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[2] New Research Takes On Future, Past Fish Runs

Two new papers from the University of Washington show that it takes more than getting a lot of fish back to spawn to ensure good numbers in the future. Both were published last month in *Proceedings of the National Academy of Sciences*.

Titled **"Frequency and intensity of productivity regime shifts in marine fish stocks,"** Katyana Vert-pre and her co-authors found that sheer population abundance was satisfactory for explaining future returns in only 18 percent of the 230 stocks they examined, while nearly 39 percent were better explained by a "regimes" hypothesis, where shifts between high- and low-level production regimes were unrelated to abundance.

Another 30 percent were explained by a "mixed hypothesis," where production was related to a combination of abundance and irregular changes in the relationship. A "random" hypothesis--where production was unrelated either to abundance or regime shifts--best explained another 13 percent of the stocks studied.

The paper also took a passing shot at conventional fisheries management, which calls for lowering catches to rebuild stocks, "so sustainable harvests will follow once stocks are rebuilt." The authors point out that such a world view may be wrong. They said that if a stock's production is governed by productivity regimes and stock assessments don't account for these shifts, "the underlying management theory with respect to sustainable yield is incorrect."

In a statement that accompanied the paper's release, study co-author Olaf Jensen of Rutgers University said, "We can think of fisheries like natural savings accounts, where we're trying to harvest the interest--what fisheries scientists call the 'surplus production'--without causing a long-term decline in the principal or abundance of mature adult fish.

"Fisheries scientists have generally operated under the assumption that the 'interest' is determined by the abundance of mature adults," Jensen continued. "Our research shows that this is rarely the case. Instead of operating like a simple savings account, fisheries are more like volatile stocks where the rate of return is determined by a variety of complex factors outside the control of managers."

The paper noted that oceanographic factors are important drivers of fish production in the North Pacific, tropical Pacific, and North Atlantic, but they "found no obvious correlation between oceanic regime shifts and changes in productivity of individual stocks."

A wide range of factors could be involved, the authors said, "influencing recruitment, survival, or growth. Each of these may be influenced by physical changes in the environment, as well as by changes associated with food, competitors, or predators. Because we know from the long-term historical record that fish stocks fluctuate considerably in abundance in the absence of fishing, it should be expected that changes in abundance or in predators and prey of any species would lead to changes in their productivity. It is not at all clear that one should expect a direct causal relationship between physical changes associated with oceanic regime shifts and shifts in productivity of fish stocks."

Another **new paper** has examined sockeye salmon productivity in southwestern Alaska lakes in 16 different watersheds over the past 500 years--long before commercial fishing began to take its toll a hundred years ago.

The new paper--"Centennial-scale fluctuations and regional complexity characterize Pacific salmon population dynamics over the past five centuries"--has found that climate regimes generally favorable to salmon did not mean all populations went up at the same time.

By analyzing marine-derived nitrogen isotopes in lake sediments brought back by spawning sockeye, scientist Lauren Rogers and her co-authors found large fluctuations--"indicating prolonged periods of higher-than-average and lower-than-average salmon abundance lasting for decades to centuries." (*NW Fishletter* first reported on the sockeye/sediment research in 1996 **here.**)

The authors say the dominant mode of variability was on centennial time scales, including cycles that lasted up to 200 years. They said some population patterns do not seem to track with the changes in periodicity of the Pacific Decadal Oscillation over the past 400 years that are evident in coral and tree-ring records. The PDO may have shifted every

20 to 30 years before the past century, they say, instead of the 70-90 year periods since around 1800.

But factors other than climate may be playing roles in these low-frequency variations in sockeye numbers, say the authors, who suggested localized food-web interactions and disease dynamics could be involved, or bottom-up changes in the biological productivity of the 20 lakes in the study, coming from differences in nutrient inputs or the slow build-up of predator populations in lakes or estuaries.

"Furthermore," they say, "climate variation is likely to interact with these ecological mechanisms to create non-linear dynamics that may play out uniquely in different ecosystems."

Daniel Schindler, UW professor of aquatic and fishery sciences and co-author of the paper, said, "Surprisingly, salmon populations in the same regions do not all show the same changes through time. It is clear that the salmon returning to different rivers march to the beat of a different--slow--drummer. The implications for management are profound.

"While it is convenient to assume that ecosystems have a constant static capacity for producing fish or any natural resource," he continued, "our data demonstrate clearly that capacity is anything but stationary. Thus, management must be ready to reduce harvesting when ecosystems become unexpectedly less productive and allow increased harvesting when ecosystems shift to more productive regimes.

"Management should also allow, and probably even encourage, fishers to move among rivers to exploit salmon populations that are particularly productive," he said. "It is not realistic to assume that all rivers in a region will perform equally well or poorly all the time." ***-B. R.***

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Frequency and intensity of productivity regime shifts in marine fish stocks

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