SALTMARSH/SEAGRASS FISH PRODUCTIVITY CALCULATOR

FACT SHEET

Last update: April 2021

Why make this tool?

The importance of coastal marine habitats serving as juvenile nurseries has been acknowledged in fisheries science for well over a century. While investments in coastal habitat conservation and restoration have been undertaken to achieve various and multiple ecosystem services, the enhancement of fisheries production has remained a primary motivation in these investments. Unfortunately, despite being identified as a clear need, the tools to quantify ecosystem services expected from conservation actions and/or restored habitat have not developed alongside the investments in habitat conservation and restoration, and fisheries production is no exception. This tool allows users to quickly obtain quantitative estimates of the fishery enhancement attributable to the presence of alternative coastal habitats (seagrasses and salt marsh edge) in the United States.

We've also made a similar tool for oyster habitat. In addition to fish production, that tool also estimates another key ecosystem service, water filtration from oysters.

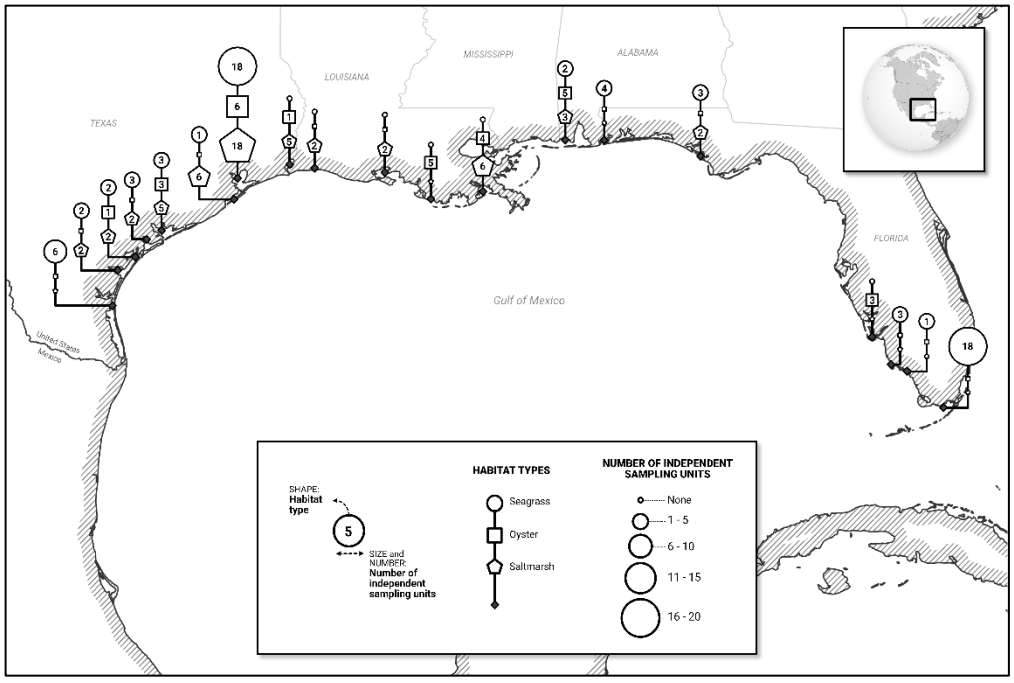
Where do the fish estimates come from?

The fish estimates you see in this tool are from zu Ermgassen et al. 2021 based on zu Ermgassen et al. 2016. Across the US, the area covered by coastal marine habitats has declined rapidly over the last century as a result of coastal development and other environmental stressors. The methodology used to estimate fish production assumes that the nursery value provided by coastal habitats is area-limited. In such a scenario, the presence or addition of habitat increases the number of individuals recruiting to some fish and invertebrate populations. This can be either as a result of enhanced settlement rates of larvae or lower post-settlement mortality of newly settled individuals.

Enhanced production is calculated by first identifying which species are consistently enhanced (present in higher densities) as juveniles in structured habitats across many studies. We compiled over 25,000 paired fish sampling events across the Gulf of Mexico and east coast of the United States. See Figure 1 next page showing the distribution of samples within each habitat type.

Figure 1:

Map showing the number of independent sampling units for each habitat type.

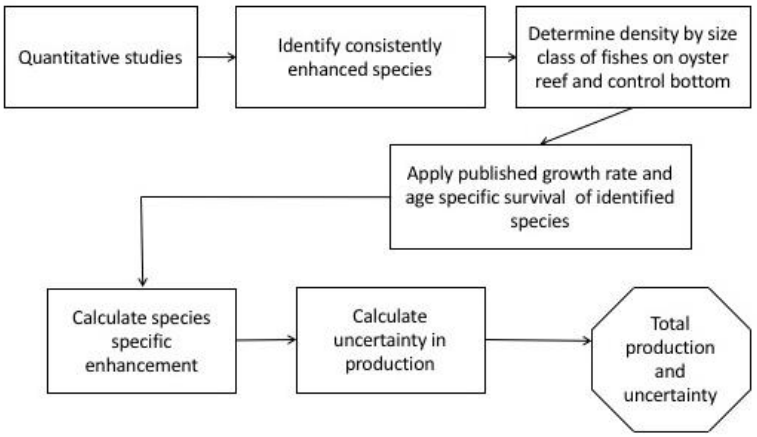


For consistently enhanced species, the mean and standard error of the density enhancement is then determined. ***Enhancement is the density of individuals present in the structured habitat over and above what was found in the unstructured control***. Therefore, the values the tool gives you is the number of new (young-of-the-year) fish that are "made" each year that we can attribute to that area of habitat. For saltmarsh habitat, we only consider the area of saltmarsh edge (i.e. the linear edge, with an approximate 3 meter buffer inland and seaward)

Growth and size dependent mortality models are then applied to these starting densities to determine the lifetime benefit (production) of the enhancement of these species by the structured habitat. The calculated standard errors in the mean enhancement is also inputted into the model. A starting density is then iteratively pulled from the modelled densities (as determined by the mean and standard error in the input data). A modelled mean and standard deviation (uncertainty) of the potential enhancement of fish and invertebrate communities is then generated. A flow chart outlining the steps in the methodology is given in Figure 2.

