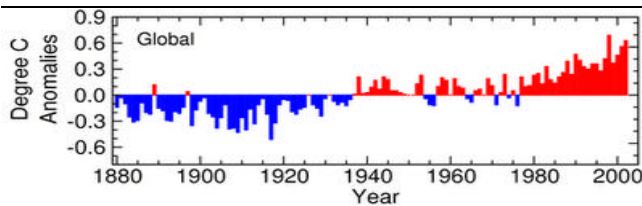




Bird Reproduction in Northwest U.S. Linked to Global Climate Phenomena

By Phil Nott, David DeSante, Rodney Siegel, and Peter Pyle

In August 2000, tourists at the North Pole observed a large hole in the ice where no hole had been seen before. In the last decade, high temperature records have fallen across the United States and Europe. The National Climatic Data Center reported that in 2002, “Global average combined land and sea surface temperature was the third warmest on record for May and second warmest for March-May.” Virtually all scientists agree that global warming is real and that the global climate is changing rapidly.



Differences from mean global temperature (anomalies) over the last 122 years. Note the increasing trend since the early 1900s, especially during the last two decades. Plot provided by NOAA - <http://lwf.ncdc.noaa.gov/oa/ncdc.html> July 2002.

Scientific literature shows that at least two global climate phenomena, the well-known El Niño/Southern Oscillation (ENSO) of the Pacific Ocean, and the North Atlantic Oscillation (NAO), which drives temperature fluctuations in North Atlantic surface waters, affect many plants and animals worldwide.

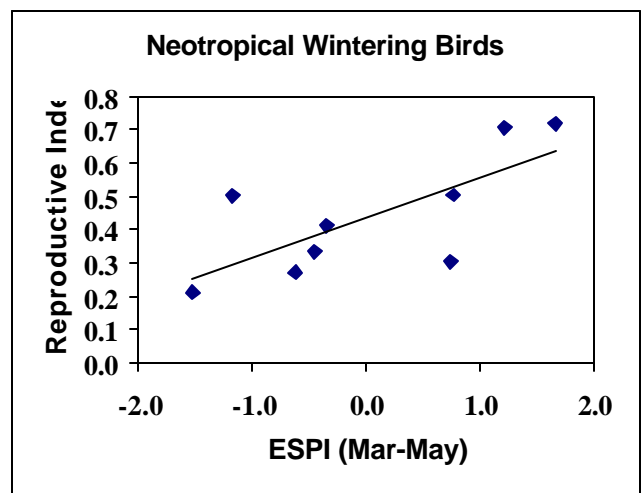
Does global climate affect bird populations in the ecologically important Pacific Northwest bioregion? We at the Institute for Bird Populations (IBP) operate 36 Monitoring Avian Productivity and Survivorship (MAPS) stations on six national forests in Washington and Oregon. For 34 landbird species that breed at these stations, we investigated the relationships between seasonal ENSO and NAO climate data and measures of reproductive success from nine years (1992-2000) of MAPS bird banding data. The National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) provided the climate data used in this study.

Strong relationships emerged between seasonal climate indices and annual reproductive indices (the ratio of juveniles to adults captured). Surprisingly, for both ENSO and NAO, reproductive success on the breeding grounds correlated most strongly with the late winter and early spring conditions prevalent three months prior to the breeding season - before many birds have even reached their breeding grounds!

How do these climate phenomena influence bird population dynamics? Oceanic oscillations can influence seasonal weather patterns that determine, for instance, the onset of spring, the strength and direction of winds during migration, and the abundance of insects and seeds on both wintering and breeding grounds. These factors affect the physical condition of adults, which, in turn, can affect various components of breeding success, such as clutch size, number of clutches, nest success, and juvenile survival.

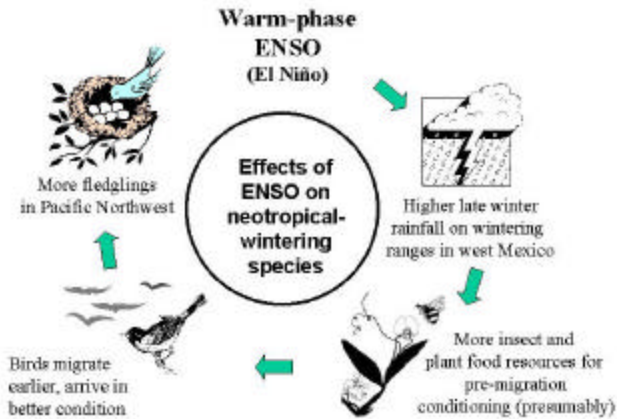
We know regional differences exist in relationships between climate and weather, and we also know that species breeding in the Pacific Northwest overwinter in different climatic regions. We therefore decided to investigate whether the effects of climate on neotropical migrant species that overwinter in western Mexico differ from the effects on temperate wintering species that overwinter from California to Washington.

