Climate change causes timing shifts in fish reproduction

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Research by Rebecca Asch, a recent graduate of Scripps Institution of Oceanography at UC San Diego, shows a strong correlation between warmer ocean temperatures and changes in the timing of fish reproduction.

The study, "Climate Change and Decadal Shifts in the Phenology of Larval Fishes in the California Current Ecosystem ," was published in the July 9 early edition of the *Proceedings of the National Academy of Science*. This is the first study to examine the effects of temperature,

upwelling, and abundance of zooplankton on fish phenology in the Southern California Current ecosystem.

Climate variability has changed the seasonal cycle of larvae production by fishes in the California Current. Such shifts in seasonal, biological processes are known as phenology. Changes in phenology are studied by scientists as a key way to assess the effects of climate change on a species.

There have been extensive studies on the phenology of terrestrial (land) species, but comparatively few studies on how climate variability affects seasonal behavior of marine species. Existing studies indicate that changes in seasonal cycles are occurring earlier in most terrestrial ecosystems. Climate change may cause the phenology of marine animals to change more rapidly than terrestrial species.

Unseasonably warm ocean temperatures may also affect migration patterns, bringing several marine species usually found in regions closer to the Equator closer to Southern California. In February, a pod of false killer whales were seen from the Scripps Pier; this was the first time these whales have been seen north of central Baja California.

Asch studied the larval stages of 43 fish species that were collected off the Southern California coast between 1951 and 2008. The research used the larval fishes from the California Cooperative Oceanic Fisheries Investigations (CalCOFI), a unique data set that has been consistently collected and maintained for over 60 years; it is among the oldest and most complete datasets of its type.

The data showed that many fish species spawned earlier, other species showed no long-term change in spawning cycles, and a few species spawned later. Many of the species with no long-term changes in spawning show variations in spawning between years, indicating that the

changes in their spawning cycles may have occurred due to factors other than climate change, such as naturally occurring climate variability.

Asch's findings may also be useful for fisheries management. "The fishes are reacting to climate change and it will be important for any fisheries management with a seasonal component to adapt their practices to avoid mismanagement," she said.

The Southern California Current is an example of an Eastern Boundary Current Upwelling (EBCU) ecosystem. These ecosystems account for over twenty percent of global fish catch. If the California Current is representative of other EBCU ecosystems, similar changes in fish phenology to ones observed by Asch could be occurring around the world.

A change in the time of year when fish reproduce can affect their overall ecology. Generally, fish reproduce during seasons when there is an abundance of zooplankton and/or when upwelling is minimal. This behavior maximizes the survival of larvae and prevents larvae from being swept into unfavorable habitats by currents. Unlike fishes, zooplankton have not exhibited continuous changes in phenology over the 60-year period of the CalCOFI program. Over time, this "mismatch" between the seasonality of larvae and zooplankton could cause fish species to potentially spawn during less than ideal periods for larvae survival.

More information: "Climate change and decadal shifts in the phenology of larval fishes in the California Current ecosystem." *PNAS* 2015 112 (30) E4065-E4074; published ahead of print July 9, 2015, DOI: 10.1073/pnas.1421946112

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