Identifying Effective Strategies to Protect Louisiana’s Precious Wetlands

Dr Kim de Mutsert

Scientia

IDENTIFYING EFFECTIVE STRATEGIES TO PROTECT LOUISIANA'S PRECIOUS WETLANDS

The Louisiana coastal zone is the fastest-eroding wetland in the US. This region is home to a variety of vitally important fish species for local fishing industry and ecosystems, which are currently under threat. Conservation schemes have been proposed under the 2017 Louisiana Coastal Master Plan in an attempt to preserve coastal habitats and their inhabitants. **Dr Kim de Mutsert** of the University of Southern Mississippi and her colleagues use simulations to reveal how different management strategies will affect fish and shellfish up to 50 years from now.

Coastal Erosion in Louisiana

Louisiana is one of the most rapidly eroding states in the US. In fact, 90% of coastal wetland loss in the country occurs in this state – at almost 23 square miles per year between 1932 and 2016. This is predicted to rise to around 35 square miles per year by the early 2050s.

'The Louisiana coast suffers from a land-loss problem, where coastal wetlands are sinking and eroding away until open water remains,' explains Dr Kim de Mutsert from the University of Southern Mississippi. As 40% of wetlands in the US are found in Louisiana, conservation is of great importance for protecting the local environment and its species.

Rising sea levels, fragmentation (where channels that are dug for the oil and gas industry break up habitats into smaller sections), and the construction of levees on rivers are mainly to blame for the rapid disappearance of coastal wetlands.

Levees are artificially raised riverbanks, which prevent areas next to the river from flooding. They are incredibly beneficial as a form of flood protection – especially when settlements have been built on floodplains. However, levees on the Mississippi river in Louisiana prevent valuable sediment from reaching the important coastal wetlands, which means that eroded land is not replenished. Levees also prevent nutrients and freshwater from reaching these wetlands, which has resulted in shifts in the communities of aquatic species towards species that prefer more salty environments.

The Louisiana Coastal Master Plan

The Louisiana Coastal Master Plan (CMP) describes strategies to maintain and regenerate these coastal areas, which are being eroded and degraded by human activity. The plan compiles scientific research and engineering approaches to establish the best possible conservation strategies along 800 square miles of coastline. The aim of the CMP is simply to protect

coastal land, its species, and the communities that depend on them, through a combination of strategies that maintain and restore coastal land, with freshwater diversion schemes standing at the forefront.

Dr de Mutsert is working with other researchers to evaluate the effects of various restoration approaches on fish and shellfish using models. One of their main criteria is how well a given strategy will help to restore wetlands, which

will have knock-on effects on aquatic species populations.

Dr de Mutsert has been involved with multiple projects that have contributed to the CMP, including modelling and comparing outcomes of potential restoration projects. The simulations run to 20 and 50 years into the future and are compared with a scenario in which no restoration action is taken. The models also test combinations of projects in order to find the optimal conservation strategy for each area.

'Restoring the coast has the potential to change the biomass and distribution of economically and ecologically important fisheries species,' says Dr de Mutsert. 'However, not restoring the coast may have negative impacts on these species due to the loss of habitat.'

The study addresses the issue on a landscape-wide scale over 50 years – a novel insight that simulates impacts on multiple aquatic species, and considers environmental factors and fishing. Specifically, Dr de Mutsert's research focuses on the effects of sediment diversion schemes, which involve creating openings in levees to divert freshwater, sediment, and nutrients to wetlands and estuaries. Prior to Dr de Mutsert's research, simpler models were used that do not simulate species interactions and focus on the suitability of the habitat only.

The Ecopath with Ecosim Model

Dr de Mutsert and her fellow researchers use the Ecopath with Ecosim (EwE) modelling software, which was developed to investigate food webs, fisheries, and ecosystems. EwE has three components: Ecopath, a snapshot of the ecosystem at a particular period of time; Ecosim, to simulate how a policy might influence a system over time; and Ecospace, which adds a spatial component to the model.

The model was initially calibrated in Ecosim on one section of the Louisiana coast, the Mississippi River Delta. This area was scaled up to cover the entire Louisiana coast in 2015 in order to support decision-making for the 2017 CMP. The smaller area was used again in Dr de Mutsert's most recent 2021 paper, where she simulated the effects of the CMP.

The model considers environmental characteristics that may influence the biomass of aquatic species, such as the extent of the marsh edge, water temperature, salt content, the availability and deposition of sediment, and the nutrient concentration in the water. These factors change over time in Dr de Mutsert's model in order to replicate a changing climate and the resulting change in biomass and distribution of species.

