation's waters" —suggests that a party should not have to sidestep the existing water quality criteria to address an acknowledged and looming water quality problem. If revising the criterion for marine pH is not merited given the existing data — as EPA found in 2010 — but the current standard is nearly impossible to test (and hence to violate), the criterion may be vulnerable to facial challenge.

Under the Administrative Procedure Act, courts will strike down agency rules where those regulations are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." Despite reviewing courts' deference to agency expertise in setting appropriate guidelines for water quality, a rule is invalid, according to *Motor Vehicle Manufacturers Ass'n v. State Farm,* where the agency "has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise."

There is no evidence of bad faith or deception here; in the Red Book, EPA's risk manual, the agency offers reasonable justification for its decisions surrounding the difficult task of setting water quality criteria for pH. But in practice, it is not clear that the existing standards are equal to the challenge that ocean acidification presents. An untestable, inviolable water quality criterion — again, due to the lack of precise, real-time data and sufficient historical or modeled information — would seem to fall squarely within several of the above categories of arbitrary-and-capricious agency actions. In order to function to further the CWA's statutory purpose (or indeed, to function in any capacity), water criteria must be testable; a bright line that can't ever be crossed is no bright line at all. Benjamin Cardozo put it differently, but his point was the same: "Law as a guide to conduct is reduced to the level of mere futility if it is unknown and unknowable." To the extent that existing water quality criteria are untestable as a practical matter, they therefore may be vulnerable to legal challenge. In reality, however, a court would be likely to invalidate the current marine pH criterion only if there were a better way to protect the designated uses of the nation's waters.

Given that the United States appears already to be experiencing some adverse economic, cultural, and ecological effects of ocean acidification (particularly in the Pacific Northwest), it seems apparent that this is an environmental challenge EPA cannot ignore. The Clean Water Act and its attendant water quality standards clearly apply here — ocean acidification is a water quality problem and pH is a pollutant under the act — but the numeric water quality criterion for marine pH is difficult to apply in practice. Consequently, it makes sense to ask whether alternative forms of water quality standards might better defend existing designated uses.

One such alternative would be a criterion based on the ecosystem effects of ocean acidification, rather than the chemical change itself. EPA recommends effects-based criteria in the case of nutrient loadings; rather than applying a single numeric water quality criterion to a system with naturally dynamic background nutrient levels, states can set impairment thresholds based on the ecological response of a particular waterbody to nutrient pollution. When a pre-determined, quantitative ecological threshold is crossed, the waterbody is classified as impaired, and the listing process ensues. This more holistic, ecosystem-level focus is a move away from the single-stressor metrics of impairment that are the traditional focus of the CWA.

Marine pH is a regulatory challenge that is highly analogous to that of nutrient pollution, given the large spatial and temporal fluctuations in water chemistry that occur naturally. And because of the practical difficulty of testing the present water quality criterion for marine pH, establishing a more easily trackable, ecosystem-based criterion is an attractive idea. But the lack of data required to link changes in ecosystem state to fluctuations in pH makes it impossible to create effects-based standards for marine pH at present. Perhaps as we accrue information about easily-detected shifts in species assemblages — for example, in marine bacterial communities, sampled with genetic methods — that respond to changes in underlying water chemistry, such biological criteria will become more tenable.

A more immediate (though modest) improvement to CWA implementation would be to monitor a metric relevant to both the chemistry and biology of ocean acidification. A parameter called omega — a measure of the propensity of shells to dissolve in a sample of seawater — has some of the hallmarks of a useful regulatory tool. Techniques for modeling omega are now being developed, and although the models' data needs are still substantial, discrete real-time measurements are amenable to evaluation against a background map that estimates spatial and temporal variability. Moreover, unlike pH, omega speaks directly to one of the more alarming biological effects of ocean acidification: shell dissolution that threatens key designated uses such as shellfish harvesting and marine habitat. Although EPA does not provide guidelines for monitoring omega as it does for marine pH, states are free to develop their own criteria for assessing the effects of marine pollution, and could choose to measure omega as a means of better safeguarding these and other designated uses.

It remains to be seen how EPA and the states will effectively handle the new kind of regulatory challenge that ocean acidification represents, and whether developing new water quality criteria might be desirable. Ensuring we have a scientifically testable standard would be a good start. •

What About Using the Clean Air Act?

