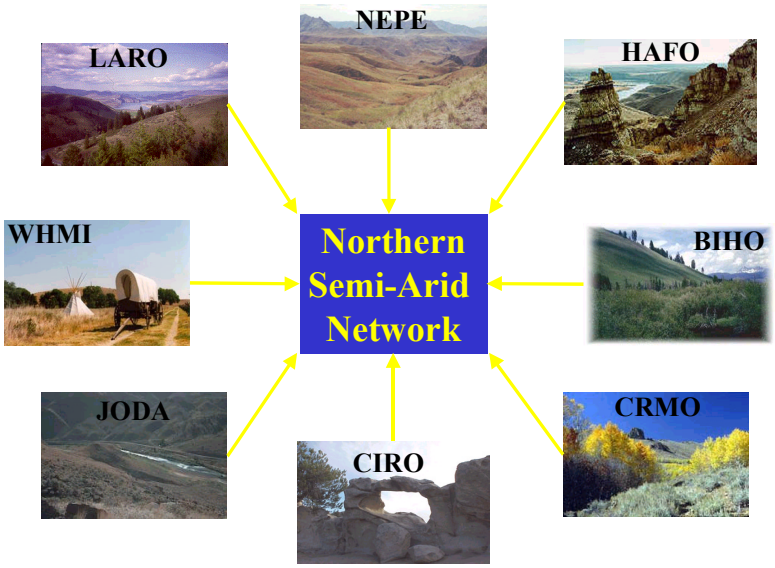
Vital Signs Monitoring Workshop Report for the Northern Semi-Arid Network



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Northern Semi-Arid Network
Vital Signs Monitoring Plan

Program Background and Justification

In accordance with the Congressional mandate to increase scientific research and detect long-term changes and trends in resources in the National Park System, the ***Inventory and Monitoring Program*** *was created in the early 1990's. The program's intent was to document trends and conditions of valuable resources to assure the ecological integrity of each park's ecosystem, as well as preserving its biodiversity and uniqueness. The national strategy for inventory and monitoring seeks to:*

- *Detect significant changes in resource abundance, condition, population structure or ecological processes.*
- *Evaluate the effects of management action on population or community dynamics or ecological processes.*

The national strategy consists of a framework having three major components:

- *Completion of basic resource inventories upon which monitoring can be based.*
- *Creation of an experimental Prototype Monitoring Program to evaluate alternative monitoring designs and strategies.*
- *Implementation of operational monitoring of critical parameters ("vital signs") in all natural resource parks.*

An important component of the NPS national framework for monitoring consists of ***networks of parks*** *that will conduct long-term ecological monitoring for critical parameters or "vital signs." As of October 1, 2000, approximately 270 park units organized in 32 networks will participate in Vital Signs Monitoring.*

The ***Northern Semi-Arid Network*** *is one such network, uniting eight park sites in four western states, on the basis of shared characteristics, which include:*

- *Low to moderate rainfall*
- *Plant communities that typically occur in these climates*
- *Similar adjacent land use histories*
- *Characterization as "islands" amidst surrounding, often fragmented, landscapes*
- *Generally small size, with lack of buffer zones*

Defined Objectives of the Northern Semi-Arid Network Monitoring Program:

- ✓ *Determine status and trends of the health of the park ecosystem*
- ✓ *Establish normal limits of variation in key park resources*
- ✓ *Provide early warning signs of resource decline*
- ✓ *Evaluate the effectiveness of resource management practices*

*In preparation for the **Vital Signs Monitoring Plan Workshop**, the network has completed a computerized resource database documenting all natural resource studies pertaining to each site; documented species lists for each park in the network; documented information on existing natural resource data. To avoid a "death by models" situation, a simple, straightforward conceptual model was developed before the workshop, providing a starting point and framework for addressing and evaluating vital signs and monitoring strategies at the network level. The workshop was organized to identify and validate vital signs common to each park site, substantiate the conceptual model's premises, and add further input to monitoring focus, measures and methods. Prior to the workshop, a copy of the **Draft Vital Signs Monitoring Plan for the Northern Semi-Arid Network** was distributed to participants. Resource Managers were also sent a questionnaire, examining the following points as preparation for workshop discussions:*

- ✓ What are your park's most significant resources for which information about status and trends is needed?
- ✓ What park resources have regional or even national significance due to their unique nature or because they serve as indicators of regional trends?
- ✓ Are there particular resources that the park has special mandates or commitments to protect either by park legislation, in a general management plan, or in other laws of planning documents? (e.g. Federally listed species at all parks)
- ✓ What, in your opinion, are the greatest current or prospective internal threats to significant park resources? (e.g. climbing at CIRO, trail impacts at JODA)
- ✓ What are the greatest external threats? (e.g. irrigation at HAFO)
- ✓ Are there significant current or future ecosystem restoration projects in the park for which long-term monitoring is needed? (e.g. vegetation restoration projects at WHMI)
- ✓ (Especially for Resource Managers) What long-term natural resources monitoring projects have been undertaken in the past or are ongoing now?

