Forest Change Fast Facts

FACT: The state of things as they are (a thing that has actually happened or is true)
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Facts

Use photo of late-successional forest stand to brainstorm/share what they know about forests, use animal photos to remind students who lives in the habitat.

LIGHT: Dominated by tall trees, layered canopy = very shady, openings made from a fallen tree provide sunny areas
AIR: Trees slow wind, except along forest edges and openings. Shade = cool temps
WATER: Fog and rain collect in tree branches and drip to ground.
SOIL: Lots of organics (needles, decaying leaves, tree trunks) makes lots of space for air and water. Soil absorbs and holds water like a sponge.

- **Coastal temperate rain forests:**
  - Have a complex structure including many different canopy layers and different age trees in a single stand. (lots of habitats in this habitat!)
  - Have an abundance of epiphytes (plants living on the surface of other plants, such as lichens, mosses and ferns).
  - Are unique in their abundance of coniferous trees which can grow year round. Have cool temperatures, short growing seasons and a short drought period in summer
  - Have few deciduous tree species and these are found primarily in disturbed areas (riverbanks, blowdown sites, clearcuts, etc) They need more light.
  - Have half of their biomass made of dead trees, including snags and nurse logs. (Think - the making of high organic content soils!) Trees are habitat to many plants and animals in life and death. Stumps, nurse logs and standing dead trees provide important nutrients and access to LAWS.
  - Are dominated by Sitka spruce and a thick understory of salal.

- **Marbled Murrelet (predator, carnivore/specialist)**
  - Diving seabird that nests in old-growth coastal conifers.
  - Needs tree branches that are at least 6” diameter on which to nest.
  - Because it is a rapid, but not precise flyer – there must be large spaces between branches so it can land. This bird drops straight off branch to gain speed for take-off.

- **Western Redback Salamander (predator, omnivore/specialist)**
  - Big eyes – sees well in dark places.
  - Lives in forests, often under or in decaying logs
  - Eats worms, beetles – anything it can catch and swallow

- **Big Brown Bat (Predator, carnivore/specialist)**
  - Nocturnal – uses echolocation to locate night-flying insects
  - Roosts by feet in tree cavities, in deep bark crevices, logs or under bark (and buildings)
  - Eight species use the refuge – little brown myotis, big brown bat, Yuma myotis, long-eared myotis, long-legged myotis, California myotis, silver-haired bat, and hoary bat.

- **Tree Growth Rings**
  - Light color shows growth period, dark reflects winter dormant period – represents full year
  - Outside edge (directly under bark) is the growing area called cambium. Oldest rings in center
  - Wide bands = fast growth, narrow rings = slow growth
  - Dark marks curving or perpendicular may indicate fungus

Observation

Compare growth rings of two or more trees using tree cookies. What can students infer about the trees' habitat based on the fact of growth ring measurements?

Possible Inferences

- Trees of the same age compete for sunlight, grow tall and skinny (dog hair stand)
  - Tree rings will reflect fast growth when young(wide rings), slower growth when older (narrow rings)
- Something occurred in the habitat to remove all trees quickly. (logging or wind storm)
- Less complex in forest structure means fewer snags/dead logs, no multilayer canopy or forest gaps, minimal understory plants (less plant and wildlife diversity)
- Specialists lose habitat. Marbled murrelets don't have big enough branches on which to nest, bats and salamanders lose their shelter and possible food sources.

Test/Experiment

Use photo of dog hair forest stand to show composition and competition for L.A.W.S.

Variables that may Cause Change

Windstorms, flood, fire (rare in coastal forests), cutting ,clearing for development

What is the Refuge Doing to Help Wildlife?

Partnership with The Nature Conservancy to thin trees. Thinning speeds up the process towards late-successional stand composition. Trees grow larger with less competition. Understory is more diverse with increased access to L.A.W.S.

Dunes Change Fast Facts

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Facts

Use historic Leadbetter photo to brainstorm/share what they know about dunes. Use bellows to illustrate that sediment are wind transported freely with few plants to block movement. Dunes stay relatively low and level. Use animal photos to remind students who lives in the habitat.

