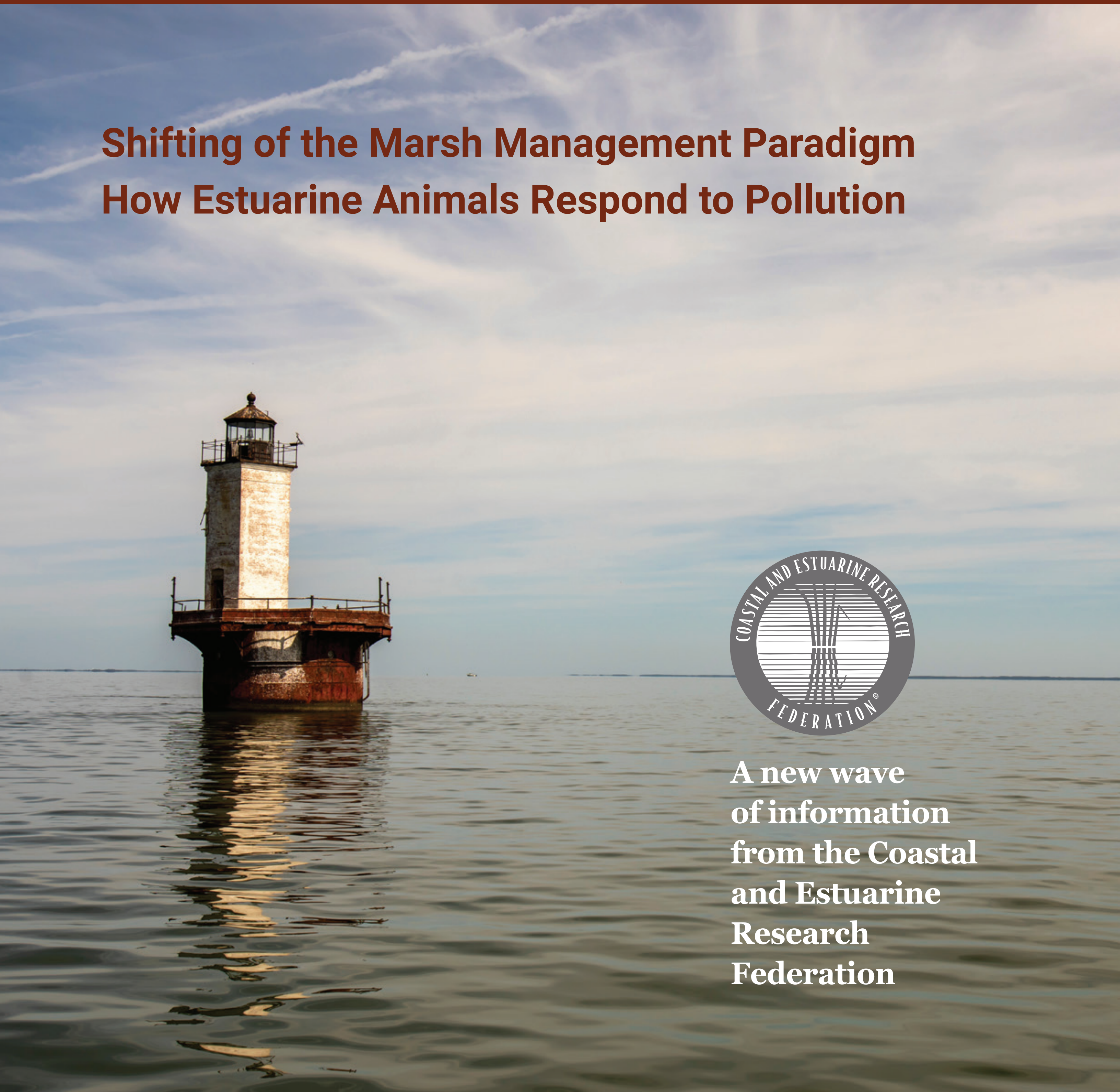
CERF's Up!

Volume 49 • Number 1 • March 2023



Shifting of the Marsh Management Paradigm

How Estuarine Animals Respond to Pollution

Coastal and Estuarine Research Federation®

A new wave of information from the Coastal and Estuarine Research Federation

CERF's Up!

Volume 49 • Number 1 • March 2023

Table of Contents

Front Cover: *Solomons Lump LIghthouse reflecting in Chesapeake Bay* Photo: Karen Foley Photography

Back Cover: *Flamingos in Ebro Delta Nature Park, Tarragona, Catalunya, Spain* Photo: GG-Foto

Call for Cover Photos for *CERF's Up!*

Would you like to see your favorite estuary displayed on the cover of *CERF's Up!*? If so, send high-resolution shots showing the place's natural beauty, along with a short caption and photo credit, to bulletin@cerf.science.

The Shifting of the Marsh Management Paradigm

Cathleen Wigand
Atlantic Coastal Environmental Sciences Division, Center for Environmental Measurement and Modeling, Office of Research and Development, US Environmental Protection Agency, Narragansett, Rhode Island, USA
wigand.cathleen@epa.gov

In recent decades we have seen a shift in the approach to assessing and restoring coastal marshes. Global climate change stressors (CCS), such as an increase in the frequency and intensity of storms, accelerated sea level rise (ASLR), and a general increase in extreme events (e.g., droughts, flooding) have caused vegetation die-offs and degradation of vulnerable coastal marshes. No longer do natural resource managers only evaluate salt marsh condition and integrity, but now monitor and assess vulnerability to CCS and overall coastal resiliency. Implementation plans for restoration also include climate adaptation considerations, which might include redesigning or modifying marshes to increase resiliency to CCS.

Forecasting coastal marsh responses to CCS is complex and requires systems modelling and simulations that consider not only ecological responses, but also social ones. Social and ecological scientists now provide input to improve these modelling efforts. Coastal marshes provide aesthetic and cultural value and other ecosystem services that are essential to many communities. Coastal marshes provide flood abatement, water quality maintenance, fish and wildlife habitat, carbon sequestration, among other benefits.[1] A collaborative, socio-ecological, adaptive management approach allows for setting social goals as well as ecological ones, and the iterative monitoring and assessment aspect of the approach allows evaluation of reaching or falling short of social and ecological targets.[2] Lessons learned through a socio-ecological systems approach can inform future climate adaptation actions. Many coastal marshes are unable to accrete enough sediment and organic matter to keep up with sea level rise and as a result are drowning.[3] After determining that a coastal marsh is vulnerable to ASLR and degrading, some possible adaptation actions a conservationist might take to improve resiliency are to facilitate landward migration, increase marsh platform elevation, and/or increase surface drainage.[4]

In a recent (2017, 2018) Rhode Island statewide survey, expansive coastal marshes in the less urbanized southern parts of Narragansett Bay were assessed to be vulnerable to ASLR and drowning.[5] In monitoring efforts just over a decade earlier (2004, 2005), some of these same southern marshes were reported as least impacted and of highest integrity (i.e., most healthy) because of less surrounding development and low wastewater loading, while fringe marshes in the more urbanized northern part of the estuary were reported as of lower integrity.[6] These southern marshes are low-lying and more vulnerable to ASLR, while the northern marshes are situated at a higher elevation, providing resilience to the rising seas. Just over a decade later, the coastal marshes in southern Rhode Island were assessed to be vulnerable, perhaps even more vulnerable than some of their urbanized counterpart marshes in the northern parts of Narragansett Bay. Conservationists can use these marsh assessments to help guide climate adaptation and restoration actions.