Resource Managers responded to the questionnaire in writing and also addressed the critical points in the workshop. Summaries of those presentations are contained in Workshop Proceedings: Park Summaries.

Workshop Participants

Frank Andrews, Resource Management Lake Roosevelt National Recreation Area Frank_Andrews@nps.gov	Wallace Keck, Superintendent City of Rocks National Reserve CIRO_Superintendent@nps.gov
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Workshop Proceedings
April 16-17, 2002

A workshop on the Vital Signs Monitoring Plan for the Northern Semi-Arid Network was conducted at the University of Idaho on April 16-17, with representatives from the eight park sites attending. Appropriate additional resource specialists and scientists also participated. The objectives of the workshop were threefold:

- ❖ To identify significant natural resources and their future desired condition
- ❖ To identify current threats and stresses that can affect park resources
- ❖ Brainstorm and recommend potential vital sign indicators for long-term monitoring that can evaluate the condition and health of the natural resources of network parks.

Based on the network approach, the program will set up new vital signs monitoring opportunities based on commonality, but will also identify more site-specific situations, and facilitate improved database storage. An inventory-monitoring strategy will help synthesize new programs and facilitate more efficient management decisions. The following handouts guided the workshop proceedings:

- **Draft Vital Signs Monitoring Plan for the Northern Semi-Arid Network**
- **Workshop Agenda (Appendix A)**
- **Conceptual Model Worksheet (Appendix B)**
- **Ecosystem Effects Worksheet (Appendix C)**
- **Vital Signs Indicator Worksheet (Appendix D)**

Park Summaries

Network park site representatives defined their park's ecological concerns in written responses and workshop presentations (a more detailed evaluation of each park site is contained in the **Draft Vital Signs Monitoring Plan for the Northern Semi-Arid Network**). Park site representatives addressed site conditions and concerns in the context of the following:

- ✓ *What are the park's most significant resources for which information about status and trends is needed?*

- ✓ *What park resources have regional or even national significance due to uniqueness, or because they serve as indicators of regional trends?*

- ✓ *What are the greatest current or prospective internal threats to significant park resources?*

- ✓ *What are the greatest external threats?*

Big Hole National Battlefield (BIHO) Dan Foster

Cultural landscapes are the most significant resources to be protected at BIHO, with invasion of exotic species and changes to local hydrology as both internal and external threats. Over the years, fire has been kept out of the landscape, creating a change in ecology. Additionally, four nearby irrigation canals have leaked, encouraging non-native willow growth. Grazing patterns near park borders have impacted native grasses, as well. BIHO identifies restoration of forest ecology by thinning and prescribed burn, and prescribed fire in willow/riparian and sage/grasslands as ecosystem restoration projects for which long-term monitoring is needed.

Nez Perce National Historical Park (NEPE) Dan Foster

With 38 dispersed cultural landscape locations, the park's sites are all listed on the National Register of Historic Places and are thus in need of protection, especially from encroaching development to satisfy visitor demand. Proposed visitor centers such as those at Bear Paw and Heart of the Monster will impact ecosystems. Currently NEPE's Spalding site needs restoration of ponderosa pine/grass areas, while the White Bird village site requires building removal. All locations suffer some amount of impact from exotic species.

City of Rocks National Reserve (CIRO) Wallace Keck

CIRO's significant resources include the California Trail, Indian Grove and riparian communities, with the area boasting Idaho's largest pinyon pine and a large pinyon pine forest. The park's high elevation supports several distinct plant communities (sagebrush, pinyon-juniper, etc.), and granite monoliths provide shelter for raptors, pack rats, cliff swallows and swifts. The area is a rock-climbing mecca, but current threats from rock climbers are being mitigated. Grazing in riparian areas, dust dispersal from gravel roads, and erosion and sedimentation are additional areas of concern within the park, and juniper theft is an external threat that has become a recent problem.

Craters of the Moon National Monument (CRMO) John Apel

With its borders recently expanded to more than 12 times the original size, CRMO's significant resources include numerous volcanic features, kipukas, a Class I airshed, lava tubes, populations of sage grouse, Townsend's big-eared bats and pygmy rabbits, natural quiet and night skies. The spread of invasive weeds, destruction of geologic features by collectors, and illegal off-road vehicle use pose some of the biggest problems to the park itself. External threats include the spread of invasive weeds, regional haze impacts on

visibility, development impacts on night sky, and white pine blister rust impacts on limber pine. Restoration of sagebrush steppe habitat downgraded by wildland fire and invasion of cheat grass is a major focus.

