

NPS Inventory and Monitoring: Monitoring Landscape Dynamics

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Road map ...

- Overview of NPS I&M program
- I&M landscape dynamics monitoring
 - Past
 - Current
 - Future

State of the Parks Report (circa 2000)

- 80 (1/3) of the “natural resource parks” had no professional natural resource manager; 1/3 had only 1 or 2 natural resource professionals.
- Almost all projects/studies were short-term; staff focused on “crisis of the day”.
- Emphasis on data collection; little analysis or reporting; data & products difficult to find or use
- Science products mostly used by other scientists

No Time

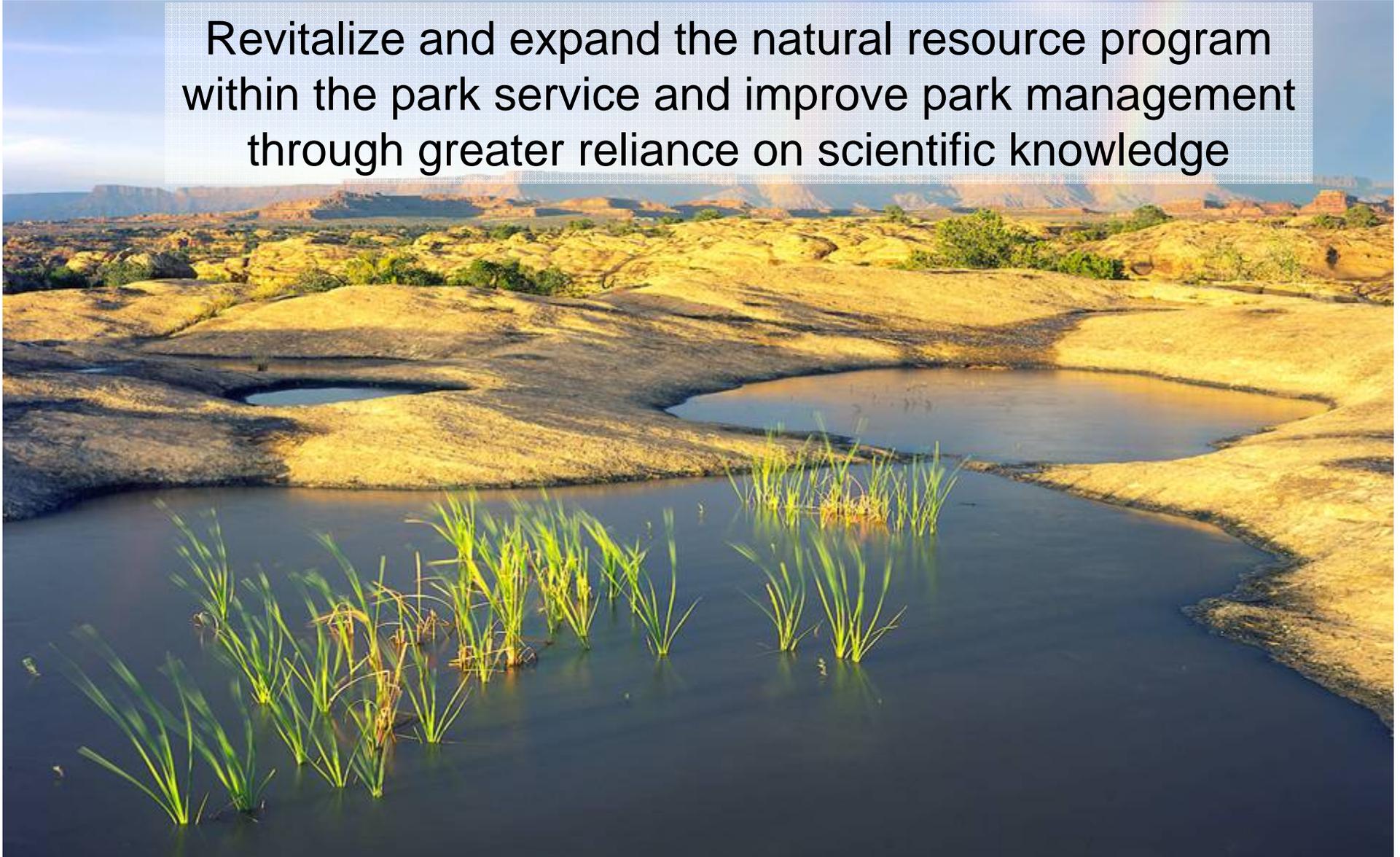
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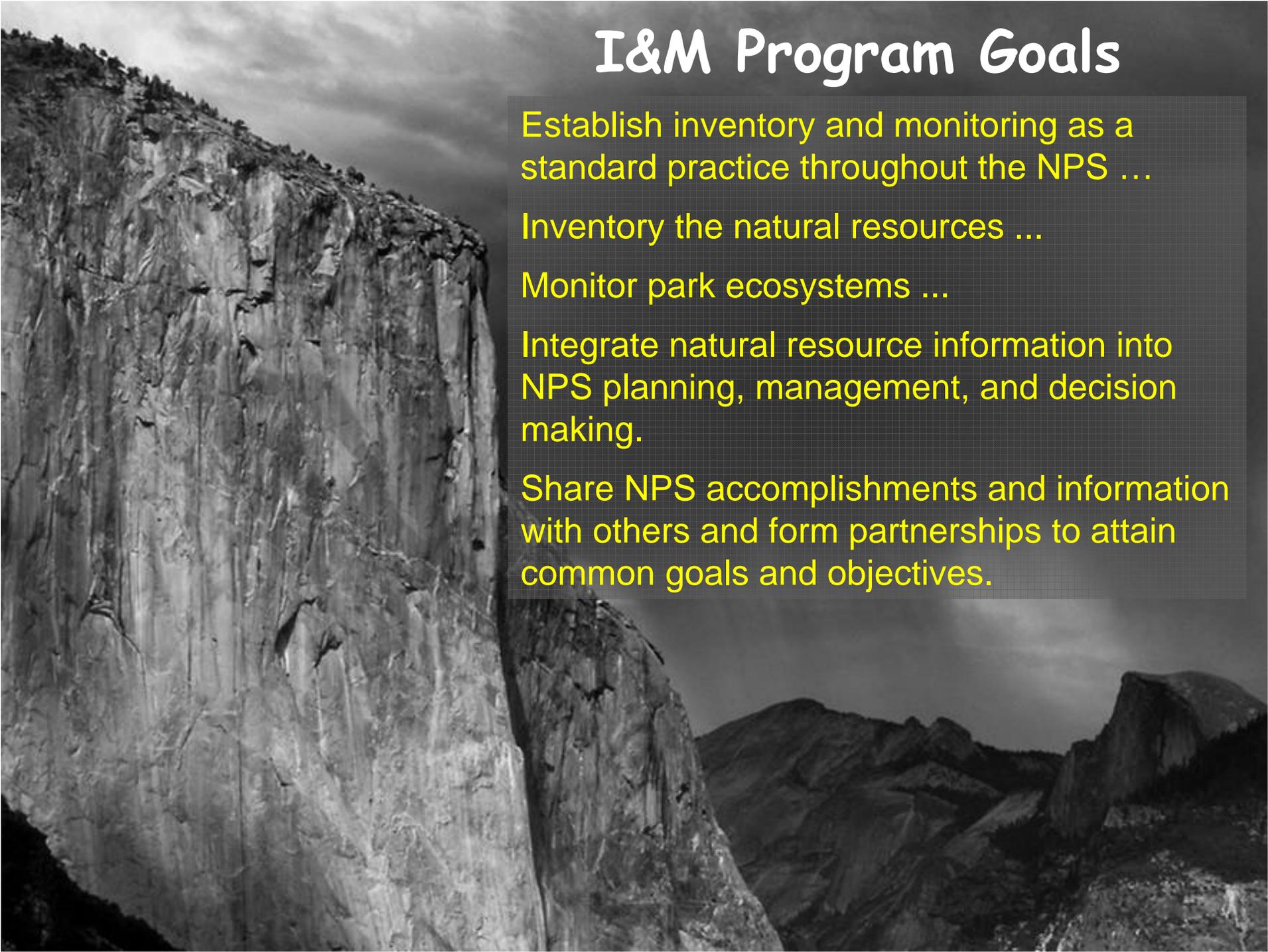
No Clue

National Park Service Natural Resource Challenge - 2000



Revitalize and expand the natural resource program within the park service and improve park management through greater reliance on scientific knowledge





I&M Program Goals

Establish inventory and monitoring as a standard practice throughout the NPS ...

Inventory the natural resources ...

Monitor park ecosystems ...