LIGHT: Few trees and shrubs = very sunny
AIR: Open = very windy. Lack of shade = hot temps
WATER: High water table = seasonal wetlands. Sand drains quickly = dry
SOIL: Sandy with lots of space for air. Sand historically unstable and moved with wind.

- **Dunes/grasslands are…**
  - Historically open areas with native prairie vegetation
  - Native plants have been out-competed by non-native grasses and sand stabilization
  - These openings were maintained by high disturbance - wind transported sand, small mammal activity, herbivory (animals eating plants) and fire
  - Are characterized by low relief, mild temperature, high rainfall and fog, high water table, wind.
  - Are large areas of open sand and sparsely vegetated with native dune plants, few trees and shrubs (high sun – lack of shade).
  - Most plants have thick, leathery or waxy leaves to maintain moisture (wind & sun)
- **Western Snowy Plover**
  - Run, Stop, look, peck - visual foraging.
  - Upright posture, big eyes, round head, thick neck and short, thick bills.
  - Walking feet – minimized hind toe.
  - Nests in scrape on upper beach and dunes, needs high level of camouflage. Note markings and use of oyster shell around nest site. Will use broken wing display to distract predators from nest.
- **Streaked Horned Lark**
  - Uses sharp beak and long claws to dig in ground.
  - Eats insects, spiders, snails and seeds.
  - Long, pointed wings good for flying in windy conditions.
  - Has short legs and long claws – elongated hind claw.
  - Male performs elaborate flight and song to attract attention of female. Rises 800', circles and dives back to ground where he struts with horns raised and wings drooped.
  - Ground nester – shallow depression lined with plant material.

Variables that may Cause Change

Invasive plant – European beach grass arrives (show photos of dunes covered with non-native beach grass)

Possible Inferences

- Beach grass has web of roots and tall stems to capture sand
    - Dune will build up/gain steep elevation on Oceanside (where wind comes from)
    - More plants can take root as sand slows or stops moving with the wind
- Increased plant cover. Specialists lose habitat. Examples are Western Snowy Plover, Streaked-horned Lark. Lose foraging and nesting locations. Pink Sand Verbena cannot compete for LAWS.

Test/Experiment

Add toothpicks to dune to represent beach grass. Place toothpicks in tight clumps to represent how beach grass grows. Use bellows to simulate wind.

Observation

What happens when tall, tightly clumped plants are added to the dune? Wind slows when it encounters plants and sand drops out.

What is the Refuge Doing to Help Wildlife?

Use photos to illustrate that staff remove beach grass and grade dune to historic elevations to create sediment movement, space for native plants to grow and birds to nest. Add oyster shell to provide nesting camouflage for Western Snowy Plovers. Encourage or plant native plants such as pink sand verbena that can now thrive with less completion for L.A.W.S.

Mudflats and Saltmarsh Change Fast Facts

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Facts

Use mudflat photo to brainstorm/share what they know about saltmarsh and mudflats. Use tweezers and chopsticks to remove invertebrates from mud.

LIGHT: No trees or shrubs = very sunny
AIR: Open = very windy. Lack of shade = hot temps
WATER: Brackish water, tidal influence (ongoing changing water and salinity levels)
SOIL: Sandy, muddy or gravely depending on stream locations. Lots of dead material.

- **Salt marshes and Mudflats**
  - Are coastal wetlands that are flooded by tides (submersion, salinity, and temperature changes).
  - Smell like rotten eggs due to bacteria that grow in areas of extreme low oxygen (high amount of organic material – decomposing)
  - Occur worldwide, including every coast of the U.S. Are essential food, refuge and nursery habitat for more than 75% of all fisheries species (including fin fish and shellfish)
  - Have different plant communities and animals live at different elevational zones (due to salinity, tidal inundation). These zones may differ in as little as a few centimeters but has great effect on the amount of salinity the plant may be faced with. (high in elevation more salty due to less water to flush the dried salts away)
  - Currents make it hard for annual plants to establish from seed (so most are perennial growing each year from established roots or clone by breaking off from parent plant to root).
  - Mudflats have a rich diversity and abundance of invertebrates (worms, amphipods, isopods, mollusks)