Figure 2:

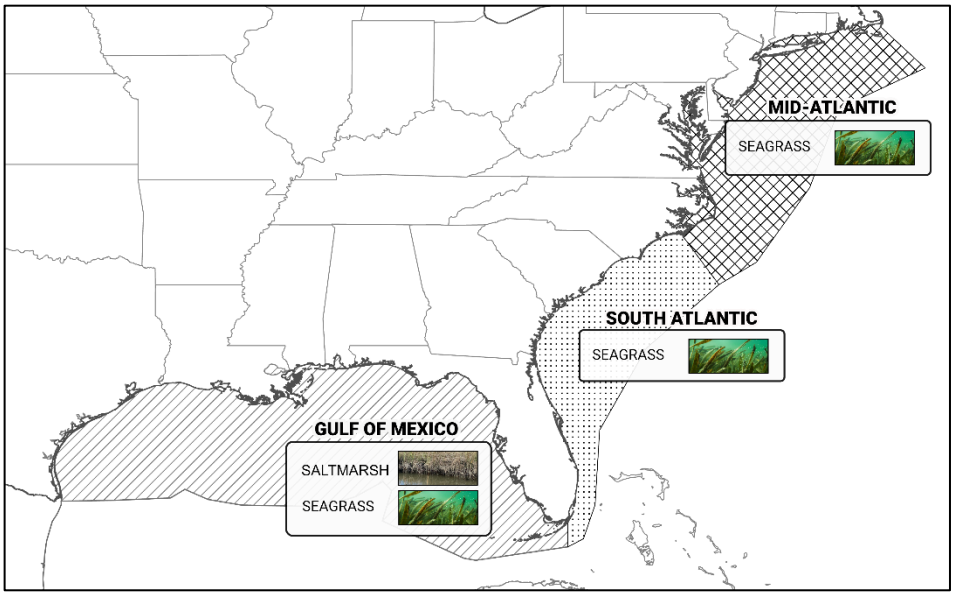
Flowchart of the steps taken to develop estimates of fish and mobile invertebrate production by threatened and declining coastal habitats.



The methods outlined above require quantitative density data of juveniles utilizing the nursery habitat, alongside density data from an unstructured control habitat. Therefore, we can only estimate fish enhancement where there has been sufficient sampling that efficiently sampled young of year individuals, and that used paired sampling on both the structured habitat and an unstructured control. As a result, the tool only shows estimates for saltmarsh edge along the Gulf of Mexico. On the other hand, estimates for seagrass beds can be found in both the Gulf of Mexico and the Atlantic coast. See map below with ecoregions.

Figure 3:

Ecoregions used for this tool, with the habitat types included within each region.



Where is my fish?

This tool calculates the enhancement rate provided by structured coastal habitats and it is not meant to list every fish ever found on a patch of habitat. The model only accounts for enhancement that results from nursery function provided by the habitat, and does not account for fish that may be "growth enhanced" by the structured habitat (e.g. an older, or adult fish that may use the habitat for food or protection). If a fish is not listed in the model outputs it could be because i) the fish is not nursery enhanced by the structured habitat in question; or ii) the fish may or may not be enhanced, but currently we do not have enough data to determine. When using the tool, click the Where's my fish? link to see if this fish you're interested in is enhanced, not enhanced, or if not enough data exists to determine.

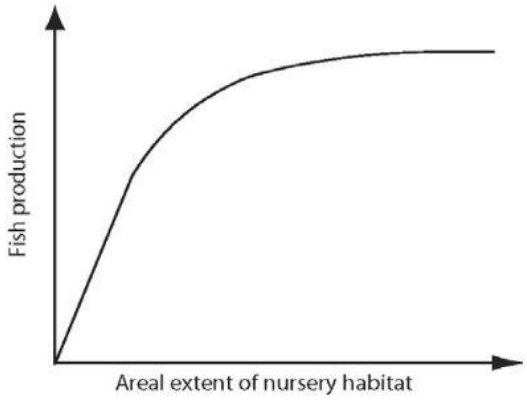
How should you apply and NOT apply these results?

The methodology used to estimate fish enhancement and production provides us with ecoregion-specific estimates of the number and lifetime production of fish arising from the enhancement of juveniles by nursery habitats, as well as the uncertainty or variance in these estimates.

The results are presented in units of mass per area of habitat. As the habitats in question have extremely low extents relative to historical levels, we would expect that an additional areal unit of habitat would promote fish recruitment in a linear fashion (see Figure 4). However, in areas where this may not be the case, caution should be used when applying these values.

Figure 4:

Theoretical relationship between habitat extent and fish production. As a result of decades of habitat loss, the model assumes that the current area of coastal habitats lies in the bottom left of the curve, where the relationship between areal extent and fish production is linear.



We hope this tool will be especially valuable for fishery managers wanting to understand the importance of nursery habitats for fish production, or evaluate the potential benefits of investing in a given area of coastal ecosystem protection or restoration. However, it must be noted that as a modelled estimate, these values should not replace the valuable role of field sampling in locations where the true value is required.