San Francisco Bay Area Network
Phase II Report Appendices

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N.B.—Primary appendices referenced in the SFAN Phase II report and contained herein are listed numerically, in order of their appearance in the body of the Phase II report (e.g., Appendix 1, 2, 3, etc.) Secondary appendices (appendices within appendices) contained within workshop reports and other subdocuments are listed alphabetically, in the order they are referenced within the subdocument (e.g., Appendix A, B, C, etc.)

Throughout the appendices, references are made to supporting sections, external documents, and web sites. For those references that appear as blue underlined text when the document is viewed in its electronic format, a hyperlink will connect the reader to the supporting information. Depress the "Ctrl" button and click the left mouse button simultaneously to follow the link. In some cases, the web address is supplied for web-based documents.

Appendix 1

Pinnacles National Monument
2001 Vital Signs Workshop Summary

VITAL SIGNS SCOPING WORKSHOP

Pinnacles National Monument

September, 2002

Prepared by Amy Fesnock
Wildlife Biologist, Pinnacles National Monument

SUMMARY OF VITAL SIGNS SCOPING WORKSHOP

Pinnacles National Monument

September 18-20, 2001

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SUMMARY OF VITAL SIGNS SCOPING WORKSHOP

Pinnacles National Monument
September 18-20, 2001

INTRODUCTION

Knowledge about the condition of the natural resources in national parks is fundamental to the National Park Service's ability to protect and manage parks. Park managers are confronted with increasingly complex and challenging issues and are asked to provide scientifically credible information to select and defend management actions. In addition, the National Parks Omnibus Management Act of 1998 includes a Congressional mandate to provide information on the long-term trends in the condition of the National Park system resources. In response, the Service has identified 270 parks with significant natural resources for which inventories will be completed and long-term ecological or vital signs monitoring will be initiated. A process for these tasks has been developed. The first step is to identify individuals with knowledge about the natural resources and convene a multi-disciplinary workshop to brainstorm ideas. The workshop for Pinnacles National Monument was held from September 18-20, 2001 with 29 participants. (See Appendix A for complete list.)

WORKSHOP OBJECTIVES:

1. Write down assumptions and develop a conceptual model.
2. Identify stressors, anything that can affect park resources.
3. Brainstorm potential vital signs monitoring questions, indicators, and sketch out how the monitoring could be accomplished.

Park staff provided current knowledge about the natural resources, the forces of change, and the management issues during a walk through the park and in a meeting room. Discussions were lively punctuated with information from the convened researchers and specialists. The group concurred with the stressor list that park staff provided. Three smaller working groups worked on the vital signs monitoring signs and indicators based on three major resource types: physical, vegetative and wildlife resources. The group reunited to look at common linkages between the potential monitoring needs and the characteristics of a good vital signs monitoring program.

In following the process recommended by the NPS Washington Office, the next steps are as follows:

1. Circulate this workshop summary to a wider group of specialists for additional comments. Included with the workshop summary is a draft of a simplified model of the Pinnacles NM ecosystem and how it functions. This was compiled by park staff, the network I&M Coordinator and selected specialists. The deadline for responses is Dec 8, 2001.
2. Decide on implementation strategies and determine priorities. A small group of specialists will be convened to assist the park with this process, including a statistician

3. Draft the monitoring plan for Pinnacles and have it widely reviewed by scientists and other specialists.
4. Approve and implement the monitoring plan.

The following summarizes the workshop group's discoveries:

POTENTIAL MANAGEMENT GOALS RELATED TO NATURAL RESOURCE MONITORING:

This was based on the park enabling legislation, other legal mandates and the workshop discussions. For reference, the park mission statement is included in italics.

The purpose of Pinnacles National Monument is to preserve for their scientific interest the pinnacle rocks and caves, and the surrounding congressional mandated wilderness. The monument contains and protects significant qualities and provides opportunities including: natural dark and quiet; remnant native plant and animal communities; cultural and historical values; class I air quality; outstanding scenery and view sheds; diverse and accessible recreational opportunities; and open space in an increasingly urban setting.

1. Protect pinnacle rocks and caves and associated biota. These are considered primary park resources and a reason the park was created.
2. Preserve wilderness values including natural quiet and dark.
3. Maintain good air quality and visibility.
4. Protect threatened and endangered species and preserve their habitat.
5. Preserve natural processes. Patchiness of habitats in the park creates a high diversity of species.
6. Maintain native plants. Since there has been little unnatural disturbance, there is a high percent of native plant species.
7. Conserve necessary migratory corridors and habitats. Many park animals require a larger space than occurs within the park boundary.

GOALS OF VITAL SIGN MONITORING:

1. To develop scientifically sound information on the status and trends in the composition, structure and function of park ecosystems, and
2. To determine how well current management practices are sustaining ecosystems.

DEFINITIONS:

Vital sign = any measurable feature of the environment that provides insight into the state of the ecosystem

Stressor = an effect that creates change

SUMMARY OF STRESSORS (in decreasing order of social impact):

- Development/land use (internal and external of the park boundary)
  (air and water pollutants, water quantity, light, ingress of exotic species, decrease in migratory corridors)
- Visitor use
  (noise, wildlife distribution and reproduction, habitat fragmentation, social trails and loss of vegetative cover, soil erosion)
- Exotic species
  (competition with native species, loss of diversity, change in vegetation community structure and wildlife)
- Wildland fire (natural ignition frequency every 40-100 years)
  (vegetative cover, wildlife, erosion)
- Flood
  (catastrophic change and sediment loss)
- Climate
  (global warming)
- Geology
  (uplift and movement northward, earthquakes)

A complete list of stressors developed at the workshop can be found in Appendix B

INFORMATION GAPS AND INVENTORY NEEDS:

Although this workshop was focused on monitoring needs it became obvious, through the course of discussions, that there were some "data gaps" where baseline inventories were needed prior to development of monitoring strategies. In addition, some of the questions asked by the group were research questions rather than monitoring questions. These two lists have been included to provide a complete picture of the research, monitoring and inventory needs of the Monument, as seen by the interdisciplinary group.

<u>Inventory Needs</u>

- Mass wasting and landslide potential. Management concern: safety. Map historic slides and develop a model of potential hazard zones.
- Soil map. Management concerns: effect of fire lines, location of trails, rehab efforts. Inventory the soils throughout the park, characterize soil geochemistry, water holding capacity and erosion potential.
- Caves. Management concern: visitor use, rare species. Inventory cultural, biological, hydrological and atmospheric resources in 12 significant caves, fauna?.
- Natural soundscape. Management concern: visitor use, wildlife. Do a baseline measurement.
- Bats. Management concern: rare species reproduction, visitor use, distribution.
- Earthworms. Management concern: presence of a non-native earthworm.
- Wildlife disease. Management concern: health and safety. Determine the presence/absence of Hanta virus and Lymes disease.
- Lichens. Management concern: air pollution, visitor use.

- Rare plants. Management concern: How are sensitive plant species distributed within Pinnacles
- What was the original vegetation on the Pinnacles Ranch?
- What is the distribution of mistletoe in the Monument?

Research Needs

- What is the nutrient flow through the park and how does fire affect it?
- What are the microclimates in the different ecosystems? Move the four moveable meteorological stations to different areas of the park once every year.
- What is the sedimentation rate in the reservoir?
- What effect do the bolts and chalk have on the rocks?
- Do social trails have an effect on geophysical resources? (compaction, increased erosion)
- What effect is noise having on natural quiet and biological resources?
- What effect is human sanitation off trails having on water quality and other resources?
- What is the water quality entering the park?
- What effect do land use changes (maintenance activities, restoration activities) within the park have on geophysical processes
- What are the biological and geochemical effects of air pollutants (ozone)?
- What is the flushing distance for selected species of birds?
- What are the impacts of the non-native turkey, what do they eat, reproductive rates?
- What are the impacts of starlings to cavity nesters?
- Would the distribution of gray pines be an appropriate vital signs indicator that is sensitive to fire, flood or air pollution?
- What are key pollinators for important native plant communities?
- What is the carrying capacity for visitors by trail, climbing route, etc.?
- Do existing or impending exotic species have geophysical effects, including flora and fauna?
- How do feral pigs modify nutrient cycling, soil development and erosion?
- What effects to the pig fence have on channels that it crosses.
- What impacts to pigs have on biological systems – specifically salamanders, earthworms, vegetation – looking inside and outside fence?
- What affect does the fence have on limiting the distribution of species, both plant and animal?
- What species are truly affected by pigs?
- How are pollutants affecting biological and physical systems in the rock/scree community?

