Monitoring Ecological Reserves in a Changing Climate: Perspectives from National Parks

Mark Huff

Park Staff

North Coast and Cascades Inventory & Monitoring Network

Presentation
Monitoring
--Climate Change Theme--

1. Background—Utility of Monitoring (CC)
2. Opportunities for National Park Service to provide information on Climate Change
3. Interagency/NGO exchange of information--monitoring

National Park Service
Vital Signs Monitoring Program

- Program Overview
- Monitoring at North Coast and Cascades Network

North Coast and Cascades Network

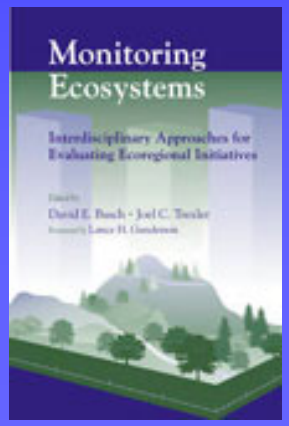
Inventory and Monitoring Program

National Park Service
U.S. Department of the Interior

--context of climate change--

Utility of Monitoring Background Reference

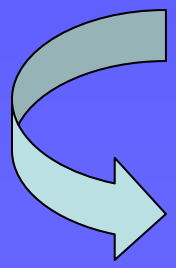
- "Monitoring Ecosystems"--D.E. Busch and J.C. Trexler
- "Conceptual Issues in Monitoring Ecological Resources"--B.R. Noon



Monitoring & Research

- Research—emphasis experimental; addresses cause and effect questions
- Monitoring—emphasis temporal & spatial;

  tracking: repeated measures, specified interval



Integration

Concurrent

Challenge
Detecting Meaningful Change

- Natural systems--inherently
  dynamic &
  spatially heterogeneous

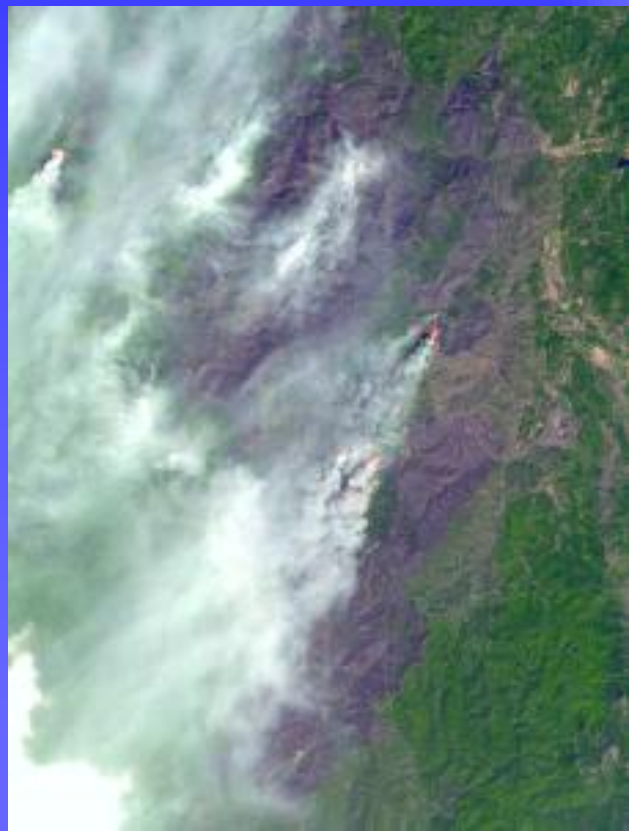
Intrinsic and Extrinsic Change Natural Systems

Intrinsic

- Stochastic and cyclic variation
- Succession (disturbance)

Extrinsic

- Consequence of some human action (singly or interactions)



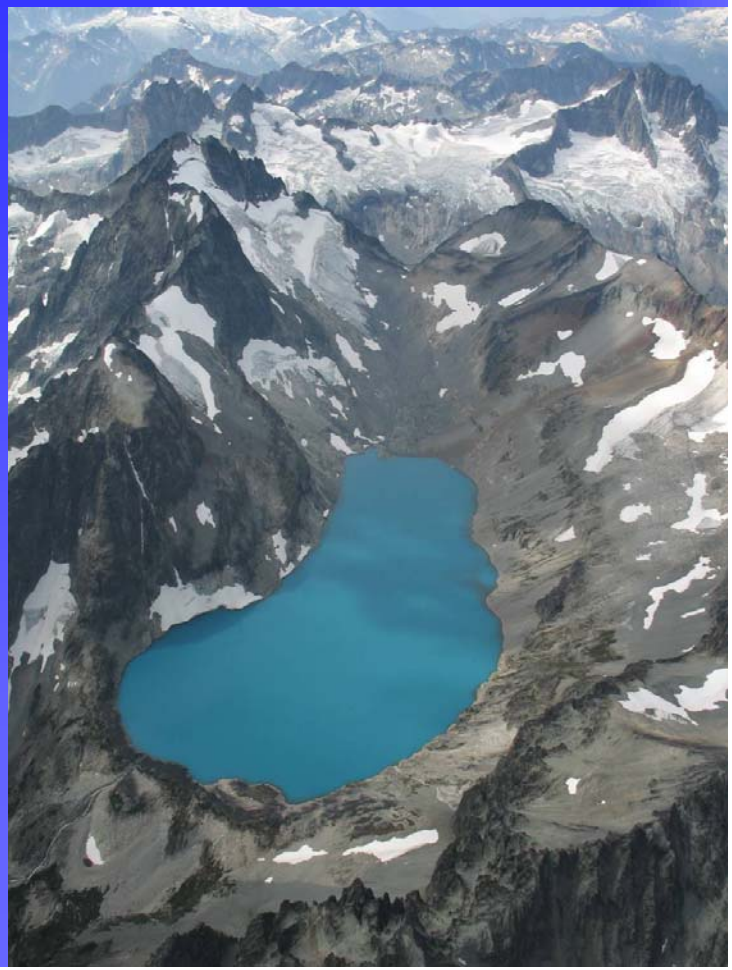
Effects vs. Predictive Monitoring

Effects-oriented

- detecting change
- without link to cause

Predictive (↑$)

- detect change
- with known cause
- (e.g., climate change)



Overarching Monitoring Goals & Objectives

- ✓Select indicators that change can be readily interpreted (prior scientific knowledge)
- ✓Discriminate between extrinsic and intrinsic drivers of change
- ✓Detect “early warning” (indicators within acceptable range or as predicted)

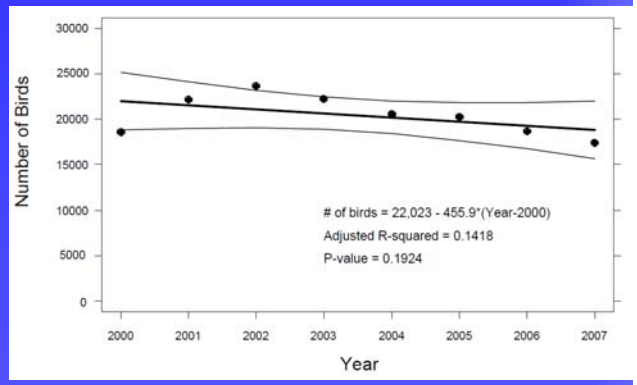
Overarching Monitoring Goals & Objectives

- ✓ Provide insights--ecological consequences
- ✓ Aid decision-makers --adjust management strategies & practices

Summary--Role of Monitoring

- Indicators of the quality, health, or integrity of the larger system

- Status and trends



Links to Research

- Ecological Thresholds (abrupt change)

- Simulation Modeling/Predictive models

National Parks & Climate Change

- NPS uniquely positioned

  contribute and communicate effects of climate change

“The Park Service is the caretaker of many of the nation’s most precious natural resources”

National Park Service Opportunities Understand & Communicate Effects of Climate Change

1. Ecological Reserves
2. Public Interpretation/Outreach
3. Vital Signs Monitoring

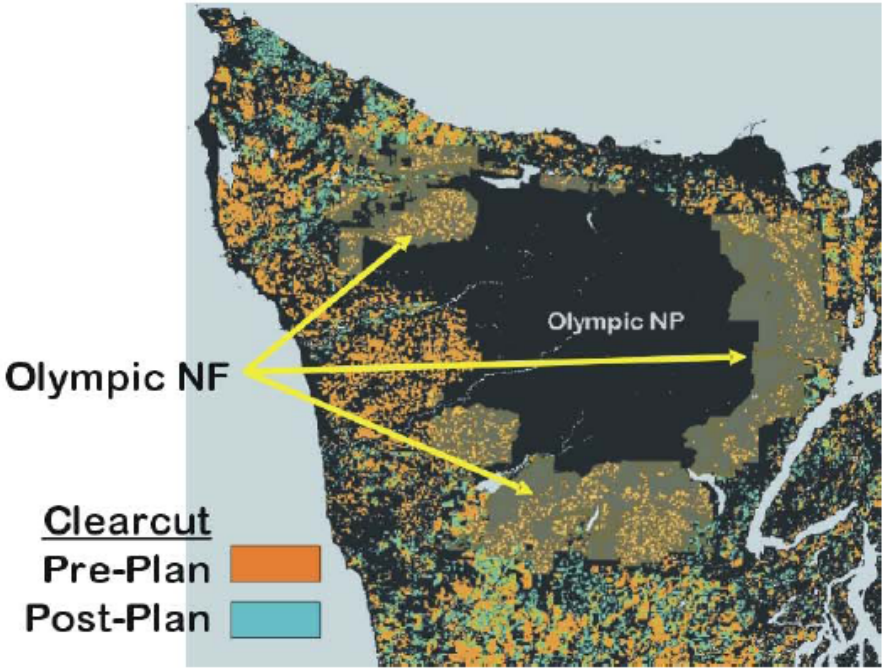
National Parks--Opportunities Ecological Reserves

Large “ecosystems”; relatively pristine with minimal direct human intervention

Legislative mandates…. “preserve for future generations”

Baseline to compare with landscapes/ecosystems with much greater influences from humans

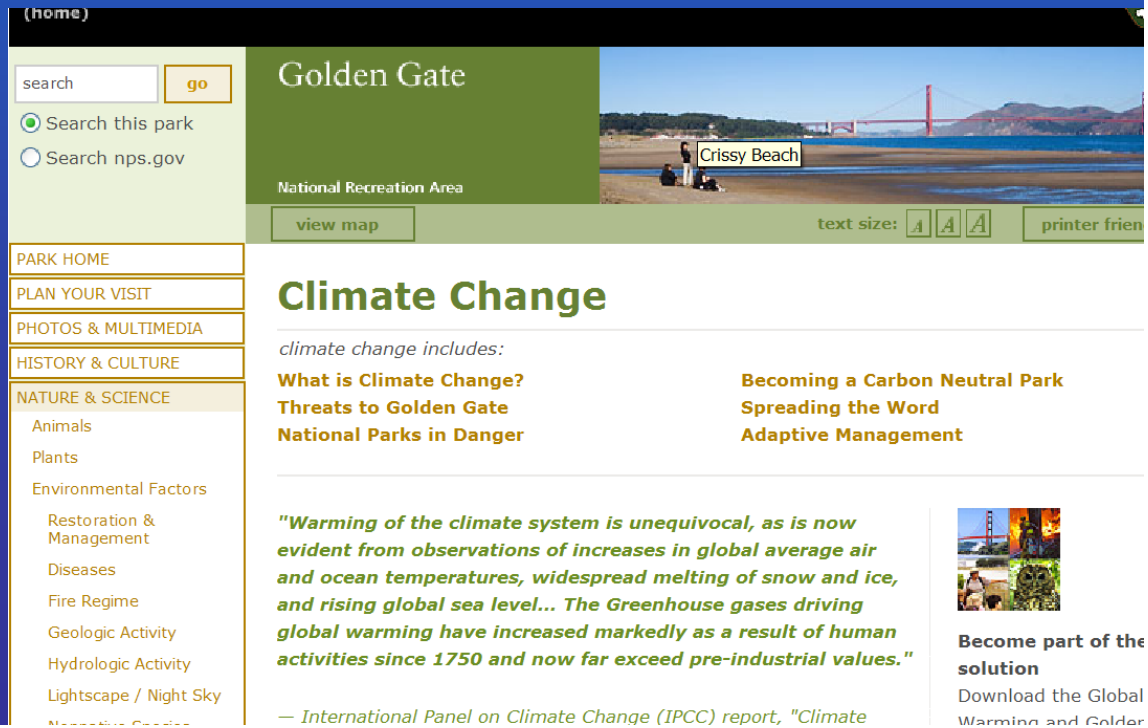
Post-clearcut landscape on the border of Olympic National Park



