

Implementing an ecosystem approach to fisheries management: Gulf of Alaska Pacific cod

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In 2014-2016 an unprecedented warming event in the eastern North Pacific triggered changes in ecosystem productivity in the Gulf of Alaska (GOA) that ultimately impacted fisheries management. The marine heatwave was noteworthy in its geographical extent, depth range, and persistence, with evidence of shifts in species distribution and reduced productivity of lower-trophic and upper-trophic organisms. In 2017 groundfish surveys indicated that GOA Pacific cod (*Gadus macrocephalus*) had experienced a greater than 70% decline in abundance from the previous survey in 2015. Ecosystem indicators and bioenergetics models suggested this decline could be explained by an increase in metabolic demand during this “endless summer” and a reduced prey supply. Although increased mortality likely led to the decline in current fishable population, historically low recruitment concurrent with the heat wave portends a slow recovery for the stock. The GOA Pacific cod fishery supports a \$103 million dollar fishery, 29% of the total groundfish harvest in the GOA. The single-species age-structured assessment model determined that an 80% reduction in allowable biological catch was needed, with similarly low quotas projected for at least the following four years. The 40-year history of cooperative research and adaptive management along with a coherent story on the likely decline of this stock and personal contacts among stakeholders facilitated the fast response and acceptance of the reduction in quota taken by the North Pacific Fisheries Management Council. This action demonstrates a successful intersection of climate change with ecosystem-based fisheries management in context of GOA Pacific cod.