See Appendix C for additional research questions developed by the Pinnacles staff.

POTENTIAL VITAL SIGN MONITORING QUESTIONS RATED HIGH:

This process was thought to be helpful in developing specific monitoring goals and objectives. The objectives will be based on the park's enabling legislation, legal mandates (wetlands, threatened/endangered species, wilderness), planning documents such as the General Management Plan, stressors affecting park resources, and other management needs.

Vegetation and Fire resources

1. What are mortality, recruitment and general demography of gray pine in and outside the Monument?
2. Is oak recruitment and Mortality within the natural range of variation within the coastal range?
3. How is the gross vegetation community within and adjacent to the park changing? (aerial photos every 5-10 years)
4. Is the distribution and abundance (both actual and relative) of non-native species changing within the Monument? Are there areas where change is happening more quickly? (fence, roads, trails, burned areas, grazed lands, flooded areas, specific habitats)
5. What is the frequency, spatial distribution, intensity and source of fires that occur in the Monument?
6. Are there changes in the native bulb species distribution and abundance as a result of pigs, both inside and outside fence?
7. Is the distribution and abundance of riparian species changing as a result of changes in water table, flooding etc.?
8. Are there changes in the distribution and abundance of native bunchgrasses, and can areas at Pinnacles be used as reference areas for more disturbed sites?
9. Is the distribution and abundance of plant species from southern California and northern California at the edge of their range changing?
10. Is the distribution and abundance of plant species becoming rare outside of the park changing within the park?

Wildlife resources

1. How does wildlife respond to habitat structure and change in structure through time?
2. Is species "X" increasing or decreasing parkwide and within specific habitats including exotic species?
3. To what extent is Pinnacles National Monument connected to surround open space and how is this changing over time?
4. What kind of habitat does the pinnacles formations provide and for which species over time?
5. How is the aquatic community changing from year to year?
6. Can we use an index of mortality to determine effects of development and use both outside and inside Monument?
7. What is the health of California Thrasher, Sage Sparrow, Wrentit, Blue-grey gnatcatcher, Spotted Towhee related to successful reproduction?
8. What is the health of raptors and ravens related to successful reproduction?

Physical resources

1. How are park roads, tails and parking lots and restoration activities, modifying sediment load, nutrient flow, hydrology, groundwater recharge?
2. What are the changes of land use zoning, and development within 250km of park which effect viewsheds, air, water and light pollution in the park?
3. Are park and surrounding community activities mining groundwater?
4. How are activities altering the park's quality and quantity of water entering the park?
5. What impact is climbing having on the park's number one resource The Rock? How does chalk and bolting effect rock erosion?
6. Do we know where all of the social trails and other areas of soil compaction/erosion activities? Are they getting better or worse?
7. What levels, timing and numbers, spatial distribution, of visitor activities are occurring in park?
8. How can internal park air pollution sources be reduced to improve the park's impact on regional air quality?
9. How are human sanitation issues, both above and below ground, affecting park resources?
10. What are the fire frequency, intensity, size and seasonality of fires and floods in the park? Where are the hydrophobic soils?
11. What is the hydrologic pattern of the park including drying patterns?
12. What is the natural range of variability of sediment flow as related to fire and flood?

POTENTIAL IMPORTANT LINKAGES TO OTHERS:

Agricultural neighbors

Other monitoring sources along migratory corridors

CHARACTERISTICS OF SUCCESSFUL LONG-TERM MONITORING PROGRAMS (over 10 years):

1. Simple. There is an understandable indicator, simple training, cheap and easy to use protocols for monitoring.
2. Scientific. Monitoring protocols and vital signs indicators are peer-reviewed initially and periodically thereafter (every five years for Pinnacles). Inferences can be made to a larger population or region. Precision will increase as the number of years of sampling increases.
3. Standard. Protocols are standard with good quality assurance and control. Sampling protocols are not changed unless there is an overlap between methods for several years.
4. Statistical. Indicators are measurable, the hypothesis and statistical measurements are determined in advance, bias is minimized, data show a trend or change (at least 10-12 years of data are often required).
5. Sustainable. Cost and manpower are minimized, logistical support is easy.
6. Systematic. Measurements are repeatable over regular intervals to tease out trends. Permanent plots revisited over time and regular sampling intervals are recommended since the objective is to detect change over time.

Development of sound data management practices and required annual reports is the key to making this program work. The experience of successful monitoring programs is that at least 30% of total funding should be used for data management and reporting. Also integral to success is for one park staff member be responsible for both the I&M program and for the research permits so that they can be linked.

A major emphasis of this program is to make information more readily available. It is anticipated that vital signs information will used in various ways:

- Management of the park. Information needs to be available to and interpreted for the planning and decision-making process and the compliance process.
- Education. Photos of how the monitoring is done and how the monitoring is used are important. Information may also be made available through NPS web sites as well as normal avenues such as ranger talks, pamphlets, and waysides.
- Expand boundary through partnerships. Since park staff will not be able to do the entire program themselves, partners will be needed for technical knowledge, funding, manpower, and specialized equipment. Evaluations become based on a larger landscape. Park neighbors become involved and interested in protecting their resources also.
- Multi-disciplinary approaches are encouraged. Costs are reduced for all participants. Synergistic opportunities abound. Shared data and methods make data sets more robust.

VITAL SIGN INDICATORS SELECTION CRITERIA:

In order to prioritize indicators to monitor park resources, the following selection criteria will be used (taken from the Lake Mead NRA 1998 workshop). The monitoring indicator:

1. has low impact to all resources
2. has measurable results that are repeatable with different personnel
3. has results that can be interpreted and explained
4. has costs that are not prohibitive
5. can be accurately and precisely estimated
6. is distributed over a wide geographical area and/or is very numerous
7. has dynamics attributed to either natural cycles or anthropogenic stressors
8. has low natural variability
9. is sensitive enough to provide an early warning of change
10. has dynamics that parallel those of the ecosystem or component of interest.

Appendix 1 – List of Vital Signs Workshop Participants

Invitee	Expertise	Position
Ray Sauvagot	ecology	NPS science advisor/SAMO Chief of RM
Bruce Rogers	geology/caves	USGS geologist
Reg Barrett	wildlife	UC Berkeley professor
Minda Troost	geology	NPS-PINN physical scientist
Clay Fletcher	wildlife	NPS-PINN temporary biologist
Jon Keeley	fire ecology	UGSG-BRD
Judy Rocchio	air quality	NPS natural resources
Tom Parker	fire ecology	San Francisco State professor
Steve Alsup	wildlife	NPS-PINN temporary biologist
Sam Webber	biologist	NPS-CABR chief of resource
Peggy Herzog	fire ecology	NPS fire ecologist
Steve Acker	natural resources	NPS regional I and M
Grant Ballard	ornithologist	PRBO
Leslie Chow	wildlife ecologist	USGS-WERC
Tom Leatherman	botany	NPS-PINN botanist
Keith Barker	fire	NPS-PINN fire
Chad Moore	earth science	NPS-PINN physical scientist
Amy Fesnock	biology	NPS-PINN wildlife biology
Terry Griswald	entomologist	Utah Bee Lab Researcher
Jenny Bjork	ecologist	I and M network coordinator
Paul Johnson	zoology	NPS-PINN temporary biologist
Jay Goldsmith	natural resources	NPS natural resources
Sarah Allen	wildlife	NPS science advisor
Paul Reeberg	fire, vegetation	NPS ecologist, monitoring
Howard Sakai	wildlife ecologist	REDW
Julie Hammon	veg	BLM
Ben Becker	aquatic ecologist	PORE Learning Center Director
Dawn Adams	wildlife	PORE I&M Coordinator

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Appendix 2 - Complete list of stressors from workshop

Development

- Loss of open space
- Habitat fragmentation – landscape patterns
- Air pollution – toxins and fertilizers
- Park – roads, trails, bridges, footprint
- Water use, septic
- Poachers
- Light pollution
- Visibility
- Viewsheds