From Moeur et al. 2006

National Parks—Opportunities Communicating Science

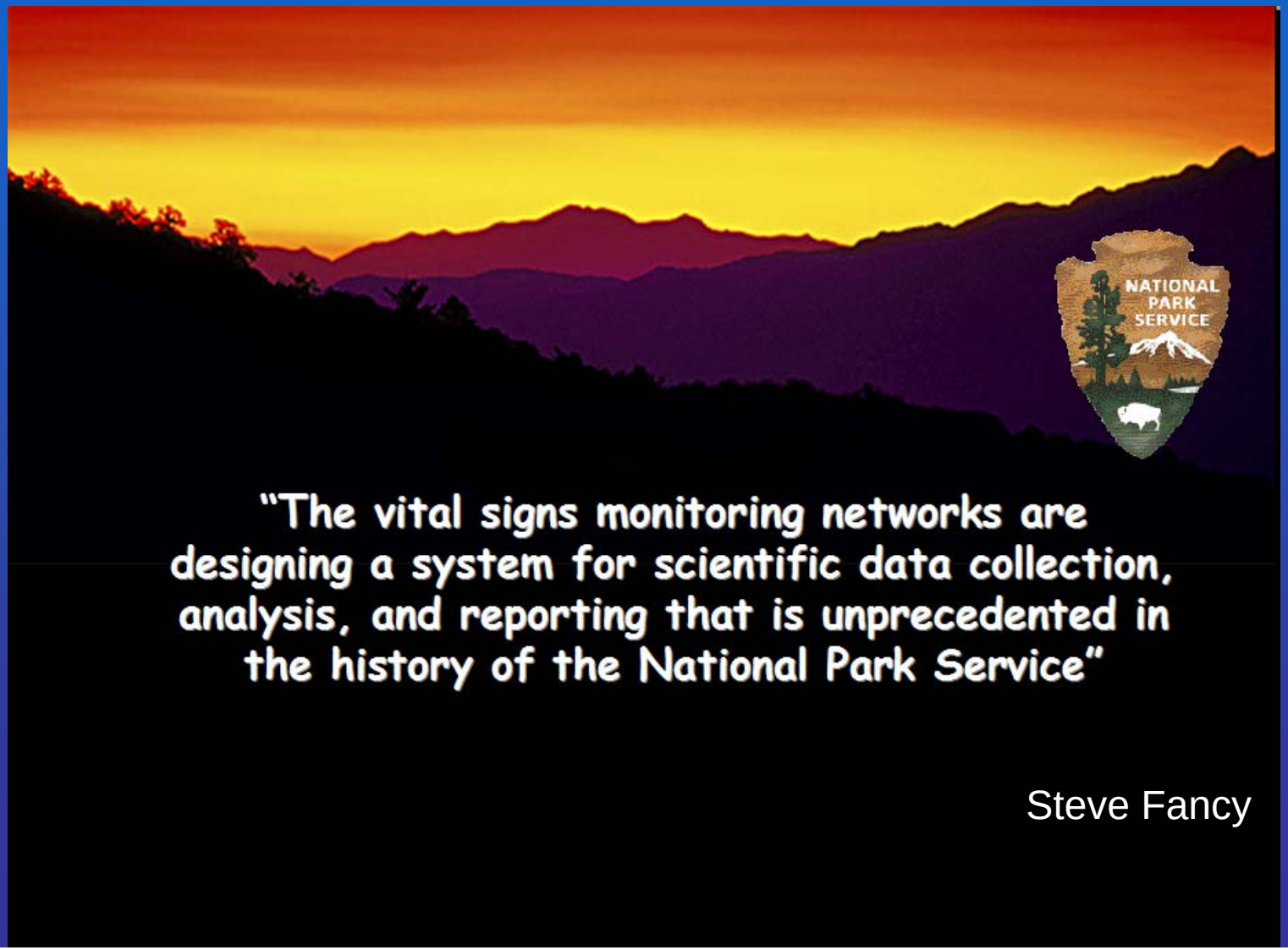
- Agency Mission: Public outreach
- Interpretive/education emphasis
- NPS.gov—high traffic (ranked ~1200 among U.S. websites)



Communicating Threats to National Parks

Climate change and air pollution (expected) greatest threats to National Parks in the Pacific Northwest

National Parks—Opportunities Vital Signs Monitoring



"The vital signs monitoring networks are designing a system for scientific data collection, analysis, and reporting that is unprecedented in the history of the National Park Service"

Steve Fancy

Vital Signs Monitoring

National Parks Omnibus Management Act of 1998:

"The Secretary shall undertake a program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources."

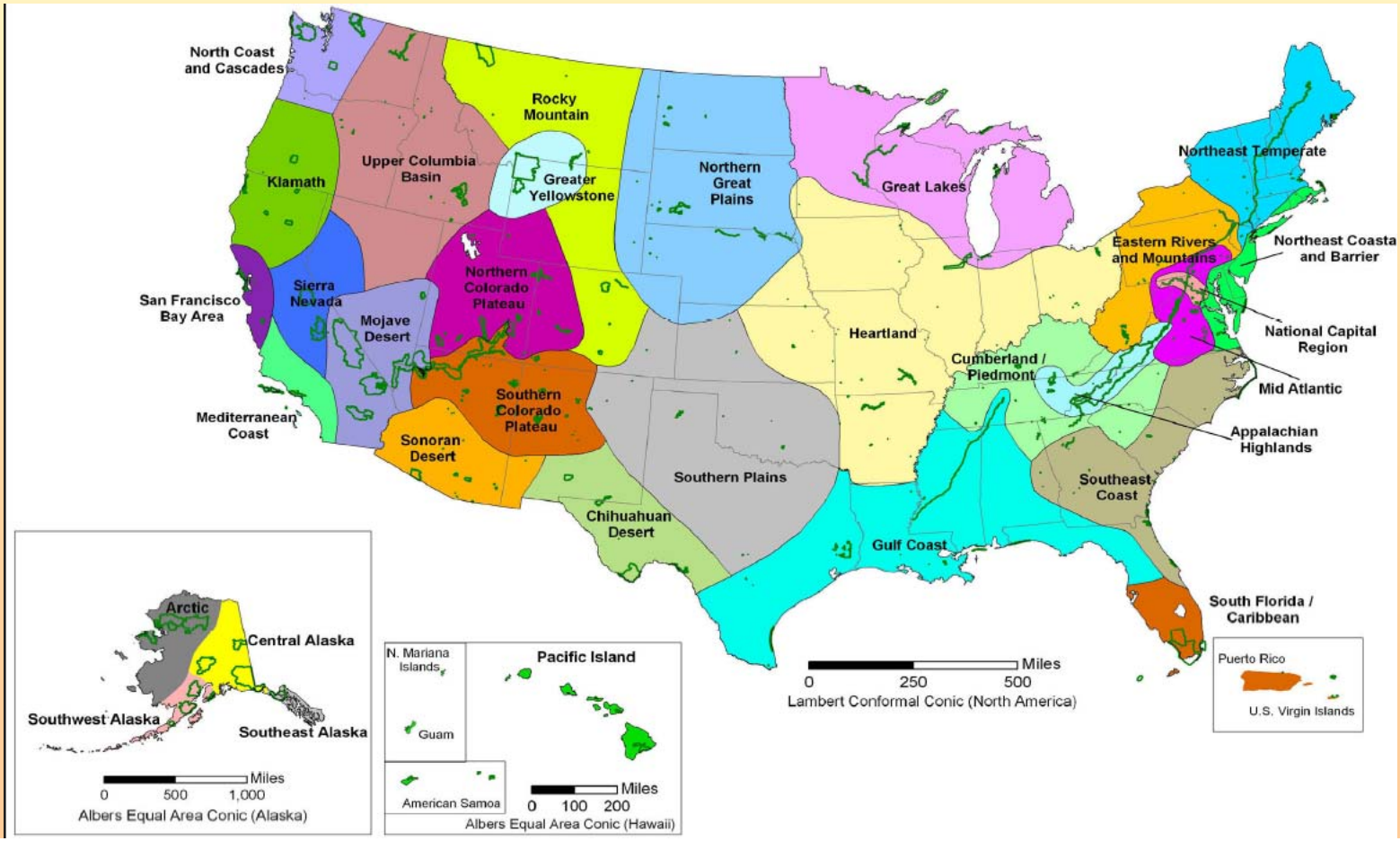
Vital Signs Monitoring – Funded FY 2001

Key Characteristics

- **Long-term, ecological monitoring perspective**
- **Integration and coordination among parks, programs, and agencies**
- **Emphasis on Information Management**
- **Centralized Guidelines**

32 Monitoring Networks

3-16 parks/network (~independent)
~2% agency's $1.9 billion operating budget



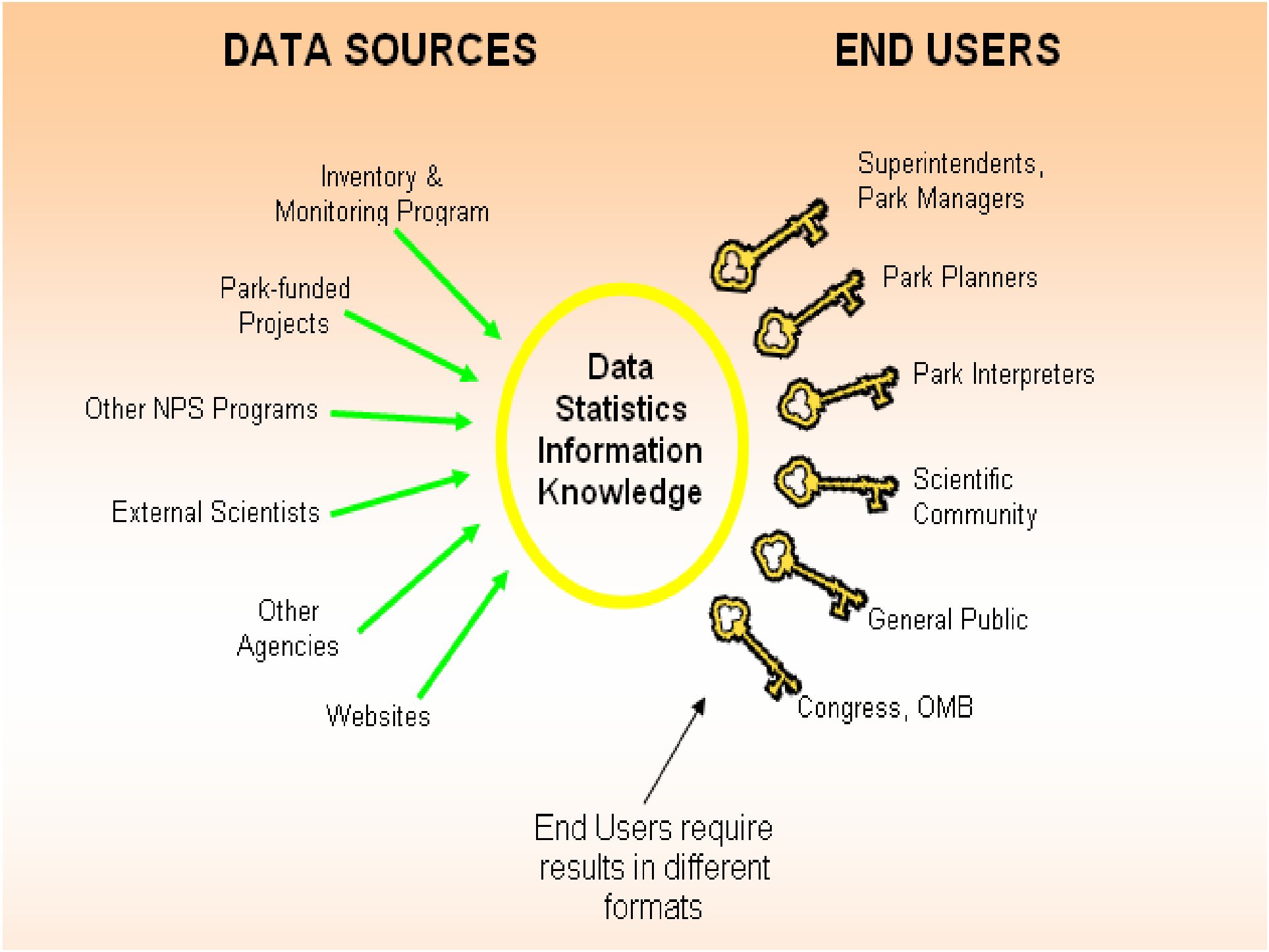
Vital Sign

Subset of physical, chemical, and biological elements and processes of park ecosystems