- **Dunlin (predator, carnivore/specialist)**
  - Medium length, slender bill probes in bare, wet mud for worms, crustaceans and mollusks. Uses touch & smell.
  - Walking feet – short, elevated hind toe.
  - Often conserves heat by standing on one leg (tucking other into body).
  - Migrates to wet, coastal arctic to nest. Long, narrow, pointed wings for rapid, direct, long-distance flight.
  - Fast and agile flyer – will rapidly change directions as group to confuse predators such as peregrine falcons.
  - Diet is rich and can gain large amounts of weight in winter.

- **Pickleweed (producer, specialist)**
  - Has fleshy stems eaten raw or preserved as ‘sea asparagus’
  - Salt tolerant, doesn’t grow in places with high wave action

- **Lyngby's Sedge (producer)**
  - Most common shoreline sedge – pioneer colonizer of mudflats.
  - Prime forage for geese, swans and bears – high protein when young (25% crude)

- **Newcomb's littorine snail (prey, herbivore/specialist)**
  - Lives on the stems of pickleweed, and possibly other marsh plants. It also lives on substrate such as woody debris and rocks beneath vegetation, where it remains moist and protected from the sun and wind.
  - It feeds on microscopic and macroscopic algae and the vascular plants on and under which it lives. It presumably eats by rasping the surfaces with its radula (toothed tongue) to remove small particles for digestion.

Variables that may Cause Change

Invasive plant – spartina arrives (show photos of spartina invasion, root system)

Additional Facts

- Spartina is tolerant of salinity and being submerged
- Spartina grows fast, tall and compact, extensive root system
- Spartina has no native predators

Possible Inferences

- Spartina has deep web of roots and tall stems to capture sediments
  - sediment will build up and change grade of bay floor
  - tidally submerged mudflats turn to raised meadows of spartina
- Increased plant cover and loss of mudflats decrease number of invertebrates (loss of habitat), shellfish and other bottom dwellers.
- Specialists lose habitat. Examples are Newcomb's littorine snail (loses pickleweed as it is outcompeted by spartina), eelgrass (bay is transformed from partially submerged mudflats to meadows and channels, leaving little suitable habitat for eelgrass to grow) and shorebirds who eat invertebrates during winter or migration.

Test/Experiment

Use tweezers and chopsticks to remove invertebrates from sediments from below spartina.

Observation

Compare number of invertebrates from two samples. Over 10 x number of species in mudflat than spartina. (only a few species with low abundance will grow in spartina meadows)

What is the Refuge Doing to Help Wildlife?

Staff work with County, State and landowners to remove spartina clones. This helps re-establish sediment movement and mudflats.

Freshwater Streams Change Fast Facts

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Facts

Use stream and wildlife photos to brainstorm/share what they know about stream composition and wildlife. Pour stream water (including gravel, rocks, wood, plants and fish) into jar with large funnel to represent normal stream flow.

LIGHT: Streams often shaded by trees. Wetlands are often open and sunny
AIR: Moving water with riffles increases dissolved oxygen in water
WATER: Fresh water. Streams are generally clear. Wetlands can be murky with tannins
SOIL: Wet soils. Can be gravely in streams and rich in organics with finer particles in wetlands and ponds

- **Wetlands are:**
  - Any area periodically inundated or saturated by water (slow or stagnant water)
  - Are generally found near permanent water bodies (lakes, rivers, oceans, bays)
  - Soak up 'excess' waters from rains or floods like a sponge quickly – release slowly
  - Serve as filters and buffers (slow currents, sediment falls from water)
  - Plants often has less structure because they will be supported by water at least part of the time
- **Streams are:**
  - Moving water
  - Have large woody debris, pool & riffles, canopy shade (cool temps, high dissolved oxygen) - all important elements for cold, clear water needed by fish, mussels, invertebrates
  - Experience frequent disturbance from high-flow events - flooding.