Two climate adaptation actions used to build marsh resiliency in drowning Narragansett Bay salt marshes were (1) sediment placement of dredged, clean, sandy sediments on the surface of the marsh to increase marsh platform elevation,[7] and (2) digging runnels or shallow ditches to increase surface drainage.[8] These climate adaptation actions were carried out collaboratively by environmental non-governmental organizations and local, state, and federal government partners. Both ecological and social goals were considered.[2,7,8] At the Ninigret Pond marsh 10–48 cm of dredged sediments was added to the marsh surface to build elevation capital, providing an estimated 67–320 years of ambient elevation gain, increasing its resilience to ASLR (Fig. 1).[7] In meeting social goals,

Fig. 1. (A) The southeast area of Ninigret marsh in year 2014 showing interior ponding attributed to accelerated sea level rise

(B) The southeast area of the marsh in 2020, approximately 4 years after dredged sediment application showing plant colonization of restored areas of the marsh

Photos: Wenley Ferguson

Fig. 2. (A) Interior ponding attributed to accelerated sea level rise and legacy human impacts including agricultural activities and mosquito control at Pettaquamscutt marsh in 2015

(B) Runnel construction in 2015 and 2016 to restore hydrology

(C and D) Restored marsh areas in 2019

Photos: Wenley Ferguson

the dredging of the nearby channel allowed improved boating access and water circulation and in meeting an ecological goal, this provided the sediment to place on the drowning marsh.[2,7] In the second example, use of runnels at the Pettaquamscutt Cove marsh mitigated drowning and re-established marsh vegetation, which in turn will provide the ecosystem services and benefits of a healthy marsh (Fig. 2).[8] Climate adaptation actions often engineer, modify, or re-design vulnerable and deteriorating marshes to improve resiliency to CCS.

In the present era characterized by human dominance of biological, chemical, and geological processes on Earth (i.e., the Anthropocene Epoch),[9] we find ourselves in a shifting marsh management paradigm. As reported for the conservation of mangroves, many unpredictable and novel conditions of the Anthropocene era affect systems and are poorly understood, and furthermore, effective conservation practices will require the inclusion and involvement of local communities.[10] In earlier decades (1970s–2000s), the coastal marsh management paradigm entailed assessing marsh condition and integrity and implementing restoration actions to return marshes to an earlier reference state. In the present paradigm, marsh management entails assessing condition and vulnerability and implementing climate adaptation actions to build marsh resiliency to CCS. Creating partnerships among local, state, and federal entities to meet the challenges caused by the effects of CCS on marshes and coastal communities will facilitate development and implementation of adaptation actions that better address short- and long-term cultural, social, ecological, and conservation goals.

Acknowledgements

The views expressed in this article are those of the author and do not necessarily represent the views or policies of the US Environmental Protection Agency.

References

1. Barbier, E.B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C., and Silliman, B.R. 2011. The value of estuarine and coastal ecosystem services. *Ecological Monographs* 81 (2):169–193. https://doi.org/10.1890/10-1510.1

2. Mulvaney, K.K., Ayvazian, S., Chaffee, C., Wigand, C., Canfield, K., and Schoell, M. 2022. Open SESAME: a social-ecological systems framework for collaborative adaptive management and engagement in coastal restoration and climate adaptation. *Wetlands Ecology and Management* 52. https://doi.org/10.1007/s11273-022-09891-3

3. Raposa, K.B., Weber, R.L.J., Ekberg, M. C., and Ferguson, W. 2017. Vegetation dynamics in Rhode Island salt marshes during a period of accelerating sea level rise and extreme sea level events. *Estuaries and Coasts* 40:640–650. https://doi.org/10.1007/s12237-015-0018-4

4. Wigand, C., Ardito, T., Chaffee, C., Ferguson, W., Paton, S., Raposa, K.B., Vandemoer, C., Watson, E.B. 2017. A climate change adaptation strategy for management of coastal marsh systems. *Estuaries and Coasts* 40:682-693. https://doi.org/10.1007/s12237-015-0003-y

5. Kutcher, T.E., Raposa, K.B., and Roman, C.T. 2022. A rapid method to assess salt marsh condition and guide management decisions. *Ecological Indicators* 138:108841. https://doi.org/10.1016/j.ecolind.2022.108841

6. Wigand, C., Carlisle, B., Smith, J., Carullo, M., Fillis, D., Charpentier, McKinney, R., Johnson, R., and Heltshe, J. 2011. Development and validation of rapid assessment indices of condition for coastal tidal wetlands in southern New England, USA. *Environmental Monitoring and Assessment* 182:31–46. https://doi.org/10.1007/s10661-010-1856-y

7. Raposa, K.B., Bradley, M., Chaffee, C., Ernst, N., Ferguson, W., Kutcher, T.E., McKinney, R.A., Miller, K.M., Rasmussen, S., Tymkiw, E., and Wigand, C. 2022. Laying it on thick: Ecosystem effects of sediment placement on a microtidal Rhode Island salt marsh. *Frontiers in Environmental Science*. https://doi.org/10.3389/fenvs.2022.939870

8. Watson, E.B., Ferguson, W., Champlin, L.K., White, J., Ernst, N., Sylla, H., Wilburn, B. and Wigand. C. 2022. Runnels mitigate marsh drowning in microtidal salt marshes. *Frontiers in Environmental Science (Conservation and Restoration Ecology section)*. https://doi.org/10.3389/fenvs.2022.987246

9. Crutzen, P.J. 2002. Geology of mankind. *Nature* 415:23. https://doi.org/10.1038/415023a

10. Lugo, A.E., Medina, E., and McGinley, K. 2014. Issues and challenges of mangrove conservation in the Anthropocene. *Madera y Bosques* 20:11–38. https://doi.org/10.21829/myb.2014.200146

Call for CERF 2025 Conference Co-Chairs

CERF is seeking volunteers to co-chair the 28th Biennial CERF Conference to be held 9-13 November 2025 in Richmond, Virginia. The volunteer co-chairs oversee all aspects of conference planning with support from CERF staff. This is a creative activity which provides opportunity to identify a theme; recruit and appoint volunteers for the scientific program, attendee experience, and inclusive culture committees; and provide guidance and direction for the conference. The role requires strong organizational skills, a wide coastal and estuarine science and management network, lots of teamwork, and a commitment to creating a welcoming and inclusive conference experience. The reward is putting your unique stamp on this marquee event, as well as developing relationships and having fun with a great group of dedicated professionals. CERF 2025 planning will kick off in late summer of 2023. Reaching out to co-chairs of past CERF conferences (https://www.cerf.science/past-cerf-conferences) is a great way to learn more about this rewarding experience. If you wish to be considered, please submit a letter of interest to CERF Executive Director Susan Park (spark@cerf.science) by 5 May 2023.

EPA and Army Release New "Waters of the United States" Rule

The US Environmental Protection Agency (EPA) and Army Corps of Engineers released a final rule defining the "waters of the United States" (WOTUS) in December 2022. WOTUS defines what waters fall under the protection of many programs under the Clean Water Act (CWA). The EPA notes that this revised rule, "returns to a reasonable and familiar framework founded on the pre-2015 definition with updates to reflect existing Supreme Court decisions, the latest science, and the agencies' technical expertise."

