Tracking the king of the swamp

Radio transmitters have moved beyond the days of talking to your friends through walkie talkies. They are now being used to track alligators, the rulers of the swamp, to learn more about their movements between freshwater and marine environments. Once attached, the GPS and radio transmission devices can track the alligator's movements for up to four months. With the use of these devices, scientists from the Georgia Coastal Ecosystems LTER site were able to determine that time spent in each ecosystem is dependent on multiple physical factors within the environment, such as tidal range and temperature.

Unlike their cousins the crocodiles, alligators do not have salt glands and therefore lack the traits necessary to survive full-time in salt water. They move back and forth between marine and freshwater ecosystems to feed and rebalance their salt levels. By tracking the alligators, the scientists discovered the most important factor influencing the duration of trips to the marine environments was maximum water depth, a proxy for tidal range.

The team found that alligators remained in marine habitats for longer periods of time around spring tide events, where there is the greatest difference between high and low tides. Spring tides mean one thing for these alligators: more food. Due to the extreme high and low tidal heights, water speeds increase and displace common marine prey such as small fish and crustaceans. Additionally, the extremely low water depths isolate and concentrate aquatic prey. Both of these spring tide factors make it easier for the alligators to feed and explains why they spend more time in marine environments around spring tides.

Other physical factors contribute to patterns of movement, such as temperature and precipitation, which are associated with the need to balance salt and water intake. By understanding which factors contribute to the movement between ecosystems, managers will gain a better understanding of the alligator's ecological impact on coastal ecosystems and be able to target conservation priority areas for the alligator.

Story picked up by the National Science Foundation: Alligators, rulers of the swamps, link marine and freshwater ecosystems

The white spruce and the snowshoe hare

Photo Credit: Dave Doe

In Alaska, the race of the tortoise and the hare has been reimagined as the race of the white spruce tree and the snowshoe hare. With the climate warming, forests are advancing upwards in elevation and northward in latitude, which is expanding available habitat for wildlife, such as snowshoe hares. To better understand this advancing treeline, scientists from the Bonanza Creek LTER site modeled the pattern of spruce establishment from 1970 to 2009 and found that fewer spruce established during periods of high hare abundance.

At both broad and fine scales, the range and habitat preferences of hares and white spruce overlap. They both prefer floodplain habitat with closed tree canopies, but (being mobile) the hares often beat new spruce seedlings to these preferable areas. Snowshoe hares have already spread into the increasing shrubby habitat far beyond the forest treeline and therefore as the spruce treeline advances, it must pass through a "snowshoe hare filter."

This filter is best represented by the 2009 peak in the hare population. With the increased population came an increase in feeding and therefore fewer trees were able establish. Additionally, with little snow on the ground, the hares easily feasted on the young seedlings. Spruce established well on floodplains with little tree cover due to the lower hare population in this habitat, but this location puts the trees at greater risk of drying out during the hot and dry summer months. Therefore, the hares push spruce into unfavorable habitats and prevent them from establishing due to higher feeding rates.

This study provides a unique opportunity to study the effects of herbivory on expanding vegetation under a warming climate. As the tundra shifts to tall shrubs and then forests, the spatial and temporal distribution of snowshoe hares will be one of the dominant factors determining the expansion of the treeline. Therefore, scientists and resource managers must continue paying attention to those shy and small herbivores occupying the undergrowth.

Recovering New England forests mitigate climate change

In nineteenth century New England, most of what is now forest was covered by farmland. To assess how climate change is affecting forest regrowth (and vice versa) researchers at the [Harvard Forest LTER] simulated forest recovery processes with and without climate change.

Under the climate change simulation, tree growth and biomass increased but forest community composition showed little change. This result contrasts with the outcome of climate niche models—which typically show species ranges shifting northward. Why the difference? Climate niche models simulate future suitable habitat based on the climatic conditions where species currently live. However, they do not assume species will continue to grow or simulate the actual process of the species moving. The mechanistic model used in this study incorporates tree dispersal, growth, and succession, accounting for the slow turnover of forests.

These findings are significant since most management decisions have been based on niche models rather than mechanistic models. Moving forward, managers should consider the strengths and limitations of both models to make the best science-informed decisions.

The team performed two different simulations from 2010 to 2110: one with current climate conditions and one with climate change projections. In the climate change scenario, forest growth increased due to a longer growing season. Forests were able to take advantage of these favorable growing conditions because they are still well below their maximum biomass capacity due to the previous disturbances. This increased productivity increases the amount of carbon that can be taken out of the atmosphere and stored in wood and soils, a climate mitigating effect.

