Finding a Common Language:
Quantifying Physical Forcing on Biological Systems Palmer LTER

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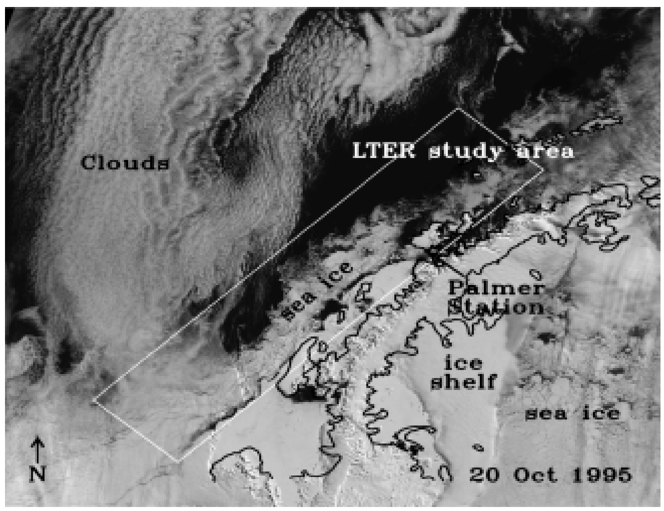
Physical and biological systems traditionally are studied by different disciplines with different sets of terminology. But a recent article in *BioScience* by Palmer LTER (PAL) participants (R.Smith, K.Baker and S.Stammerjohn, 48(2):83-93,1998) bridges the gap between these disciplines. The article proposes a scientific method for quantifying physical forcing on biological systems. 'Exploring Sea Ice Indexes for Polar Ecosystem Studies' develops the concept of sea-ice indexes as the common vocabulary for the quantitative description of sea ice.

Sea ice is a complex matrix of physics and biology. How sea ice forms determines its internal structure, strength and thickness, as well as the amount of incorporated biological material, and ultimately, the amount of ocean covered—hence its function as both a biological platform for or barrier to the marine ecosystem.

Because of this complexity of physics and biology, a qualitative description of sea ice can create more confusion than insight. For example, a description such as "a high sea ice year" may refer to very different situations: i) a lot of sea ice at one particular time during the winter, or ii) lots of sea ice throughout the winter. Designating any particular year as a high sea-ice year is extremely vague, especially in the polar marine environment where seasonal and interannual variability are notoriously high, and such vagueness can lead easily to inconsistencies in its interpretation. These inconsistencies not only inhibit cross-comparisons but also limit the identification of the physical mechanisms forcing the variability in the marine ecosystem. In short, information such as the timing and duration of maximum sea ice extent are not conveyed in designating a year as having high or low sea ice.



Sea Ice at Palmer LTER

The BioScience article, describing the wax and wane of sea ice over the 20 million km2 of Antarctic ocean, develops a set of systematic and quantitative indexes that describes both the magnitude and timing of sea ice. A variety of temporal scales are provided to capture both the seasonal and interannual variability of sea ice, and a variety of spatial scales are examined to emphasize the need to identify the appropriate spatial scale(s). For example, the spatial scale(s) must be defined based on both the geographical region of physical influence and the seasonal changes in distribution patterns within the ecosystem. Thus, suitable sea ice indexes not only provide a quantitative and consistent definition of the timing and magnitude of sea ice but also a common context to better resolve ice-ecosystem dynamics.

Although this particular study focuses on sea ice and the Antarctic marine ecosystem, the approach is applicable to any ecosystem study, as exemplified by many other LTERs. The approach requires communication between physical and biological scientists in order to determine the most appropriate biological spatial and temporal scales of physical forcing. One strength of LTER's is that they are inherently multidisciplinary, making cross-discipline communication not only necessary but accessible. The scientific community at large benefits from the LTER example where a wealth of information is gained through cross-discipline communication.

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marshes, landscape analyses will be used to determine how local marsh changes may affect the viability of the regional population (i.e., the metapopulation).

In another effort, begun years earlier, Erwin and colleagues from partner organizations, the USGS, The Nature Conservancy, the College of William and Mary, and the Virginia Game and Inland Fisheries Department, have been collecting data since the mid 1970s on breeding populations and colony site use by more than 25 species of waterbirds along the Virginia barrier islands. The data have been entered into a GIS and will be analyzed to determine the degree to which physical attributes at the local and regional scales influence colony site dynamics by each species or group.

Combining the information from these efforts should enable biologists to determine the spatial and temporal risks of marsh loss, the number of waterbird species that benefit or are adversely affected by potential marsh changes, and with spatial modeling, should allow predictions to be made of how dynamic habitat changes will influence not only population trends by species, but also how colony nesting site and feeding distributions will change with incremental changes in relative sea level. Model results can then be tested in a number of other estuaries along the Atlantic and Gulf coasts to see how generalizable the pattern appears to be.

Figure 4. Collecting sediment cores in a salt marsh impoundment at Merritt Island National Wildlife Refuge, FL. Impoundments provide the opportunity to manipulate hydroperiods (photo by Linda Blum, UVA).

Figure 2. Installing Sedimentation Erosion Table pipe in Spartina patens at Nauset Marsh, Wellfleet, Cape Cod National Seashore MA . (Photo by Charles Roman, USGS)