Natural disturbance and intermediate disturbance hypothesis

* In many plant communities, natural disturbance supports niche apportionment/successional dynamics (e.g., forest gap dynamics, fire disturbed landscapes, etc.).
* However, magnitude and/or duration of disturbance may destabilize communities, bringing about an alternative stable state.
  + In estuaries, successional compositional structure may include very short ground covering plants, and taller canopy-forming graminoids.
* Grazing as a form of natural disturbance
  + Grazing disturbance in many ecosystems; degree of disturbance related to herbivore population size.
  + Goose grazing in estuaries is natural, although in the PNW may be exacerbated by introduced populations of Canada geese (*Branta canadensis*, “CAGO”)
  + Define grazing vs. grubbing, and seasonal patterns of this behavior.
  + Following intensive grazing/grubbing, graminoid habitat (densely covered by tall perennials with deep, rhizomatous roots) is converted to mudflat, populated by ruderal species (densely covered by short annuals with shallow, filamentous roots).
    - Recovery over time is possible if geese are excluded, and vegetation is allowed to recover from clonal expansion and/or seed.
    - These recovery mechanisms are dependent on vegetation dynamics

Vegetation dynamics, and facilitation of seed trapping and retention

* Above-ground vegetation facilitates seed trapping.
  + General information about seed bank retention:
    - Vegetation density/complexity facilitating seed trapping
      * Define ‘structural traits’ – pay attention to cover, height, life history strategies.
    - Site structural complexity drives grounding of intertidal hydrochorous dispersal
  + General info about seed production in estuaries
    - How often do plants of different groups produce seed (compared to vegetative clonal growth)
    - goose grazing can increase seed production of grazed plants (citation in press or Kathey Kelsey, personal comm.?)
* However, testing seed bank richness and abundance across different disturbance conditions and seasons has not been tested in Pacific Northwest estuaries. This is important to understand potential availability of native seed in the seed bank to regenerate following disturbance, or to identify potential pathways for invasive species to establish.

Estuary vegetation reproductive mechanisms and seed bank dynamics, focusing on the PNW

* Broadly define estuaries (define salinity regime & plant characteristics).
  + Explain basic geomorphologic details between coastal plain Atlantic estuaries and fjord-restricted PNW.
  + Explain both coasts dominated by perennial herbaceous graminoids, and studies typical focus on the Atlantic coast, although PNW evidence is increasing.
* Mostly perennial graminoids, with some annual species.
  + Several invasive species occur (Brass buttons, others?), however rhizomatous, perennial grasses may be of higher concern because of their ability to form clonal mats that exclude other species.
* Seasonal variation in seed bank richness & abundance
  + Seed sources may be local plants (“seed rain”), or intertidal hydrochory.
    - Most graminoid species disperse seed from the parent plant in autumn
    - Hydrochorous dispersal depends on buoyancy; buoyancy is highest at dispersal from the parent plant.
    - Seeds ‘ground’ following imbibition
  + Winter chilling is important for dormancy release; storms/tidal surges result in higher intertidal dispersal
  + Germination occurs in the late spring/early summer, provided sufficient WoO and competitive space.

The main objective of this research is to understand how vegetation structure affects surface seed bank dynamics in a grazing-disturbed ecosystem. We investigate the following: 1) How does CAGO grazing impact species and Plant Functional Groups (PFGs)? 2) How do species and PFGs respond over time since grazing exclusion? 3) How do seed banks respond over time since grazing exclusion? 4) Is seed bank composition similar to above-ground species composition?