Using the model, her team made projections over timescales of 20 and 50 years, as well as some higher-resolution projections over one to five years. In one of Dr de Mutsert's earlier research papers, she points out that many differences between schemes become much more apparent over longer periods of time. By running simulations over 20 and 50 years, policy makers

involved in the Louisiana CMP gain a reliable projection of how different actions are likely to impact aquatic species and can see how these outcomes diverge over longer periods of time.

How Will the CMP Impact Coastal Environments?

A future with the Louisiana CMP appears to have generally positive outcomes for coastal habitats and fish populations compared to a scenario where no conservation strategy is put in place. Dr de Mutsert's research focuses on how the CMP will impact aquatic species – the results of which are a little more intricate.

Different species live in different habitats along the Louisiana coastline, and therefore restoration strategies have varying impacts in different areas. For example, the biomass of blue crabs and black drum fish will be lower in the Birdsfoot Delta region when modelled under the proposed CMP scenario, as opposed to where no action is taken. Meanwhile, biomass of brown and white shrimp is projected to be the same or higher in all basins under the same scenario, while spatial distribution changes. Policy makers therefore need to respond to the outcomes of CMP strategies, such as by supporting fishers with the resources they need to continue fishing when species distributions change.

This can be easily explained by the preference of species for a particular type of environment, such as saltier water. When modelling scenarios where more water is diverted to wetlands from freshwater rivers, the populations of species that favour salty water moved or decreased while the number of those that prefer more freshwater environments increased. There will therefore be evident trade-offs between species when implementing restoration schemes.

Another complexity that has been investigated by other research is that, while an increase in nutrient flow from river diversions is an essential factor for increasing biomass in coastal wetlands, the associated increase in water-suspended sediment and nutrients – causing eutrophication in some areas – could block sunlight from reaching plant species at the sea bed. In other areas, however, an increase in nutrients will increase the biomass of some species. The likely result from this is that some species that are able to move will be redistributed, while the biomass of other species that are static will be reduced. Furthermore, an increased influx of nutrient-rich freshwater may weaken the plant root structure, making the wetlands more susceptible to erosion during storms.

Dr de Mutsert's research will be exceptionally important to policy makers and resource managers who will be able to use the information to manage and adapt local ecosystems in response to CMP schemes.

The Mid-Barataria Diversion

Recently, Dr de Mutsert and her collaborators investigated the potential effects of one particular CMP tool, the Mid-Barataria sediment diversion from the Mississippi River. Sediment models feeding into the ecosystem models from Dr de Mutsert's 2017 and 2021 papers have shown that in the absence of this proposed diversion, significant negative changes would be witnessed in the coming decades, with serious damage to Louisiana's coast, its ecosystems, and the local economy.

'The Mid-Barataria diversion gives us a chance to keep Barataria Bay from disappearing rapidly,' says Dr de Mutsert. 'Perhaps surprisingly, most living marine resources are better off when the diversion is built compared to a future without it.' In a letter addressed to policy makers, Dr de Mutsert and 54 other signatories express their overwhelming support for the proposed scheme.

Next Steps

Dr de Mutsert's research enables decision makers to understand projected successes and shortfalls of CMP schemes before putting them in place, and can offer advice to determine which strategy, or combination of strategies, are likely to be most beneficial for each area. Changes can also be made prior to implementation to ensure the most beneficial outcome for both local communities and wildlife.

Meet the researcher

Dr Kim de Mutsert
Division of Coastal Sciences
School of Ocean Science and Engineering
University of Southern Mississippi
Ocean Springs, MS
USA

Dr Kim de Mutsert earned her PhD in Oceanography and Coastal Sciences in 2010 from Louisiana State University, after completing an MS in Biology at the University of Amsterdam. She then remained at Louisiana State University until 2011 as a postdoctoral researcher, before moving on to become Assistant Professor at George Mason University. Dr de Mutsert now works as Assistant Professor in the Division of Coastal Sciences of the School of Ocean Science and Engineering at the University of Mississippi and is Affiliate Faculty at George Mason University. She specialises in coastal and estuarine fish ecology, particularly looking at human and environmental impacts on abundance, structure, and dynamics of fish communities, and her work has been cited more than 600 times. During her career, Dr de Mutsert has developed models to simulate how environmental changes affect fish and fisheries. She has been working on projects pertaining to coastal restoration for over 10 years and has published a substantial quantity of research on the topic.

CONTACT

E: kim.demutsert@usm.edu
W: demutsertlab.com
@demutsertlab

KEY COLLABORATORS

Kristy Lewis, University of Central Florida
Joe Buszowski, Ecopath International Initiative
Steve Brandt, Oregon State University
Dave Chagaris, University of Florida

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FURTHER READING

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