External Development

- Habitat loss - conversion from low intensity to high intensity
- Habitat fragmentation and loss of connectivity -spatial distribution of remaining open space
- Changing agricultural practices
- Nutrient loss in developed lands further isolates our systems
- Pesticide drift
- Air quality/Pollution
- Noise - soundscapes
- changes in the zoning within the area

Internal Development

- Restoration - activities
- loss of large contiguous patches

Visitor Use

- Climbing – direct rock impacts
- Climber access areas
- Shortcutting
- Wildlife disturbance – sight and sound
- Climbing - bats, raptors
- importing exotics (seeds, animals)
- Hiker disturbance of wildlife (timing, numbers, spatial distr.)
- Impacts to caves
- Feeding wildlife
- Playback of animal sounds disrupting activities
- Trash
- Vehicle impacts (cars and bikes) - runoff, road kills, sound,
- Trail maintenance - erosion and compaction
- Sanitation
- Personnel (park and researchers)
- Noise
- Use of the landscape in terms of products (edibles)

Exotics species

- Pigs Fence impacts

- Non-native plants
- Sunfish
- Effects on soil biota (exotic worms)
- Exotic ants
- Starlings (other birds)
- Exotic bees
- Earwigs
- time and spatial distribution of exotics
- routes of introductions
- Wildlife diseases
- Plant diseases
- Factors contributing to expansion of exotics
- Degree of threat
- Competition with natives

Fire

- Vegetation composition and diversity
- Vegetation reproduction
- Wildlife population changes
- Soil modification (hydrophobic)
- Air quality
- changes in ignition sources
- Fire frequencies
- Fire size
- Fire intensity
- Vegetation distribution
- Seasonality/Timing
- Duration
- Control effects (+&-)
- Slope stability (erosion)
- Increased susceptability to exotic invasions
- Management and human development policies
- Soil chemistry changes
- changes in landscape outside and inside that lead to modification of these events

Floods

- Bed and Bank Erosion
- Habitat loss and creation
- Flow
- Inundation
- Introduction of exotics
- changes in landscape outside and inside that lead to modification of these events
- Transportation of resources into or out of Monument
- Money - cleaning up after the mess
- Changes in water yield and watershed

- Structures in stream to mitigate effects
- response of our actions on downstream users
- introduction of pollutants

Climate Change
- Drought / Quantity
- Timing
- Temperature
- Changes (Trends)
- climate cycle
- effects on fires and floods
- species distribution
- atmospheric chemistry changes
- variability

Geology
- Mass wasting
- Weathering / soil development
- Tectonics
- Earthquakes – talus caves
- general erosion
- acid deposition
- earth surface activities(Fluvial)

Other ideas
- Look at migratory species at other locations in there life cycle
- tie into monitoring programs at other sites on migratory paths

Appendix 3 - Research Needs Identified by PINN Staff

1. Impact of climbing chalk on the physical structure of the Pinnacle rocks.
2. Impact of climbing bolting to the structural integrity of the Pinnacle rocks.
3. The causes of "pygmy" chamise. (Chamise chaparral that is >40 years old, but only 2-3 feet tall)
4. Distribution of Coast Horned Lizards and the associated ant fauna
5. Impacts of high ozone on indicator plant species as well as general plant flora.
6. Cave temperature/humidity modeling
7. Landuse history of the Chalone Creek Watershed
8. Long-term monitoring of geomorphic change of Chalone Creek
9. Response of creeks to fire frequency and climate change
10. Analysis of central California Climate based upon floodplain sediments, tree rings, and woodrat middens at Pinnacles NM
11. Reconstruct past climates, esp El Nino Phenomenon
12. Assess the Chalone Creek Fault as the Ancestor of the San Andreas Fault
13. Bee faunal associations with fire following plant flora
14. Distribution of Soil Types and Surficial Geology (entire park, not just new lands)
15. Document the recovery of the landscape after the removal of feral pigs both vegetation and soil stability
16. Reintroduction of Foothill Yellow Legged Frogs
17. Reintroduction of Western Spade-foot Toad
18. Assess spatial/temporal distribution of sycamores and willows and the impacts to Western Red Bats
19. Assess the viability of Valley Oaks, are they a remnant Pleistocene species?
20. Distribution and impact of mistletoe
21. Understand the impacts of Feral pig fence on movements of Black-tailed deer fawns
22. Impacts of grazing and fire on bee faunal distributions
23. Impact of fire on bats
24. Distribution of crack/crevice roosting bats and potential impacts of rock climbing.
25. Determine the human carrying capacity of PINN
26. Evaluate visitor use of trail system and impacts to wildlife use of these habitats
27. Determine the source of pollution causing PINN to exceed National standards of ozone (air distribution/movement map)
28. Regeneration of Blue Oaks related to fire and grazing
29. Inventory of Moth species and determination of good indicator species for long-term monitoring efforts.

Also, anything related to climbing and impacts on the natural system would be encouraged, anything on fire effects on wildlife, anything related to bats -- foraging ecology, roosting, etc., anything associating visitor use and changes in wildlife habitat use.

Appendix 2

Eugene O'Neill and John Muir National Historic Sites
2002 Vital Signs Workshop Summary

WORKSHOP SUMMARY

Conceptual Model Development Workshop
For
John Muir National Historic Site
Eugene O'Neill National Historic Site

This document is a summary of a one-day workshop held on August 5, 2002. The goal of the workshop was to create a conceptual model for John Muir National Historic Site (JOMU) and Eugene O'Neill National Historic Site (EUON) in order to help us to identify indicators and why we select them for vital signs monitoring. Knowledge regarding the significant natural resources in and adjacent to the park that were determined at the Vital Signs Scoping Workshop in January 2002, were revisited (Appendix A).

The Vital Signs Scoping Workshop:
1. Identified the natural resource base, significant natural resources and processes for the two parks,
2. Identified current threats and stresses that affect those natural resources, and
3. Recommended potential vital signs indicators for long-term monitoring that would capture changes in the significant natural resources.

The goal of this Conceptual Model Development Workshop:
1. Development of a conceptual model and assumptions about the ecosystems
2. Review/prioritize vital signs indicators and develop monitoring goals.

The conceptual model developed for each park will be incorporated in a San Francisco Bay Network conceptual model for large-scale, network-wide ecosystem function and management. The conceptual models for each park grouping are specific to the local environment and represent important resources and indicators that may be relevant only to those particular parks. The JOMU and EUON conceptual model is combined due to close proximity of the two parks, relatively similar ecosystems and threats, and combined management of the parks.

Nine participants took place in the workshop facilitated by Jennifer Bjork, the Network Coordinator (Appendix A). This summary was developed by Susan O'Neil, Network Biological Technician.

Why use a conceptual model?

To help us identify indicators for vital signs monitoring and reasons for selecting them.

How will this be accomplished?