In 2015, the Obama administration released a revised rule that would have greatly expanded the definition of WOTUS based on the "Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence" report, which reviewed more than 1,200 peer-reviewed publications. This rule was never implemented because of legal challenges. The Trump administration repealed the 2015 rule and replaced it with the new "Navigable Waters Protection Rule" (NWPR) that was not based on science and would have eliminated federal protection for many critical aquatic systems, particularly headwater streams and wetlands. Similarly, this rule was blocked by a federal judge and never implemented. Effectively, CWA protections have continued to follow the pre-2015 WOTUS definition, and this new rule largely maintains this. There are some changes, including clarifying which wetlands and headwater streams fall under federal protection based on their connectivity with adjacent larger waterways, either with a "relatively permanent" surface connect, or by having a "significant" ecological or hydrological "nexus." This test has been at the center of much of the legal action around WOTUS. The current US Supreme Court case *Michael Sackett v. United States Environmental Protection Agency* is an example of the challenge to this definition.

CERF, in partnership with other environmental science societies, has submitted comments and made public statements on WOTUS and NWPR, which can be found on the Consortium of Aquatic Science Societies WOTUS website.[1] In addition, a group of 12 societies including CERF, submitted an amicus curiae brief[2] to the Supreme Court in response to the *Sackett v. EPA* case. Oral arguments on the case were heard in October 2022, and a decision is expected later this year. It is unclear at this time how the Court's decision will affect the revised rule, or vice versa.

1. https://aquaticsocieties.org/waters-of-the-united-states/ 2. https://bit.ly/WOTUSbrief

A Semipalmated Plover (*Charadrius semipalmatus*) wades and forages in a panne within the salt marshes near Rough Meadows Wildlife Sanctuary in Rowley, Massachusetts, USA

Photo: Karen Aerni

The Piles Creek Story: What a Creek Taught Us about How Estuarine Animals Respond to Pollution

Judith S. Weis
Department of Biological Sciences, Rutgers University, Newark, New Jersey, USA
jweis@newark.rutgers.edu

A polluted creek was the source of research over decades, providing projects for many students and leading to advances in understanding how pollution affects estuarine animals.

Tolerance to pollution

Killifish. 1970s. Earth Day had happened; there was a federal agency to protect the environment. Stimulated by reports of terrible effects of mercury pollution in Japan, we were interested in effects it might have on fish embryos. We decided

*Fig.1 Killifish or mummichog (*Fundulus heteroclitus*)* Photo: Peddrick Weis

to look at effects of methylmercury—an especially toxic form—on development of killifish (*Fundulus heteroclitus*) (Fig. 1) embryos. These small fish live in tidal creeks of salt marshes. Our initial experiments were done in Montauk, New York (Long Island). We pooled eggs stripped from females and fertilized them with sperm from males and divided the fertilized eggs into groups to be treated with different concentrations of methylmercury (meHg) during development. Before they were ready to hatch, we examined them and saw a large variation in responses of embryos that had been in the same concentration. Those exposed to higher doses were, naturally, more

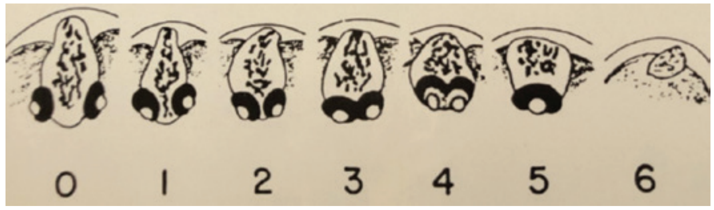


Fig. 2 Malformed killifish embryos from MeHg exposure. 0 = normal head, 1–5 = increasing severity - fusion of the eyes, 6 = no head, no eyes Diagram by Catherine Bush

affected than those in lower concentrations. Embryos showed a variety of deformities including abnormal head and eye development: mildly affected ones had their eyes slightly converging, more affected ones had the two eyes touching in the front of the head, and more severely affected ones were cyclopic (Fig. 2). There were also problems in heart and skeletal development, which varied from mildly affected to severely messed up. Seeing such a huge variation was puzzling. Why were there such differences in response to the same concentration? The results were incomprehensible, but rather than give up, we decided to try to figure out why. The next time, we separated eggs from different females to see if different females might produce eggs with different susceptibility. Bingo! The huge variation was because each female consistently produced eggs with specific susceptibility. The male didn't matter.

Wondering how fish from a mercury-polluted environment might respond, we went to the polluted Newark Bay, New Jersey, area where there had been abundant heavy industry for a century, long before any laws prevented them from dumping wastes in the marsh; sediments were highly contaminated with mercury and other pollutants. We chose as a study site Piles Creek (PC), which enters the Arthur Kill; a bridge allowed us to hang traps without having to wade in the contaminated muck. A variety of industrial sites surrounded it (Fig. 3); mercury levels were high. When we repeated the same exposures, practically all females produced embryos with

Fig. 3 Sign at Piles Creek in the early 1980s Photo: Peddrick Weis

only slightly abnormal development, indicating tolerance to meHg. This was the first study showing evolution of pollution tolerance in estuarine fish. Evolution could have happened quickly since presumably there were already females that produced tolerant embryos.

We thought adults from PC would be "superfish" but we were wrong. While sperm and eggs also showed mercury tolerance, juveniles and adults did not; rather, they seemed stressed. For example, their fin regeneration was much slower than that of Long Island (LI) fish. Both populations regenerated fins more slowly in meHg, but PC fish in clean water were even slower than LI fish in meHg! PC fish also did not live as long or grow as well as those from the clean environment.

*Fig. 4 Grass shrimp (*Palaemonetes pugio*)*
Photo: NOAA

*Fig. 5 Fiddler crab (*Uca pugnax*)*
Photo: Claus Holzapfel

Grass shrimp and fiddler crabs. We investigated grass shrimp (*Palaemonetes pugio*) (Fig. 4) and fiddler crab (*Uca pugnax*) (Fig. 5) adults from PC and LI for effects of meHg on limb regeneration and molting. In all cases, meHg slowed regeneration and delayed molting, but PC individuals were more tolerant—their regeneration and molting in meHg was not slowed down nearly as much as animals from LI. We found an interesting adaptation in fiddler crabs, especially from PC—they moved much of the mercury and lead from internal organs into their exoskeleton shortly before molting it, an efficient way to eliminate contaminants quickly.

Altered Behavior and Ecology

Killifish. Why was tolerance of PC killifish seen only in early stages, and why did adults not grow as well or live as long? Through an accidental observation by a graduate student that PC fish didn't catch shrimp well, we could explain their shorter life span and poor growth: abnormal behavior. In lab experiments, unfed fish were put in tanks with grass shrimp (and a rock for hiding). PC killifish captured far fewer shrimp than the "clean" fish (by now, Tuckerton, New Jersey [TK] was our clean site). Fish from both places had their stomach contents analyzed. PC stomachs contained mostly detritus (decaying plant material) known to be non-nutritious for them. TK stomachs contained various foods, including grass shrimp, small crustaceans, worms, and detritus. Poor prey capture and eating of non-nutritious detritus ("junk food") could explain PC killies' poor growth and survival. When TK fish were kept in aquaria with PC sediments and water for two months, their prey-capture ability declined to that of native PC fish and their brain-mercury levels increased to that of PC fish. When PC killies were kept in clean water and sediments for two months, they showed a slight improvement in prey capture and their brain mercury declined slightly. After more time in clean water, they might eliminate enough contaminants to improve their prey-capture ability. These "switch" experiments show that environment causes the behavioral problems of PC fish.

