Overview of site-specific research questions at the 8 coastal/marine sites in the U.S. LTER network

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Moorea Coral Reef LTER
Coastal / Marine Sites in the US LTER Network

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- 8 of the current LTER sites focus on coastal marine ecosystems
- Diverse set of coastal / marine biomes & research themes
- Oceanography 2013, vol 26(3) dedicated to the long-term research at these 8 sites
The principal biome at 4 coastal LTER sites is a benthic and/or pelagic marine ecosystem.
Understanding how disturbance & long-term change shape the nature of coral reef ecosystems
Moorea Coral Reef (MCR) LTER Central Research Questions

- What processes & attributes enhance or weaken the ecological resilience of contemporary coral reef ecosystems? (State change dynamics & consequences)
- How will changing environmental drivers alter community composition, ecosystem functioning & resilience of reefs in the future?

External Drivers

- Short-term Pulses:
  - Temperature
  - Cyclones
  - Pest Outbreaks (COTS)

- Long-term Presses:
  - Ocean Acidification
  - Ocean Warming
  - Sea Level Rise

Coral Reef Ecosystem

- Habitat connectivity
- Propagule connectivity / Recruitment
- Nutrient regimes

Corallivory ↔ Coral - Algae Interactions ↔ Herbivory

Alternative Community States
Principal biome: Semi-arid coastal zone (kelp forests, watersheds, nearshore ocean)

Understanding ecosystem connectivity at the land-ocean margin
Overarching Question

How are the structure and function of kelp forests and their material exchange with adjacent land and ocean ecosystems altered by disturbance and climate?
California Current Ecosystem (CCE) LTER

Principal biome: Coastal upwelling zone

Understanding drivers of abrupt ecosystem transitions in a changing ocean climate
Mechanisms Underlying Ecosystem Transitions

Hypothesized mechanisms:

- Sustained, anomalous **alongshore advection** of different assemblages
- **In situ food web changes** in response to altered stratification and nutrient supply
- Changes in **cross-shore transport** and loss/retention of organisms
- Altered **predation pressure**
Principal biome: Polar marine pelagic

Understanding drivers of primary production & food web dynamics

Focus on mechanisms coupling climate variability, sea ice, marine ecosystem dynamics and biogeochemistry
Research Themes and questions, 2014-20:

**Long-term change and ecosystem transitions.** What is the sensitivity or resilience of the ecosystem to external perturbations as a function of the ecosystem state?

**Lateral connections and vertical stratification.** What are the effects of lateral transports (connectivity: sea ice, glacial meltwater, offshore heat and nutrients, iron) on local stratification and productivity and how do they drive changes in the ecosystem?

**Top-down controls and shifting baselines.** Is the ecosystem responding to this large-scale change in top-down control resulting from the recovery of whales from human predation?

**Foodweb structure and biogeochemical processes.** How do temporal and spatial variations in foodweb structure influence carbon and nutrient cycling, export, and storage?
The principal biome at the remaining 4 coastal LTER sites is an estuarine ecosystem on a protected coast or embayment.
Plum Island Ecosystems (PIE) LTER Est. 1998

**Principal biome:** Coastal estuary (cold water Acadian Province)

*Understanding ecosystem & community responses of estuarine ecosystems to changing environmental drivers*

A linked land-water system: studies include the watersheds, fresh, brackish and salt water marshes, estuaries, bays and tidal flats.
How will trophic structure & productivity respond to changes in organic matter, nutrient loading & hydrodynamics caused by climate, land use & sea level?

**Climate**

- Flows and transformations of C, N, P, and S in areas with different geomorphology

**Human activities**

- Physical changes in marsh-creek structure

**Sea Level**

- Changes in river flows, N and C export with urbanization and beaver ponds
- Hydrodynamic and geomorphic controls on the distribution and abundance of organisms

**Current Foci Include:**

- Parker River Daily Discharge
- Physical changes in marsh-creek structure
- Changes in river flows, N and C export with urbanization and beaver ponds
Virginia Coast Reserve (VCR) LTER  Est. 1987

**Principal biome:** Coastal barrier island complex (salt marsh, lagoon, barrier island)

*Understanding how long-term change and disturbance control the dynamic nature of coastal barrier landscapes*

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**Climate Press:** Sea level rise, temperature, precipitation, [CO₂]

**Climate Pulse:** Storms

**Regional Press:** Land use change, atmospheric deposition, poultry farms, aquaculture

**Regional Pulse:** Invasions
Ecosystem changes on the coastal barrier landscape in response to long-term drivers are primarily the result of complex non-linear dynamics based on the existence of alternative stable states and threshold responses.
Georgia Coastal Ecosystems LTER
Est. 2000

Principal biome: Coastal barrier island / marsh complex

Understanding how salinity regimes affect community structure & ecosystem processes
GCE Focus: How does variation in salinity and inundation affect coastal ecosystems?

Area 1
Variation in precipitation, freshwater input, and sea level

Area 2
Variation in estuarine salinity and tidal flooding

Area 3a
Effects on fresh/brackish wetland structure & function

Area 3b
Effects on Spartina marsh structure & function

Area 3c
Effects on high marsh structure & function

Area 4
Consequences for habitat distribution and carbon exchange in estuaries

Mainland (McIntosh County)

Habitat
- Upland, Islands
- Water
- Fresh, brackish marsh
- High marsh
- Salt marsh

Water Flows
- Riverine inflow
- Runoff, Groundwater
- Freshwater exchange
- Seawater
- Precipitation, ET
Florida Coastal Everglades (FCE) LTER

Principal biome: Freshwater marsh – estuarine mangroves

Exploring long-term ecological dynamics in a sensitive coastal ecotone

Shark River Slough (SRS)

- Freshwater Slough
- Oligohaline Ecotone
- Gulf of Mexico

Taylor Slough (TS/Ph)

- Freshwater Slough
- Oligohaline Ecotone
- Florida Bay
How does climate change (SLR) interact with freshwater allocation decisions (RESTORATION) to control:

1. Hydrologic conditions
2. Carbon balance in the oligohaline ecotone?
3. Do legacies of disturbance influence vulnerability?
4. What are possible futures for the FCE under contrasting SLR and freshwater flow scenarios?
Expanding the US Network of Coastal Ocean Ecosystem LTERs?

For more information on LTER sites: http://lternet.edu