Integrate natural resource information into NPS planning, management, and decision making.

Share NPS accomplishments and information with others and form partnerships to attain common goals and objectives.

Overall Purpose of Vital Signs Monitoring:

Determine status and trends in the condition of selected park resources

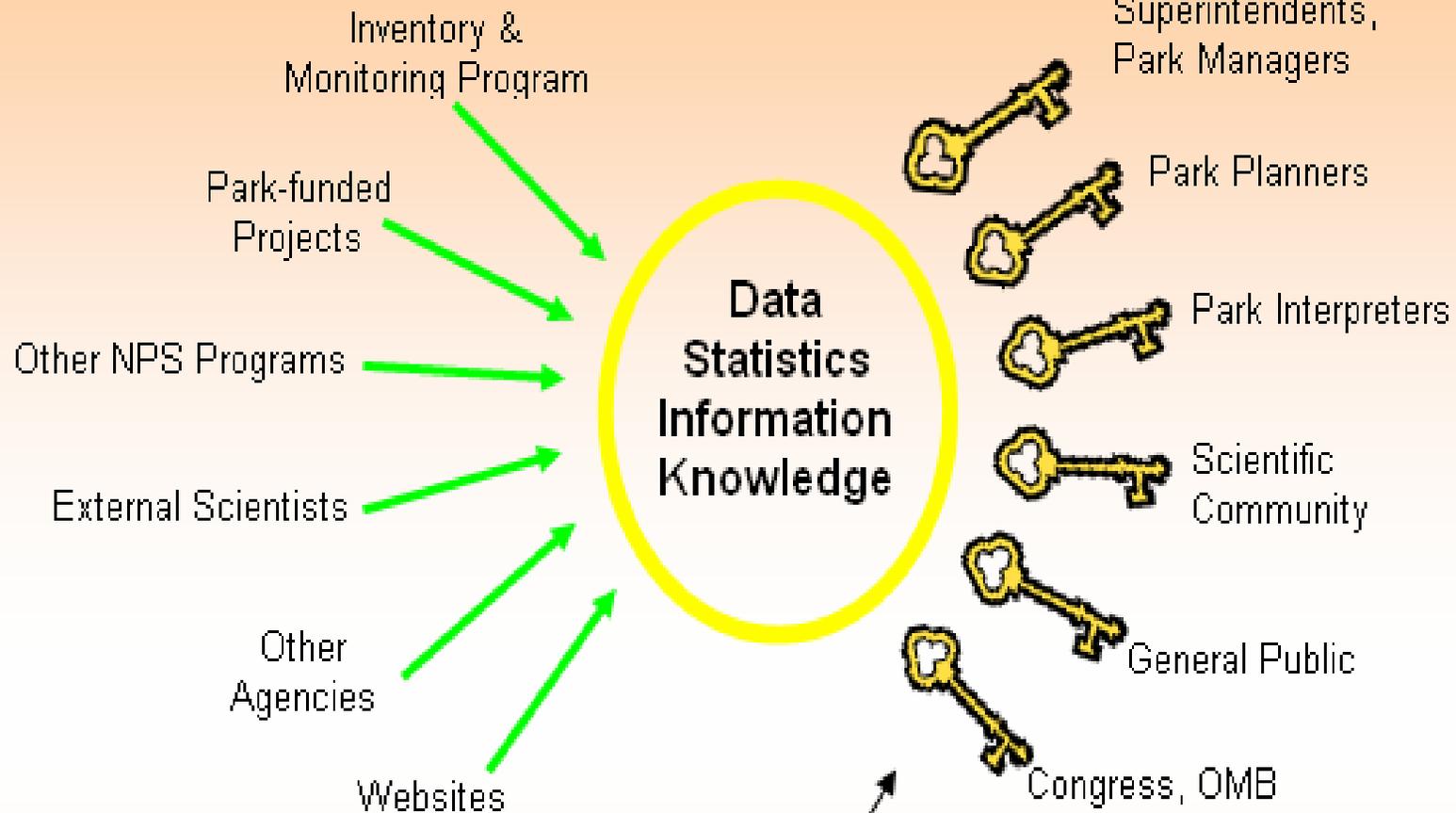
The intent of vital signs monitoring is to track a subset of physical, chemical, and biological elements and processes of park ecosystems that represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements with important human values.

