Weeds and Habitat Shifts in a Changing Climate: Modelling and Responding

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Introduction

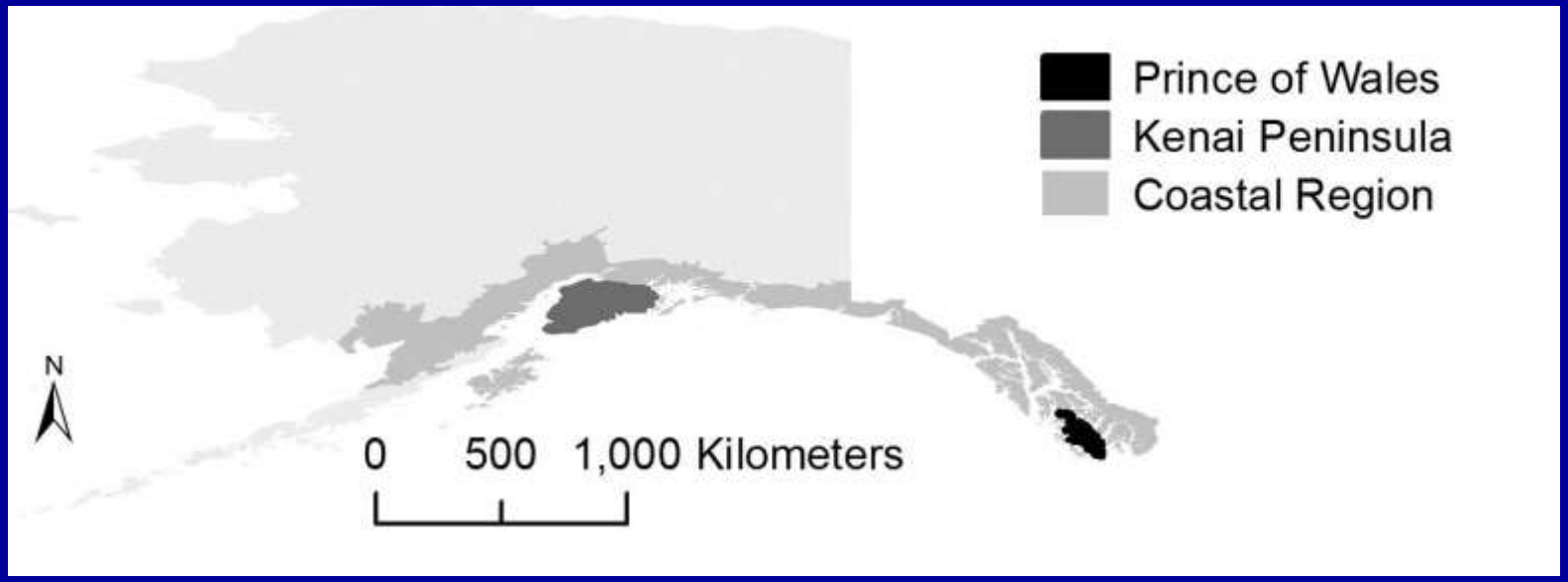
- Modelling habitat shifts at regional and local scales
- Developing IWM strategies
- Attempting to keep sight of the forest
- How we have influence

Modelling work in Alaska

- Modelling habitat shifts and consequences for 3 invasive species in SE Alaska
- Developing Alaska IWM strategies