Hagerman Fossil Beds National Monument (HAFO) Mike Wissenbach

Fossils and the associated stratigraphy are HAFO's most significant resources, while landslides, altered hydrological regimes (high water tables, fluctuating reservoir levels, perched aquifers, irrigation) and wind/water erosion pose the biggest threats to slope stability and fossil resources. Restoration and monitoring work would likely focus on revegetation of landslide areas to stabilize slopes, and control of exotic species. This section of the Snake River does not currently meet water quality standards; some of the impacts affect submerged lands that are within monument boundaries.

John Day Fossil Beds National Monument (JODA) Ken Hyde

JODA lists three areas of focus: riparian area vegetation changes; changes in plant communities due to noxious weed invasions and reintroduction of fire; population dynamics of amphibians, reptiles and small rodents. The amphibian population as well as steelhead salmon, bald eagle and Columbia spotted frog, are of concern, and noxious weeds such as cheat grass and medusa head are impacting sagebrush, mountain mahogany and rodent populations. The reintroduction of fire may or may not benefit native plant and animal communities, and newly planted old farm fields should be monitored for noxious weeds, future flood events and benefits to native wildlife populations.

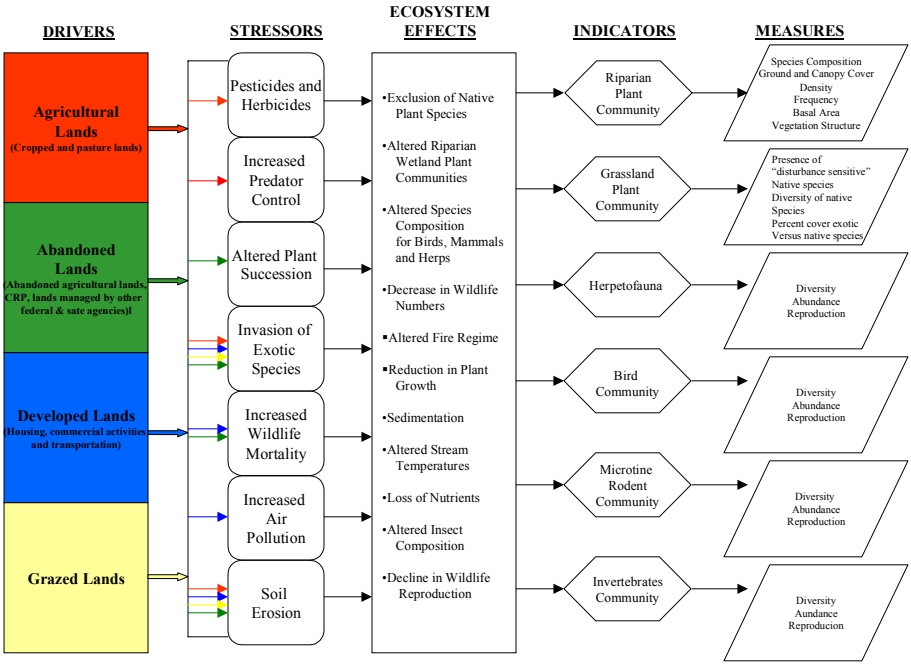
Lake Roosevelt National Recreation Area (LARO) Scott Hebner

LARO's focus concentrates on plant communities, water and fish, with raptors and water birds also of special significance. The mixed ownership and water fluctuations fragment resource management, and industrial pollution, residential development and noxious weeds pose major threats to the landscape. Restoration projects which require monitoring programs include polluted sediment impacts and shrub-steppe and forest restoration. Because the lake is manmade, it is not a natural aquatic environment.

Whitman Mission National Historic Site (WHMI) Roger Trick

WHMI has a cultural resource focus, but native vegetation and surface water quality and quantity are the park's major resource interests for new monitoring programs. As with other network sites, exotic species and noxious weeds are a major concern, as is the quality of irrigation water coming into the park. There is some ongoing vegetation restoration work, which will require monitoring, and water quality monitoring also needs to be undertaken.

Workshop Evaluation of Conceptual Model



The initial conceptual model developed for the Northern Semi-Arid Network assessed common situations, noting that all eight park sites feature:

- *Low to moderate rainfall (arid/semi-arid)*
- *Isolated riparian areas*
- *Plant communities that typically occur in these climates*
- *Similar adjacent land use histories*
- *Characterization as "islands" amidst surrounding, often fragmented, landscapes*
- *Generally small size, with lack of buffer zones*

The workshop itself was conducted in four segments, using the same steps to evaluate each component (Drivers, Stressors, Ecosystem Effects, Indicators/Vital Signs) of the conceptual model. Each segment followed essentially the same format:

Process

- ⇨ Breakout group discussion/validation of model component
- ⇨ Changes and proposals to the model as addressed in small groups
- ⇨ Questions and problems brought to the main group
- ⇨ Consensus of the whole group

Decision

- ⇨ Agreement to add, subtract or alter categories or features of model
- ⇨ Amend conceptual model to reflect group suggestions
- ⇨ Go to next segment of workshop, incorporating amended model

Segment One: DRIVERS

In Segment One, DRIVERS were identified as:

- Agricultural Lands
- Abandoned Lands
- Developed Lands
- Grazed Lands

Process:

Red Group Discussed *recreational access* as a potential Driver or Stressor, and also considered *flowing water* as a Driver. The group considered *public perception* and *politics* as Drivers, as well, but finally agreed to leave the current set of Drivers in place with broad definitions. The group wanted to identify pathways between Drivers and Stressors, such as streams and channels, and also wanted some emphasis on access and recreation issues at a future point.