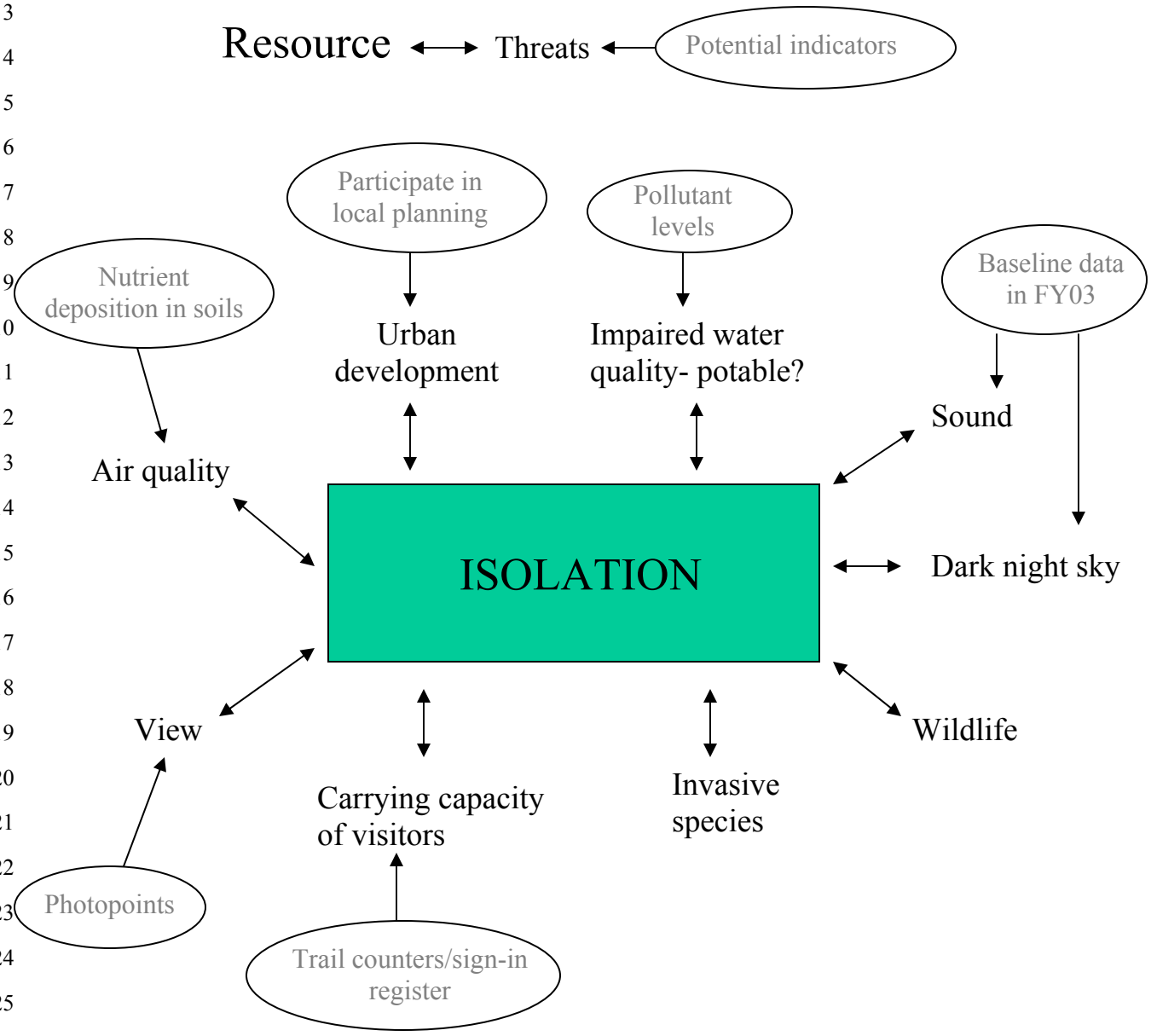
Use previous workshop information and draft conceptual models. Fit JOMU/EUON into those models or adjust them to fit park resources.

Workshop Process:
1. Review knowledge and assumptions and make sure they are correct,

2. Review significant resources from past workshop,
3. Review stressors (what affects the resource),
4. Determine the effect of the stressors and what vital sign ecological indicators we can use to monitor the effect.

The group concentrated on five significant resources for the two parks. They brainstormed all threats to the resource and selected some potential indicators. The significant resources were a feeling of isolation, wildlife habitat, wildlife, species of special concern, and viewshed into park. What follows is a summary of the group's findings for each resource. Three are represented visually, as they were conceived during the meeting. The significant resources wildlife and species of special concern are presented in table form because they were not as well developed for visual representation. Following the summaries of each resource are lists of gaps in knowledge as well as mitigation/potential management actions that became apparent during the brainstorming process.

1. ISOLATION


Resource
Threats
Potential indicators
Participate in local planning
Pollutant levels
Baseline data in FY03
Nutrient deposition in soils
Urban development
Impaired water quality- potable?
Sound
Air quality
ISOLATION
Dark night sky
View
Wildlife
Carrying capacity of visitors
Invasive species
Photopoints
Trail counters/sign-in register

1. ISOLATION:

Suggestions for mitigation/management:

- At JOMU, the fireroad going up from the Strain Ranch should be converted to a trail.
- Superintendent should be involved in planning and development around parks that may affect resources. Documentation and a record of participation should be kept.
- Maintain connectivity to other open spaces (physically and managerially).
- Develop interpretive waysides, especially a geologic map.
- Attempt to maintain a buffer (i.e. woodlands) around the park through involvement in neighborhood association and East Bay Regional Parks.
- Remove all major invasive plants.
- Include some mechanism to interpret the JOMU house site during off-hours, i.e. a platform to view his house, wayside for Mt. Wanda access.
- Eliminate septic system at JOMU.
- Provide interpretive meteor shower and other dark night sky events to educate public.

Examples of indicator selection for this resource-

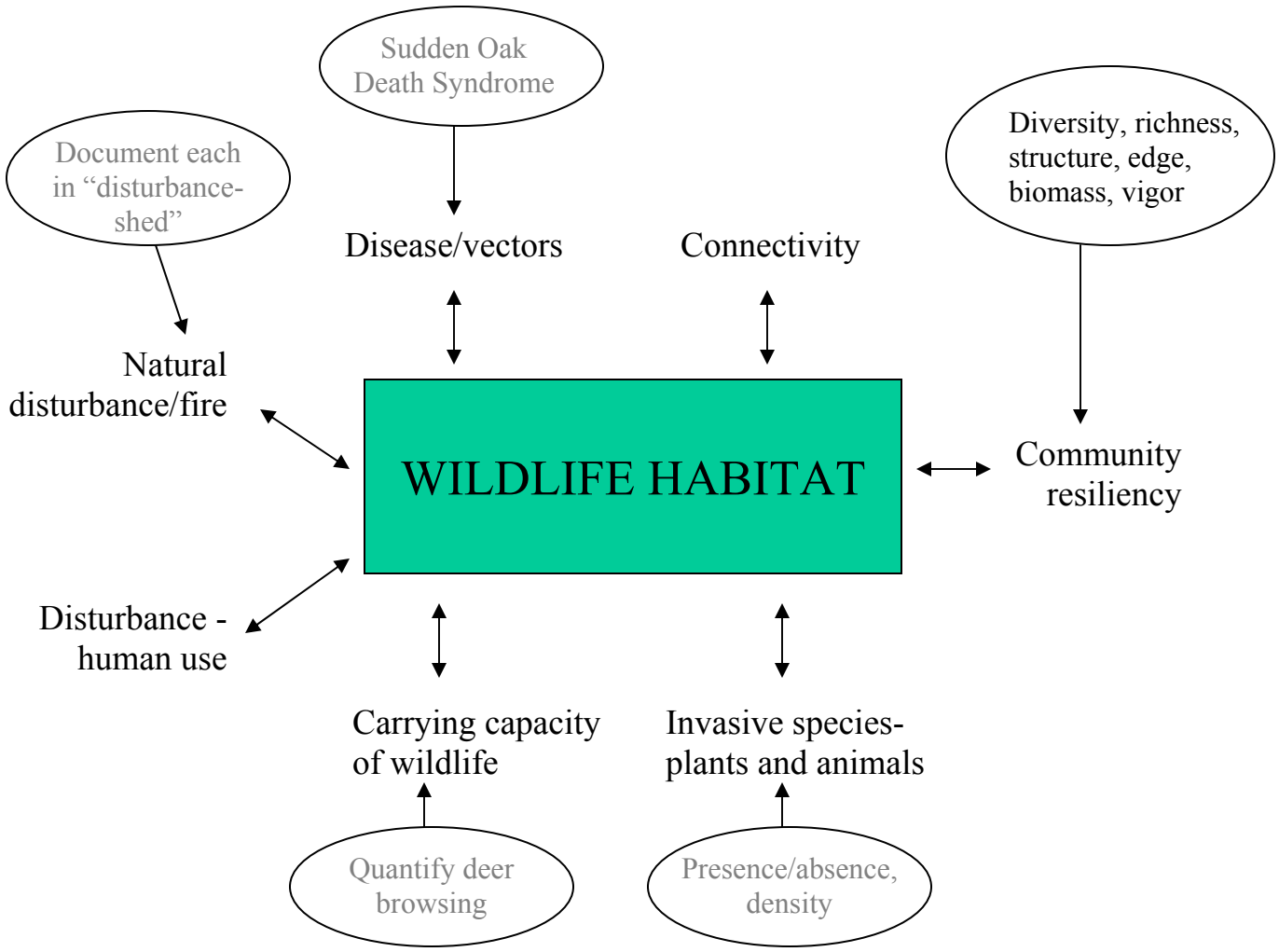
Indicator: Aesthetics (sound, view, and dark night sky).
Why is it selected: These are ethereal senses that affect the feeling of isolation.
Sensitive attribute of indicator:

Sound- decibel level, type and frequency
Light pollution – location, intensity
View- distances and objects seen

Management objective: Develop baseline data for later use in decision making.
Management response: Become involved in planning of nearby areas, and evaluate baselines and determine future protocol.