Southeast Alaska

Broken into 3 sub-regions



POW – Heavily forested

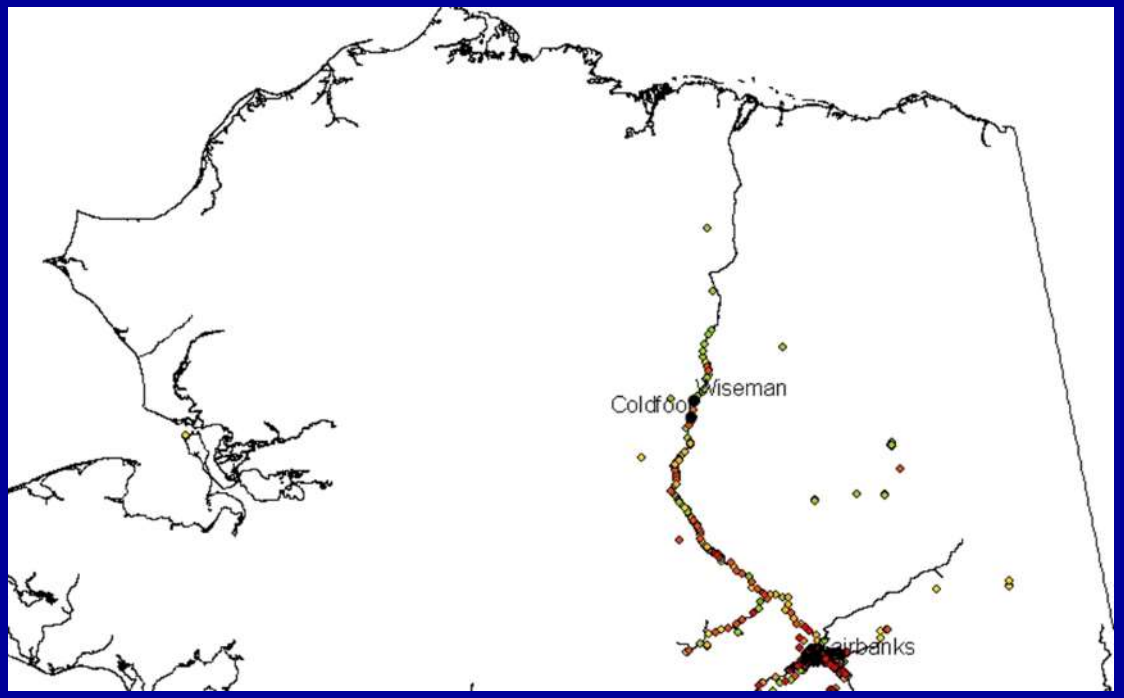
Kenai Peninsula – Growing human population