This model comparison shows that the major changes to community composition will likely be due to the continued recovery of New England forests, with increases in shade-tolerant species. Not only will these recovery dynamics have a greater impact than climate change on forest composition, they will also play a climate mitigation role in the decades to come.

A changing tide: How local human disturbances affect sandy beach ecosystems

Photo Credit: Ingrid Taylar

To maintain the image of a pristine beach—wide stretches of sand absent of fly-ridden piles of seaweed—managers often add sand to beaches and remove seaweed. This removal may lead to a more enjoyable experience for humans, but it constitutes a major loss of habitat for sandy beach critters, which use the piles of washed-up kelp for food and shelter. Revisiting sites that had been sampled in the 1970's, researchers from the Santa Barbara Coastal LTER found that beaches with high human disturbances saw declines in species associated with wrack, or beached giant kelp.

The researchers performed intertidal surveys on 13 sandy beaches along the California coast in the 1970s and 2009-2011. On most of the beaches surveyed, wrack-associated invertebrates showed the largest changes in species richness. At beaches with little beach filling or grooming, richness of the wrack-associated invertebrate species increased.

Wrack-associated species play a vital role in nutrient cycling on beaches through the breakdown of wrack and are also important food sources for wildlife, especially shorebirds. The long term decline of these species represents a significant loss to the biodiversity and function of coastal ecosystems. Declines in biodiversity could lead to decreased ecosystem stability and function, as well as increased vulnerability to invasion.

The declines in wrack-associated species mirror trends for other beach-dependent species on urban coasts, such as turtles and nesting plovers, and highlights the impact of local human disturbances, relative to regional trends, on these beach ecosystems. Over time, local impacts to this ecologically important component of intertidal biodiversity may be reversed with management changes that reduce disturbances and allow for recovery. The recovery of these species will be especially important since sandy beach ecosystems dominate shorelines, making up 70% of open coasts.

Genetic differences may help corals adapt to changing conditions

Photo Credit: Moorea Coral Reef LTER

Individuals – even individuals of the same species – don't always respond to a stimulus in the same way. Studying calcification in a key coral species, *Acropora pulchra*, researchers at the Moorea Coral Reef LTER found greater variety in the corals' response to temperature than to high levels of CO_2 in seawater. Since individual variation is the raw material of evolution, the contrast suggests it may be easier for this coral species to adapt to rising temperatures than to increased ocean acidification.

Previous studies of coral colonies have shown that ocean acidification and high temperatures can inhibit the deposition of calcium, known as calcification, that builds coral reef structure. The common garden experiment described here was designed specifically to examine whether individual colonies of *Acropora pulchra* responded in different ways to ocean warming and acidification.

In addition to greater variation in the response to temperature than CO_2, the team also found that the fastest growing colonies under normal conditions were most affected by elevated temperature and CO_2 levels. This implies that coral colonies contributing the most to reef growth will be disproportionately affected by changing environmental conditions.

Since natural selection acts on individuals, knowledge of within-population genetic variability can help predict adaptive capacity under changing conditions.

How will climate change affect peak firefly activity?

Photo Credit: kobaken++

A typical warm summer night is complemented with the familiar glow of fireflies and the light spectacle they create darting around and lighting up the night sky. However, the timing of these light shows might be affected by environmental changes. In order to better understand the life history of the firefly, researchers from the Kellogg Biological Station (KBS) LTER investigated the phenological patterns of fireflies from 2004-2015 to determine what explains the variability observed in their mating season.

From long term weather and insect trap datasets, the researchers determined that temperature accumulation was the primary driver of phenology, with peak activity occurring around 800 degree-days (base 10°C). However, there was variation in the timing of peak activity, which was explained by changes in precipitation. In years with precipitation extremes, the mating season was delayed.

Warming temperatures and changes in precipitation patterns clearly have the potential to disrupt firefly phenology. Climate-change driven asynchronies also add the possibility of decoupling with other related systems, which can have community-wide consequences. Shifts in adult activity probably mirror shifts in larvae development, which could lead to a potential mismatch between the larvae and their food source, where resource availability is an important determinant of future mating success. Additionally, firefly larvae and other predaceous beetles are known to have a dramatic effect on the establishment of agricultural pests in the growing season, so an asynchrony could lead to an increase in agricultural pests.