EXECUTIVE SUMMARY

Coral Reef Fish and Fisheries

Dominica, Grenada, Saint Lucia, St. Kitts & Nevis, and St. Vincent & the Grenadines

Mapping Ocean Wealth (MOW) and Caribbean Regional Oceanscape Project (CROP)

OECS Organisation of Eastern Caribbean States

gef

WORLD BANK GROUP

The Nature Conservancy

MAPPING OCEAN WEALTH

CROP Project Overview:
https:/oecs.org/en/crop

Map Viewer:
maps.oceanwealth.org/oecs

ABOUT THIS PROJECT

The Global Environment Facility (GEF) and the Organisation of Eastern Caribbean States (OECS) Commission, in partnership with the World Bank, is implementing the Caribbean Regional Oceanscape Project (CROP) to improve systems and put relevant structures in place in an effort to foster a Blue Economy and to promote greater consideration of the ecosystem functions and services which the ocean provides for member states. The project timeline was October 2017–December 2021. Under this project, The Nature Conservancy used the Mapping Ocean Wealth approach to develop ecosystem service models and maps for the five CROP countries in the Eastern Caribbean. Under this work, a team at Florida International University led the development of the Coral Reef Fisheries model.

Photo: © Tim Calver

Introduction

The Mapping Ocean Wealth (MOW) project aims to develop ecosystem service models and maps at the scale of the Eastern Caribbean in support of the Caribbean Regional Oceanscape Project (CROP). The theory of change behind the MOW approach is that developing and improving access to accurate and spatially explicit metrics of the value of natural ecosystems could provide a critical tool in encouraging efforts to use nature sustainably, and work towards its protection, maintenance or restoration. The CROP aims to foster a Blue Economy and promote greater consideration of the ecosystem functions and services that the ocean provides for the focal countries of Dominica, Grenada, Saint Lucia, St. Kitts & Nevis, and St. Vincent and the Grenadines. Coral reefs within the CROP area provide vital nutrition and income to fishers but are threatened by a range of stressors that have impacted the health of reefs and the fish assemblages they support. One of the activities in need of greater attention and improved management is reef fisheries, as a part of further growth of the blue economy. **As such, a sub-component of the project was to model and map fishing impact and fish biomass throughout the region and assess the potential of conservation and management measures for reef fisheries.**

Despite depletions, many people rely on reef fisheries for food and income. Reef fisheries in the region are also vulnerable to climate change, underscoring the need for prudent management.

The reefs of the Eastern Caribbean are a vital resource for island residents, supporting subsistence, artisanal, and smallscale commercial fishing. Reef fisheries contribute to social well-being by supporting island economies, contributing to food security, and playing a role in the region's cultural identity. These are multi-species and multi-gear fisheries, targeting several major fish groups: snappers, groupers, parrotfish, grunts, jacks, squirrelfish, surgeonfish and triggerfish are the most common. Traps and hook-and-line (predominately handlines) are widely used, along with some use of spears, nets, and vertical and bottom longlines. Though fishing pressure on reef species is variable across the region, in general coral reefs have been heavily fished, and populations of snappers and groupers have been severely depleted. Despite depletions, many people rely on reef fisheries for food and income. Reef fisheries in the region are also vulnerable to climate change and other threats, underscoring the need for prudent management.

To model fishing impact, data were examined from expert fish surveys done on SCUBA across common reef habitats in the focal countries and other nearby islands (which were added to the analysis to increase the size of the available dataset for the study). Please note, the maps only represent coral reef fisheries, they do not cover the extensive offshore fisheries for pelagic species (such as mahi mahi, wahoo, tuna) or fishing in seagrass meadows (where invertebrates such as lobster are found). At each site, the mean length of parrotfishes >10cm was used as a proxy of fishing impact—parrotfish populations are sensitive to fishing pressure and the abundance and size of different species of parrotfish provides a powerful indicator of fishing levels on a reef. As fishing pressure increases, the mean size decreases. Mean length and by extension, biomass, is influenced by a wide range of factors such as, depth, temperature, coral cover and human activities (fishing) at and around a site. Therefore, the models gave an indication of

Data from actual fish surveys done on SCUBA was fundamental in building and testing these models.

the mathematical relationships between the size of parrotfishes and each factor, which allowed for building statistical models for sites where there was no fish length data, but there was access to data for habitat, ecology and other fishing related variables. The estimated mean length for each area was then converted into a scale of fishing impact, which was used to estimate and map fishing impact across OECS countries.