Indicator: Nutrient deposition in soils.
Why is it selected: Nutrient flow, invasibility, air pollution deposition, water quality, health of ecosystem.
Sensitive attribute of indicator: Concentration
Management objective: Understand until we have a baseline and then reconsider (decrease?) Will only work if monitored as a network
Management response: Education (present info to air quality board)

2. WILDLIFE HABITAT:



Research needed for wildlife habitat:

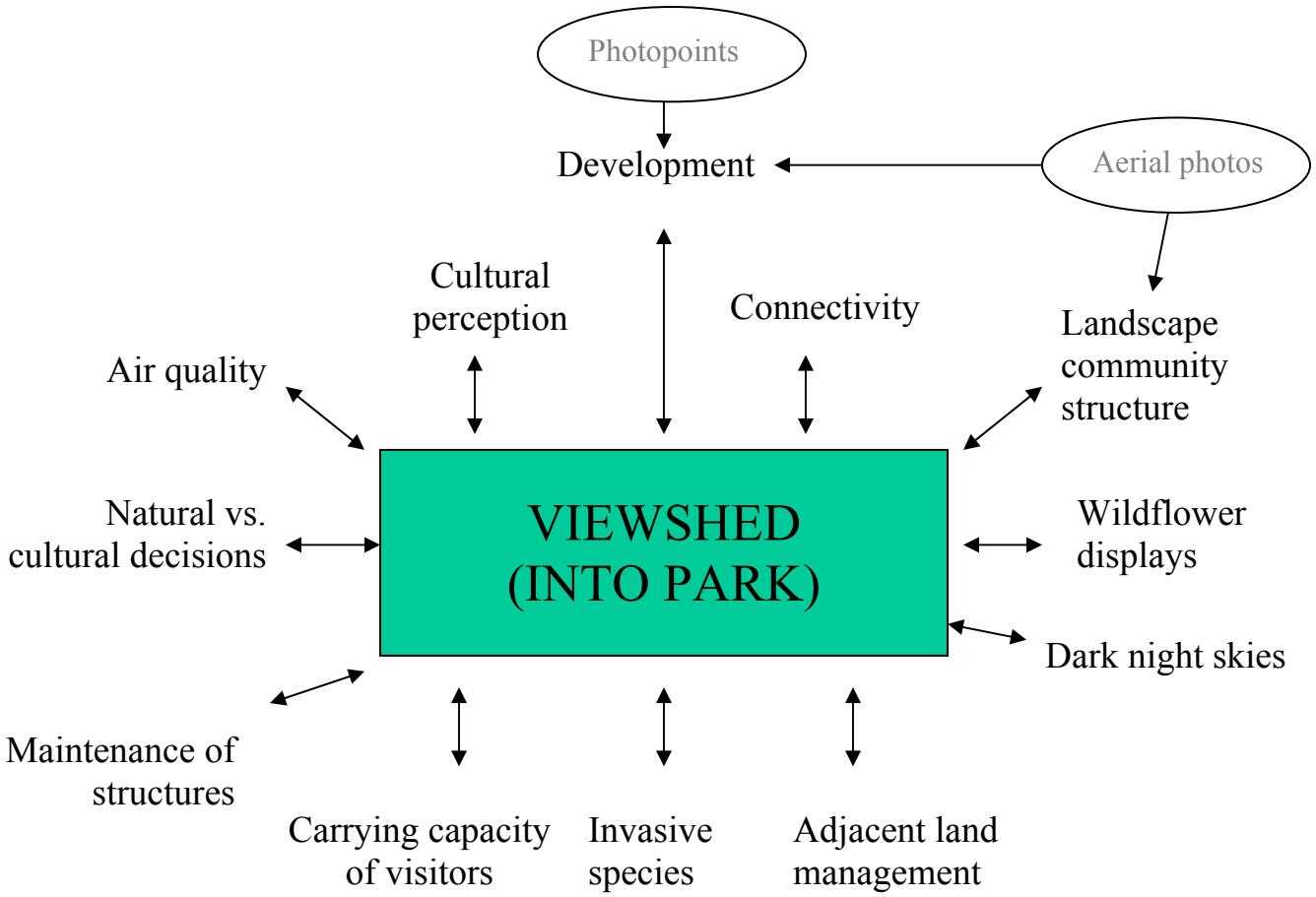
- Determine the historical vegetation communities present on Mt. Wanda and the potential for native grassland communities.
- Research corridor needs for wildlife and plants.
- Determine natural disturbance regimes.
- Determine natural oak regeneration – started summer 2002.
- Artificial pond at EUON should be studied as a source for bullfrogs, algal blooms, habitat potential, etc.

Suggestions for mitigation:

- Remove 12 most invasive plant species (Appendix A).
- Take appropriate measures to prevent the spread of disease.
- Use local seed/seedling sources for restoration.
- Work with outside planning groups (for buffer and connectivity) and internal NPS resources to manage the area holistically

- Obtain a vegetation map (utilize CNPS, WHR, park teams).

3. VIEWSHED INTO PARK



Research needs:
- Develop landscape maps during periods of Muir and O'Neill. Compare and assess what is left or has changed (done for EUON)
- Review by a cultural landscape expert
- Define pastoral scene

Suggestions:
- Treat Mt. Wanda and Port Chicago as both natural and cultural.

4. WILDLIFE (large and medium sized vertebrates)

Threats:	Potential indicators:
Disease	
Parasitism	
Predation	
Quality and quantity of habitat	
Population viability/genetic stability	Trailmaster camera
Poaching	
Invasive species	
Ingestion of toxins	

Research needed:

- Conduct an invertebrate inventory.
- Determine natural level of variation for population sizes.
- Gary Feller's report on vertebrates at JOMU and EUON (subject will be revisited for indicators following his report) is needed before further indicator selection.
- Presence of feral cats, ground squirrels (Mt. Wanda), red fox (EUON)

Suggestions:

- Use 30 years of bird data gathered from Mt Wanda

5. SPECIES OF SPECIAL CONCERN (Rare and invasive species)

Threats:	Potential indicators:
Inter-annual climate	
Global climate	
Microclimate	
Herbivory	
Disease	Sudden Oak Death
Competition from non-natives	
Disturbance	
Competition from natives	
Soil	Nutrient levels
Population size/structure	Mortality/recruitment
Land management	
Poaching/collecting	
Parasites	
Change in community structure or composition	

List of species of special concern:

- Invasive plants (especially the 12 plant species noted in previous workshop) and animals (starlings, feral cats, etc.)
- Helianthella castanea *(JOMU)*
- *All oak species*
- *Salvia mellifera* (JOMU)- northernmost range for black sage
- Helianthemum scoparium
- Asclepius cordifolia- southernmost populations (2 plants on Mt. Wanda)
- Amphibians

Research needed:

- Research stressors and impacts to each species

Examples of indicator selection for this resource-

Indicator: Disease- *Phytophthora ramoram*
Why is it selected: Protocol already described, tie into larger project, know condition of a significant natural resource (oak woodland), potential large ecosystem-wide impacts.
Sensitive attribute of indicator: Magnitude and location of affected trees. Look at pattern for potential natural resistance, signs of symptoms.
Management objective: Maintain or improve the oak woodland
Management response: Cache acorns for future use. If present, determine vectors and follow procedures, improve prevention of transmission. Update as more is known.

Indicator: Mortality/recruitment
Why is it selected: Easy for management to understand and quantify whether populations are increasing/decreasing, strength, health and vulnerability.
Sensitive attribute of indicator: presence/absence, number of individuals, aerial extent, and presence of seedlings.
Management objective: Maintain or increase rare species, decrease invasive species
Management response: For rare species, if population drops below current size start research, reintroduce, consult external databases. For invasive species, if there is an increase that should trigger research and an increase in control efforts.

Suggestions for a conceptual model for the EUON/JOMU ecosystems

Separate categories based on geo-physical, biological and cultural.
Incorporate water quality, soils, channel shape and change, disturbance regimes, mass wasting.