Green Group Considered *climate change* as a Driver and agreed to be cognizant of that in future discussions. The group discussed *land conversion, soundscape, overflights, clear night sky, light pollution and air quality* as relative issues, but agreed to propose *increased visitation* as the only added Driver.

Blue Group Stressed that Drivers needed to be significant to the whole network in order to be considered. The group also discussed whether Drivers were internal or external, and considered *climate* as a possible Driver, along with *natural influences*. The group further agreed that there should be an established baseline for Drivers, and that participants should understand the baseline and stay within it.

Additional Comments/Questions

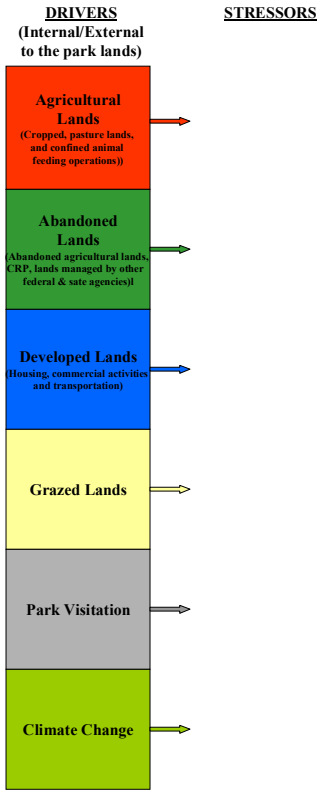
- Every park could list *increased visitation*, but with the size park being discussed, is it applicable?
- We should be looking to the future and collecting baseline data now.
- Is *increased visitation* a Driver or more of a pathway or subtext of development?

Decision:

Consensus of Group

- Need to amplify current Drivers to clarify Developed Lands as internal or external to park, Agricultural Lands to include Confined Animal Feeding Operations.
- Drivers proposed:

- ***Park Visitation***
- ***Climate Change***



Segment Two: STRESSORS

In Segment Two, Stressors were identified as:

- Pesticides and Herbicides
- Increased Predator Control
- Altered Plant Succession
- Invasion of Exotic Species
- Increased Wildlife Mortality
- Increased Air Pollution
- Soil Erosion

Process:

Red Group The group first reconsidered *park visitation* as a Stressor, viewing the park as an attraction and therefore a Driver. When visitation was viewed as a Driver, however, such things as *water consumption (both internal and external)* and *water pollution* were

rated as Stressors. *Increased predator control* was viewed as too narrow in scope, and *animal control* became the new delineation.

Green Group The group regrouped Drivers and Stressors in the following way:

Drivers	Stressors
▪ Agricultural Lands >	Water Quality, Irrigation
▪ Abandoned Lands >	Water Quality
▪ Developed Lands >	Noise, Light, Air Quality
▪ Grazed Lands >	No Changes in Stressors
▪ Park Visitation >	Roads, Traffic, Noise, Light
▪ Climate >	Air Stream Temperature, Precip/Moisture Levels

Other changes:

- Omit Increased Wildlife Mortality
- Grazed Lands changed to Grazed and Range Lands
- Add Crop and Forage Lands to Agricultural Lands.

Blue Group The group submitted the following changes and comments:

- Increased Wildlife Mortality changed to Increased Wildlife and Plant Mortality
- Move Increased Plant Mortality moved to Ecosystem Effects
- Altered Plant Succession changed to Altered Plant Succession/Plant Community Composition
- Fragmentation added to Ecosystem Effects
- Water Quality as Stressor or Ecosystem Effect?
- Water Pollution considered as a Stressor leading to Water Quality as an Ecosystem Effect
- Altered Hydrology and Altered Fire Regime both evaluated as Stressors

Group Consensus

The groups summarized the following:

- Pesticides and Herbicides changed to ***Agricultural Chemical Applications***, which includes herbicides, insecticides and fertilizers.
- Increased Predator Control changed to ***Animal Damage Control***.
- Altered Plant Succession changed to ***Altered Plant Succession/Community Composition.***
- Increased Wildlife Mortality moved to Ecosystem Effects.
- The following Stressors added:
  - ✓ Air Pollution
  - ✓ Soil Erosion
  - ✓ Noise Pollution

- ✓ Light Pollution
- ✓ Water Pollution
- ✓ Altered Hydrology
- ✓ Roads/Traffic
- ✓ Altered Temperature/Precipitation

A vote on the amended Stressors ranked them in the following order of importance: (vote counts shown in parenthesis)