The fishing impact maps were then used as a key input alongside other environmental data into additional models of current fish biomass for three groups: key carnivores (snappers and groupers); herbivores (parrotfishes), and all reef fish species combined. Again, data from actual fish surveys done on SCUBA was fundamental in building and testing these models.

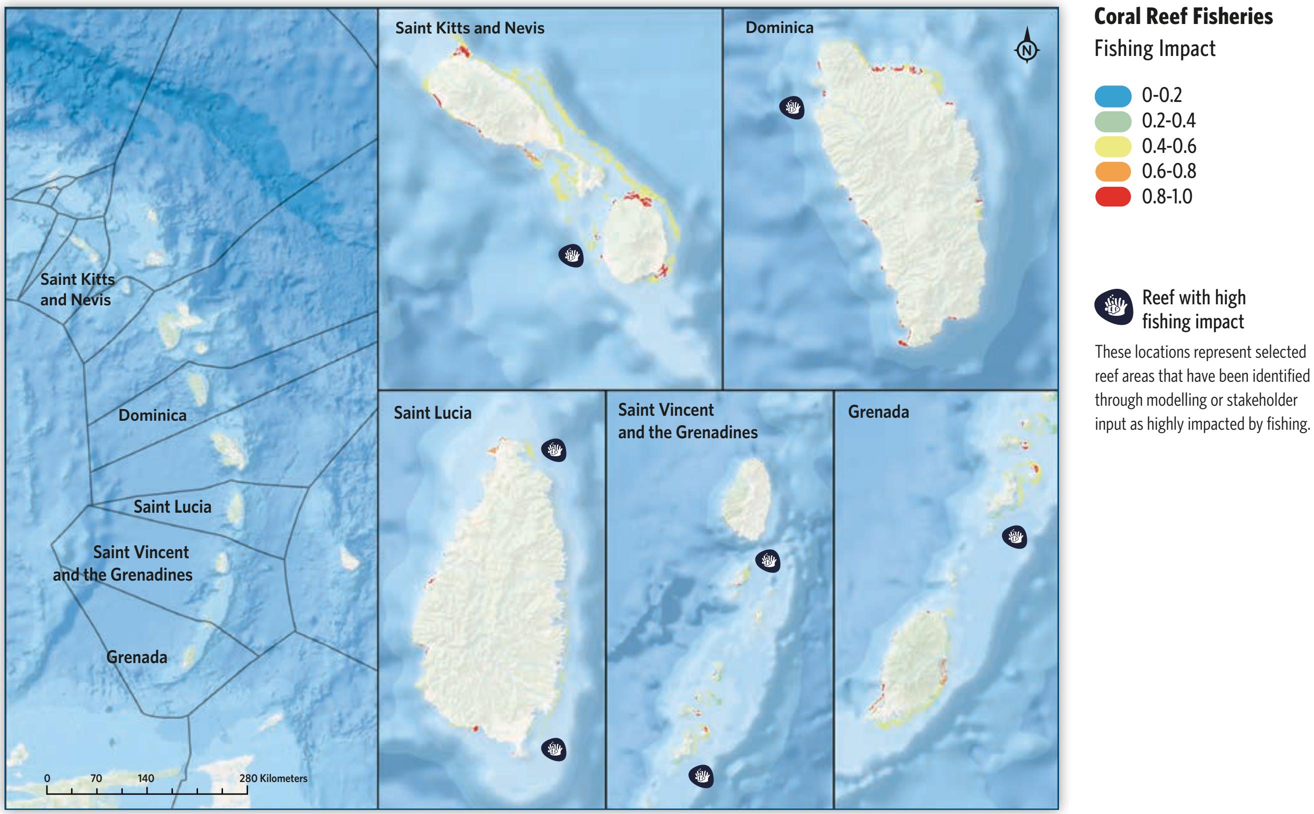
Finally, the models of current biomass were then used to estimate the potential biomass under different management initiatives. For example, fishing impact can be adjusted to zero in an area, simulating a no-take zone being implemented. If future model outputs identify additional management-related covariates as significant (e.g. mangrove availability for parrotfishes), these could be used to simulate other management approaches, such as restoring mangrove forests or to estimate potential effects of climate change (increasing sea surface temperatures). The estimated effect of increased coral cover on parrotfish biomass was also done.