Coastal Region – Mostly undisturbed

AKEPIC

Alaska exotic plants information clearinghouse

http://accs.uaa.alaska.edu/invasive-species/non-native-plants/



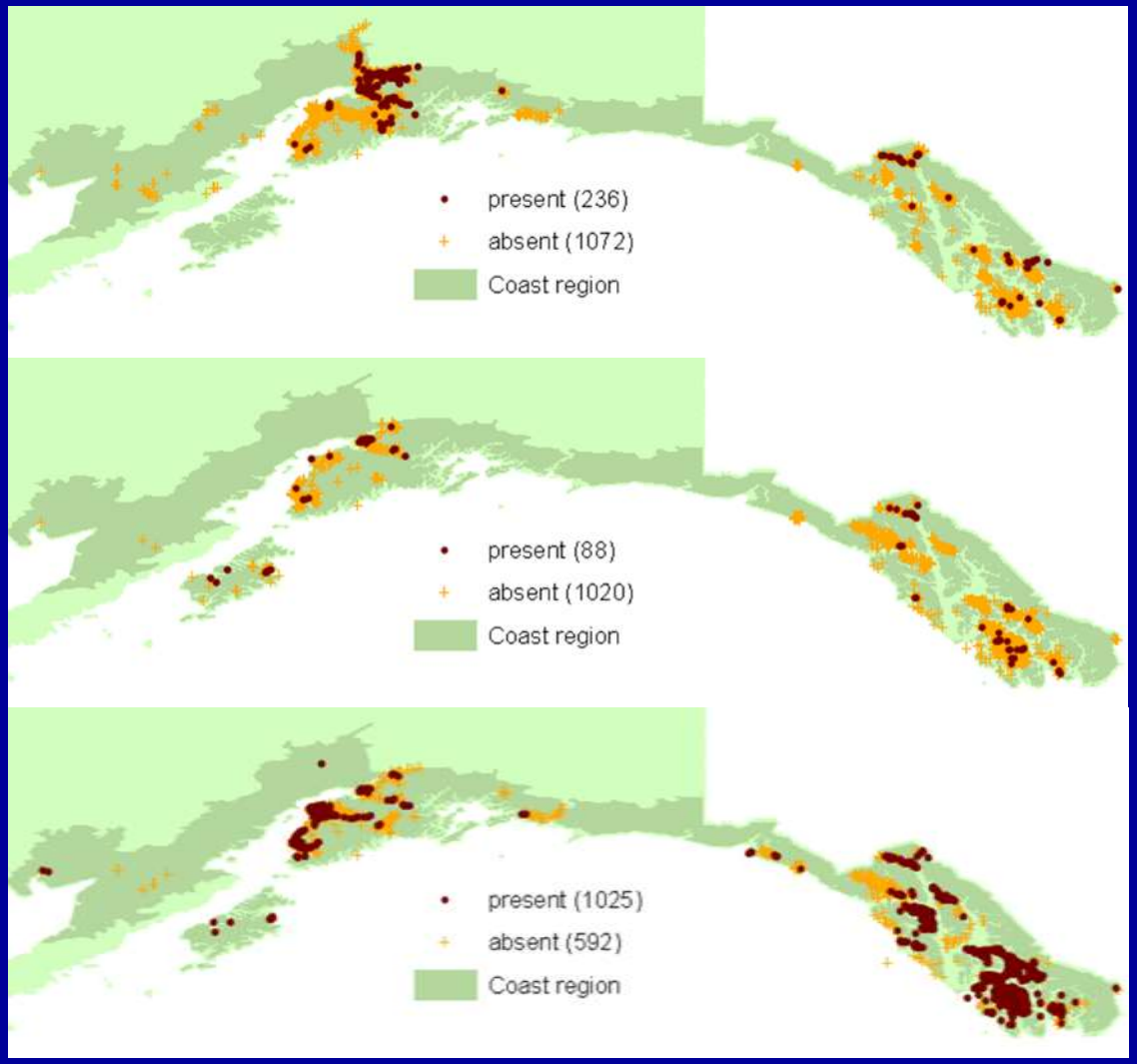
Invasive plants on Dalton Highway

Plant species of Concern

- White sweetclover (*Melilotus albus*)
- Canada thistle (*Cirsium avense*)
- Reed Canarygrass (*Phalaris arundinacea*)

Location of the Weeds

- We knew where they were and were not
- WSC
- CT
- RCG



The Modeling

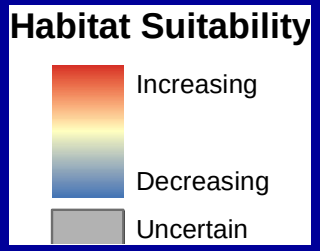
- Regional model incorporated current weed infestations with two climate change scenarios
  - A2, a less ecologically minded world
  - B1, a more ecologically minded world
- Local model for Kenai Peninsula and Prince of Wales Island incorporated distance from
  - Anthropogenic factors
  - Water and wetlands
  - Land cover type
  - Elevation