Selected to represent the overall health or condition of park resources

Key Uses of Vital Signs Monitoring Results

- Management decision-making informed by scientific information
- Planning – connecting science and management
- Science Communication to Public
- Collaboration with Scientific Community


DATA SOURCES
END USERS
Inventory & Monitoring Program
Park-funded Projects
Other NPS Programs
External Scientists
Other Agencies
Websites
Data Statistics Information Knowledge
Superintendents, Park Managers
Park Planners
Park Interpreters
Scientific Community
General Public
Congress, OMB
End Users require results in different formats

Guidelines for long-term monitoring protocols

Karen L. Oakley, Lisa P. Thomas, and Steven G. Fancy

Abstract Monitoring protocols are detailed study plans that explain how data are to be collected, managed, analyzed, and reported, and are a key component of quality assurance for natural resource monitoring programs. Protocols are necessary to ensure that changes detected by monitoring actually are occurring in nature and not simply a result of measurements taken by different people or in slightly different ways. We developed and present here guidelines for the recommended content and format of monitoring protocols. The National Park Service and United States Geological Survey have adopted these guidelines to assist scientists developing protocols for more than 270 national park units.

Key words format, guidelines, monitoring, national park, natural resources, policy, protocol, sampling

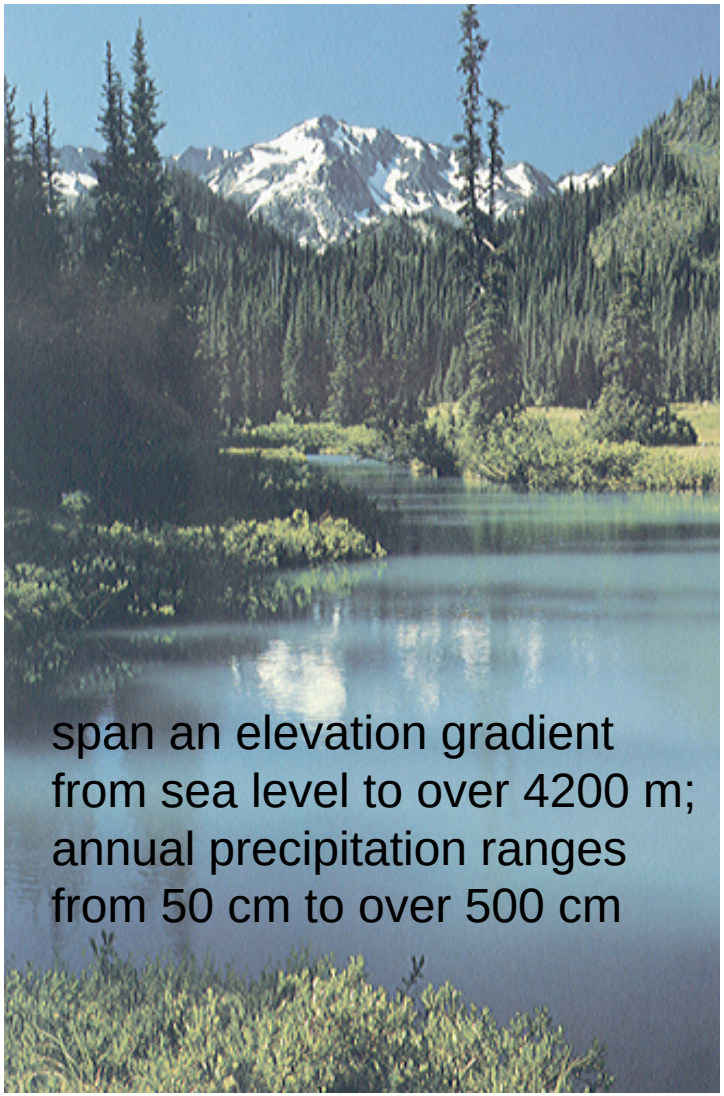
NPS-USGS Protocol Standards (**REQUIRED**):

Wildlife Society Bulletin 2003 31(4): 1000-1003.

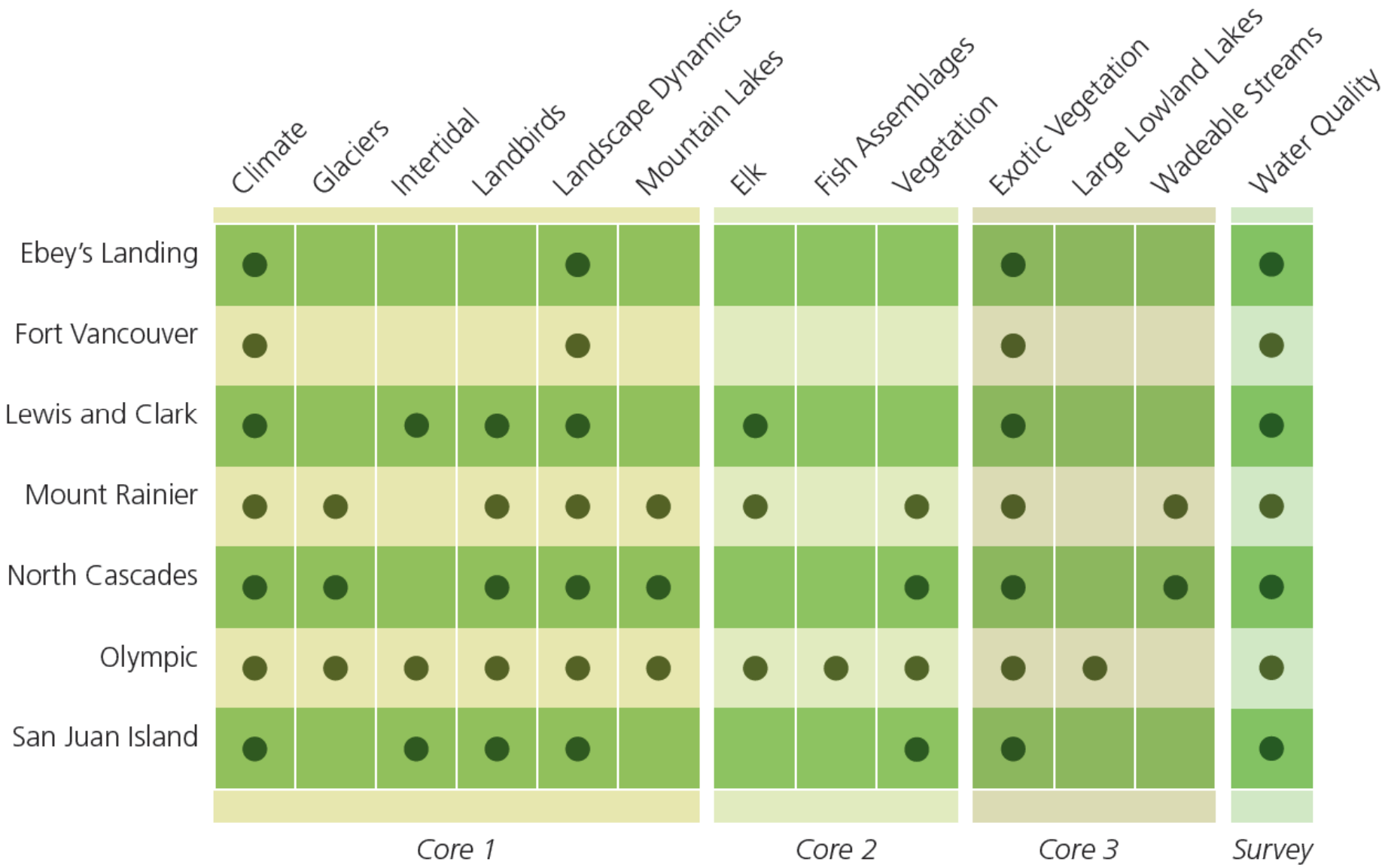
Vital Sign Monitoring & Climate Change

- **Climate change is not a programmatic focus or unifying theme**
- **Significant explanatory variable of certain vital signs among networks**