Appendix A

Vital Signs Scoping Workshop, January 22-24, 2002

John Muir National Historic Site

Significant natural resources - desired future conditions (in alphabetical order)

1. Floodplain terrace (Strain ranch area)
   Desired future condition: The ideal future condition is to have a functional floodplain with related values such as sediment retention, but safety and acting as a "good neighbor" may modify this condition.

   Actions: Consider restoration of the Strain flats to a wetland.

2. Grassland (Mt. Wanda peak area)
   Desired future condition: Encourage more diversity and percent cover of native grasses and herbs.

   Actions: Keep invasive exotic plants out.

   It may not be feasible to develop native grassland. Constant disturbance will be required to maintain it. There was much discussion about how to create the disturbance (fire, mowing, grazing). The California ground squirrel used to be a major grazer. Should it be reintroduced here? The NPS does use short-term disturbance to restore an area, but it would be unusual to use long-term manipulated disturbance to maintain an area. There was also much discussion about whether this area had been shrubland or grassland in prehistoric times. If the area became a chaparral shrubland, fire protection would become a major park activity. A soil survey was encouraged to help answer the question of what vegetation type was desirable. In the meantime, maintaining the native grassland seemed appropriate.

3. Muir meadow (off Alhambra Rd.)
   Desired future condition: Unknown without further research on the appropriateness of combining oak woodland/grass restoration. There were more native grasses here than on the Mt. Wanda peak area.

1. Migratory corridors
   Desired future condition: Create and maintain migratory corridors and linkages to allow for healthy migratory populations.

   Particular species of concern: coyote, grey fox, mountain lion, bobcat, raptors, owls.

   Actions: Link the park with existing open space including the Sky Ranch, Almond property and Briones.

2. Oak woodland
   Desired future condition: Maintain a healthy community at the current size; restore the fire road along "no name" creek to a hiking trail

   Actions: Control noxious invasive plants. Encourage regeneration and, if necessary, develop a planting program to replace oaks that die. Treat the "no name" creek as an oak woodland, since it has a species composition closer to that community and since the creek bed is

intermittent and dry most of the year. Could wildland fire fighting access be through the Almond property instead of up the creek? Then the park could restore the road to a hiking trail and reduce sediment erosion. The "no name" creek woodland is currently the most diverse in the park, provides important bird habitat, shade for visitors, and has the qualities of dark night sky and natural sound. The stock pond upstream of the fork in the creek bed is 90% full of sediment. The head cut above it is not stable. It needs to be reconfigured to slow erosion possibly using a natural stepped system.

3. Pastoral cultural scene
   Pastoral means of or pertaining to the countryside. The pastoral scene includes the orchards by the Muir House, the gravesite and orchards, the agricultural areas, and the ornamentals planted by the Muirs.

   Desired future condition: A mosaic of historical, rural, pastoral and wild landscape that is quiet, clean and has dark night skies.

   Actions: See actions under Viewshed.

4. Riparian corridors and wetlands
   Desired future conditions: Healthy, functional riparian corridors and wetlands

   Actions: Control noxious invasive plants.

   A possible restoration site is the Strain floodplain terrace using willows and other wetland plants developing a more sinuous stream corridor. It was thought that it is not appropriate to develop retention ponds and wetlands upstream in "no name" creek. A second potential restoration site is at Franklin Creek to develop a more natural riparian corridor.

5. Special status species
   Desired future condition: Maintain and enhance species populations and habitat.

   Actions: Actively remove invasive non-native plants in and adjacent to these habitats.

6. Top-level predators
   Desired future condition: Maintain habitat for top-level predators such as bobcats, raptors and owls.

   Actions: Maintain connectivity with other adjacent, large natural areas. Except for a few roads/transportation corridors that create barriers, there is a natural connection north to the Carquinez Straits or south following the creek beds.

7. Viewshed
   Desired future conditions: Good air quality, natural sounds and quiet, dark night sky, limited man-made structures.

   Actions: This will take a partnership with city and county land use planners. It is important to limit ridge-top development for all views from the park.

   Important views:

   a) Upper Mt. Wanda views to the S-SW to the N-NW. These views currently have a limited amount of development. This viewshed is critical to maintain desired future condition.
   b) Refinery and delta. Important to maintain clean air quality. Desired goal is to see the Sierra's.

c) Grassland. Define the historical condition of the grasslands and determine if they are appropriate. It they are, it is appropriate to manage as a wildland, native grassland.
d) Train trestle to Muir Station. Ridgetops are currently unbuilt.
e) Views into and of the park. The fire roads are an intrusion to these views.

8. Watershed
   Desired future condition: Maintain it in a healthy state.

   Actions: Adopt the Alhambra Creek Watershed management goals if they do not oppose any park guiding principles.

<u>Known stresses:</u>

	Natural	Human-influenced
➢ External land use		X
➢ Landslides/erosion	X	X
➢ Non-native invasive plants		X
➢ Deep thatch in grassland		
➢ Wildland fire	X	X
➢ Disease	X	X
➢ Toxins/pollutants (air, water)		X

<u>Vital signs monitoring indicators</u>

All monitoring mentioned was felt to be necessary, but it was recognized that funding and manpower constraints would limit the park's ability to do all of the monitoring immediately. A voting exercise was used to recommend the sequence of initiating the monitoring.

Highest priority = start this year, if possible (ranked 6 to 9)

- **invasive non-native plants** as an indicator of native plant community health. Map distribution and assess relative abundance of current populations for the baseline. Revisit, map and assess on a regular basis (frequency to be determined). Visit potential areas of introduction to document the presence of the non-native plants and record new introductions. Obtain historic records of control actions and keep current records to determine effectiveness of control actions. Monitor along vectors. The following invasive plants are of primary concern. Most have a clumped distribution, so should be easier to monitor and control*:

  1. *Ailanthus altissima* (tree of heaven)
  2. *Centaurea solstitialis* (yellow-star thistle)
  3. *Cynara cardunculus* (artichoke thistle)
  4. *Lepidium latifolium* (pepperweed, tall white top)
  5. *Euphorbia oblongata* (oblong spurge)
  6. *Centaurea calcitrapa* (purple star thistle)
  7. *Arundo donax* (giant reed)

8. *Vinca major* (periwinkle)
9. *Rabinius pseudoacacia* (black locust)
10. *Foeniculum vulgare* (fennel)*
11. *Genista monspessulana* (French broom)*
12. *Conium maculatum* (poison hemlock)*

* In reviewing from first workshop, NPS staff would like a new list of species considered with lesser focus on those species with an asterisk and including the following: Harding grass, bull thistle, Italian thistle, *Cotoneaster* sp.

- **connectivity and top-level predators** as an indicator of community health. The most important aspect is to identify, maintain and monitor the migratory corridors themselves. Aerial photos could be used for this monitoring. Partnerships with large adjacent landholders such as the Almond property, Sky Ranch and Briones are important. Top level predators include:

  a) coyote
  b) mountain lion
  c) bobcat
  d) grey fox
  e) raptors (September migrant VIP event, nest cavity searches, spring counts)
  f) owls

Medium priority = start soon (ranked 2 to 4)

- **Native plants** (percent cover, richness and diversity). Inventory transects were established and surveyed in 1992. These could be used as the baseline and repeated every ten years. Black oaks may be a rare component of the woodland and deserve greater attention.
- **Deer** (charismatic, large mega-fauna). They browse woody vegetation and eat large amounts of acorns in the fall. Monitoring could be via habitat monitoring including mast production baskets and browse line surveys.
- **Ticks, lizards and disease**. Lizards are a dead-end vector for Lymes disease. Yearly collection of ticks and analysis for disease will allow the park to know and share information about the likelihood of getting the disease in the park. Monitor lizard population trends.
- **Water quality**. Identify and evaluate current data from other organizations such as the Central Sanitation (Alhambra Creek) and Contra-Costa County Water District (Delta intake). Select monitoring indicators. Aquatic invertebrates in Franklin Creek could be monitored. Monitor debris in Franklin Creek.