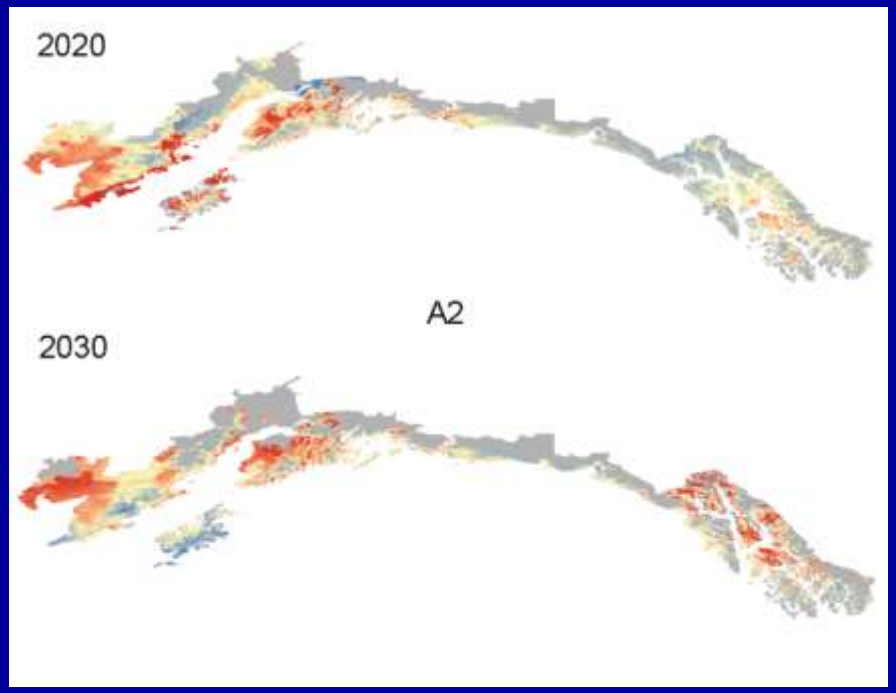
The Modeling

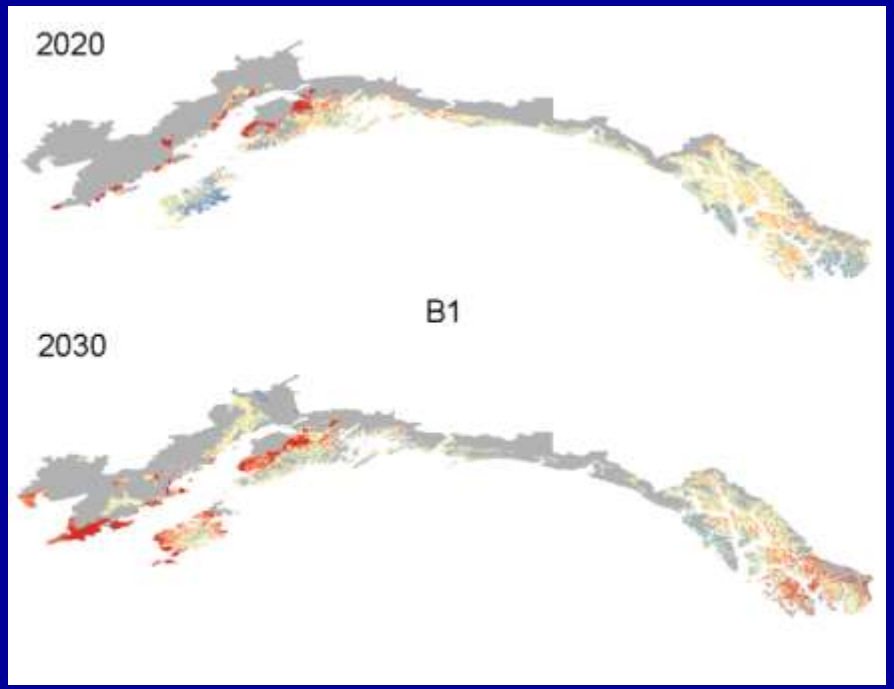
- For climate data we used maximum entropy modelling program Maxent
- For species distribution we used Software for Assisted Habitat Modeling (SAHM)
- Modelers were Cathrerine Jarnevich and Tracy Holcombe at USGS in Fort Collins, CO
- Five Alaskans went down twice to help with variable selection
  - Jarnevich et al. 2014. Cross-scale assessment of potential habitat shifts in a rapidly changing climate. Invasive Plant Science and Management. 7:491-502