Collect, Analyze, Report



DATA SOURCES

END USERS



End Users require results in different formats

The 32 park networks are an administrative tool for greater efficiency by sharing staff & funding.

I&M serves ~ 280 park units



| Vital Signs Monitoring Framework (Abbreviated) | | |
|---|--------------------------------------|---|
| Level 1 Category | Level 2 Category | Example Vital Signs |
| Air and Climate | Air Quality | Ozone, wet & dry deposition, visibility |
| | Weather and Climate | Temperature and precipitation |
| Geology and Soils | Geomorphology | Glaciers, shoreline change, channel morphology |
| | Subsurface Geologic Processes | Cave air quality, seismic activity |
| Water | Hydrology | Surface and groundwater water dynamics |
| | Water Quality | Water chemistry, aquatic macroinvertebrates |
| Biological Integrity | Invasive Species | Early detection of invasive plants |
| | Infestations and Disease | Whitebark pine disease, forest insect/disease outbreaks |
| | Focal Species or Communities | Landbirds, forest vegetation, fish communities, salt marsh vegetation |
| Human use | Point-Source Human Effects | Contaminants, illegal roads and trails |
| | Consumptive Use | Fisheries harvest, poaching of native plants and animals |
| | Visitor and Recreation Use | Visitor usage |
| Landscapes (Ecosystem Pattern and Processes) | Fire and fuel dynamics | Fire occurrence and extent, fuel loading |
| | Landscape Dynamics | Land cover and use |
| | Nutrient Dynamics | Nutrient cycling |
| | Productivity | Forest productivity, plant phenology |

Vital Signs for Tonto National Monument

| Level 1 Category | Vital Sign: | Frequency |
|----------------------|---|----------------|
| Air and Climate | Atmospheric Deposition (NADP) | Monthly |
| | Visibility and particulate matter (IMPROVE) | Monthly |
| | Climate (9 parameters) | Daily |
| Geology and Soils | Stream Channel Morphology | Every 5 years |
| | Biological Soil Crusts | Every 5 years |
| | Soil Aggregate Stability | Every 5 years |
| | Soil Compaction | Every 5 years |
| | Soil Cover | Annually |
| Water | Groundwater Depth | Annually |
| | Core Water Quality Parameters | Annually |
| | Nutrient Loading (N & P) | Annually |
| Biological Integrity | Invasive/Exotic Plants – Early Detection | Biennially |
| | Invasive/Exotic Plants – Status and Trends | Every 5 Years |
| | Plant Phenology | Annually |
| | Vegetation Lifeform Abundance | Annually |
| | Landbirds | Annually |
| | Vegetation Structure and Composition | Every 5 years |
| Human Use | Visitor Use | Monthly |
| | Visitor Use Impacts | Every 5 years |
| Landscapes | Landscape Dynamics (Land Use & Cover) | Every 10 years |

Most common vital signs include:

- Landscape dynamics
- Weather and climate
- Invasive species
- Water quality
- Vegetation communities
- Surface water dynamics, including snow
- Air quality

Landscape dynamics was identified as a priority vital sign by almost every I&M Network

Some key landscape monitoring activities

- Workshops (2004; NARSEC 2005, 2007)
 - w/ NASA, Parks Canada, CCRS
- Network-sponsored protocol development
 - Warren Cohen / Robert Kennedy
 - Andy Hansen
 - Phil Townsend et al.
 - Y.Q. Wang
 - Brad Reed
- NASA projects
 - Jeff Morrisette - invasives
 - Andy Hansen et al.

What have we learned??

Broad-scale analyses of landscape dynamics:

- Common core variables across networks.
- Potential to use inexpensive, widely-available data.
- Change detection – may use inexpensive high-frequency, coarse-resolution data to strategically acquire expensive data.