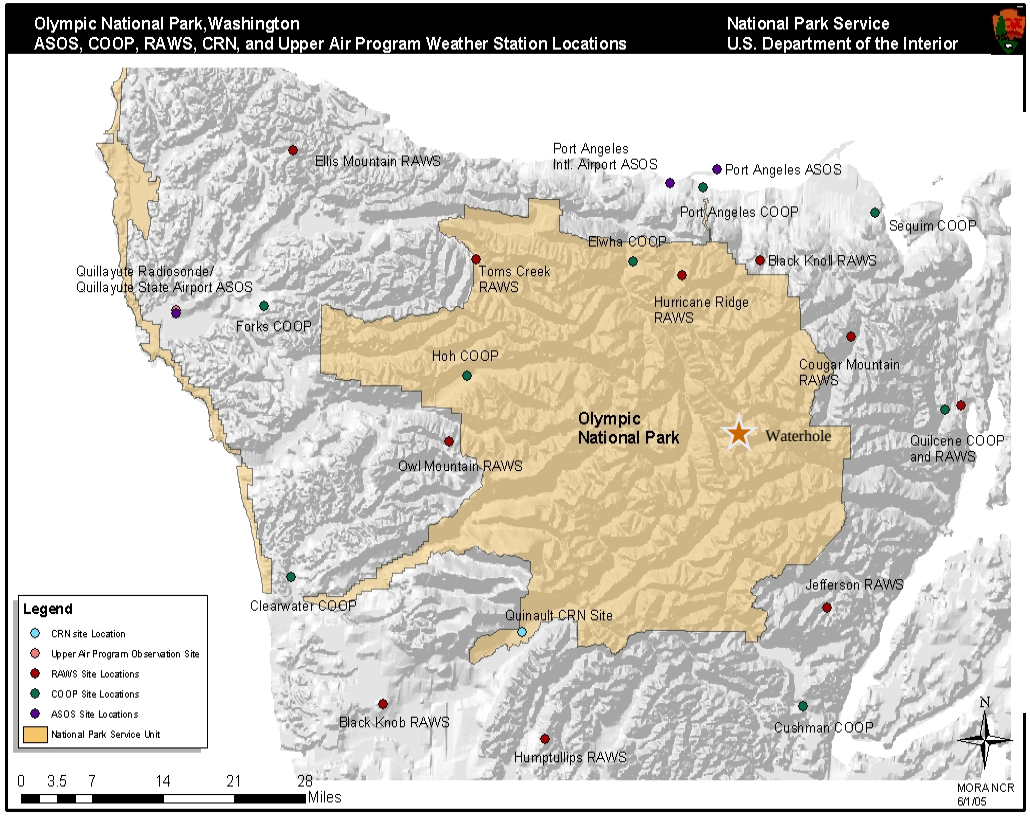
North Coast & Cascades Network

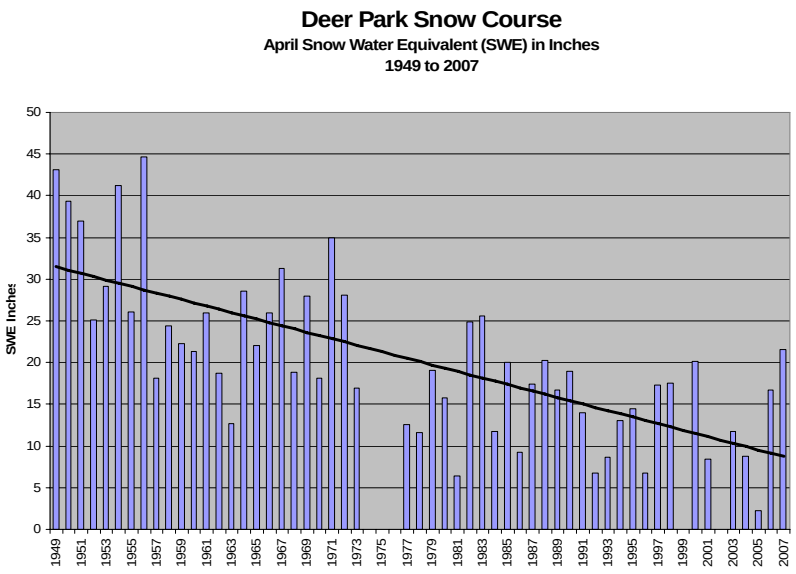


North Coast & Cascades Vital Signs



Climate


Olympic National Park,Washington
ASOS, COOP, RAWS, CRN, and Upper Air Program Weather Station Locations
National Park Service
U.S. Department of the Interior
Ellis Mountain RAWS
Port Angeles Intl. Airport ASOS
Port Angeles ASOS
Port Angeles COOP
Sequim COOP
Elwha COOP
Black Knoll RAWS
Toms Creek RAWS
Hurricane Ridge RAWS
Quillayute Radiosonde/ Quillayute State Airport ASOS
Forks COOP
Hoh COOP
Cougar Mountain RAWS
Olympic National Park
Waterhole
Quilcene COOP and RAWS
Owl Mountain RAWS
Clearwater COOP
Quinault CRN Site
Jefferson RAWS
Legend
CRN site Location
Upper Air Program Observation Site
RAWS Site Locations
COOP Site Locations
ASOS Site Locations
National Park Service Unit
Black Knob RAWS
Cushman COOP
Humptulips RAWS
N
0 3.5 7 14 21 28
Miles
MORA NCR
6/1/05


Deer Park Snow Course
April Snow Water Equivalent (SWE) in Inches
1949 to 2007
SWE Inches
0
5
10
15
20
25
30
35
40
45
50
1949
1951
1953
1955
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1959
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1963
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2001
2003
2005
2007

Climate Information Links to Vital Signs in NCCN parks

Vital Sign Protocol	Climate Links
Landscape Dynamics	Snow pack, precipitation rate, maximum wind speed & wind direction
Forest Under & Overstory	Soil temp & moisture, air temp, RH, snow pack, precipitation, radiation
Prairie Vegetation	Soil temp & moisture, air temp, precipitation, solar radiation
Subalpine Vegetation	Soil temp & moisture, air temp, RH, snow pack, precipitation, radiation
Exotic Plants	Soil temp & moisture, air temp, RH, snow pack, precipitation, radiation
Landbirds	Air temp, precipitation, snow pack
Elk	Air temp, snow pack
Wadeable Streams	Air temp, precipitation, snow pack
Large Lakes	Air temp, RH, radiation, precipitation
Large Rivers	Air temp, precipitation, snow pack
Mountain Lakes and Ponds	Air temp, precipitation, snow pack, ice phenology
Intertidal Communities	Air temp, precipitation
Glaciers	Air temp, solar radiation, precipitation and snow pack

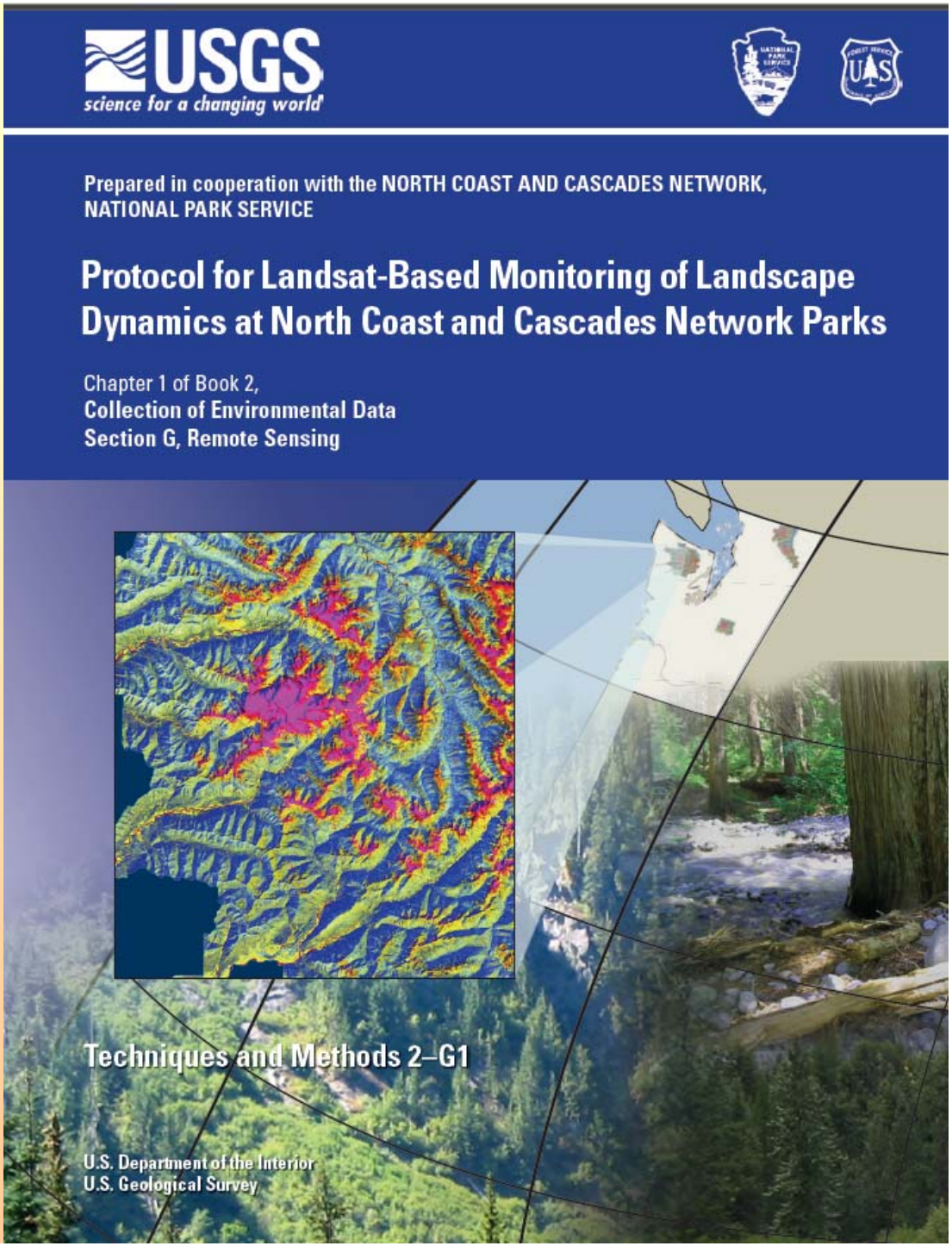
Robert E. Kennedy

Warren B. Cohen

Alan A. Kirschbaum

Erik Haunreiter

2007

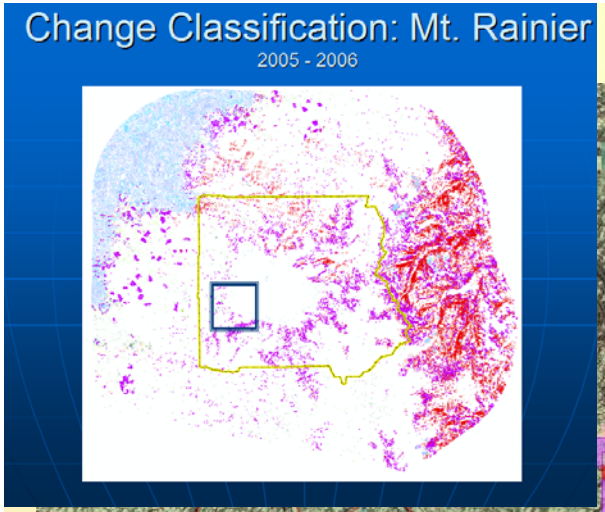


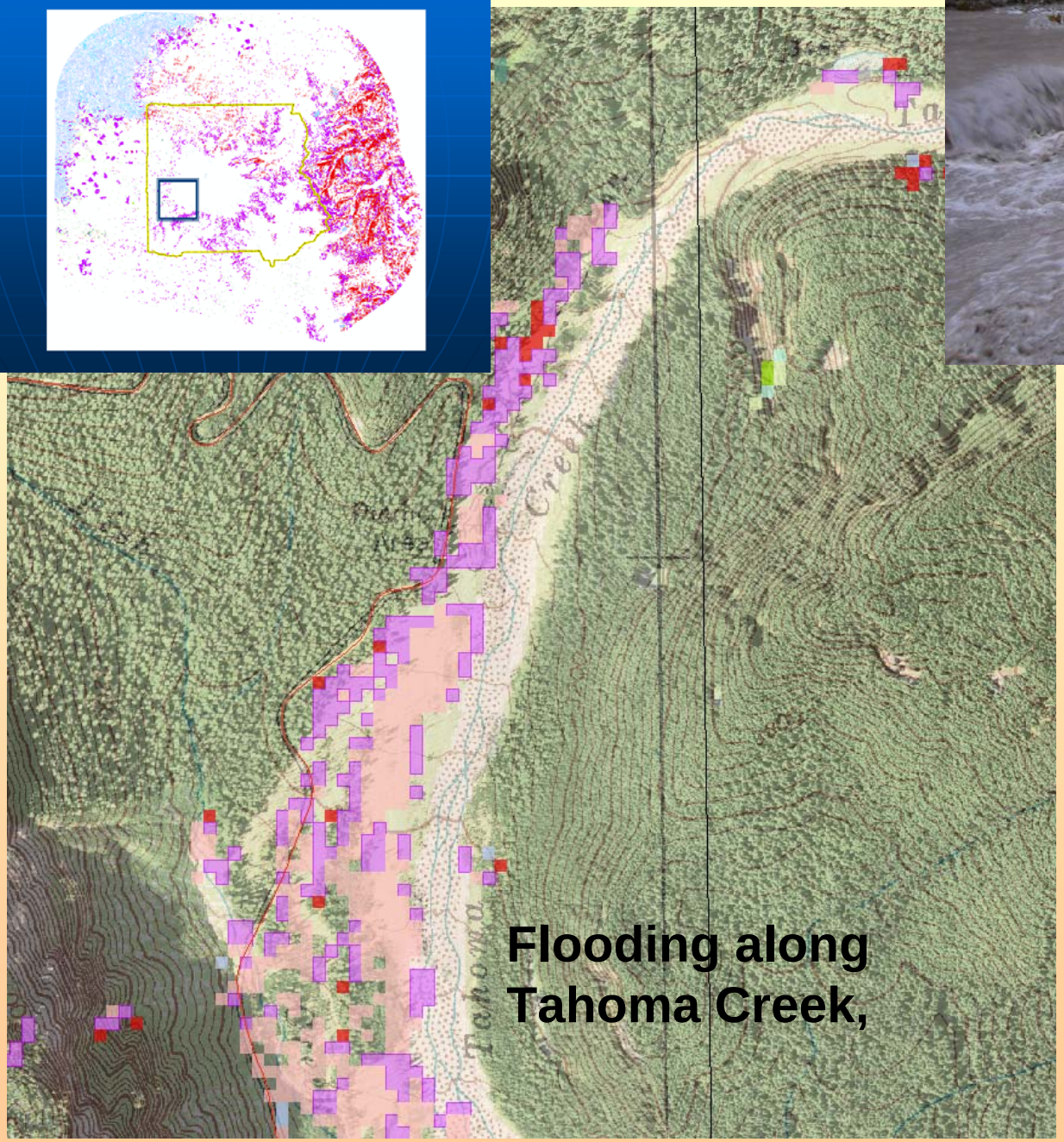
Annual Monitoring—Type 1 (Climate Change)