Overall results for Canada thistle

Difference between current and future climate scenarios





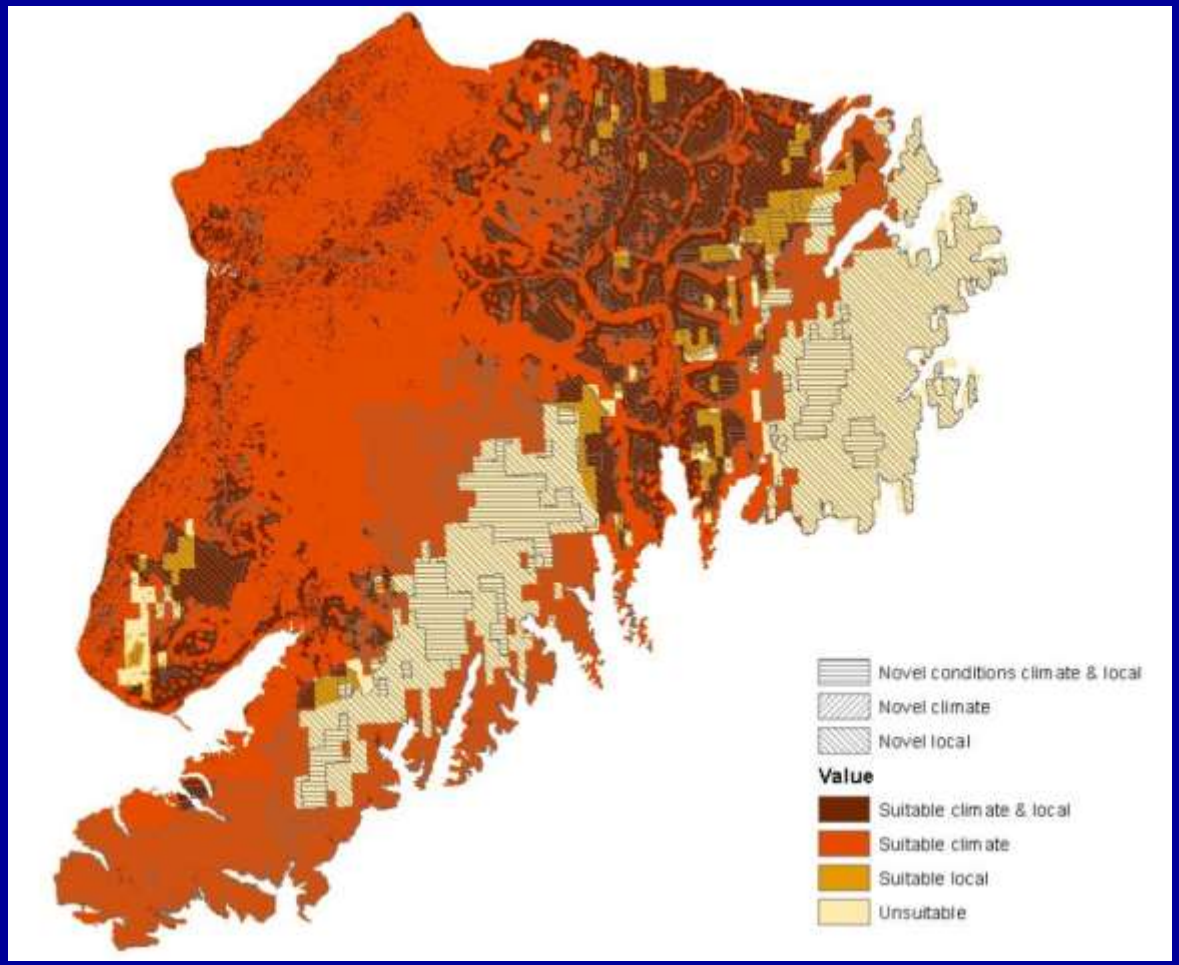


Results for Canada thistle

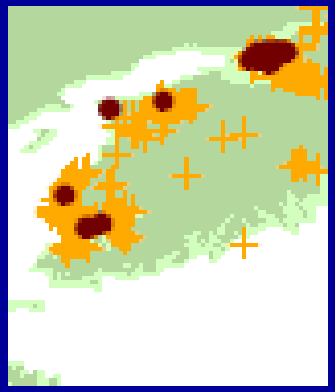
Habitat suitability on the Kenai Peninsula

Regional Model

Local Model



And remember where it currently is



Having reliable information on where a species can move if left unchecked helps immeasurably when trying to influence weed control decisions

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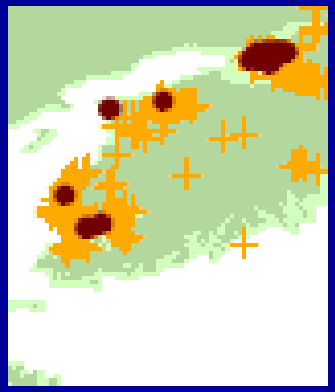

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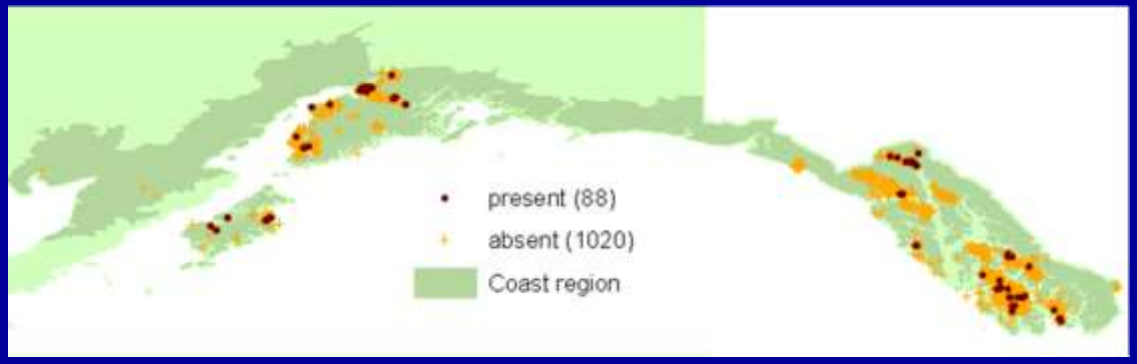
In the Kenai Peninsula the goal is eradication of Canada thistle