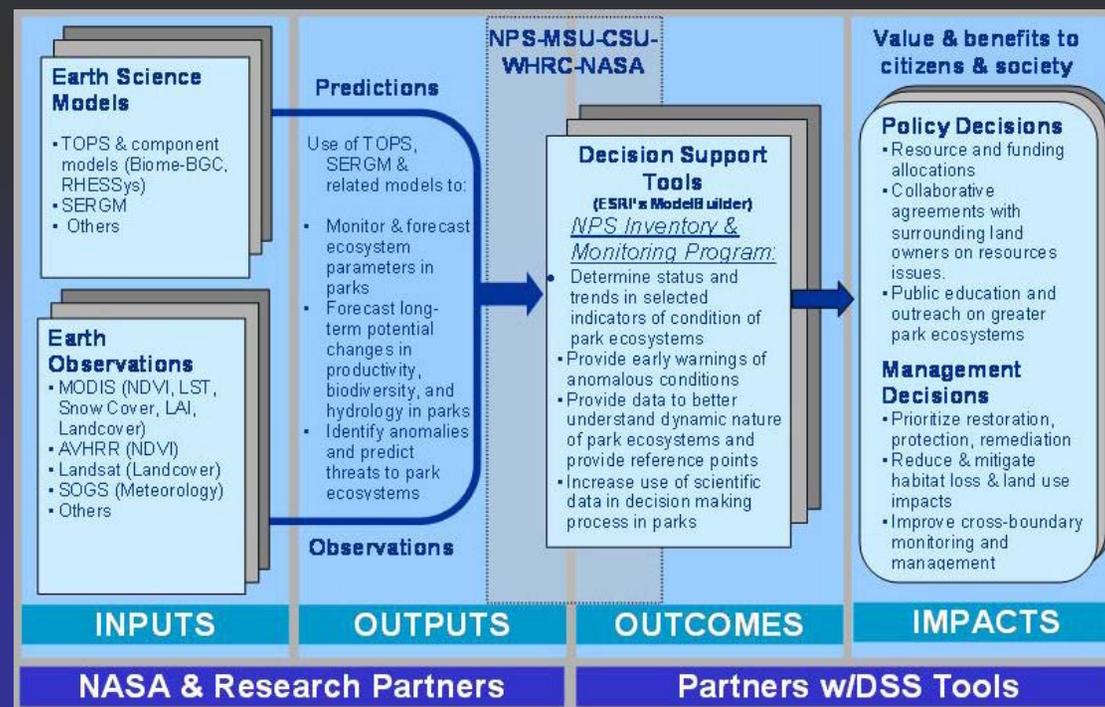
Finer-scale landscape dynamics (e.g. vegetation change)

- Commonalities more at regional to local scales
 - Many more network- or park-specific issues
 - Change detection is a very big issue
-

Two current, broader-scale efforts

NASA-NPS Project - PALMS

- Hansen, Goetz, Theobald, Nemani, Melton, and Gross
- Integration of RS data, ancillary data, models
- Strong reliance on TOPS for ecosystem processes
- Focused on four prototype parks



NASA-NPS - PALMS

- Strengths in RS science
 - Working closely with parks to ID needs
 - Very strong modeling capabilities
 - Conceptual advancements (e.g., GPE)
 - Educating / informing NPS staff
 - State-of-the art web presence via TOPS
 - Sophisticated use of data, models, analyses
 - Hope to expand in the future
-

I&M - Monitoring Landscape Dynamics (MoLD)

- Networks confronting reality - expensive & difficult
 - Real progress limited to a few Networks
- To exploit efficiencies in:
 - Identifying measures
 - Acquiring and processing data
 - Interpreting & reporting core measures
- Agency imperative to know about our parks
 - Consistency for regional to national reporting
- Build on NASA project; much less sophisticated but more broadly applied

Overall Goal

Identify, evaluate, and report a suite of landscape-scale measures for all I&M parks.

Use measures to assess current status, threats, and conservation vulnerability and opportunity.

Project Scope:

Must rely on existing data at regional to national scales

Well established measures, e.g.:

- area of land cover types
- habitat pattern
- impervious surfaces
- housing density
- major disturbances ?

Human Footprint / Drivers

- Human population / housing
- Roads
- Impervious surface
- Hydrological impoundments
- Agricultural lands

Natural Systems

- Area of habitats
- Core area
- Connectivity / fragmentation
- Disturbances

Threat
assessment

Status and
conservation value
assessment

Conservation Context

- Land ownership
- Land management
- Key connecting patches (nodes)