- Avalanche chute clearing
- Clearcuts
- Fire
- Insect/disease defoliation
- Landslides
- Riparian disturbance
- Windthrow

Decadal Monitoring—Type 2 (Climate Change)

- Alpine tree establishment*
- Forest Structure*
- Hardwood/conifer forest composition





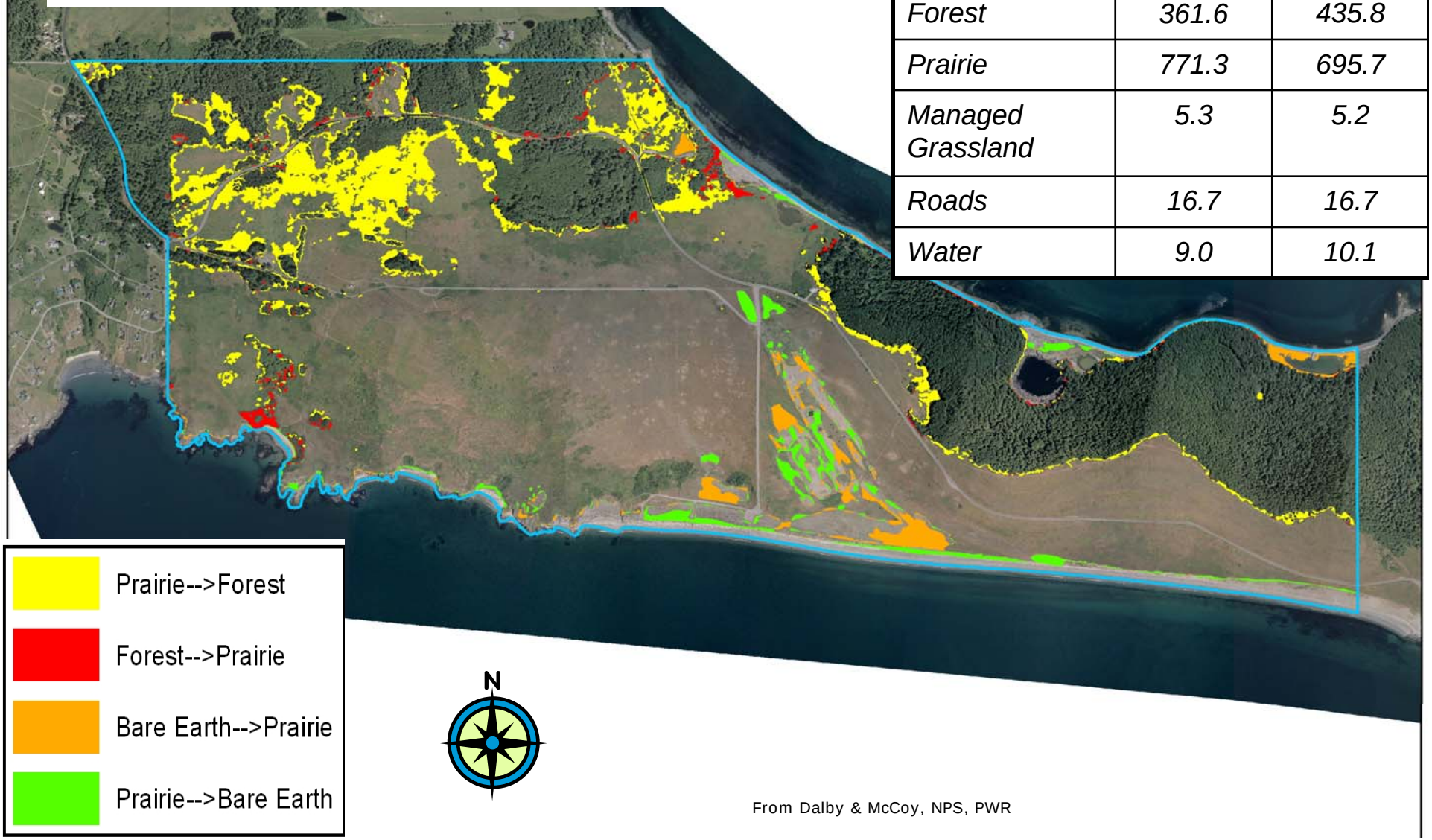
Flooding along Tahoma Creek,

Legend

- complete veg to water
- decrease in conifer
- decrease in broadleaf
- decrease in vegetation
- increase in broadleaf
- increase in conifer
- increase in snow
- increase in vegetation
- partial veg to water
- rock/soil to water
- water to complete veg cover
- water to partial veg cover
- water to rock/soil

San Juan National Historic Park: American Camp

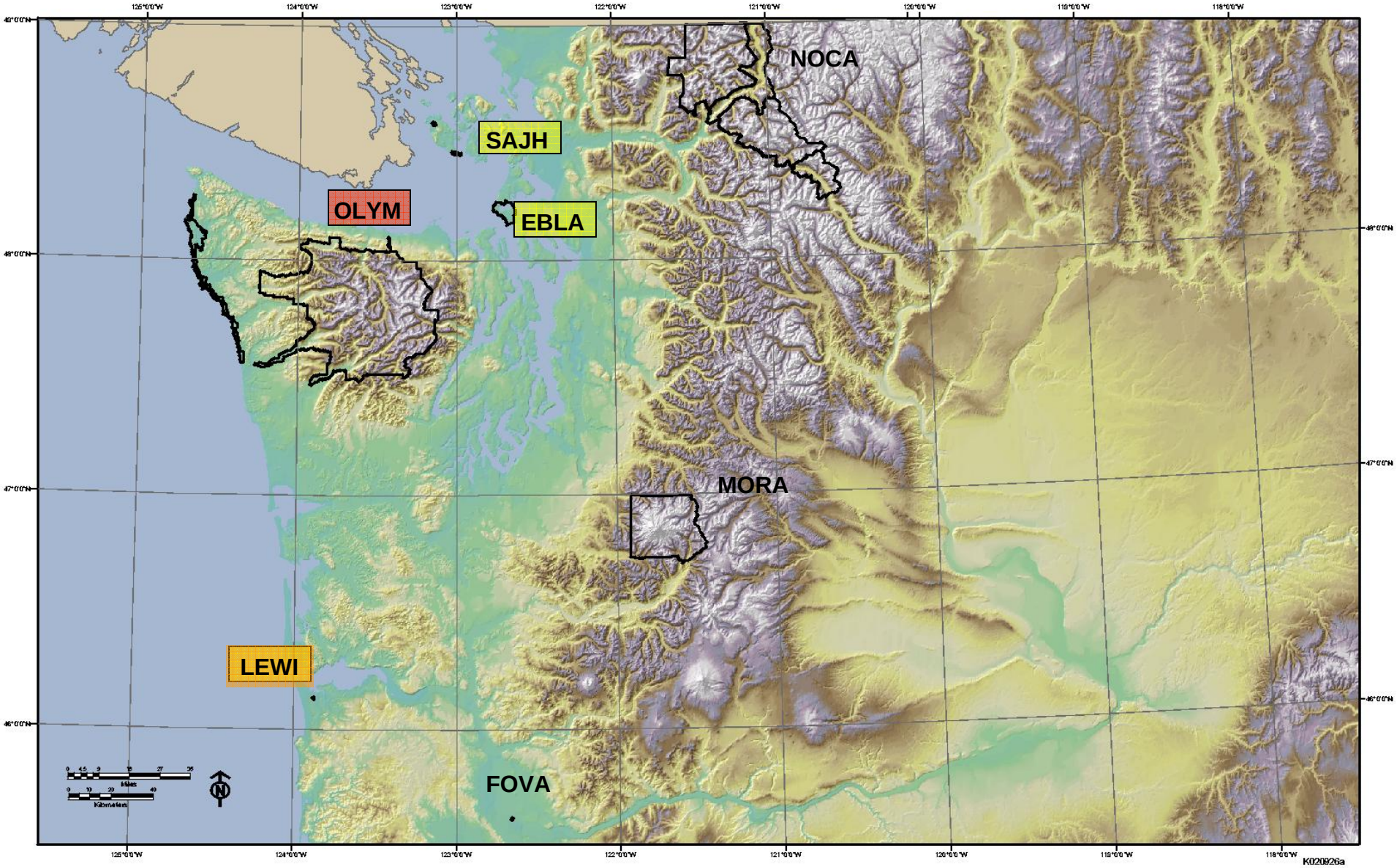
Change Detection 1997-2007



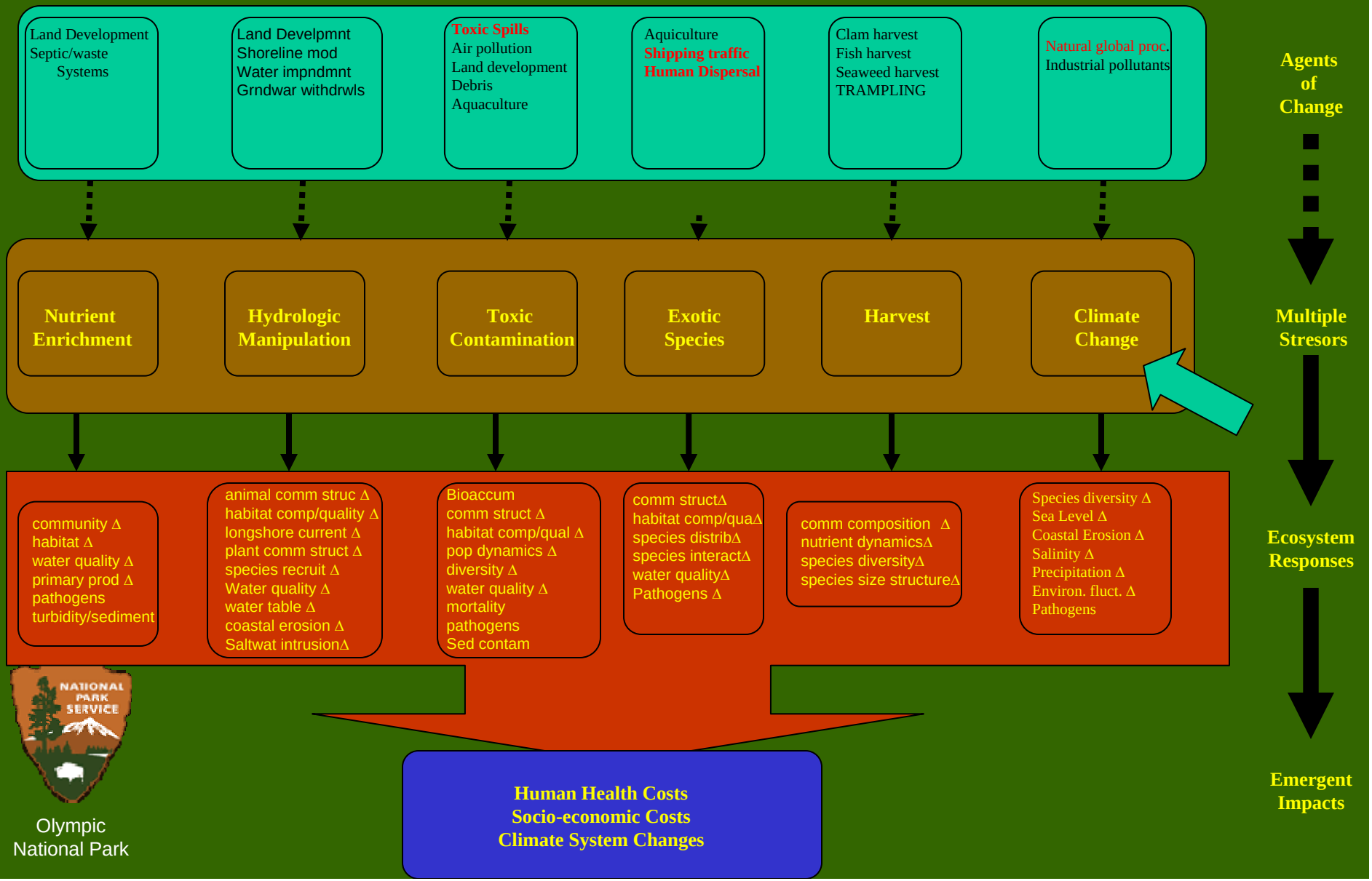
American Camp Land Cover Type	1997 Acreage	2007 Acreage
Bare Earth	*85.1*	*85.4*
Buildings	*0.1*	*0.1*
Forest	*361.6*	*435.8*
Prairie	*771.3*	*695.7*
Managed Grassland	*5.3*	*5.2*
Roads	*16.7*	*16.7*
Water	*9.0*	*10.1*