1. Invasion of Exotic Species (21)
2. Altered Plant Succession/Community Composition (14)
3. Altered Fire Regime (13)
4. Altered Hydrology (9)
5. Agricultural Chemical Applications (7)
6. Roads and Traffic (6)
7. Soil Erosion (5)
   Light Pollution (5)
   Water Pollution (5)
8. Altered Temperature/Precipitation
9. Animal Damage Control (2)
10. Noise Pollution (1)
11. Air Pollution (0)

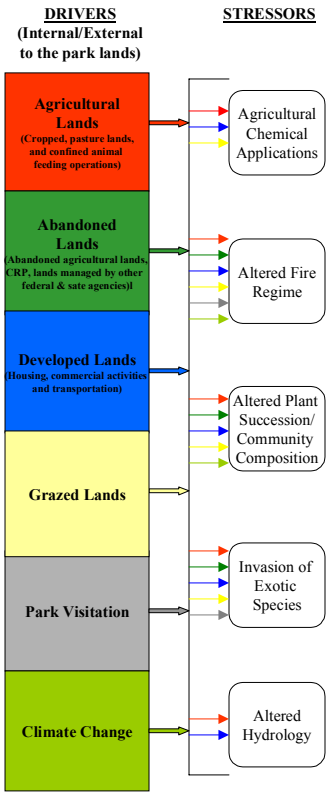
Additional Comments

One workshop participant questioned the findings as useful for short-term, but wondered if the long-term was being left out, as in the case of Climate Change. The facilitator noted that Climate Change had been elevated to Driver, while it was further explained that monitoring would ultimately focus more long-term but that wasn't realistic at this point.

Decision:

The group identified the top 5 as Stressors, and reorganized the remaining categories as either Ecosystem Effects or Indicators. The conceptual model added the amended Stressors:

1. **Invasion of Exotic Species**
2. **Altered Plant Succession/Community Composition**
3. **Altered Fire Regime**
4. **Altered Hydrology**
5. **Agricultural Chemical Applications**



Segment Three: ECOSYSTEM EFFECTS

(Handout: Ecosystem Effects Worksheet – Appendix C)

In Segment Three, Ecosystem Effects were identified and numbered as follows:

1. Exclusion of native species
2. Altered riparian/wetland plant communities
3. Altered species composition for bird, mammals, herps
4. Decrease in wildlife numbers
5. Altered fire regime
6. Reduction in plant growth
7. Sedimentation
8. Altered stream temperatures
9. Loss of nutrients
10. Altered insect composition
11. Decline in wildlife reproduction

Process:

Red Group

- Change 3 to ***Altered Vertebrate Composition***
- Change 4 to ***Change in Wildlife Abundance***
- Change 10 to ***Altered Invertebrate Composition***
- Add new category, ***Altered Soil Properties (#12)***
- Add new category, ***Alteration of Grass/Shrub Lands (#13)***
- Add new category, ***Alteration of Forests*** (dropped)

Green Group

- Change 1 to ***Exclusion of Native Plant Communities/Structures***
- Change 7 to ***Soil Erosion and Sedimentation***
- Change 9 to ***Change in Nutrient Availability***
- Add new category, ***Water Quality***

Blue Group

- Combine 4 and 11 to ***Altered Wildlife Abundance/Reproduction***
- Change 9 to ***Loss of Soil Nutrients***
- Add new category, ***Altered Grass/ Shrub-Steppe Community (Same as #13 for Red Group)***
- Change 10 to ***Altered Invertebrate Composition***

Additional Discussion

Altered Hydrology as an issue:

- CRMO – Moot point because all hydrology currently involves park domestic water supply
- JODA – Springs
- LARO – Main theme, especially water fluctuation
- NEPE – Water everywhere, surface runoff
- HAFO – Irrigation, perched aquifers, river shoreline
- BIHO – Leaking irrigation canals
- WHMI – Water quality
- CIRO – Erosion and deepening channels

The full group consensus was that the effects of Altered Hydrology showed up under other categories and could not be addressed in a network wide manner. There was further clarification, noting distinctions between water quality and water amount; also distinctions between precipitation and stream flow as related to Altered Hydrology.

General discussion on Effects:

Does "change" refer to number or composition in #1? Return to using term "exclusion" because the other categories cover number and composition.

Weather station discussion:

Is there a network need for weather stations? CRMO, WHMI, JODA have stations, but CIRO does not. Fire funding allows for summer weather monitoring, such as at LARO. NEPE has multiple sites, some near Forest Service and BLM weather stations. BIHO has no station but does have Forest Service facility nearby.