CORAL REEFS
in CROP countries support
38 tons of fish
per square kilometer

Main Findings

Fishing impact

The fishing impact model predicted the fishing impact values across contiguous reef tracts around target countries, with an acceptable value for the correlation between observed and predicted values. Fishing impacts (as represented by mean parrotfish size) decreased with increasing distance from fish landing sites and was higher where there were greater concentrations of people within a standard defined geographical area (market gravity). These results reflect the importance of reefs distance from human populations for maintaining general fish stocks and the utility of market gravity as a proxy for fishing impacts. **Countries that reported a higher number of small-scale fishers showed higher fishing impacts on nearshore reefs.**



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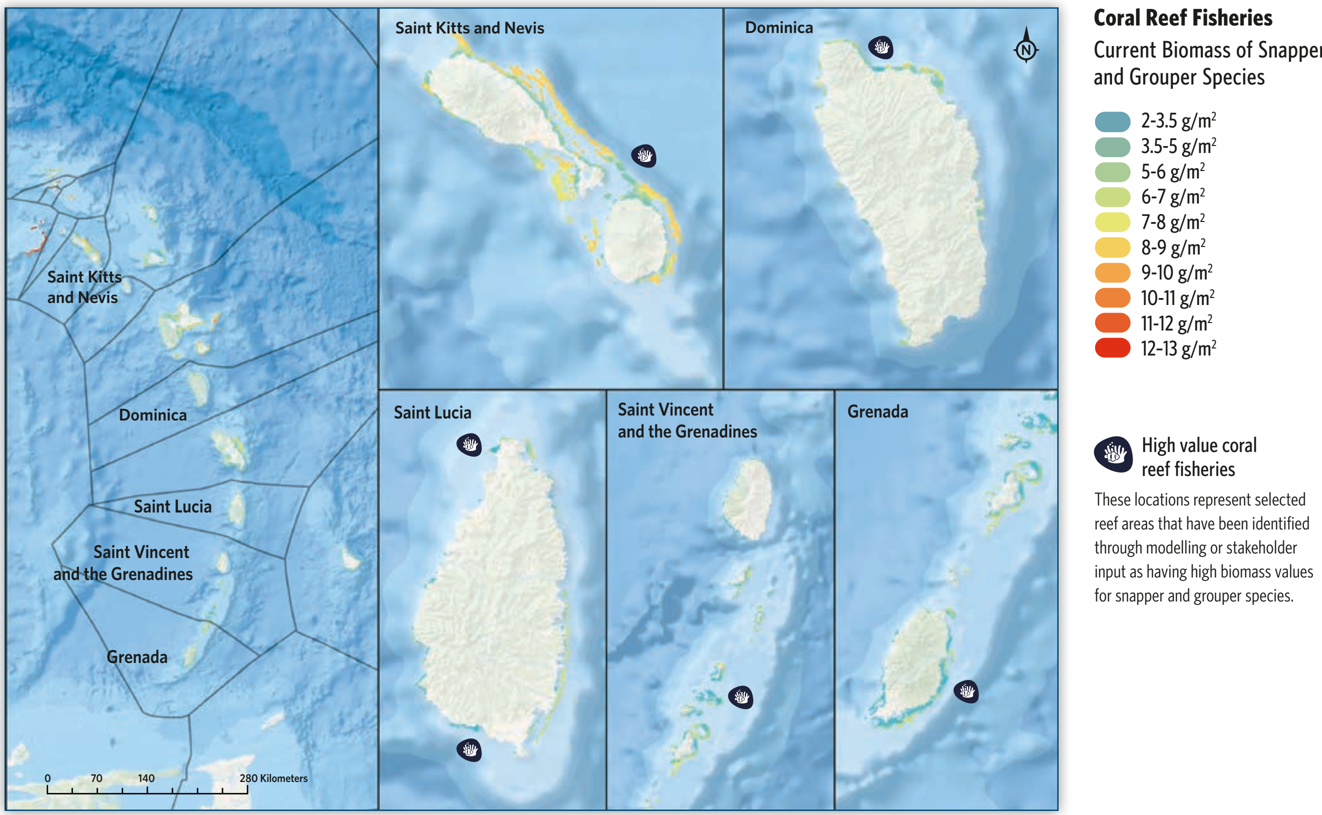
The model also showed that the mean size of parrotfish is influenced by several biophysical variables. **Areas with higher wave exposure, a proxy for higher primary productivity, recorded larger sized parrotfishes.** The mean size of parrotfishes also decreased with areas that recorded high sea-surface temperatures, which is consistent with observations from other studies that show climate change may lead to a decrease in the average size of fishes. There was also a decrease in parrotfish size in areas with lower live coral cover.