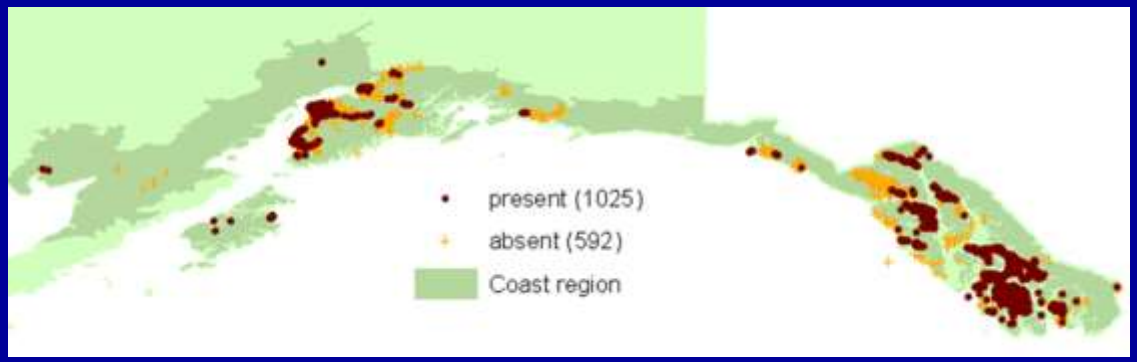
Developing integrated weed management strategies

- In the Kenai
  - CT is unacceptable – ERADICATE
    - Herbicides (applied just before flowering)
    - Physical removal
    - Active monitoring of infested sites



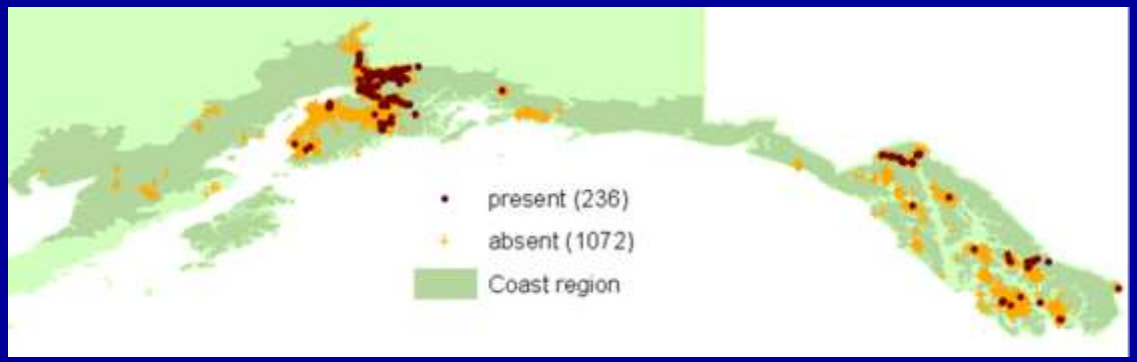
Developing integrated weed management strategies

- In the Kenai
  - RCG is focused in a few watersheds – LIMIT
    - Monitor adjacent watersheds
    - Work from upstream down
    - Herbicides
    - Removal
    - Tarping



Developing integrated weed management strategies

- In the Kenai
  - WSC on a few roadsides and urban areas – LIMIT
    - Monitoring roadsides
    - AK DOT can now use herbicides
    - Roadside maintenance goes from clean to infested areas
    - Physical removal



Developing integrated weed management strategies

- In the Kenai example the plan is simple
- Most of the weed control budget goes to Early Detection and Rapid Response (EDRR)
- For selected species treatments are applied to limit spread or eradicate

How does this translate to WA?

- The climate is changing (although not as fast as in AK)
- There are newish weed species
  - Yellow nutsedge (*Cyperus esculentus*)
  - Shining geranium (*Geranium lucidum*)
    - Skagit and Clark counties
  - Garlic mustard (*Alliaria petiolate*)
  - Yellow archangel (*Lamiastrum galeobdolon*)
- Others?

Losing site of the forest

- We all can get excited about new weed species
  - Where did they come from
  - What are their life cycles
  - Do they have weak points we can exploit
- We must keep in mind that changes in weed species (composition and number) are associated with changes in the native flora (and fauna)
- Remember, weed species are adaptive

Weed Adaptation – WSC example

- In Alaska, it was studied as a pasture forage and nitrogen fixer (1913)
  - Annual habit
  - Poor survivability did not produce seed

Weed Adaptation – WSC example

- In Alaska, it was studied as a pasture forage and nitrogen fixer (1913)
  - Annual habit
  - Poor survivability did not produce seed
- After WWII, a DOT employee mixed it in seed as part of a revegetation seed mix (bee keeper)
  - Climate selection pressure resulted in
    - Biennial habit
    - Improved freezing tolerance
    - More root portioning
    - More responsive to shortening photoperiods