- **Western Pearlshell Mussel (predator/prey, omnivore/specialist)**
  - Live only in cold, clear streams
  - Use gills to filter algae, zooplankton and bacteria out of water.
- **Chum Salmon (predator/prey, omnivore/specialist)**
  - Migrate upstream to fresh water to spawn
  - Woody debris in streams protects fry from predation before they move downstream to estuary
  - Need:
    - clear (low turbidity – suspended sediment), cold (shaded) water
    - gravel stream bottoms (spawning beds)
    - riffles (increased oxygen in water)
    - pools (resting areas)

Variables that may Cause Change

Road building, diking and development have altered stream flow (show photos of culvert)

Possible Inferences

- Culverts slows stream flow and cause sediment to fall out of water and collect on upstream side
- Culverts often clog and block flow large flood debris
- Culverts create barriers for fish (to small of an opening, water becomes too shallow, blocked by debris, raised about water column)
- Specialists lose habitat. Salmon cannot migrate upstream to spawn. Sediment buildup can cover spawning beds and freshwater mussel habitat.

Test/Experiment

Pour “stream water” through narrow funnel to represent stream flow through culvert.

Observation

Compare stream flow through culvert with unobstructed flow. What happens to debris, to fish?

What is the Refuge Doing to Help Wildlife?

Staff work with County, State and landowners to replace small diameter culverts with bridges (or large diameter culverts) that span the full width of a stream (show picture). This helps re-establish natural stream flow and removes barriers to fish. Large woody debris has also been placed in streams to create pools, riffles and habitat.

Bay Change Fast Facts

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Facts

Use shellfish and plankton photos to brainstorm/share what lives in the bay. Use seawater chart to share the ingredients of bay water.

LIGHT: No trees or shrubs = very sunny, Shallow = light to bottom in most places
AIR: Open = very windy, lack of shade = hot temps
WATER: Brackish water, tidal influence (changing water and salinity levels)
SOIL: Sandy, muddy or gravely. Lots of dead material.

- Seawater contains many minerals and substances including chloride, sodium and calcium.
- Many animals create protective shells out of calcium and other similar minerals they extract from seawater and secrete from their bodies.
- Calcium is basic (show pH chart). Calcium is used in antacids to help/change an acid stomach.
- **Willapa Bay is**
  - characterized by open water, tidal cycles,
  - Salinity can change drastically – being more fresh when tide is out allowing river water to influence, higher when tidal waters from ocean inundate
  - has sand and mud bottom, with patches of vegetation
  - shallow**, with only a few deep channels at low tide**
  - rich organic content in mud, sand and water – lots of dead materials (plant, animal, waste/poop)
  - Dominated by eelgrass meadows (few bays exist like this on the Pacific Coast)
- **Phytoplankton & Zooplankton**
  - Microscopic, often one-celled plants, very diverse
  - Live in water column
  - Food for many
  - Diatoms are plankton
  - Hundreds of thousands of plankton can fit in a 1 centimeter cube
- **Littleneck Clam (prey, omnivore/detritivore/specialist)**
  - Filter feeder – draws water through siphon and gills to filter out phytoplankton and detritus from water.
  - Uses foot to dig into sand or gravelly substrate.
  - As larvae they swim and considered zooplankton

Variables that may Cause Change

Climate change is increasing the amount of carbon dioxide is in the air and absorbed in sea water.

Additional Facts

- Additional CO2 is being created by humans (vehicles, industry) and increased incidence of fire.
- Increase CO2 changes the pH of water – making it more acidic (show pH chart)

Possible Inferences

- Increased acid in sea water (lower pH), decreases calcium available for wildlife
- Plankton with calcite shells decrease.
- Lower rates of calcite accretion in clams, mussels and oysters slows growth.
- Specialists do not adapt quickly.

Test/Experiment

Put calcium tablets in regular bay water, bay water with vinegar(decreased pH = more acid).

Observation

Compare pH with how quickly tablets dissolves.

What is the Refuge Doing to Help Wildlife?

Refuge staff integrate climate change awareness into management activities, including enhancing and maintaining robust habitats that can withstand change. Refuges partner with organizations, agencies and people like you to encourage wise use of resources to slow carbon emissions.