The proportion of reef area that had a low, medium or high fishing pressure highlighted minor differences across the region. None of the reefs assessed in the CROP countries fell into the low impact category. Only remote, offshore reefs fell into this category. **Approximately 40% of the reefs in Dominica and Saint Lucia were categorized as having high fishing impact, while reefs in St. Vincent and the Grenadines, St. Kitts and Nevis and Grenada had a much lower portion of their reefs within this category.**

Spatial distribution of fish biomass

Integrating the fishing impact data with biophysical variables allowed the team to model the total fish biomass[1] for the region and each country. Total fish biomass and the biomass of important species decreased in warmer water, potentially reinforcing concerns about the impact of climate change on fisheries. Biomass values were higher in deeper water, potentially reflecting increased productivity close to areas of upwelling and the use of reef walls by large transient predators. The increase in biomass of snappers, groupers and parrotfishes in deeper water may likely be reflecting the challenges of living in shallower reef habitats with high water movement. The increasing biomass of parrotfishes with the availability of nursery habitats is consistent with many of these species using seagrass and mangroves as juveniles before moving to offshore reefs.



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1 Fish species included in these models were those recording using Atlantic Gulf Rapid Reef Assessment protocols

Map viewer on Mapping Ocean Wealth Platform

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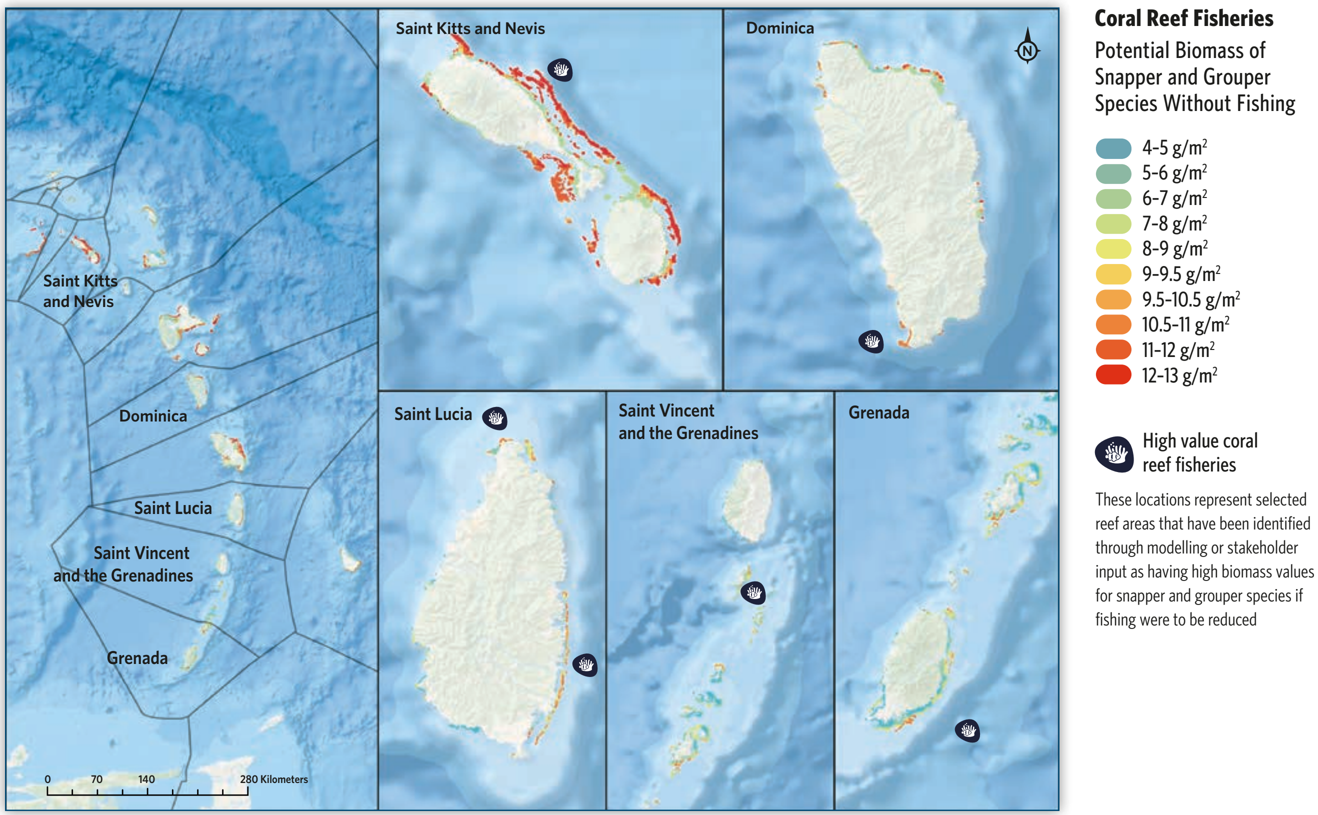
Exploring potential benefits of management actions