From Dalby & McCoy, NPS, PWR

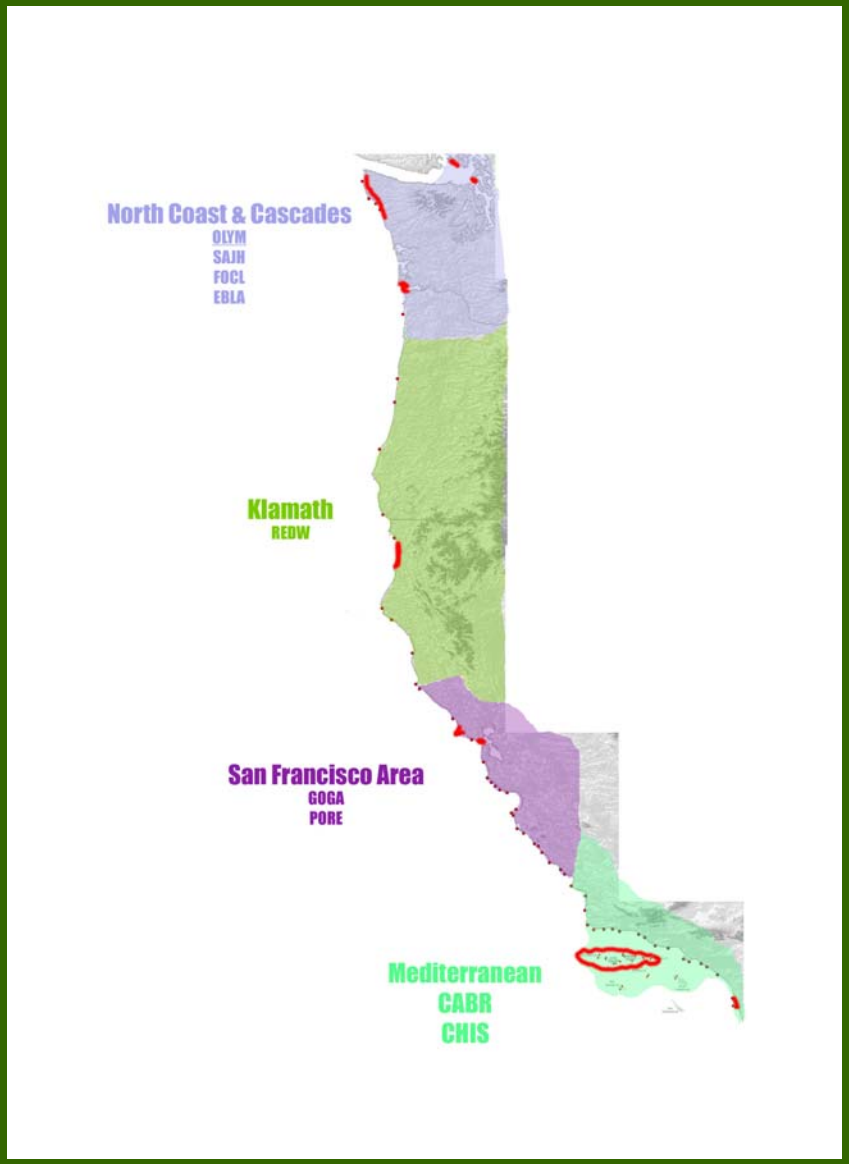
Intertidal--NCCN Marine Parks

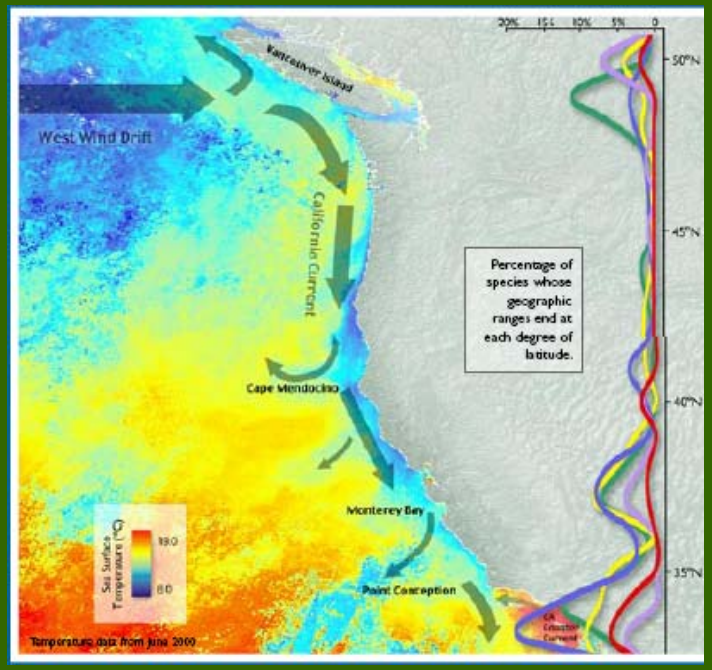


Conceptual Model of NCCN Marine Ecosystem Change



The “Network” Marine National Parks





Olympic
National Park

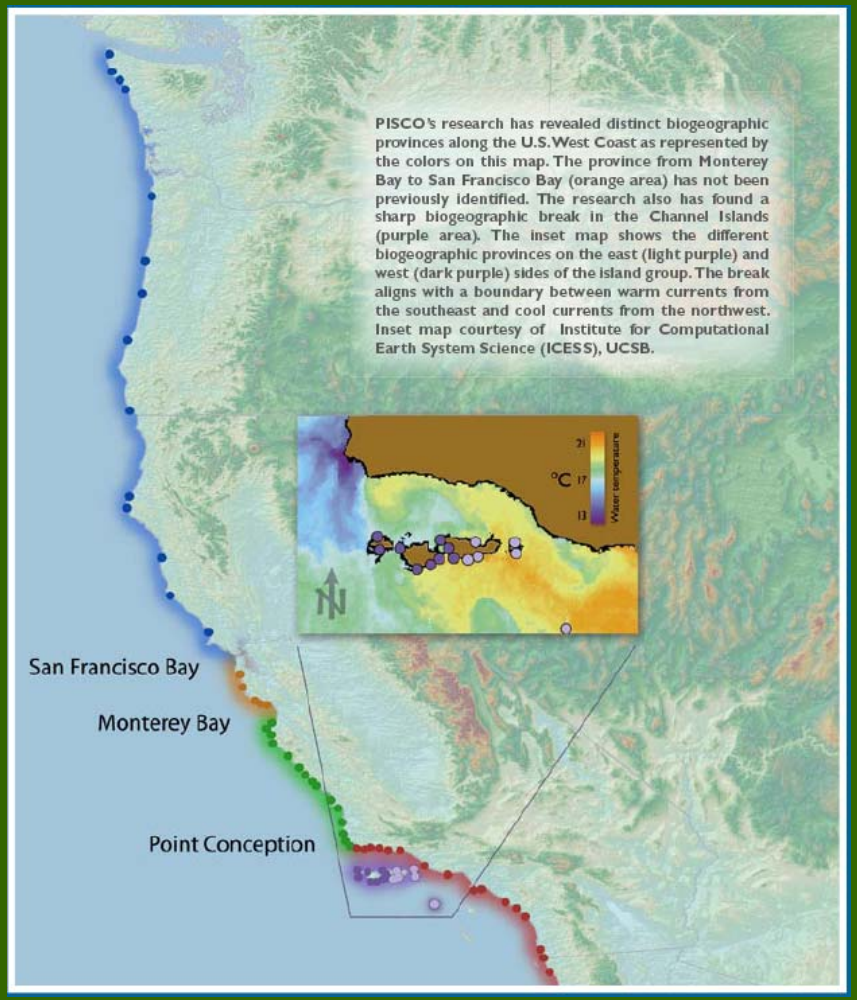
Collaborative Partners

MARINe
Multi-Agency Rocky Intertidal Network

PISCO
Partnership for Interdisciplinary Studies of Coastal Oceans

Marine "Network"