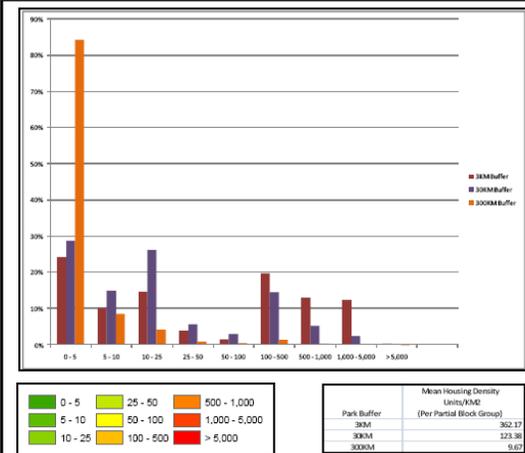
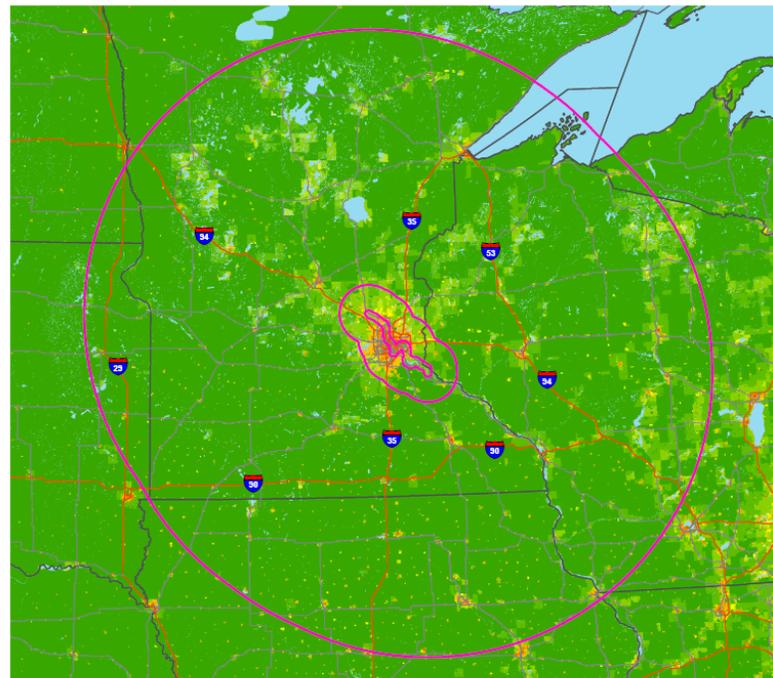
Vulnerability and opportunity

Three Basic *Spatial Scales of Analysis*

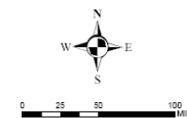
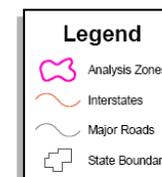
- *Adjacent to park - 3 km buffer.*
 - Data-limited; Networks/parks can enhance results
- *Local - 30 km buffer*
- *Regional scale - variable*
 - Based on watersheds and biomes

MISS housing density (from SILVIS data)

Housing Density - Analysis Zones



Source: SILVIS Lab, University of Wisconsin-Madison

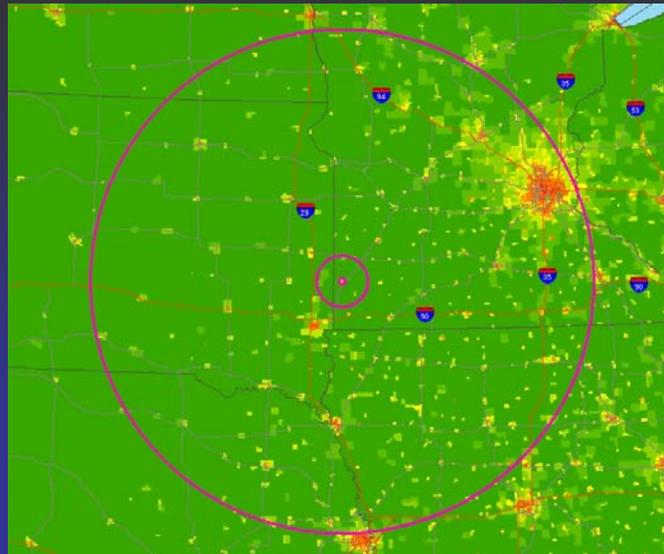


*Three Basic **Time** Scales of Analysis*

- *Historical*
 - How did we get here, and how fast?
- *Current*
 - What is status of resource / driver / attribute?
- *Future*
 - Where are we headed, should we do something about this, and if so, what?