The models were used to simulate a range of management scenarios, for example, no-take fishing closures for snappers and groupers for the region's reefs. These simulations demonstrated, for example, that marine reserves have the potential to increase the biomass of snappers and groupers by up to 113%. However, reserves need to be well-enforced and established for a long time to have this effect, and such reserves are currently rare in the region.

When exploring the relationship between parrotfish biomass and coral cover, the models highlighted that increasing coral cover by 25% could increase parrotfish biomass significantly compared to current levels. This simulated the potential outcomes of a successful, long term coral restoration initiative, showing that this may have a positive impact on parrotfishes, a species group important for healthy reef fish assemblages.



Estimating fish assemblage time to recovery

The impacts of a no-take marine reserve or a habitat-based management intervention (e.g. reef restoration to increase coral cover) on fish biomass are not instantaneous and will lag behind the management intervention. Models estimated that it would take on average 20-40 years for most reefs to reach carrying capacity for the snapper-grouper group.[2] These results are to be interpreted with caution, given the complex life history of commercially important species (snapper and grouper) and other factors which are at play affecting reef fish assemblages. The results highlight the need for to initiate long term management initiatives for fisheries.

Photo: ©Tim Calver

2 Carrying capacity is defined as the average population size of a species below which its numbers tend to increase and above which its numbers tend to decrease because of shortages in resources

The impact of Covid-19 on this region, including the strong declines in tourism arrivals are likely to have impacted artisanal fisheries—while some market declines may have occurred, there may also have been increased reliance on fishing as a source of food or income.