of National Parks



Olympic
National Park

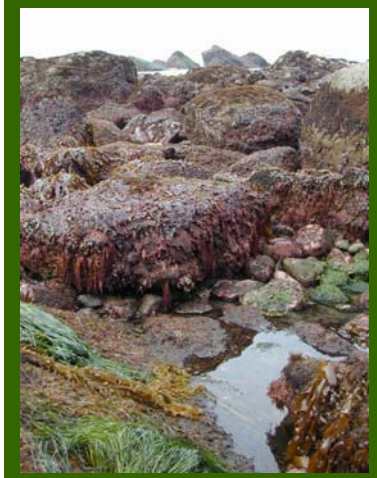
Olympic N.P. Major Habitat Types

Rock Platform Habitat = 21 %

Sand Beach Habitat = 30 %

Mixed-Coarse Habitat = 28 %

Olympic
National Park



Species Richness – Rocky Substrates
Biodiversity Hotspot

>180 Invertebrate Animals

>120 Macroalgal (Non-Vascular Seaweed) Species

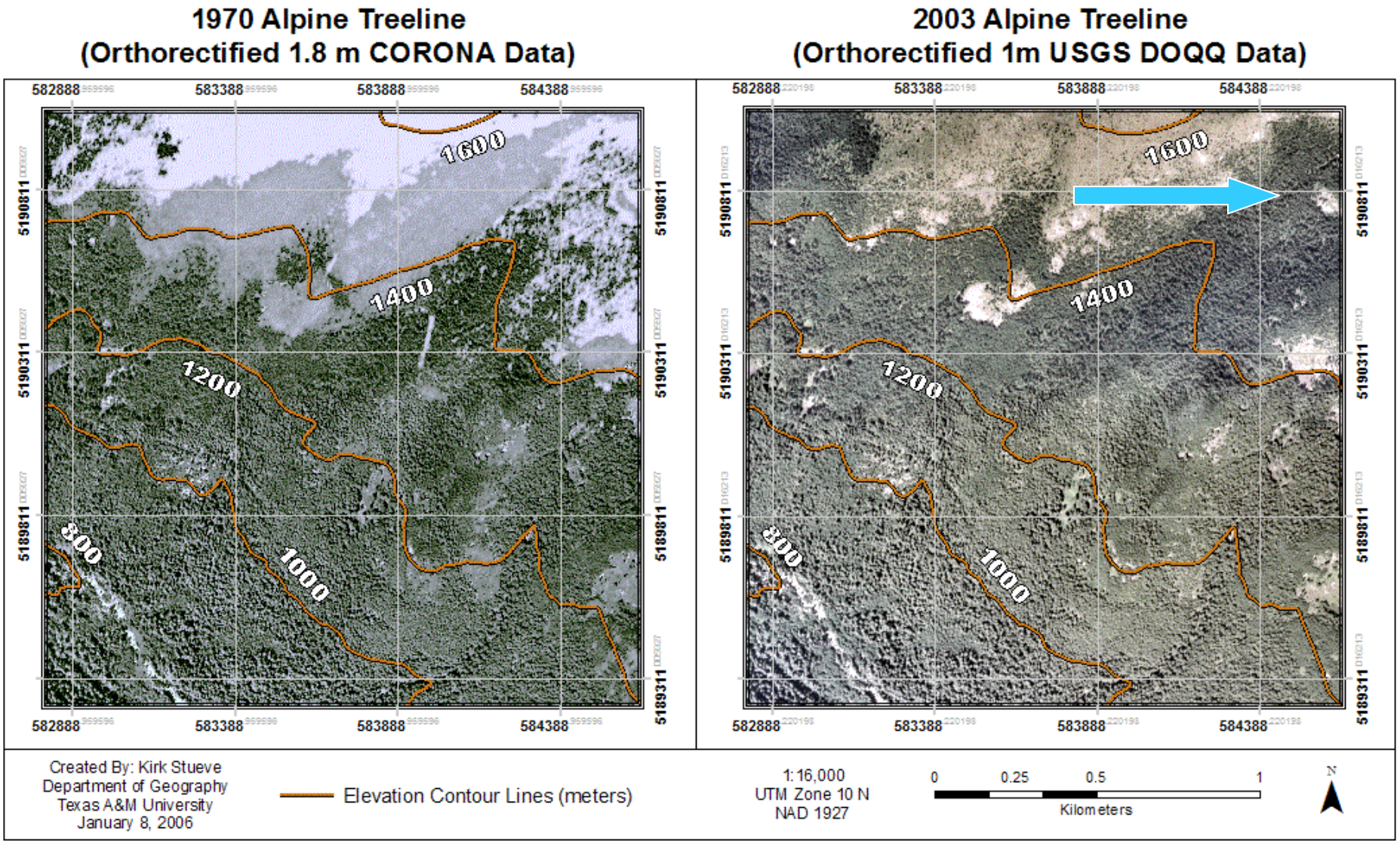
4 Vascular Plants

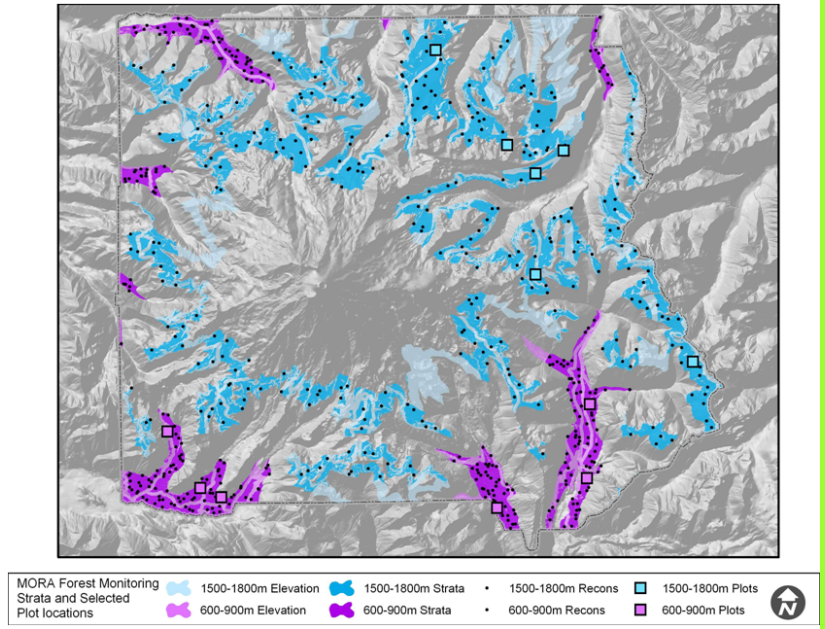
5 Lichens

Olympic
National Park

Subalpine (under development)

Forest/Treeline & Climate Change





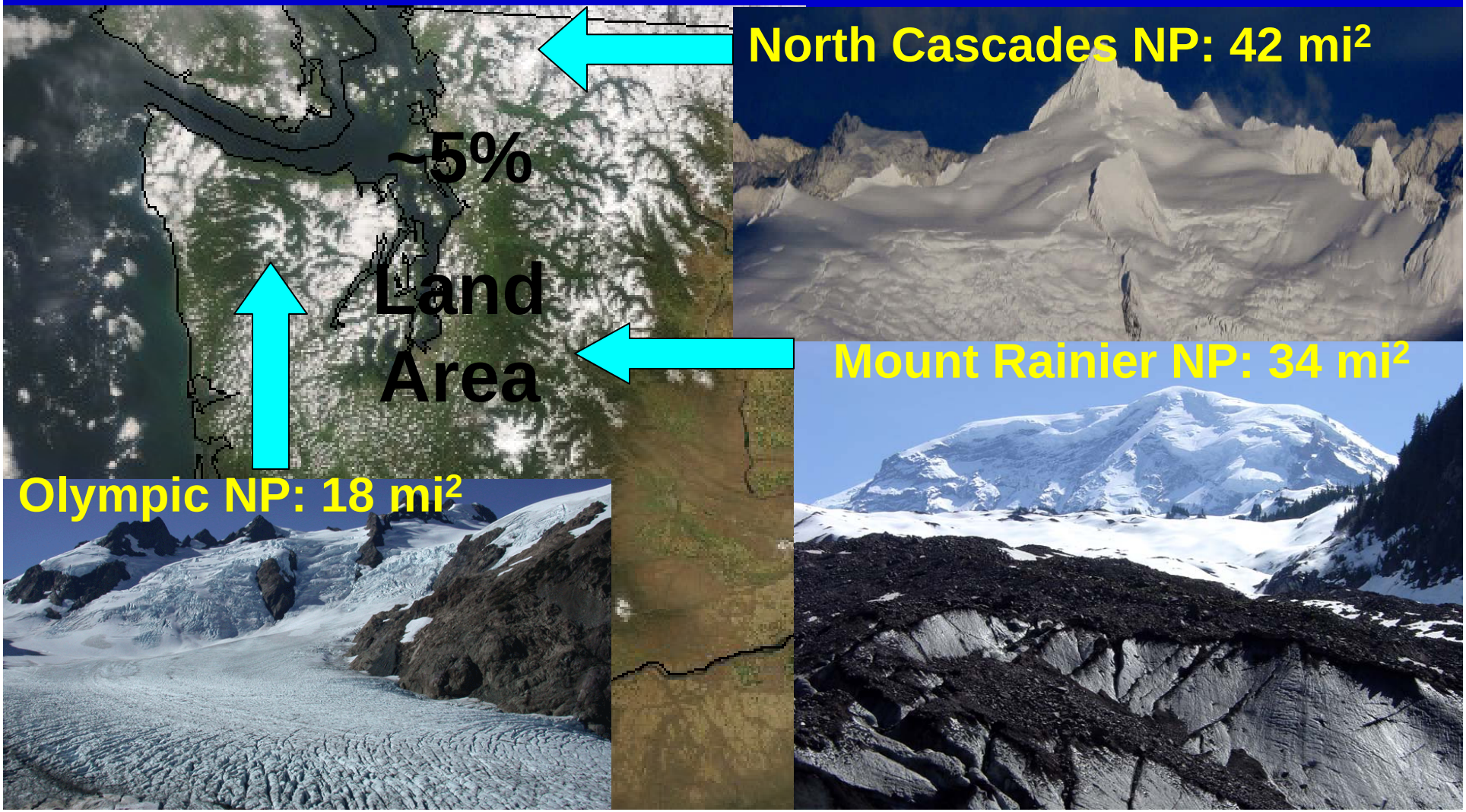
Forest Vegetation

Trends in tree mortality, recruitment, and growth

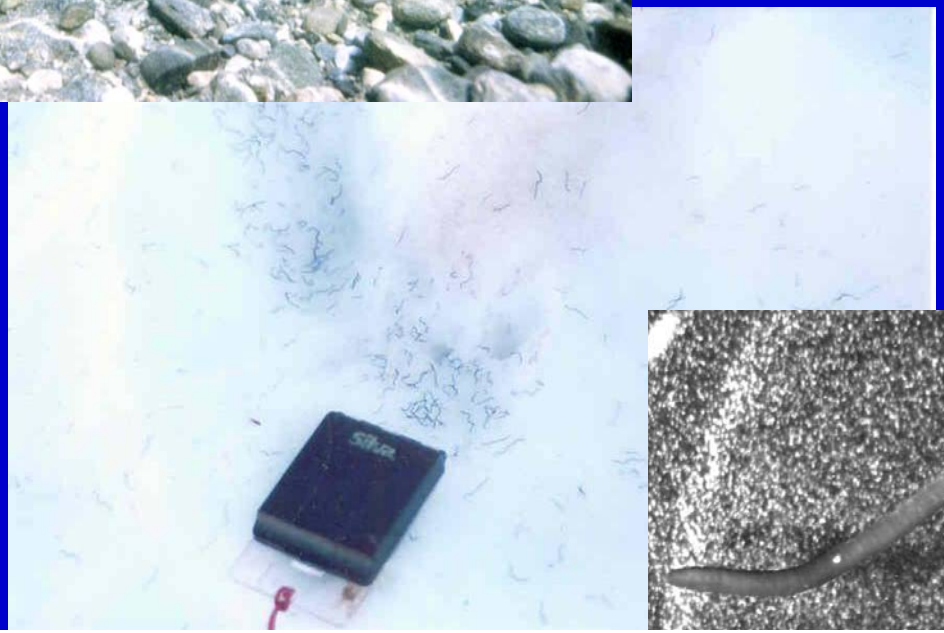
Elevation Zone - Approximate	**Lewis and Clark NHP** (180 cm precipitation)	**Mount Rainier NP** (200 – 300 cm precipitation)	**North Cascades NP** (100 – 500 cm precipitation.)	**Olympic NP** (75 – 500 cm precipitation)	**San Juan Island NHP** (50 – 75 cm precipitation)
Low (0-300 m)	Sitka spruce	Western hemlock	Western hemlock	Sitka spruce	Douglas-fir
Mid (300-1000 m)	--	Western hemlock	Western hemlock or Ponderosa pine	Western hemlock or Douglas-fir	--
Lower Montane (1000-1500 m)	--	Pacific silver fir	Pacific silver fir or Lodgepole pine	Pacific silver fir	--
Upper Montane (> 1500 m)	--	Mountain hemlock or Subalpine fir	Mountain hemlock or Subalpine fir	Mountain hemlock or Subalpine fir	--