Kelly and Caldwell highlight significant limitations in using the Clean Water Act to address ocean acidification. While ocean acidification poses a significant threat to marine ecosystems, the structure of the CWA and current limitations on data availability make the development and application of water quality criteria and Total Maximum Daily Load thresholds a near-impossible exercise.

This stands in stark contrast to EPA's approach to regulating greenhouse gases under the Clean Air Act, where the agency side-stepped similar problems by declining to set National Ambient Air Quality Standards for carbon dioxide. This approach is particularly interesting in light of the fact that EPA issued its endangerment finding — concluding that GHGs may pose a threat to public health and welfare — and a series of rules implementing Prevention of Significant Deterioration permitting for GHGs just months before declining to revise marine pH criteria. Given that atmospheric deposition of GHGs — particularly CO_2 — is a significant cause of ocean acidification, the CAA may provide an additional tool to protect the marine environment from the impacts of acidification.

Margaret Peloso

EPA's GHG endangerment finding under the CAA acknowledges the potential impacts of ocean acidification, finding that "climate change and ocean acidification will likely impair a wide range of planktonic and other marine calcifiers such as corals." Further, EPA's technical support document stated that "ocean acidification is a direct consequence of fossil fuel CO_2 emissions, which are also the main driver of anticipated climate change." EPA used these findings as one of its justifications to conclude that GHG emissions have the potential to endanger the public health and welfare under the CAA. EPA then issued a "cause or contribute" finding determining that GHG emissions from automobiles contributed to this endangerment. In turn, EPA determined that regulation of GHGs emissions from vehicles also required it to regulate large stationary sources of GHG emissions under the Clean Air Act.

However, in finding endangerment and regulating GHGs under the CAA, EPA declined to set NAAQS. EPA concluded that it was inappropriate to set NAAQS that may be unattainable even with stringent domestic pollution controls because of GHG emissions in other countries.

NAAQS are the CAA's equivalent of water quality criteria: they are ambient air quality criteria necessary to protect the public health and welfare. As with water quality criteria, they are numeric thresholds derived from available data that are intended to achieve a policy goal with respect to public health and environmental quality. As Kelly and Caldwell point out, the CWA does not provide a way to address ocean acidification unless meaningful water quality criteria and TMDLs can be established. In contrast, the D.C. Circuit's recent decision upholding EPA's GHG regulations under the CAA concludes that the setting of equivalent numeric thresholds for air pollutants is not a necessary precursor to regulation.

Given EPA's broader authority under the CAA, it is worth evaluating whether the CAA provides an additional route to address ocean acidification. A recent example demonstrates that this approach also presents significant difficulties. Earlier this year, EPA finalized its decision to retain the current one-hour secondary NAAQS for nitrogen oxides and sulfur dioxide, which aim to protect against the environmental impacts of NOx and SO_2 emissions, including aquatic acidification.

In considering revisions to the standards, EPA recognized the evidence of the impacts of acid deposition in lakes and streams and attempted to develop a quantitative measure for NOx and SO_2 based on an Aquatic Acidification Index. However, EPA concluded that "there is no reasoned way to choose a specific AAI-based standard" to set the NAAQS and decided not to revise the standards.

The one-hour secondary standards for NOx and SO_2 thus demonstrate the challenge of building up from ecosystem impacts of acidification to numeric air quality standards designed to protect aquatic ecosystems. Adopting a similar approach with GHGs would further require that EPA set NAAQS for GHGs, raising the same problem in deriving specific numerical standards that Kelly and Caldwell note under the TMDL approach.

Therefore, a Clean Air Act approach to addressing ocean acidification is likely to be similarly limited. If ocean acidification is to be addressed through environmental law in the future, it will be as a result of the generation of additional data that serve as the basis of new numeric standards or revisions to environmental laws that grant the administrator broader authority to issue regulations based on ecosystem quality. Thus, in the near term it appears that the most important approach to ocean acidification will be to limit other acidifying inputs to marine ecosystems.

Margaret Peloso is an attorney in Vinson & Elkins's environmental and climate change practice. She is currently a co-chair of the ABA Section of Environment, Energy, and Resources committee on Climate Change, Sustainable Development, and Ecosystems.