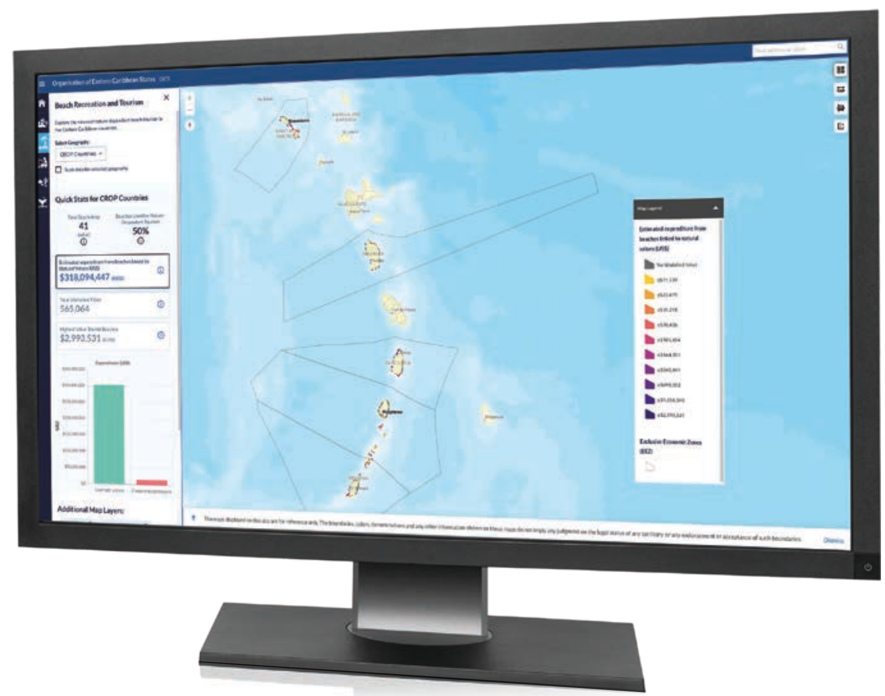
Conclusions

The maps and information presented in the full technical reports are the first spatially explicit, continuous maps of reef fishing impact, current biomass and the potential biomass gains that may accrue if certain management actions are implemented and effectively enforced in the CROP region. Maps of fishing impact and fish biomass implicitly represent aspects of ocean value, as they represent nutrition that has been, or could be, harvested. Current stocks therefore represent critical 'natural capital' and provide important insights into their distribution. Fishing impact was a significant variable in the model of snapper and grouper biomass, reflecting that these species are particularly targeted by fishers. Although the models could be improved with further data, they explain a large amount of variability in the dataset and were used to extrapolate estimates of current biomass across the project area to generate previously unavailable maps.