Are neotropical migrants and temperate wintering species affected differently? Yes. Although both phenomena affect 29 of the 34 species studied, it appears that the warm phase of ENSO, that induces El Niño conditions, increases the reproductive success of neotropical wintering species more than that of temperate wintering species. In contrast, the NAO warm phase increases the breeding success of temperate wintering species more than that of neotropical wintering birds.



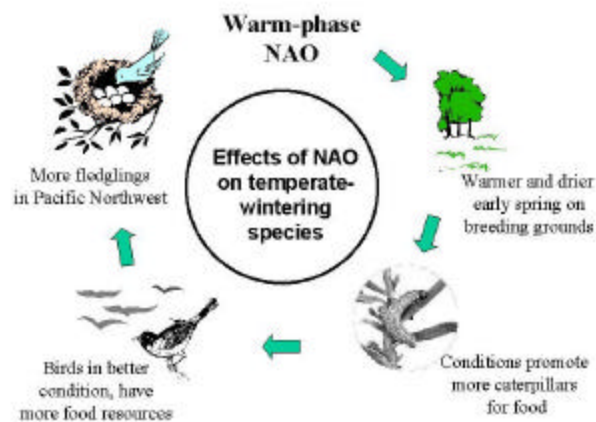
Reproductive success among neotropical migrant species increases with El Niño Precipitation Index (ESPI). Strongly positive ESPI values are associated with El Niño conditions.

How can El Niño conditions in the late winter and early spring affect the breeding success of neotropical migrants three months later and some 5,000 km farther north? We don't really know for certain, but we can propose a number of ecologically meaningful mechanisms to explain the relationship.



The Big Picture I: ENSO and neotropical migrants

For neotropical migrants, El Niño conditions prior to spring migration result in higher precipitation and lower temperatures, thus, increased soil moisture, throughout the entire Pacific slope of Mexico. Perhaps this produces more new foliage, and hence more insects. The milder environmental conditions and increased food availability would allow birds to improve their physical conditioning and better survive the rigors of migration. It's likely that other factors may play a role. For instance, analysis of NOAA wind vector data shows that spring winds are more favorable for northward migration following an El Niño winter.

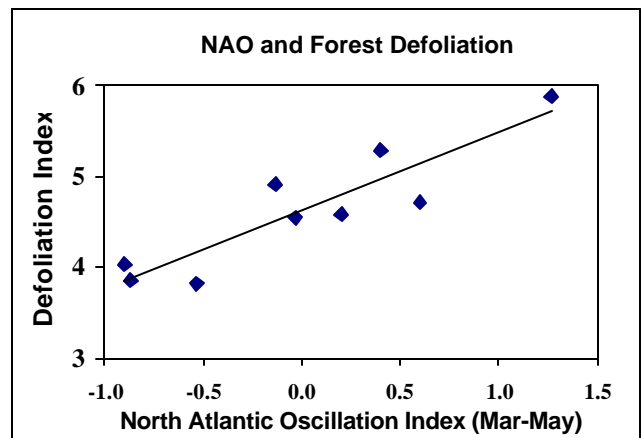


The Big Picture II: NAO and temperate wintering birds

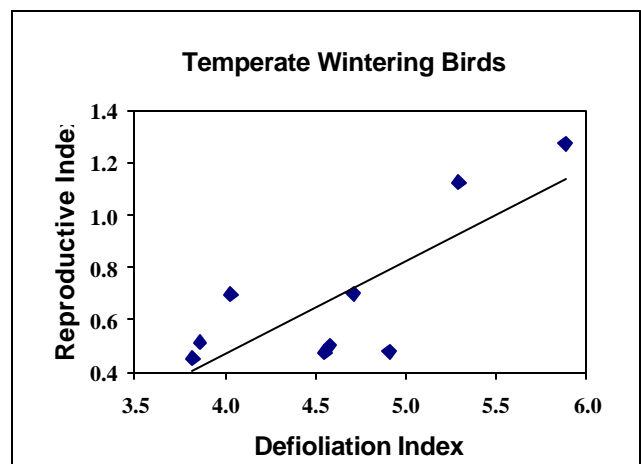
What is really exciting about these results is the strong evidence suggesting that weather conditions on

the wintering grounds of some neotropical migrants may have more effect on productivity than conditions on the breeding grounds. This critical new information suggests that we should study more closely the ecology of these birds on their wintering grounds.