PC fish were also more vulnerable to predation. We examined how many were captured by blue crabs in the lab. Over two weeks, crabs (from a seafood store) in an aquarium with PC fish captured far more than crabs with TK fish. The greater likelihood of PC fish to be eaten could account for their shorter life span. Impaired prey capture and predator avoidance can both result from being generally "slow," which we confirmed by studying overall activity levels.

Grass shrimp. PC shrimp were ***not*** more likely to be captured by killifish than TK shrimp. Surprisingly, they were, overall, larger and more numerous than TK shrimp, while PC killifish had lower population density than at TK. We checked whether PC sediments and water might accelerate growth of young shrimp, but (as expected) they didn't. The larger size of the shrimp can be due to reduced predation. Since their main predator, killifish, are ineffective and less abundant, PC shrimp experience reduced predation, so more of them lived longer, resulting in larger size and greater population density. These "top down" effects appear to outweigh negative effects of contaminants.

Fiddler crabs. Fiddler crabs don't "capture prey" since they process sediment to eat. In the field and in lab tanks with mud on the bottom, more TK crabs tended to be active on the surface, and more PC crabs were below in burrows. PC has elevated nutrients from sewage plants, which stimulate growth of single-celled algae on the sediment surface, making the sediments more nutritious. More nutritious sediments means that crabs don't need to spend as much time feeding and can stay in their burrows, while TK crabs spend more time feeding on the surface. PC fiddlers suffer major problems from contamination mostly during early life stages. Females produce more eggs than TK crabs (see below), but larvae, released into the water to go downstream, have much higher mortality and fewer juveniles return to settle. With fewer juveniles at PC there is less density, and with more nutritious sediments and less time above ground, they grow well and become larger and more fecund than TK crabs, which have greater population density and more predators.

Blue crabs. To study blue crabs (*Callinectes sapidus*) (Fig. 6) and bluefish (Fig. 8), which are rare in PC, we studied the Hackensack Meadowlands (HM) with a similar history of industrial pollution. When HM or TK blue crabs were put with active

Fig 6 Blue crab (Callinectes sapidus*)*
Photo: NOAA Fisheries

Fig. 7 Sign in Hackensack Meadowlands
Photo: Peddrick Weis

Fig. 8 Bluefish (Pomatomus saltatrix) *juveniles* (snappers) Photo: Allison Candelmo

prey (killifish or juvenile blue crabs), TK crabs caught a lot more. Stomach contents of collected TK crabs had a variety of smaller crabs, fish, other crustaceans, mollusks, and worms, but HM crabs' stomachs had mostly detritus and algae. This is similar to PC killifish and surprising for a "carnivorous" crab. Doing a "switch," TK crabs were kept in HM sediments and water or in cages in HM for two months; their prey capture declined, and they accumulated high levels of metals. When HM crabs were kept in clean conditions or in cages at TK, their prey capture ability increased to that of TK crabs and their metal levels went way down. Unlike PC killifish, HM blue crabs were not smaller than those at TK but surprisingly were larger. Apparently, they do get nutrition from detritus. Perhaps they may live longer due to reduced predation; here the major predator is people, who are warned not to catch or eat them because they are contaminated (Fig. 7). If fewer crabs are caught, they can live longer and continue to grow.

Bluefish. Bluefish (*Pomatomus saltatrix)* (Fig. 8) spawn in the ocean and juveniles ("snappers") move into estuaries in the spring to grow, then return to the ocean in the fall. What happens to juveniles that spend their "youth" in polluted estuaries vs those that summer in a clean estuary? We collected early juveniles in the spring from TK and raised them in large tanks, feeding them frozen killifish and menhaden from either HM or TK and monitored their feeding, activity, and growth. While initially both groups grew comparably, those fed HM food gradually ate more slowly, ate less, swam more slowly, and grew less. By fall, they were much smaller and lighter, which would put them at a disadvantage in the ocean where they would intermingle with larger counterparts from clean estuaries. In September, we caught snappers from HM for stomach contents analysis. They were eating killifish and menhaden, but many had empty stomachs, reflecting poor prey capture. Chemical analysis of the fish they ate vs live fish in the water showed that the eaten fish had higher mercury and PCBs than the uneaten ones, reinforcing the findings that more contaminated prey are easier to capture.

Conclusions

These studies advanced understanding of pollution tolerance in estuarine animals and use of behavior as an ecologically important response to contaminants. In the years since these studies were performed, scientists have studied killifish from other polluted areas and have found tolerance to other contaminants such as PCBs and dioxin. "Behavioral toxicology" has become a recognized field, studied mainly in the lab on animals exposed to selected concentrations of a chosen chemical. Our studies focused on animals exposed to contaminants in their environment and focused on predator/prey behavior, which is ecologically important. These findings show that animals in nature can have their behaviors impaired in ways that make their lives more difficult and shorter, and that altered behavior can change ecological relationships in the ecosystem. Some lessons learned were (1) if data don't make sense, don't give up but try to figure out why, and (2) accidental observations can lead to a new fruitful direction of research.

Thanks to Peddrick Weis, a partner in much of this, and to former graduate students: Margarete Heber, Swati Vaidya Toppin, Mark Renna, Patrick Callahan, Mark Kraus, Abu Khan, Anwar Khan, Graeme Smith, Tong Zhou, Celine Santiago Bass, Suruchi Bhan, Lauren Bergey, Jessica Reichmuth, and Allison Candelmo. And thanks to Piles Creek for getting us started on this adventure.

Relevant Publications

Weis, J.S., P. Weis, M. Heber, and S. Vaidya. 1981. Methylmercury tolerance of killifish (*Fundulus heteroclitus*) embryos from a polluted vs nonpolluted environment. *Marine Biology* 65:283-287. https://doi.org/10.1007/BF00397123

Khan, A.T. and J.S. Weis. 1987. Effects of methylmercury on sperm and egg viability of two populations of killifish, *Fundulus heteroclitus*. *Arch. Environment Contami-*

nation and Toxicology 16:499–505. https://doi.org/10.1007/BF01055273

*Weis, J.S. and P. Weis. 1989. Tolerance and stress in a polluted environment: the case of the mummichog. *BioScience* 39: 89-96. https://doi.org/10.2307/1310907

Smith, G., and J.S. Weis. 1997. Predator/prey interactions of the mummichog, *Fundulus heteroclitus*: Effects of living in a polluted environment. *Journal of Experimental Marine Biology and Ecology* 209: 75–87. https://doi.org/10.1016/S0022-0981(96)02590-7

Zhou, T., and J.S. Weis. 1998. Swimming behavior and predator avoidance in three populations of *Fundulus heteroclitus* larvae after embryonic and/or larval exposure to methylmercury. *Aquatic Toxicology* 43:131-148. https://doi.org/10.1016/S0166-445X(98)00052-6

*Weis, J.S., G. Smith, T. Zhou, C. Bass and P. Weis. 2001. Effects of contaminants on behavior: biochemical mechanisms and ecological consequences. *BioScience* 51: 209-218. https://doi.org/10.1641/0006-3568(2001)051[0209:EOCOBB]2.0.CO;2

Bass, C.S., S. Bhan, G. Smith, and J.S. Weis. 2001. Factors affecting size distribution and density of grass shrimp (*Palaemonetes pugio*) populations in two New Jersey estuaries. *Hydrobiologia* 450:231-241. https://doi.org/10.1023/A:1017505229481