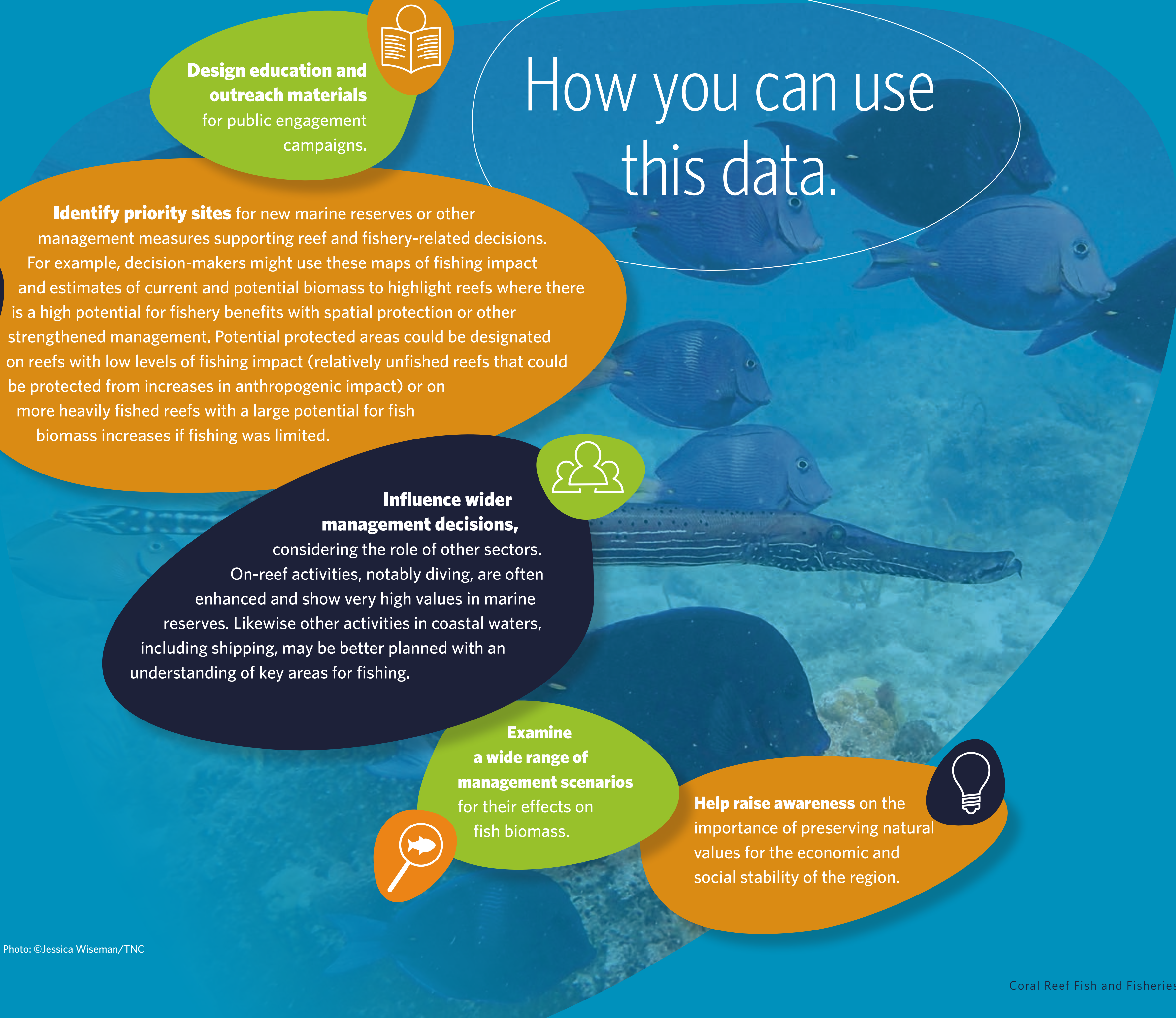
The impact of Covid-19 on this region, including the strong declines in tourism arrivals are likely to have impacted artisanal fisheries—while some market declines may have occurred, there may also have been increased reliance on fishing as a source of food or income. **It will be important to assess these impacts and to build up fisheries management to ensure sustainability in the future, and where necessary to support the recovering tourism sector.**

FIND OUT MORE

Access the full report and high-quality images of the maps on the Mapping Ocean Wealth platform https://oceanwealth.org/project-areas/caribbean/crop/coral-reef-fish-and-fisheries/.



Map viewer on Mapping Ocean Wealth Platform



How you can use this data.

Design education and outreach materials for public engagement campaigns.

Identify priority sites for new marine reserves or other management measures supporting reef and fishery-related decisions. For example, decision-makers might use these maps of fishing impact and estimates of current and potential biomass to highlight reefs where there is a high potential for fishery benefits with spatial protection or other strengthened management. Potential protected areas could be designated on reefs with low levels of fishing impact (relatively unfished reefs that could be protected from increases in anthropogenic impact) or on more heavily fished reefs with a large potential for fish biomass increases if fishing was limited.

Influence wider management decisions, considering the role of other sectors. On-reef activities, notably diving, are often enhanced and show very high values in marine reserves. Likewise other activities in coastal waters, including shipping, may be better planned with an understanding of key areas for fishing.

Examine a wide range of management scenarios for their effects on fish biomass.

Help raise awareness on the importance of preserving natural values for the economic and social stability of the region.

Photo: ©Jessica Wiseman/TNC

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https://oceanwealth.org/project-areas/caribbean/crop/

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