Lower priority = start when possible (1 vote)

- Air quality
  through County monitoring of EPA criteria pollutants

visibility

deposition

grapes for ozone

lichens for sulphur

- Amphibians as a sensitive indicator of air pollution
- Birds (September migrants, nesting)
- Dark night sky
- Deposition of nitrates, sulfates, heavy metals and POP's.
- Natural soundscape
- Small mammals such as the California ground squirrel (creates disturbance in grassland communities) and the Botta pocket gopher as an indicator of grassland community health
- Terrestrial invertebrates
- Visibility monitoring
- Weather – micro-climates

<u>Remaining Significant Natural Resources</u> (in alphabetical order)

1. Feeling of isolation
2. Grassland strip below the Tao House
3. Oak woodland/riparian edge community
4. Migratory corridor
5. Species of special concern
6. Springs (one feeding the stock pond and the second, the water towers)
7. Wildlife habitat
8. Viewshed

Desired future conditions were not developed for each of these resources, but are still needed.

<u>Known Stresses to the Significant Natural Resources:</u>

	Natural	Human-influenced
➢ Disease		
➢ Erosion and mass wasting	X	X
➢ External land use		X
➢ Non-native invasive plants		X
➢ Thatch (grass understory)		
➢ Toxins/pollutants (air, water)		X
➢ Wildland fire	X	X

<u>Potential vital signs monitoring indicators</u>

Highest priority (in rank order)

- **Native plants** (8) – monitor percent cover and species composition, closely monitor invasive noxious weed distribution (cooperate with East Bay Regional Parks)
- **Erosion features** (6)
- **Deer browsing** (6) – effect on cultural landscape and plants. What attracts deer and provides forage?
- **Surrounding land use** (6) (viewscape, sound, air quality, dark night sky)
- **Vegetation community level change** (4) (include East Bay parks)

Next priority (all 2's, in alphabetical order)

- Air quality (through existing regional monitoring stations) and visibility
- Oak health/sudden oak death
- Migratory corridor/wildlife habitat
- Riparian/woodland edge plant community
- Species of special concern

Others (in alphabetical order)

- Air pollutant deposition
- Amphibians
- Aquifer water quality
- Birds
- Surface water quality

Appendix B

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Background information for

Eugene O'Neill National Historic Site

Location

The Eugene O'Neill National Historic Site (NHS) is located 26 miles east of San Francisco adjacent to the west side of the incorporated town of Danville, Contra Costa County, California. Las Trampas Regional Wilderness Area administered by East Bay Regional Park District surrounds it on three sides. Access to the site is through a residential area on the fourth, downslope side.

Management Objectives

The significance of the park begins with the contribution of Eugene O'Neill to American drama. He was awarded the Nobel Prize for Literature in 1936 and four of his plays are Pulitzer Prize winners. Congress established the park in 1976 preserving 13.19 acres containing the Tao House, Eugene O'Neill's last residence.

A major park goal is to preserve the Tao House, courtyard and historic landscape in a representative scene of his home during 1941. The primary objective is to interpret and emphasize Eugene O'Neill's influence on American drama and society during his lifetime and since.

Objectives for or affecting natural resources include:

- To maintain and interpret the grounds, gardens, courtyard and orchards as nearly as possible as they were in 1941.
- To achieve an understanding of the natural ecosystem existing on the site prior to the O'Neill's arrival, the remnants of that ecosystem today, and to preserve and interpret those natural features that were important to the overall quality of life on the estate during O'Neill's tenure.
- To contain or eliminate non-native plants.

Under the MOU, present maximum visitation is 29,375. Actual average annual visitation to the site is approximately 3,360 (Shaver 2002).

Cultural Landscape

1. There is a small grove of coast redwood trees on the embankment behind the swimming pool area that was planted by the O'Neill's.
2. Various remnants of the orchards and original ornamental landscaping remain. Most of the original orchards are in the adjacent regional park. Walnut, almond and fruit orchards flanked the house and occupied much of the estate on the south and east sides. A Cultural Landscape Report will be completed in 2003.

Adjacent Land Uses

1. Las Trampas Regional Wilderness Area incorporates 3,458 acres of relatively natural landscape. Grazing is permitted and a number of developments (fences, dams and resulting ponds, water tanks) exist within the viewshed of the historic site and on land which once was part of the original O'Neill estate. Primarily because of grazing, but also to delineate the site

boundary, a barbed wire fence separates the site from the regional park (NPS 1992). Visitors are able to hike between the two parks.

2. An agreement between East Bay Regional Park District and the NPS conveys the water rights of springs located above the O'Neill house within Las Trampas to the NPS. The agreement outlines the right-of-way width, facilities including drain line, spring box, 3 storage tanks, maintenance access and amount of water use (E.Bay Reg'l Pks 1991).
3. Immediately to the west of the site is a small (200 by 300 foot) pond, previously used for stock watering and irrigation. A small earth-filled dam on a perennial stream impounds it. The dam was built after the O'Neill's. The NPS has planted native trees around the pond to attempt to screen it from view. Plantings include the valley oak, willows, alders and cottonwood. The pond is not within the NPS boundary.

Natural Resources and Scientific Studies

The environment at the estate was carefully crafted by O'Neill to provide the quiet serenity and inspiration he desired to be creative. As a result of the modification made by the O'Neill's and others, very little remains of any natural landscape or ecosystem on the historic site. Some native oaks were retained in the landscape design. Other native trees were planted as part of the estate plan (the sycamores around the drive and the coast redwoods near the pool). The orchards are still managed. The trees are routinely pruned and as the older trees die, are replaced by younger ones of the same species. The ground surface is disked to maintain the historic appearance. Plant cover is predominantly non-native grasses and weeds. The remnant orchards on Las Trampas are not maintained.

Air resources/ meteorology. The historic site is classified as a Class II area. No specific studies have been done to determine the air quality existing on the site. The Highway I-680 corridor presents a potential pollution source that could affect the historic site. Generally, visibility into the San Ramon Valley and to adjacent landscapes is excellent. However, there are days when a dense haze obscures Mt. Diablo, the delta and San Pablo Bay.

The Las Trampas area is located sufficiently east of the Pacific Ocean and San Francisco Bay that the climate tends to be more continental than maritime, however, no formal statistical data has been collected to document this fact. Ridges to the west generally block summer fogs. Summer temperatures exceed 100 degrees F about 14 to 21 days per year. The mean annual precipitation is estimated at 26 inches (E.Bay Reg'l Pks 1991).

Geologic resources. Small fossils and sedimentary layers along road cuts and exposures in Las Trampas display uplift and folding of marine formations. The area was at the bottom of the Pacific Ocean until 20 million years ago. Soils around the historic site are probably the Osos-Millsholm-Los Gatos association. These soils are broadly described as "moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from interbedded sedimentary rock on uplands." The higher moisture retention supports heavier and more diverse vegetation, which in turn promotes soil development. On steep slopes, these soils represent a severe erosion hazard. When cut banks approach vertical, they collapse and contribute major volumes of loose material to water flow (E.Bay Reg'l Pks 1991).

Water resources. No studies of the water quality have been done in either the pond or in the perennial stream. The historic site is within the Walnut Creek Watershed that drains about 150 square miles of central Contra Costa County and empties into Carquinez Strait. Sulphur Springs Canyon, Vail Peak and Eagle Peak drain into an unnamed creek that flows past the site. The streams or creeks produce high flows in winter and spring after heavy rains and little to no flow in the summer. Gully erosion has occurred over the years below the swimming pool and visitor center (E.Bay Reg'l Pks 1991).

The spring-fed livestock watering pond is less than 2-acres in size and was formed by damming a small north-facing canyon. Water levels fluctuate from 5-feet to almost 20-feet (E.Bay Reg'l Pks 1991).

Major aquifers beneath the eastern sides of the Las Trampas Ridge provide spring water. Sandstone rocks absorb water that is able to flow to the surface through cracks created by fault movement from two faults, the Bollinger and the Las Trampas. Eugene O'Neill NHS uses spring water for drinking and irrigation uses. The springs are known to stop flowing in drought conditions.

Vegetation resources. The historic site was probably carved out of grassland and oak woodland. Prior to cultivation and grazing, the most dominant trees occurring on the site were probably the coast live oak, bay laurel, buckeye, big leaf maple, canyon live oak, black oak and scrub oak. Native California bunchgrasses including the once dominant purple needlegrass likely dominated the understory along with several shrubs such as poison oak, toyon, elderberry and coffee berry. Most of the common wildflowers in the area are still native plants.

