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Vertical feeding strategies and pelagic-benthic energy flows determine fish food-web structure across marine ecosystems

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Size-based fish community models have been developed to characterize the structure of fish communities and to describe energy flow between the upper trophic levels in marine ecosystems. Thus far, these models have overlooked important aspects of fish diversity that emerge due to variation in feeding strategies (e.g. zooplanktivorous, benthivorous) and behaviors (e.g. diel vertical migrations) that are all associated with the vertical habitat strategy of a fish. Here, we present a size- and trait-based fish community model that resolves the vertical structure of a fish community from shelf systems to open ocean environments. Fish individuals interact with each other through predator-prey interactions that are determined by a combination of habitat overlap in the water column and body sizes of predator and prey. Our results show how pelagic-benthic energy flows, in combination with seabed depth, change the vertical structure of the fish community and determine the dominant fish functional groups. We furthermore show that in open ocean regions with a substantial detritus flux to the seabed (typical for temperate and polar environments), fish feeding interactions may drive a feeding cascade of carbon to depth. Such a cascade does not occur in areas that are primarily structured around the pelagic pathway. The results highlight the driving forces of fish community structure in marine ecosystems. The model can be used as a tool to predict global fish and fisheries production and to examine climate impacts on upper trophic level marine ecosystems.