Amended Ecosystem Effects List:

1. Exclusion of native species
2. Altered riparian/wetland plant communities
3. Altered vertebrate species composition
4. Altered wildlife abundance/reproduction
5. Altered fire regime (removed later)
6. Reduction in plant growth
7. Sedimentation and soil erosion
8. Altered stream temperatures
9. Loss of nutrients
10. Altered invertebrate species composition
11. Decline in wildlife reproduction
12. Altered soil properties*
13. Alteration of grass/shrub-steppe communities**

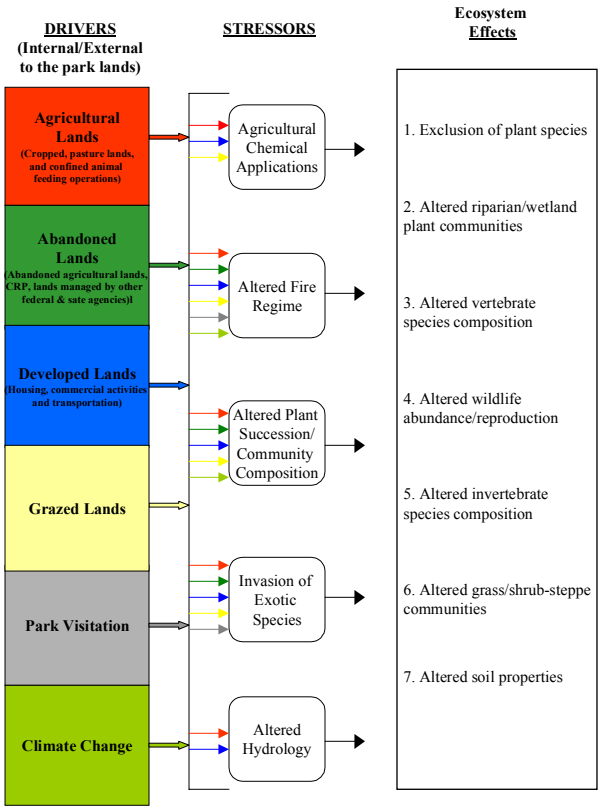
The group linked Ecosystem Effects to Stressors in the following manner (numbers keyed to Amended Ecosystem Effects List above with items #12 and #13 added by group consensus and #5 restored to Stressor):

	Invasion of Exotic Species	Altered Plant Succession/ Community Composition	Altered Fire Regime	Altered Hydrology	Agricultural Chemical Application
Blue Group	1, 2, 3, 4, 5, 10, 12	1, 2, 3, 4, 5 10, 12*	1, 2, 3, 4, 10, 12*	2, 3, 4, 10	1, 2, 3, 4, 10
Red Group	1, 2, 3, 4, 10, 12*, 13**	3, 4, 10, 12*	1, 3, 4, 10, 12*, 13**	2, 3, 4, 10, 12*	1, 2, 3, 4, 10, 12*, 13**
Green Group	1, 2, 3, 4, 5, 6, 10, 11	1, 2, 3, 4, 5, 7, 9, 10, 11	1, 2, 3, 4, 7, 9, 10	2, 3, 6, 7, 8	1, 3, 6, 9, 10

Decision:

The following ***Revised Ecosystem Effects List*** reflects consensus within the network:

1. **Exclusion of native plant species**
2. **Altered riparian/wetland plant communities**
3. **Altered vertebrate species composition**
4. **Altered wildlife abundance/reproduction**
5. **Altered invertebrate species composition**
6. **Altered grass/shrub-steppe communities**
7. **Altered soil properties**



Segment Four: INDICATORS/VITAL SIGNS

(Handout: Vital Signs Indicator Worksheet – Appendix D)

In Segment Four, INDICATORS* were identified as:

- **Riparian Plant Community**
- **Grassland Plant Community**
- **Herpetofauna**
- **Bird Community**
- **Microtine Rodent Community**
- **Invertebrate Community**

* Notes group disagreement over Indicators as correct term.

Process:

Red Group The group listed its relevant Indicators as follows:

1. Microbiotic crust
2. Sage/grass dependent birds
3. Sage/grass dependent microtine rodents
4. Bats
5. Aquatic macroinvertebrates
6. Herps
7. Invasive species
8. Neotropic birds
9. Grasshoppers/beetles/butterflies/moths
10. Structural diversity of sage/grasslands
11. Structural diversity of riparian/wetlands
12. Native plant species diversity and abundance
13. Wetland indicator plants
14. Native bunchgrasses

Green Group The group considered the following Indicator strategy:

- Monitor the abundance/frequency of
  - ✓ Perennial grass
  - ✓ Idaho fescue
  - ✓ Dominant tree species

- Monitor riparian and wetland conditions based on
  - ✓ Soil moisture
  - ✓ Abundance of species

- Consult a bird expert for the species indicator appropriate to the area and monitor abundance/reproduction (consider sage grouse, other network-wide species)
- Monitor small mammal numbers (consider mice, bats, etc.)
- Monitor aquatic insects (consider butterflies, bees, wasps)
- Monitor soil crust and observe presence of cheat grass, perennial grasses, sage grouse.