Bergey, L., and J.S Weis. 2008. Aspects of population ecology in two populations of fiddler crabs, *Uca pugnax*. *Marine Biology* 154:435–442. https://doi.org/10.1007/s00227-008-0935-x

Reichmuth, J.M., R. Roudez, T. Glover and J.S. Weis. 2009. Differences in prey capture behavior in populations of blue crab (*Callinectes sapidus Rathbun*) from contaminated and clean estuaries in New Jersey. *Estuaries and Coasts* 32: 298-308. https://doi.org/10.1007/s12237-008-9130-z

Candelmo, A., A. Deshpande, B. Dockum, P. Weis and J.S. Weis. 2010. The effect of contaminated prey on feeding, activity, and growth of young-of-the-yearbluefish, *Pomatomus saltatrix*, in the laboratory. *Estuaries and Coasts* 33: 1025-1038. https://doi.org/10.1007/s12237-010-9292-3

*Weis, J.S., L. Bergey, J. Reichmuth and A. Candelmo. 2011. Living in a contaminated estuary: Behavioral changes and ecological consequences for five species. *BioScience* 61: 375-385. https://doi.org/10.1525/bio.2011.61.5.6

**Papers with asterisk are review articles*

United Nations' Biodiversity Conference

Montreal, Canada, December 2022

The Global Biodiversity Framework is adopted in Montreal, December 2022
Photo: Convention on Biological Diversity

Last December, the 15th Conference of the Parties to the UN Convention on Biological Diversity took place in Montreal, Canada. Delegates from 190 countries worked out a breakthrough agreement to tackle the global loss of biodiversity. Among other things, they pledged to protect at least 30% of Earth's lands and waters by the year 2030 (30x30).

What drew national delegates to the conference were grave concerns about the global rate of species extinction, which is at least tens to hundreds of times higher that it has averaged over the past 10 million years. One million species are threatened with extinction; more than half of those lack sufficient habitat for long-term survival. Biodiversity loss threatens human wellbeing. The top five drivers of global biodiversity loss are changes in land and sea use, climate change, pollution, direct exploitation of natural resources, and invasive species.

At the last minute of the Montreal conference, delegates adopted the landmark Kumming-Montreal Global Biodiversity Framework. It consists of four goals and 23 targets that aim to halt and reverse biodiversity loss, restore ecosystems, and protect indigenous rights.

Almost every country in the world is a party to the Convention on Biological Diversity (the United States being a notable exception). President Clinton signed the pact in the 1990s but it was never ratified by the required two-thirds majority of the Senate. However, the American delegation at the 2022 Montreal conference played a role in the negotiations and promoted an Executive Order President Biden issued in January 2021 that made an American commitment for its own 30x30 plan.

ACCESS+ Grant Helps CERF Improve Awards Process

The 2019 CERF award recipients with CERF leadership. From left to right: Christine Angelini, University of Florida (Cronin Award); Hilary Neckles, US Geological Survey and 2017–2019 CERF President; Susan Bell, University of South Florida (Niering Award); Iris Anderson, Virginia Institute of Marine Science, College of William & Mary (Odum Award); Merryl Alber, University of Georgia (Davidson Award); Ruth Carmichael, Dauphin Island Sea Lab, University of South Alabama (Distinguished Service Award); and Susan Park, CERF Executive Director. Not pictured: Robert Chant, Rutgers University (Pritchard Award)

CERF is honored to receive a catalytic funding mini-grant from ACCESS+[1] (Amplifying the Alliance to Catalyze Change for Equity in STEM Success) to support its efforts to make the awards process more transparent and equitable. CERF is a member of the third cohort of ACCESS+, which seeks to accelerate the awareness, adoption, and adaptation of evidence-based, gender-related, and diversity, equity, and inclusion (DEI) policies, practices, and programs within and across STEM professional societies. Professional societies act as boundary spanners, influencing members who may in turn influence and affect change at their institutions, thus having an important role in culture change within a discipline. As a member of the third cohort, CERF implemented the ACCESS+ Equity Environmental Scanning Tool (EEST) to self-assess our DEI efforts across several domains. CERF received particularly low EEST scores around Awards & Recognition and thus applied for and received a mini-grant from ACCESS+ to address this concern. CERF acknowledges that awardee selections have lacked transparency and processes that might mitigate bias. CERF presents seven awards in conjunction with our biennial conference. The nomination procedures differ slightly for each award, but there are no standardized rubrics or processes for selection. This process depends greatly on nominations from a small subset of members and on the discretion of the award committee chairs and members, and we recognize the need to make the process more inclusive and equitable. Mary Anne Holmes and LaToya Myles have worked to improve diversity and equality in the awards programs of scientific societies[2] and have been invited to organize a half-day virtual workshop to brainstorm new policies and adapt proven strategies to introduce equity into these processes. Examples include shifts in nomination advertising procedures, leveraging canvassing committees composed of DEI change agents, developing representational guidelines for committee composition, and providing implicit bias training. A task force consisting of members of the awards committees, Governing Board, and Broadening Participation Council (BPC) will participate in the workshop and develop policies and procedures. We will also be able to provide an implicit bias and microaggressions training to the task force, Governing Board, Affiliate Society board, and awards committee members. We are grateful to ACCESS+ and a contribution from the CERF Enhancement Fund for facilitating this important activity, and to BPC member Lora Harris and 2023 Awards Committee chair Ruth Carmichael for their leadership.

As a reminder, we are now accepting nominations for our prestigious scientific awards:

Odum Award
Lifetime Achievement

Cronin Award
Early Achievement

Niering Award
Outstanding Educator

Pritchard Award
Physical Oceanography Paper

Davidson Award –
Stewardship (individual)

Coastal Stewardship Award
Stewardship (organization)

Diversity, Equity, Inclusion, and Justice Award

More details, including nominations procedures and past recipients, can be found on the CERF website: https://conference.cerf.science/cerf-scientific-awards.
The deadline is 6 April 2023.

[1] https://accessplusstem.com/
[2] Holmes, M. A., Myles, L., & Schneider, B. 2020. Diversity and equality in honours and awards programs–steps towards a fair representation of membership. *Advances in Geosciences* 53:41-51. https://doi.org/10.5194/adgeo-53-41-2020

Seeking Input on CERF 2023 Family-Friendly Activities

The CERF 2023 committee is doing all it can to make the conference welcoming to families. We're thinking of ways to make it easier to include your children, partners, and other family members in the conference experience, should you want to bring them. But we need your help! Please complete this survey to provide your input to the three questions below: https://bit.ly/CERF2023Families.

1. Do you plan on bringing your children/family to the conference?
2. If cost-friendly onsite childcare were available, would you take advantage of this option? If so, for how many children and what ages?
3. What suggestions do you have for making the conference more family-friendly?

You can also reach out to CERF 2023 Family Friendliness committee chair Allison Fitzgerald (afitzgerald@njcu.edu) with other input. Thanks!

Upcoming Events

PERS 2023 Annual Meeting
20–22 April 2023
Bellingham, Washington
https://www.pers-erf.org/pers-2023-annual-meeting/

2023 CAERS Conference
20–21 April 2023
Southern California Coastal Water Research Project, Costa Mesa, California
https://caers.wildapricot.org/

NEERS Spring 2023 Meeting
27–29 April 2023
Brooklyn College, Brooklyn, New York
https://newenglandestuarineresearchsociety.wildapricot.org/

ACCESS 2023
23–26 May 2023
Université de Moncton, Shippagan, New Brunswick, Canada
https://access.wildapricot.org/ACCESS-2023

Society of Wetland Scientists Annual Meeting
27–30 June 2023
Spokane, Washington
https://na.eventscloud.com/website/50365/home/

CERF 2023 Conference
12–16 November 2023
Portland, Oregon
https://conference.cerf.science/

ANGELS & SUSTAINERS 2022

Angels

From 1 January to 31 December 2022, the following Federation members donated to the William E. Odum Fund, Scott W. Nixon Fund, Donald W. Pritchard Fund, CERF Enhancement Fund, and/or the CERF Legacy Fund.