Main products - for all I&M Parks

- Results and evaluation
- Methods
- Data sets
- Stand-alone graphics



Pipestone Population Density

These projects rely on Landsat, especially NLCD

For the future:

- Continuity!!!
- Change products
- Integrative land cover change program
 - MODIS -> Landsat -> Ikonos
- Tighter link to climate change issues
 - Phenology
 - Land cover change
 - C accounting models
- Tools to locate / process Landsat image stacks

A satellite view of Earth showing cloud patterns and landmasses. The image is a high-resolution satellite photograph of the Earth, showing a large portion of the Western Hemisphere. The clouds are depicted in white and light blue, swirling in complex patterns over the oceans and continents. The landmasses are shown in darker shades of blue and brown. The overall image has a dark, almost black background, suggesting it was taken from space.

For more information:

<http://science.nature.nps.gov/im/monitor>

Specific objectives

- Describe and evaluate informative landscape-scale variables
 - historical, current, and projections where available.
- Produce Standard Operating Procedures that are easily used by Networks
- Provide consistent & comparable measures across the NPS system.
- Provide underlying data to parks and Networks.
- Recommend ways to build on & enhance results.

Reports for all I&M parks:

- narrative justifying & describing measures
- evaluation of individual measures
- overall assessment
- datasets
- maps, graphs, tables, and text to communicate results (pdf, jpg)

Socioeconomic reports are 'best practice'

Phase 1 Deliverables

November

Network report 'enhanced TOC' with key questions and objectives

Park buffers determined / in review

Population (1990, 2000, historical), light, HUC-8, available HUC-12 data processed and posted.

December

All "framework" cartographic data processed

Land ownership & land cover data sets complete

Pilot park evaluations complete

Draft measurement development summaries

Draft SOPs for population, roads, and land cover measurements

Draft report for initial review

Project Phases

1. **Scoping and project initiation** - Aug 2008 to Jan 2009
 - Develop project infrastructure
 - ID measures
 - Acquire & process data
 - Draft Measurement Development summaries
2. **Development** - Nov 2008 to July 2009
 - Template report
 - Work flows developed and implemented
3. **Production and analysis** - May 2009 -
 - Full-on production of results, reports, & graphics

What we have now

Data sets

Land Cover

- Enhanced NLCD 1992
- NLCD 1992
- NLCD 2001
- NLCD Change Product
- NLCD Impervious Surface
- NLCD Tree Canopy
- Historic Natural Fire Regime
- Landfire - all products
- Land cover diversity (Simpson's)
- Land cover characteristics
- Forest fragmentation
- Forest cover types
- Converted vs. Natural Landcover

Population

- Nighttime Lights (1992/93, 2000)
- Populated Places
- U.S. Cities
- U.S. Urban Areas
- 1990, 2000 Census Block Groups
- SEDAC Census Grids
- Housing Density (1940-2040)
- Inventoried roadless area
- Agriculture census by county
- Water use by county
- Conservation risk index
- Wildland Urban Interface

Transportation

- Roads - Multiple data sources
- Railroads (U.S. and Canada)

Climate

- Precipitation
- Temperature (min/max, variability)
- Growing season days
- NDVI
- Growing season

Hydrology

- Hydrologic Units 4, 6, 8, and 12-digit
- NHD Medium and high resolution (where available)
- Dams
- Aquifers
- Ground water climate response network
- Sea ice (North America)

Landform

- DEM - 10, 30, and 120 meter
- Slope, Aspect
- Depth to bedrock
- Sand, silt, clay fractions
- Crop capability
- Geology

Boundaries

- Omernick Ecoregions
- Bailey Ecoregions
- Physiographic Provinces
- States
- Counties
- NPS Units (with various buffers)
- Federal Lands
- National Wilderness Preservation System
- NPS Vital Sign Networks
- Continental Divide
- Protected Areas Boundaries
- NCDC Climate Divisions
- NEON Domains

Phase 2 Deliverables

| | |
|-----------------|---|
| February | |
| | Pattern measurement defined and initial testing/validation complete |
| | All available data sets acquired and initial processing completed |
| March | Initial estimate of all measurements completed for pilot parks. |
| | Complete template report ready for review |
| April | All draft SOPs completed |
| July | Report reviewed, revised, & submitted for NRTR series |

Measurement Development Summaries in Progress

Land cover land use
Conservation status
Population
Housing
Roads
Night lights
Phenology

Analytical Products (multiple spatial scales)

Housing Density:

- units / sq km, by partial Census block group

Population Density:

- individuals / sq mile, by Census block group

Road Density:

- km / sq km