Blue Group The group looked for applicable species for each area of concern and developed the following chart for its Indicators:

Effects Number	Plants	Invertebrates	Herps	Birds	Mammals
1				Brewer's Sparrow, Vesper Sparrow	Long-eared myotis bats
2			Pseudacris (Boreal Chorus, Pacific Tree Frog); True frogs (spotted, leopard) PAO*	Yellow warbler, yellow-headed blackbird	Bats

3			Striped whip snake, sagebrush lizard PAO*	Brewer's sparrow, Vesper sparrow, yellow warbler	Bats
4				Brewer's sparrow, Vesper sparrow, yellow warbler	Bats
5				Brewer's sparrow, Vesper sparrow, yellow warbler	Bats
6			Striped whip snake, sagebrush lizard	Brewer's sparrow, Vesper sparrow, yellow warbler	
7					

*PAO: Proportion of Area Occupied

Group Summary

The full group considered the following as Indicators, with applicable Ecosystem Effects numbers listed beside each species or category:

1. Bullfrog 2, 3, 4
2. Spotted frog 2, 3, 4
3. Tree frog 2, 3, 4
4. Striped whip snake 3, 4, 6
5. Sagebrush lizard 3, 4, 6
6. Vesper sparrow 1, 3, 4, 5, 6
7. Brewer's sparrow 1, 3, 4, 5, 6
8. Yellow warbler 1, 2, 3, 4, 5
9. Yellow-headed blackbird 1, 2, 3, 4, 5
10. Bats 1, 2, 3, 4, 5
11. Native grasses 1, 3, 4, 5, 6, 7
12. Dominant upland tree species (juniper) 1, 3, 4
13. Soil moisture 1, 2, 7
14. Native populus abundance 1, 2, 3, 4, 5
15. Sage grouse 1, 3, 4, 6
16. Small mammal diversity 1, 2, 3, 4, 6, 7
17. Aquatic insects 2, 3, 4, 5
18. Lacewings
19. Cheat grass 1, 3, 4, 5, 6, 7
20. Microbiotic crust 1, 6, 7
21. EPT order of insects
22. Soil erosion 7
23. Cover types via remote sensing 1, 2, 6
24. Invasive exotic plant species 1, 2, 3, 4, 5, 6, 7
25. Structural diversity of sage/grasslands 1, 3, 4, 6

26. Structural diversity of riparian/wetlands 1, 2, 3, 4
27. Native plant species diversity/abundance 1, 2, 3, 4, 5, 6, 7
28. Wetland indicator plants 1, 2
29. Native bunchgrasses (group with perennial grasses)

Group Discussion and Comments

The workshop facilitator noted that the group moved from 7 Ecosystem Effects to 29 Indicators. He also noted that #3 (altered vertebrate species composition) and #4 (altered wildlife abundance/reproduction) were always found together in groupings, so the two Effects might be considered as one in reality.

The group talked about the semantics of *composition, abundance* and *reproduction*, seeking clarification and questioning whether *"diversity"* might be the better term. One participant pointed out that there is a difference in monitoring *species composition* and *abundance.*

Discussion came back to the appropriateness of Indicators as the correct term, and clarification was sought between that term and Vital Signs. Some suggested that *Affected Communities* or *Species Assemblages* might be more accurate. Some questioned the placement of the new Indicator list on the conceptual model, and thought it might be better to list Vital Signs Indicators and another category, Specific Indicators.

In trying to solidify choices for Indicators, group members considered the following:

- Riparian/Wetlands Plant Community
- Grassland/Shrub-Steppe Plant Community
- Herpetofauna
- Avifauna
- Small Mammal Community
- Invertebrate Community
- Soils (added)

Decision:

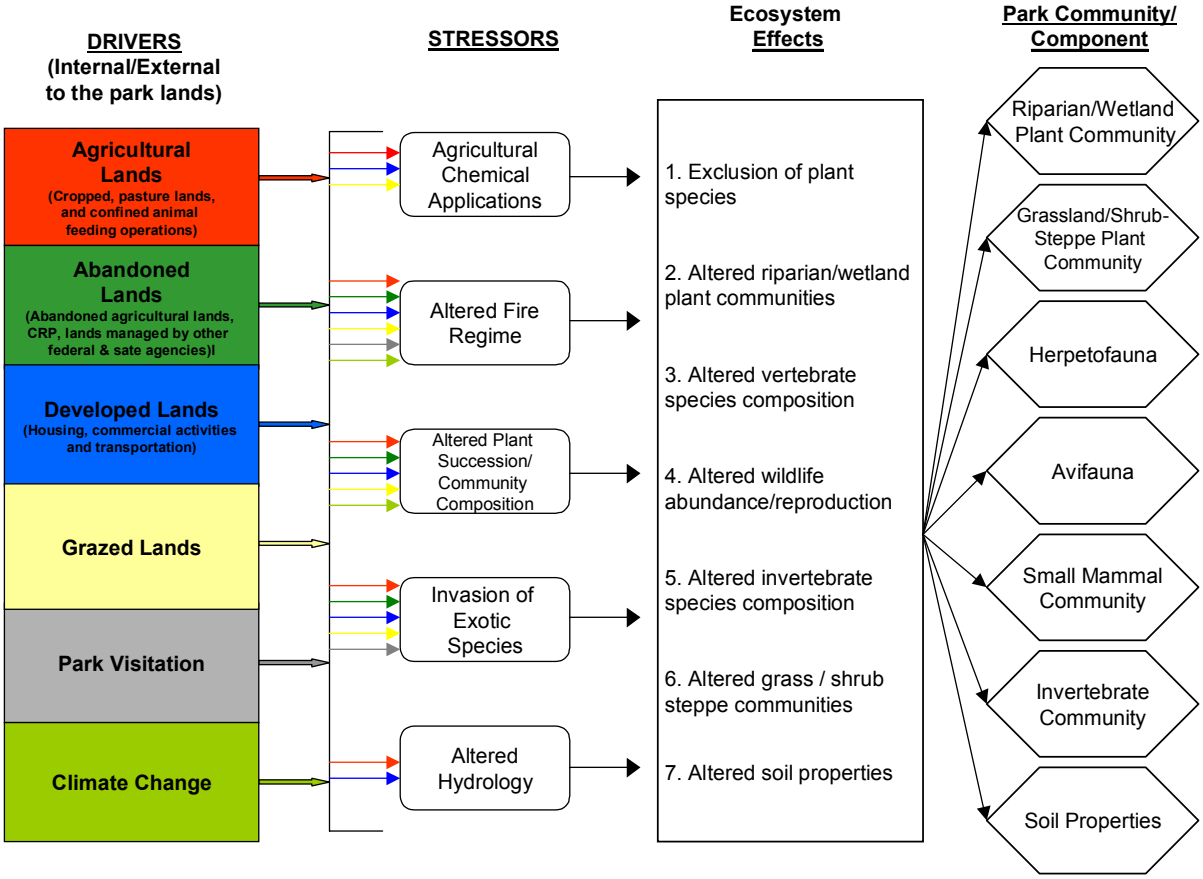
The group chose not to prioritize Indicators at this workshop, noting that many did not have enough background or information on which to make a committed decision. This segment will be further researched through a peer review process, with findings noted on the website.

Final Conceptual Model

In a final step, the Project Leader subjected the proposed Indicators and group comments to a peer review process, developing a model based on the outcome of that additional information. It was decided that a fine line exists between Measures and Methods, and that the line between the two could be easily blurred. Many of the more detailed Indicators proposed by the group could alternately be considered in the Measures column, with means of monitoring categorized as Methods.

The final conceptual model was altered to best reflect workshop findings, coupled with peer review input. Thus, the last heading in the model labeled "Indicators" was changed to "Park Community/Component." Initial categories were expanded to include a 7th Park Community/Component. The "Park Community/Component" is listed as follows:

- **Riparian/Wetlands Plant Community**
- **Grassland/Shrub-Steppe Plant Community**
- **Herpetofauna**
- **Avifauna**
- **Small Mammal Community**
- **Invertebrate Community**
- **Soil Properties**



A list of "Vital Signs" was added to the list of "Park Community/Component." **Vital Signs** are key elements that indicate the health of an ecosystem. Vital signs may occur at any level of organization including landscape, community, population, or genetic levels. They may be compositional (referring to the variety of elements in the system), structural (referring to the organization or pattern of the system), or functional (referring to ecological processes). Vital signs can be any measurable feature of the environment that provides insights into the state of the ecosystem. The term is synonymous with "ecological indicator", but use of the term and the analogy to an individual's health helps the NPS to explain the need for monitoring to managers, Congress, and the public.

"Vital Signs" were developed based on discussions with resource managers from network parks and scientists present at the workshop.

Following is the list of "Vital Signs" important to network parks, along with the associated park community/component.

- **Park Community/Component with associated Vital Signs:**

Riparian/Wetland and Grassland/Shrub-Steppe Plant Communities
Percent areal extent of exotic plant species
Species richness
Species dominance
Community structure
Change in coverage of sensitive and threatened / endangered species
Index of Floristic Quality (IFQ)

Bird Community
Diversity / density of habitat dependent species
Diversity / density of area sensitive species
Presence of threatened / endangered species

Amphibian/Reptile Community
Amphibian species diversity
Reptile species diversity
Herpetofauna "Percent of Area Occupied"

Small Mammal Community
Small mammal species diversity

Invertebrate Community
Richness of morpho-species *
Presence of Auchenorrhychus Homoptera (leaf hoppers)
Arthropod functional diversity index
Index of rarity, endemicity, and simplicity for Auchenorrhychus Homoptera (leaf hoppers)
***Species that appear the same based on body structure**

Soil Properties
Measurable level of pesticides in the soil