Robert Aller
Rebecca Asch
Mary Barber
Joy Bartholomew
Veronica Berounsky
Mark Botton
Brett Branco
James Browne
Nancy Brown-Peterson
John Callaway
Jacob Carstensen
Robert Christian
Rosalind Cohen
Gregory Cutter
Daniel Dauer
Linda Deegan
Frances Quay Dortch
Holly Greening
Robert Griffin
Francisco Gutiérrez
Leila Hamdan
Lora Harris
Douglas Hersh
Joel Hoffman
Eileen Hofmann
David Karlen
Galen Kaufman
Michael Kennish
Owen Keys
James Latimer
Matthew Liebman
Karin Limburg
Lisa Lucas
Parker MacCready
Christopher Madden
Stephen Monismith
Paul Montagna
Dr. Raymond Morgan II
David Osgood
Candace Oviatt
Hans Paerl
Anna Pfeiffer-Herbert
Jennifer Read
Hali Rederer
Charles Roman
Lawrence Rozas
David Rudnick
Lawrence Sanford
Charles Simenstad
Paul Stacey
Andrew Stoddard
Peter Straub
Mark Tedesco
R. Scott Warren
Judith Weis
Lindsey Williams

Sustainers

Many thanks to the members who joined or renewed at the Sustaining Member level in 2022. Your extra efforts on behalf of CERF will ensure the future of the Federation

Merryl Alber
Dennis Allen
Mary Barber
Joy Bartholomew
Linda Blum
Donald Boesch
Brett Branco
Deborah Bronk
Kate Buenau
Jane Caffrey
Ruth Carmichael
Melville Cote
Anthony D'Andrea
Daniel Dauer
Linda Deegan
Robert Diaz
Anne Giblin
Patricia Glibert
Holly Greening
Leila Hamdan
Kenneth Heck
Robert Howarth
R. Christian Jones
Sarah Kolesar
Karin Limburg
Parker MacCready
James McClelland
Paul Montagna
Christopher Osburn
Francis Reilly
John Rybczyk
Robert Twilley
Dara Wilber

Large CERF Presence at Restore America's Estuaries Summit

Above: The speakers for the CERF-hosted panel on growing a diverse estuarine research and management workforce. From left to right: Jacqueline Richard, Director of Coastal Studies and GIS Technology, Nunez Community College; Todd Reynolds, Executive Director, Groundwork New Orleans; Maddie Kennedy, National Fellowships Manager, NOAA National Sea Grant Office; and Allison Fitzgerald, Associate Professor, New Jersey City University Photo: Susan Park

Left: Jade Blennau (L), 2017 Rising TIDES alumnus and Peconic Estuary Partnership Program Support Specialist, with CERF Executive Director Susan Park (R) Photo: Joyce Novak

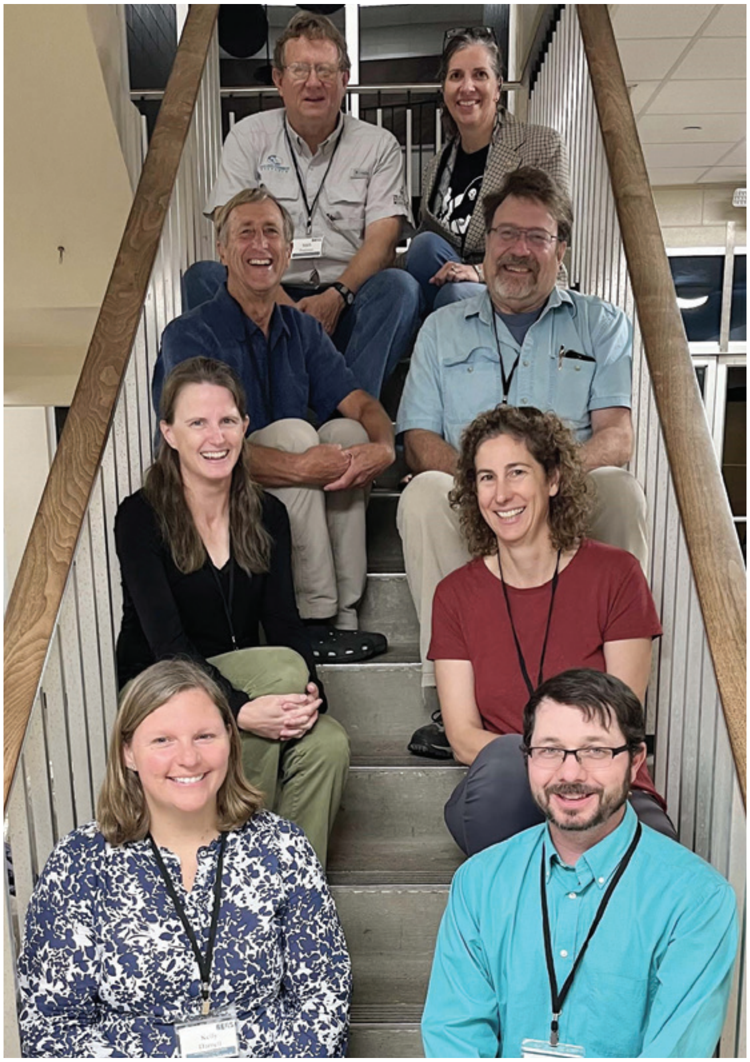
With the return to in-person conferences in full swing, Restore America's Estuaries (RAE) hosted its 11th conference, the 2022 RAE Coastal and Estuarine Summit, 3–9 December 2022. Held at the Hilton Riverside Conference Center in New Orleans, Louisiana, the conference featured approximately 500 oral sessions, a poster session with 140 contributed posters, two plenaries focusing on local and national issues, and camaraderie with colleagues that we didn't get from the previous virtual edition of the summit. New Orleans did not disappoint; warm weather, fun nights in the French Quarter, and good food were enjoyed by all. The summit began with optional field trips, including visits to a local shell recycling and salt marsh restoration project, kayak and pontoon boat tours of nearby swamps, and a trip to the Bonnet Carre Spillway. Over 1,300 people attended, with most in person and some attending and presenting through the virtual option.