Response to Climate Change Agriculture

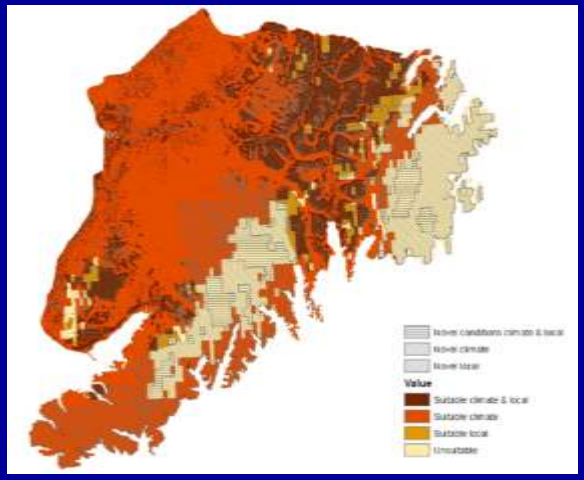
- ERS research suggests that U.S. farmers are likely to adapt to climate change by altering crops, rotations, and production practices
  - Redistribution of production across regions
  - Production regions for some crops may move from south to north (think about warm season vegetables, cotton, and citrus)
- In AK there has been a change equivalent to 5 degrees of latitude

Response to Climate Change Agriculture

- Adaptive responses to global climate change will also include the use of new crop varieties
  - Genetic combinations that are optimal for present growing environments may not be best as the growing environment changes
  - Plant breeding efforts can create varieties better suited to changed environments, and new genetic material could enhance efforts to breed new crop varieties

Response to Climate Change Agriculture

- The development of knowledge and tools to enable forecasting, preparation, and adaptation to climate change will improve the resilience of managed ecosystems including soils, fertility, and pest management

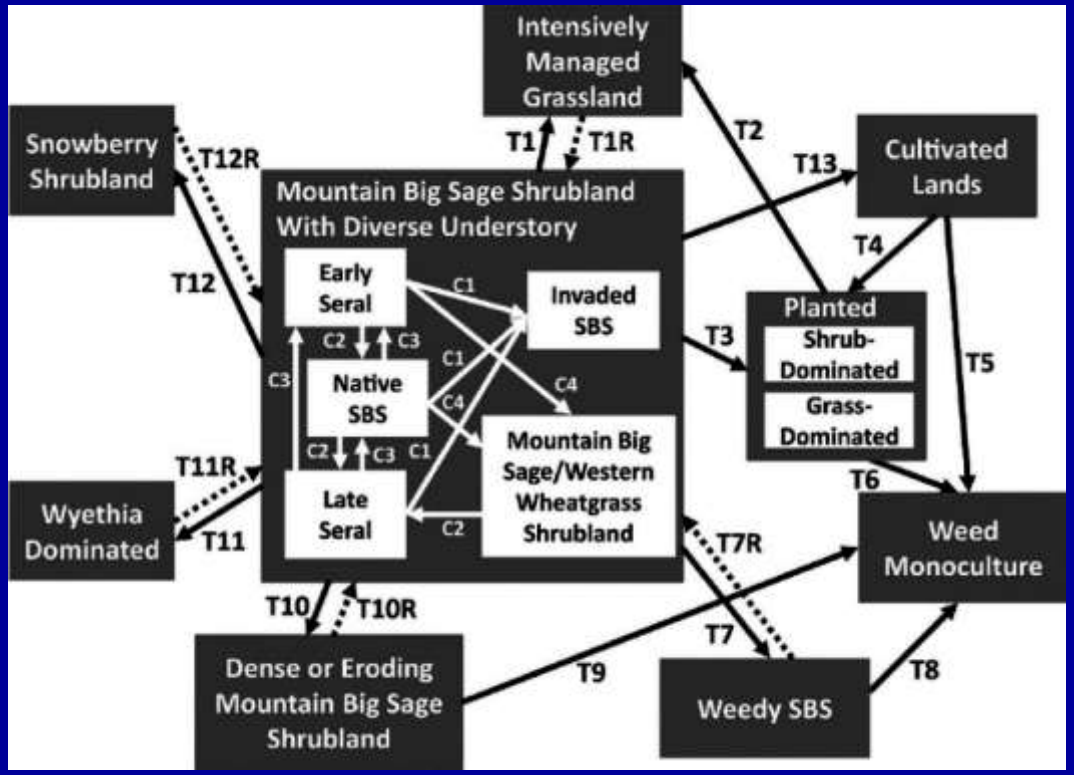


Response to Climate Change Restoration

- There will be a lot of moving parts
  - New invasive species
  - Old invasive species adapting
  - Native species will be in flux
    - Adapting or not
    - Moving in or out
    - Interacting differently within the plant community

Response to Climate Change Restoration

- Are established State and Transition models still useful



What do we do now?