Glacier Monitoring

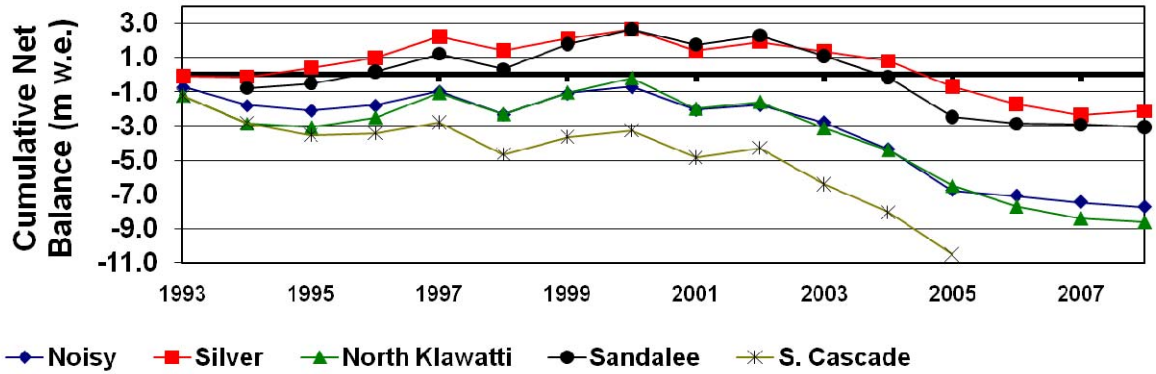
+ Indicator of Climate Change
Vitally Linked to Local Economy

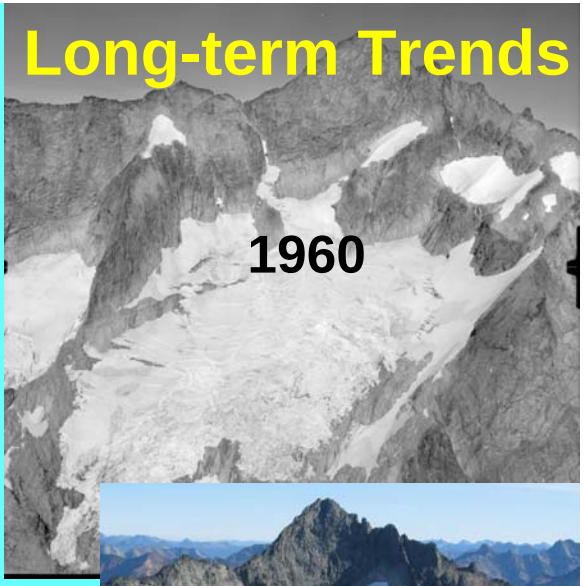


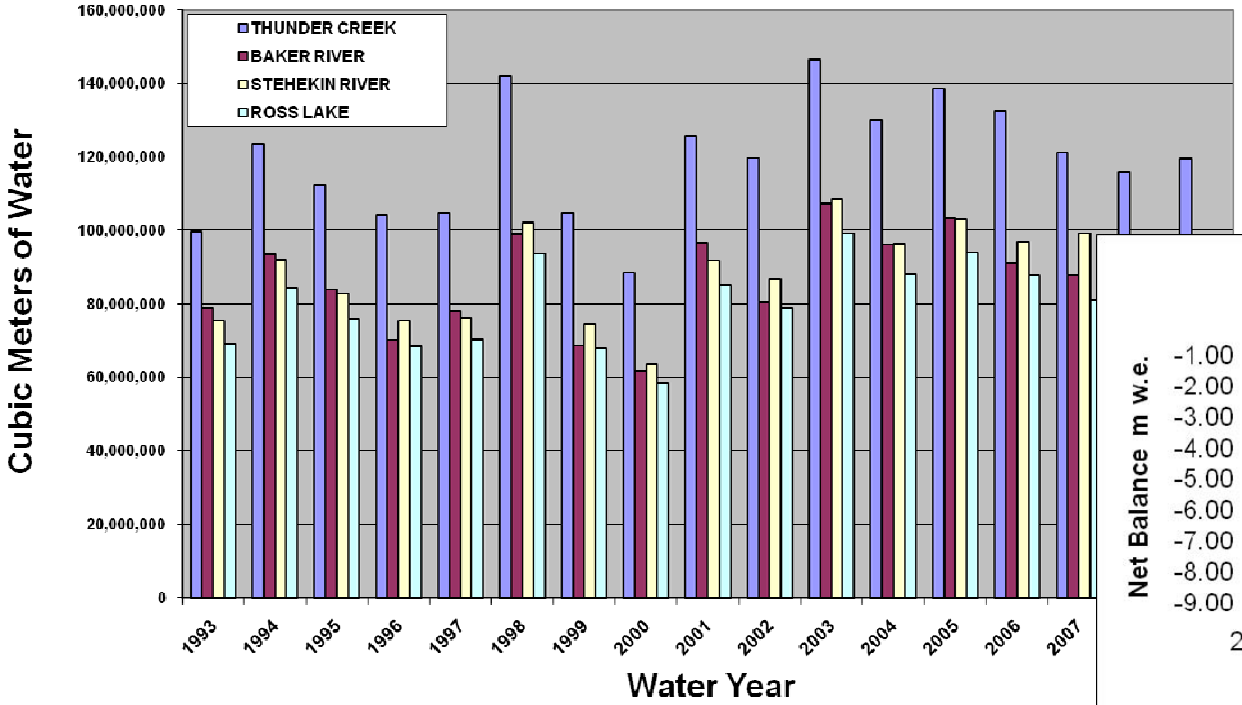
Provide Key Ecological Functions

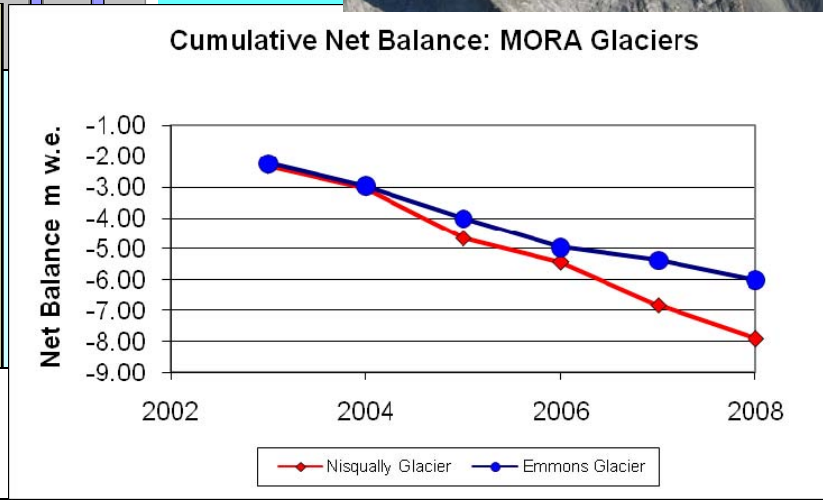


Long-term Trends



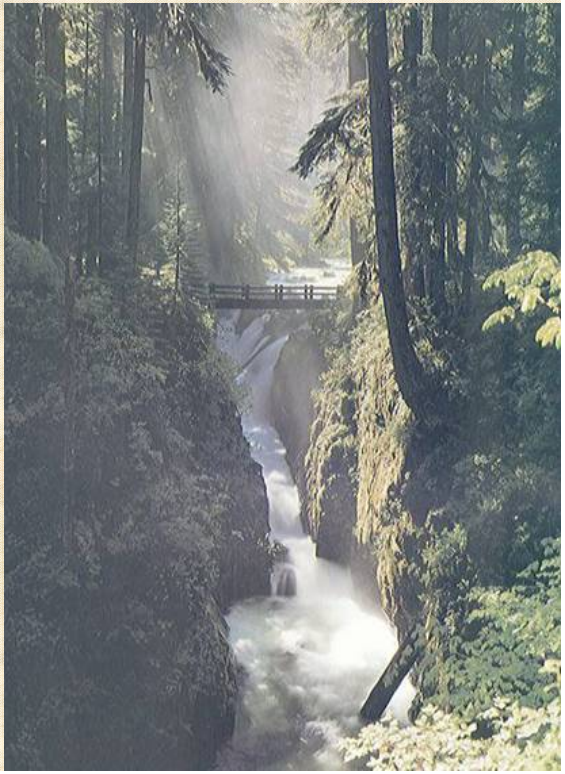
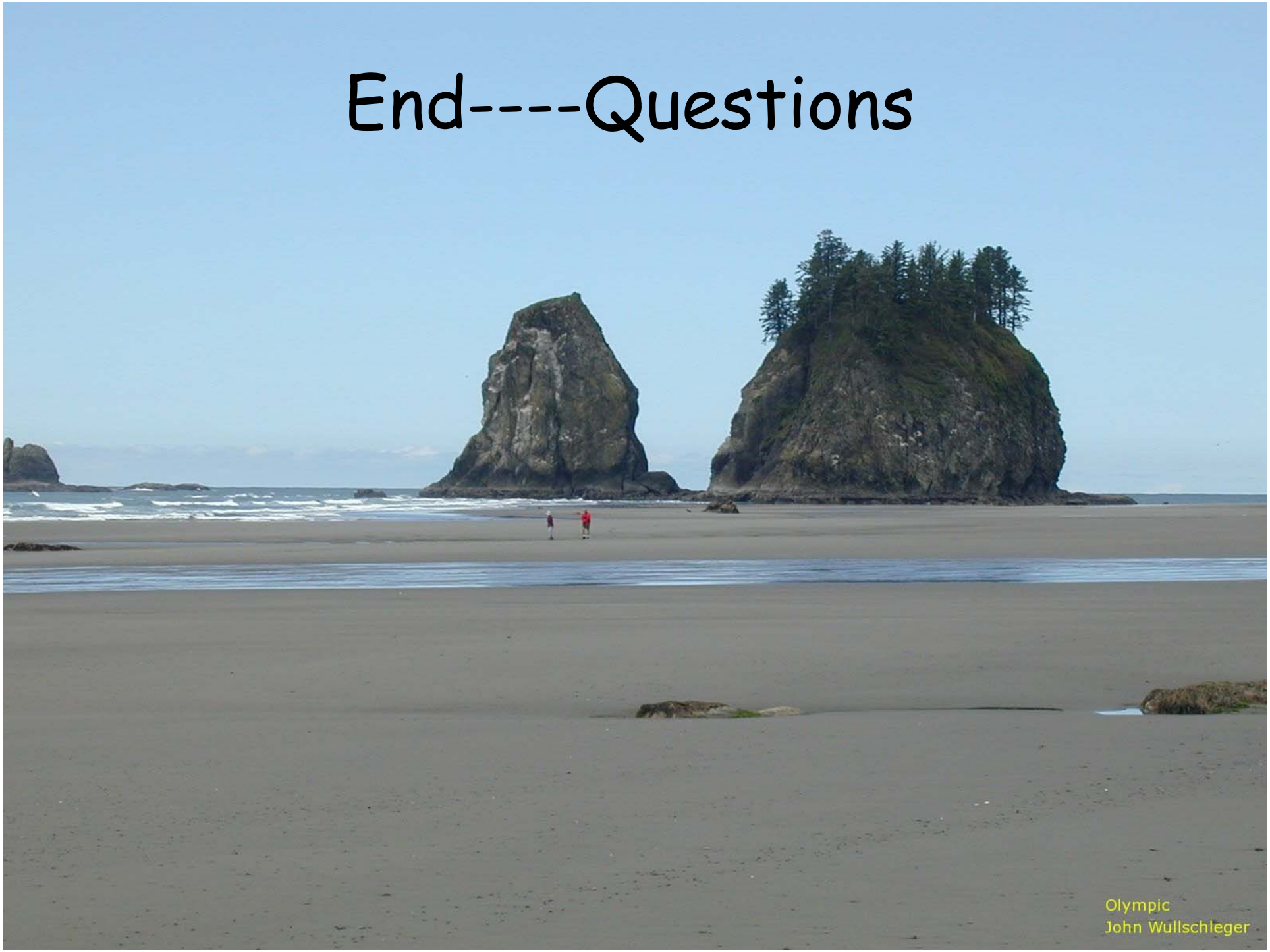






North Coast & Cascades Monitoring
Indicators & Climate Change--Challenges & Opportunities

- Air temperature, humidity, and wind speed
- Water physcial and chemical properties (e.g., quantity, quality, temperature, snow and ice)
- Species richness, distribtions, abundance, & community composition
- Sea level
- Disturbace frequency and extent
- Phenology
- Vegetative cover, mortality, growth
- Invasive species
- Population trends



End----Questions