Executive Director Susan Park staffed the CERF booth in the exhibit hall with the support of many CERF volunteers; with a great location at the front of the hall, many people stopped by to learn about CERF. Over 20 CERFers gave oral or poster presentations, and many more CERF members were in attendance, including Board Member Jennifer Pollack, CERF 2023 co-chairs John Callaway and John Rybcyzk, and Rising TIDES (Toward an Inclusive, Diverse, and Enriched Society) alumni Jade Blennau, Danielle Perry (virtual), Leslie Townsell, Briana Yancey, and Jennifer Zhu. Susan also organized a special session under the Diversity, Equity, Inclusion, Justice, and Accessibility track on Growing a Diverse Estuarine Research and Management Workforce. Allison Fitzgerald (New Jersey City University and *CERF's Up!* Editor) gave a talk summarizing the Rising TIDES program. Susan gave a talk highlighting the SEAS Islands Alliance, a National Science Foundation INCLUDES program that supports students from Guam, Puerto Rico, the US Virgin Islands, and other US-affiliated islands to pursue careers in marine and environmental science. The session also included a presentation by Maddie Kennedy (National Oceanic and Atmospheric Administration Sea Grant Office) on making the Knauss Marine Policy Fellowship more inclusive. Perhaps the highlights of the session were two inspiring local speakers: Jacqueline Richard, Director of Costal Studies and GIS Technology, described a multifaceted program she leads at Nunez Community College to train local students to join the booming Louisiana coastal restoration workforce, and Todd Reynolds, Executive Director of Groundwork New Orleans, described programs to train local youth in green infrastructure installation and maintenance that address environmental concerns such as flooding. Both of these programs demonstrate the impact of local engagement and training of the next generation of coastal and estuarine workforce, whether they pursue a career with a high school diploma, certification, or associate, undergraduate, or graduate degree.

It was great to reconnect with, or meet for the first time, so many CERFers. We look forward to seeing you again in Portland!

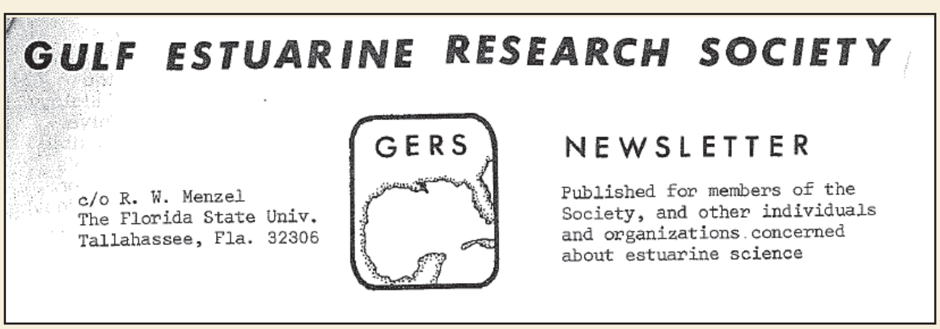
Affiliate News: Gulf Estuarine Research Society Biennial Meeting

Kelly Darnell, GERS President
The University of Southern Mississippi, Ocean Springs, Mississippi, USA
Kelly.darnell@usm.edu



Left: Former, current, and future GERS presidents in attendance at the 2022 GERS Biennial Meeting. From top left to bottom right: Mark Peterson, Ruth Carmichael, Ken Dunton, Mike Murrell, Anna Armitage, Megan La Peyre, Kelly Darnell (current President), and Charlie Martin (President-Elect). Not pictured, but also in attendance, was past President Ed Proffitt

In late 2022, GERS held its first in-person biennial meeting since November 2018 at The University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL) in Ocean Springs, Mississippi. More than 115 attendees traveled from across the Gulf of Mexico to participate in the two-day meeting, with over 50 oral presentations and 40 poster presentations. CERF President Leila Hamdan gave the plenary, during which she spoke about her research on marine microbial ecology as well as the history between CERF and the Affiliate Societies. Another highlight of the program was the panel "Rising TIDES: A discussion about increasing diversity and inclusion in our community" that included former mentors and participants of the CERF Rising TIDES program. GERS awarded 20 student travel grants and gave 10 best presentation awards in the categories of graduate oral presentation, graduate poster presentation, undergraduate oral presentation, and undergraduate poster presentation to deserving students. GCRL has a long history with GERS, which GCRL librarian and historian Joyce Shaw showcased in a display during the meeting. The display included minutes from the board meeting held at the first GERS Meeting which was hosted by GCRL in 1974 (48 years before the 2022 GERS Biennial Meeting!), and which named Dr. Gordon Gunter, GCRL Director from 1955–1971, as the first honorary member of GERS. Several past GERS presidents attended the 2022 Biennial Meeting and happily sat for a picture to document all being one place at the same time to share science and GERS memories. We are looking forward to coming together again for the next GERS Biennial Meeting in fall 2024 to celebrate the 50th anniversary of GERS meetings!



GULF ESTUARINE RESEARCH SOCIETY

c/o R. W. Menzel
The Florida State Univ.
Tallahassee, Fla. 32306

GERS

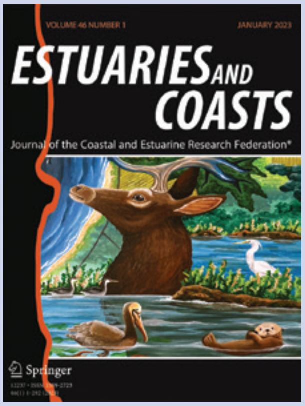
NEWSLETTER

Published for members of the Society, and other individuals and organizations concerned about estuarine science

GERS Newsletter with minutes from the first GERS meeting in October 1974

From the archives of Joyce Shaw

Estuaries and Coasts Editors' Choice Papers



July 2022
Logan, J.M. et al. 2022. A Review of Habitat Impacts from Residential Docks and Recommended Best Management Practices with an Emphasis on the Northeastern United States. *Estuaries and Coasts* 45 (5):1189-1216.
https://rdcu.be/c3D7L

September 2022
Besterman, A.F. et al. 2022. Buying Time with Runnels: a Climate Adaptation Tool for Salt Marshes. *Estuaries and Coasts* 45 (6):1491–1501.
https://rdcu.be/c3D7T

November 2022
Farrer, E.C. et al. 2022. Plant-Microbial Symbioses in Coastal Systems: Their Ecological Importance and Role in Coastal Restoration. *Estuaries and Coasts* 45 (7):1805-1822.
https://rdcu.be/c3D8k

December 2022
Moritsch, M.M. et al. 2022. Can Coastal Habitats Rise to the Challenge? Resilience of Estuarine Habitats, Carbon Accumulation, and Economic Value to Sea-Level Rise in a Puget Sound Estuary. *Estuaries and Coasts* 45 (8):2293–2309.
https://rdcu.be/c3D8W

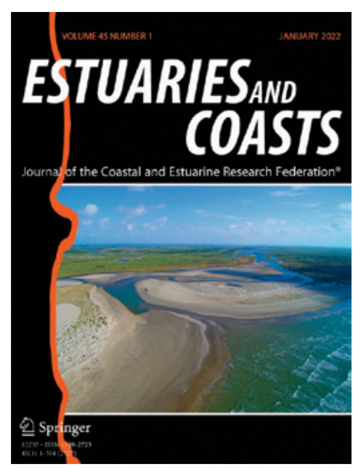
January 2023
Thyng, K.M. 2023. Seasonal Alongcoast Connectivity in Texas and Louisiana. *Estuaries and Coasts* 46 (1): 1-11.
https://rdcu.be/c3D9b

Submit your Management Applications papers to

Estuaries and Coasts!

Estuaries and Coasts, the official journal of CERF, accepts Management Applications manuscripts.

These papers demonstrate the application of estuarine and coastal research to address contemporary estuarine and coastal management, socioeconomic, and policy issues. The underlying science is expected to be at the level of Original Reports, but illustrations and case studies of how findings can be used to address real-world problems are emphasized.