How do NAO conditions affect the breeding success of Pacific Northwest birds? What is also striking about the results are the relationships among NAO, forest defoliation by moth larvae, and reproductive success, especially among temperate wintering birds. From annual surveys conducted by the USDA Forest Service Pacific Northwest Region 6, we constructed annual indices describing the severity and extent of defoliation in the same six national forests in which the MAPS stations are located.



Warmer North Atlantic surface waters, as indicated by a positive North Atlantic Oscillation Index, are associated with higher defoliation levels, caused by moth caterpillars, in six national forests located in the Pacific Northwest.



In turn, reproductive success increases as levels of defoliation increase for birds that breed in the Pacific Northwest and winter in the temperate zone.

These indices reflected the damage caused by the larvae of two moth species, the western spruce budworm and the Douglas-fir tussock moth. Clearly, as depicted in the two graphs above, avian reproductive success, springtime NAO, and defoliation are all highly correlated in this region.

A recent meteorological study published in the journal *Science* showed that warm-phase NAO activity induces drier, warmer late winter and spring conditions in the Pacific Northwest. This warmer, drier weather leads to increased foliage earlier in the year to support the spruce budworm larvae that emerge from hibernation in late April and tussock moth larvae that hatch in May. In addition, the milder weather probably helps these eggs and larvae better survive the winter.

But how do we know that birds eat these insects?

Research conducted by Torolf Torgersen, who studies forest insects for the Forest Service in the Pacific



Northwest, shows that many of the bird species in our study are very important predators of moth caterpillars, especially those of the spruce budworm and Douglas fir tussock moths that defoliate large areas of forest.

Topkill in a grand fir defoliated by western spruce budworm moth (Choristoneura occidentalis). USDA Forest Service Archives. #0806070. <http://www.forestryimages.org/>

In fact, the NAO effect was much greater among bird species *known to be predators* of these moth larvae than among species *not known to be predators*. It appears that during warm-phase NAO years, ample food is available prior to and during the breeding season, allowing for increased productivity. In addition, another piece of IBP's Pacific Northwest research (recently published by Island Press) shows that temperate wintering species in the Pacific Northwest generally nest earlier than neotropical migrants, so perhaps they benefit from the plethora of larvae that appear in April and May. This is critical information for many forest managers.

As Torgersen himself said back in 1991, "The need to reduce damage to forests from insect pests suggests that managers view [the pests'] natural enemies (birds and ants) as resources to be conserved and enhanced." Clearly, forest managers need to conserve bird habitat in order to maintain overall forest health.



Douglas-fir Tussock moth (Orgyia pseudotsugata): flightless female with pupa (left) and winged male (right). USDA Forest Service Archives. #0949032 and #2254043 from <http://www.forestryimages.org/>

What do we propose to research next? There are so many questions to ask of MAPS data - it's very exciting for us! Obviously, we want to look deeper into the mechanisms we have proposed. In fact, Phil Nott recently finished another investigation showing that seasonal weather affects not only reproductive success but also the survival rates of birds that breed in Texas. This is the first time we have been able to relate annual survival rates to weather patterns.

Our next step is to investigate the influence of weather on survival and reproductive success in other regions of North America. Results of this work will allow us to account for climate and weather in regional comparisons of the effects of landscape structure on the reproductive success of a number of target species of concern. This will be an important step towards our ultimate goal of providing land management guidelines designed to reverse recent population declines and maintain stable or increasing bird populations across North America.

These findings are published in a paper entitled "*Influences of the El Niño/Southern Oscillation and the North Atlantic Oscillation on avian productivity in forests of the Pacific Northwest of North America*" in *Global Ecology and Biogeography* (July 2002) from Blackwell Publishing, Oxford, UK. Other details can be found at www.birdpop.org.

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