- Mapping
- Measurement of density and spread
- Hand weeding
- Legislation
- Organize CNIPM and AISC
- Research weed biology and control
- Hand wringing (choices need to be made)

Preserve the Earth

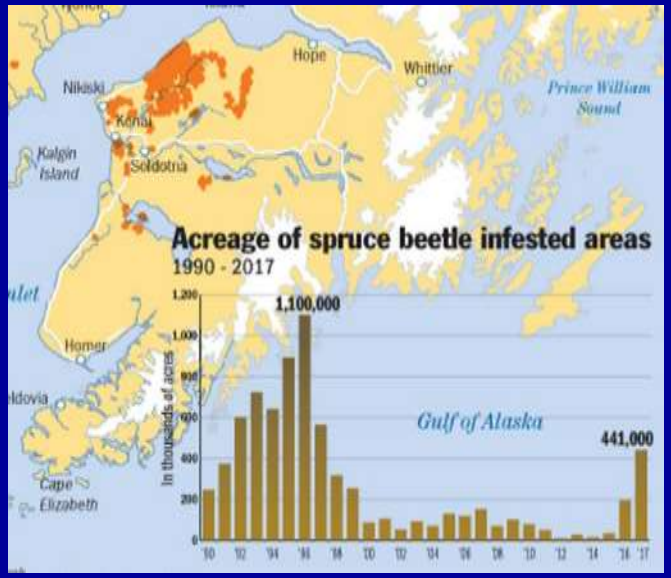
This never was an option

Preserve the Earth

Keeping sight of the forest

Assisted Migration – Kenai, AK

- In the last few decades
  - Spruce bark beetle was able to produce 2 generations in one summer
    - Huge die off of spruce forest
    - Large wild fires burned out the forest



Assisted Migration – Kenai, AK

- Increasing populations of spruce aphid and spruce budworm are weakening remaining spruce trees

Assisted Migration – Kenai, AK

- Boreal forest in Kenai has 14 tree species
  - Three of them are spruces
    - White
    - Black
    - Sitka
  - The other 11 are hardwoods
    - Alder (3 species)
    - Aspen
    - Poplar (2 species)
    - Paper birch (3 species)
    - Ash (2 species)

Assisted Migration – Kenai, AK

- What is the loss of spruce doing to the rest of the ecosystem?
  - Other vegetation
  - Animal impacts
  - Water Quality
  - ???

Assisted Migration – Kenai, AK

- Is this part of restoration
  - What if we do nothing
  - Who decides
  - Unintended consequences
  - The importance of extremes

Our Role in Ecological Restoration

- As scientists
  - Develop more local climate based models
  - Define climate limits of plants
    - Temperature extremes
    - Drought limits
    - Light requirements
  - Conduct carefully designed hypothesis driven research
  - Validate models

Our Role in Ecological Restoration

- As managers
  - Be aware of species used in counties to the south
  - Experiment with different plant mixes
  - Expect change and try to keep up with it
  - Report results of work widely

Our Role in Ecological Restoration

- As observers
  - Keep careful records
  - Be aware of and report change
  - Early detection and rapid response
  - Discuss thoughts and observations with others

Our Role in Ecological Restoration

- We cannot force change
- We can provide society with options
  - Be clear about consequences
  - Talk in terms of probabilities
    - If you plant corn, 60% chance it does not produce seed
    - If you don't spray this weed, 80% chance it takes over roadsides with full sunlight

Our Role in Ecological Restoration

- We need to speak and think in terms of the consequences of our actions
  - The climate is doing what it does inexorably
  - We need to fill the gaps when species go away
  - We need to limit new undesirable species
- We will need to assist migration
- We need to be clear that we will not always get it right

Our Role in Ecological Restoration

- We can give society and decision makers options, probabilities, and consequences
- We can treat this as a challenge to assist ecosystems in adapting and evolving smoothly along with the climate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