More information, including instructions for authors, can be found at http://www.springer.com/environment/journal/12237

The CESN logo — coastal & estuarine science news

The Latest *Coastal & Estuarine Science News (CESN)*

Merryl Alber, Managing Editor
Janet Fang, Science Writer/Coordinating Editor

CESN is an electronic newsletter that is put out on a bimonthly basis (six issues per year) and serves as a companion to the journal *Estuaries and Coasts*. Each issue of *CESN* provides a summary of four articles from the journal, written for an audience of coastal managers and other interested stakeholders and emphasizing the management applications of scientific findings. Issues are posted online and emailed to subscribers. Go to the *CESN* website at www.cerf.science/cesn to read the full summaries and sign up to have future issues delivered to your email inbox.

December 2022 CESN

Bay Beaches Erode Differently
A 20-year analysis of Apam Beach in Ghana
Source: Source: Abdul-Kareem, R. et al. 2022.
Shoreline Variability of a Bay Beach: The Case of Apam Beach, Ghana.
Estuaries and Coasts. DOI: 10.1007/s12237-022-01110-9. https://rdcu.be/cWCm1
https://cerf.memberclicks.net/cesn-december-2022#Article1

Fish Communities Don't Always Change With Salinity
Long-term monitoring reveals little impact of freshwater inflow in Florida
Source: Kendall, M.S. et al. 2022.
Too Much Freshwater, Not Enough, or Just Right? Long-Term Trawl Monitoring Demonstrates the Impact of Canals that Altered Freshwater Flow to Three Bays in SW Florida.
Estuaries and Coasts. DOI: 10.1007/s12237-022-01107-4. https://rdcu.be/cWCmX
https://cerf.memberclicks.net/cesn-december-2022#Article2

Daily Mean Discharge Data Doesn't Capture Compound Flooding
A historic analysis of extreme events in the UK
Source: Lyddon, C. et al. 2022.
Historic Spatial Patterns of Storm-Driven Compound Events in UK Estuaries.
Estuaries and Coasts. DOI: 10.1007/s12237-022-01107-4. https://rdcu.be/cWCng
https://cerf.memberclicks.net/cesn-december-2022#Article3

Where Does Citizen Science Fit?
Hundreds of stakeholders weigh in on the management of Chesapeake Bay
Source: Webster, S.E. & W.C. Dennison. 2022.
Stakeholder Perspectives on the Roles of Science and Citizen Science in Chesapeake Bay Environmental Management.
Estuaries and Coasts. DOI: 10.1007/s12237-022-01106-5. https://rdcu.be/cWCmS
https://cerf.memberclicks.net/cesn-december-2022#Article4

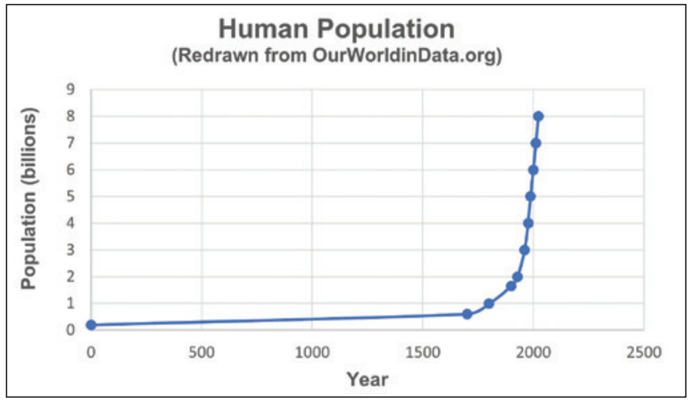
Eight Billion *Homo sapiens* (and Counting)

Stephen S. Hale, Associate Editor
stephenshale@gmail.com

If someone wanted to build an Earth-sized biosphere, they probably wouldn't stock it with eight billion humans. The human population reached 8,000,000,000 last November.[1] That's twice what it was in 1975 and eight times that of 1800.[2] Further, the UN estimates the world's population could grow to around 9.7 billion by 2050.[1] A biosphere manager would say we need to stabilize that population to have a sustainable system. With humans in the system, the manager would also have to take into consideration not just population size, but also the wildly uneven rate of natural resource consumption and waste production (including greenhouse gases) across individuals, countries, and regions.

Population size does matter. Humans and their infrastructure take up a lot of space and are distributed across most of the planet. Designated conservation areas with low human impacts are needed. The Half-Earth project of E.O. Wilson[3] calls for saving 50 percent of Earth for nature. The December 2022 30x30 goal of the UN Convention on Biological Diversity aims to conserve 30 percent of the planet for nature by 2030.

The impacts of human population are especially felt on estuaries and coasts. Many estuaries host major ports and cities. About 40 percent of the world's population lives within 100 km of the coast.[4] NOAA calculated that in the US in 2014, around 40 percent of the population lived in a coastal county.[5] Population density there is over five times that of the US average.



Beyond the overall health of the hypothetical biosphere, the biosphere manager would be worried about the health of the human population. In the animal world, unlimited growth leads to population crashes. Food becomes limiting, individuals starve, wastes created by the population become limiting, and diseases increase. With humans, rapid population growth makes dealing with poverty and hunger more difficult and puts strains on health, education, and the environment.

Around 10 percent of the world's population lives in coastal areas less than 10 meters above sea level.[5] At last November's UN Climate Change Conference of Parties in Egypt, countries that have emitted the most greenhouse gases agreed to help those that haven't contributed as much. One of the driving forces of this agreement came from countries experiencing more devastating coastal flooding as sea level rises and coastal storms become more intense and frequent.

Humans comprise only 2.3 percent of the global animal biomass.[6] But the ecological footprint of the last surviving species of the genus *Homo* is immense. The Global Footprint Network, in the tricky business of calculating human impacts on the planet, suggests we have exceeded the carrying capacity of Earth's ecosystems, using natural capital 1.7 times as fast as the planet can renew it.[7] And they suggest that if everyone on the planet lived like the people of the US, we would need four Earths to sustain us.

Thanks to some fortuitous mutations and natural selection, we eight billion *Homo sapiens* have been gifted with extraordinary intelligence relative to other species. We should be able to figure out how to do sustainable biosphere management.

References

1. https://www.un.org/en/desa/world-population-reach-8-billion-15-november-2022

2. Our World in Data. https://ourworldindata.org/

3. The Half-Earth Project. https://www.half-earthproject.org/

4. United Nations Factsheet: People and Oceans. https://www.un.org/en/conferences/ocean2022/facts-figures

5. https://oceanservice.noaa.gov/facts/population.html

6. Bar-On, Y.M., R. Phillips, and R. Milo. 2018. The biomass distribution on Earth. *Proceedings of the National Academy of Sciences* 115 (25):6506–6511. https://doi.org/10.1073/pnas.1711842115

7. Global Footprint Network. https://www.footprintnetwork.org/

Contact Information

Coastal & Estuarine Research Federation
2150 North 107th Street, Suite 205
Seattle, WA 98133-9009
(206) 209-5262
info@cerf.science

Executive Director
Susan Park
(804) 381-6658
spark@cerf.science

Chief Operating Officer
Louise S. Miller
info@cerf.science

CERF's Up! Bulletin

Editor	Allison Fitzgerald
Associate Editor	Stephen Hale
Managing Editor	Tayton Hewitt
Copy Editor	Ariel Hansen
Layout Editor	Rhonda Cole

Comments or questions on anything in this issue? Email bulletin@cerf.science

COASTAL & ESTUARINE RESEARCH FEDERATION
2150 N 107th St, Ste 205
Seattle, WA 98133
Phone: (206) 209-5262
Website: www.cerf.science
Email: info@cerf.science