Currently, there are three natural habitats on the site: grassland, wet meadow and riparian. The riparian habitats occur along intermittent streams or wet meadows associated with springs and seeps. These areas increase the value of the surrounding area as habitat for wildlife and represent an essential element for plant and animal species that require water for all or part of their life stages. Riparian woodland occupies a narrow band along streams. Trees found in this plant association include oaks, bays, willows, and white alder. Wet meadows support plants such as rabbitfoot grass, rushes, tules, sedges, horsetails, buttercups, watercress, stinging nettle and monkey flower. The cattle pond adjacent to the historic site may have been a wet meadow associated with springs. An unnamed intermittent creek below the visitor center has two upslope tributaries.

Oak woodland can be found upslope of the Eugene O' site. Stands of dense chaparral dominated by chamise occur southwest of the site. No threatened or endangered plants are known to grow on the historic site, however on adjacent land there are some rare plants. An inventory will be completed in 2002.

Wildlife resources. Several species of raptors, numerous songbirds as well as deer, raccoon, fox, opossum, bobcat, skunk and squirrels probably utilized the area historically. Eagles, hawks and owls nest in the woodlands adjacent to the grassland where they hunt. Black-

tailed deer browse the grass. Hummingbirds of several species forage on the abundant wildflowers.

Three inventory procedures were initiated in early 2001 to document terrestrial vertebrates (Fellers 2001). The procedures include 1) continuous surveillance along animal trails with automatic cameras for large and medium-sized mammals, 2) periodic live trapping for small mammals, and 3) periodic checks under artificial cover boards for reptiles and amphibians. As of November 2001, nine mammals, five reptiles and one amphibian have been detected and documented.

The pond currently supports western pond turtles and California newts. No threatened or endangered animal species are known to utilize the site. The rare Alameda whipsnake is found on Las Trampas Ridge and may migrate into the Eugene O'Neill NHS.

Threats and stresses to natural resources

1. **Non-native plants.** A number of noxious weeds have been identified and are being controlled or eliminated. Mistletoe and yellow starthistle have been mechanically removed and/or treated. The treatment areas will be monitored and maintained free of those invasive species. Eucalyptus groves are present near the pond just outside the west boundary of the site. Landowners abutting the entrance road are maintaining residences with non-native grass and ornamental plantings, which may be potential sources for non-native plant invasions onto the site.

   Non-native grasses and forbs represent about 30% of the total number of plant species found in Las Trampas Regional Park (E.Bay Reg'l Pks 1991). A vascular plant species inventory completed in 2002 will provide better information on the extent of invasive species on Eugene O'Neill NHS. Population mapping of the particularly noxious species is underway.

2. **Non-Native Animals.** Domestic and feral cats are present in the vicinity and are known to hunt small birds and rodents.

3. **Fire.** No fire history has been described for the site. Remnant grassland material left standing during the summer months can pose extreme fire hazard. Fuel hazards have historically been reduced by use of fuel breaks, by grazing, disking or mowing.

4. **Grazing.** Grazing does occur on adjacent regional parklands to reduce mulch thus reducing fire hazard. Grazing is historic to O'Neill's time. Las Trampas has fenced cattle out of the riparian corridor of Bollinger Creek to protect vegetation, reduce erosion and degradation of water quality.

5. **Landslides and erosion.** The areas around the riparian habitat and streams have a steeper slope. Soils in the historic site are prone to erosion. Some of the creek channel has already developed deep gullies.

Current and Previous Natural Resource Monitoring

There is no historical or current monitoring being done in the park.

Background Information for John Muir National Historic Site

Location

The John Muir National Historic Site (NHS) is located in Martinez, Contra Costa County, California. It is approximately 20 miles northeast of San Francisco.

Significance

The original 1964 enabling legislation preserved the 8.8 acre area containing the residence of John Muir. The remainder of the property is managed to provide a historically appropriate setting for the house containing vineyards and orchards typical of those during the Muir lifetime. In 1988, an additional 326 acres incorporated Mount Wanda, an undeveloped area of grassland and woodland (Public Law 100-563). John and his daughters used to go for evening walks there. The Mt. Wanda land is maintained to represent a pastoral setting. The area surrounding it is now primarily residential in character.

Management Objectives

The primary objective of the site is to interpret and emphasize John Muir's influence on the American conservation and environmental movement during his lifetime and since, his role in the creation of National Parks and his contribution to American literature.

Objectives for natural resources include:

- To identify, monitor and manage the flora and fauna of the Mt. Wanda area
- To protect sensitive species when identified
- To protect the natural scene associated with John Muir's days at the ranch
- To manage human and animal impacts on park resources
- To evaluate the role of fire in the maintenance of the native vegetation patterns

The park averages 31,500 visitors per year (range from 26,400 to 39,700). Monthly visitation ranges from 1,300 to 3,500.

Cultural Resources

The principal physical cultural resource is the 17-room wood-frame Strentzel home. John Muir's father-in-law built it in 1882. The two-story Martinez Adobe House, a ranch outbuilding, was built in 1849. It is one of the older structures in the San Francisco Bay area and is representative of the California adobe homes of the mid-nineteenth century. A remnant portion of a fruit orchard surrounds the John Muir gravesite along the Alhambra River. The home site is managed as an historic area with emphasis on preservation of the existing scene. Orchards and a vineyard have been planted by the National Park Service to represent the 2600 acres of the former fruit ranch. There are a few scattered, planted, old individual olives, almond and apricot trees. Research for the cultural landscape plan is underway.

Adjacent land uses

1. Southern Pacific Pipelines, Inc. and Union Oil have underground pipelines, surface valves and other appurtenances. Valves occupy the extreme southwest corner of the Site. There are three capped gas wells. There have been no gas leaks from these wells.
2. Pacific Gas and Electric has been granted a special use permit for existing pipelines which run diagonally under the southwest corner of the Site.
3. The Strain property includes a ranch complex consisting of 2 residences, a barn, corrals and several outbuildings. None of the buildings date from the Muir era.

Natural Resources

The 338 acre site is representative of the Alhambra Valley during the period when it was a rural fruit growing area.

Air resources/ meteorology. A Mediterranean climate prevails with the average annual rainfall between 16 and 20 inches per year. Over 90% of the rainfall occurs during a six-month period, from November to April. The area has a 365-day growing season with temperatures greater than 28 degrees F.

Under the terms of the Clean Air Act, the Site was designated as a Class II area. The small size of the area makes it impossible to separate the Site's air quality from that of the surrounding area. The elevated freeway produce both air and noise pollution which intrudes on the Site 24-hours a day. Nearby refineries and other industrial sources also contribute to reduced air quality. The John Muir NHS is located in a county that is designated as non-attainment for the California particulate matter and ozone standards.

An inventory conducted in 1998 to identify sources of emissions within John Muir was a first step in minimizing the impacts of air emissions from NPS activities upon environmental resources under its care. This Historic Site barely registers except in the volatile organic carbon category (0.14 tons/yr), but it is still negligible to the emissions generated in Contra Costa County (130 tons/yr).

Geologic resources. Mt. Wanda rises to over 660 feet. Near the bottom of Mt. Wanda the bedrock is sandstone, a sedimentary rock formed as sand was slowly deposited on the ocean floor. As we move up Mt. Wanda, we encounter sandstone, siltstone and shale, the "Great Valley Sequence. These rock layers are older than the sandstone, with the oldest rock on the top of Mt. Wanda. It is unusual for the oldest rocks to be on top of the youngest. Twenty to thirty million years ago, the San Andreas Fault tilted up and overturned the rocks in this area.

There are two predominant soils in the park, Los Gatos loam on 30-50% slopes and Los Osos clay loam on 15-30% slopes. Botella clay loam can be found in the creek floodplains. Most of the soils have a medium to high erosion potential.

John Muir NHS incorporates two watersheds, the Alhambra Creek watershed to the southeast and the Franklin to the northwest. The watershed basins have subparallel ridges, deeply entrenched canyons, and small valleys that trend northwestward. This regional trend is caused by geologic structure. All of the streams are classified as intermittent. The stream channels have sinuous alignments, and the relatively steep channel slopes cause rapid rises in flood flows. Flood peaks occur near the mouth of the drainage in about 3-hours after critical rainfall.

Several faults traverse the area, generally from a southeasterly to northwesterly direction. The faults have had activity in historic time.

Water Resources. The NPS Water Resources Division developed a water quality baseline for the park in 1998. The study area included surface water resources in the park and all lands and waters within at least 3 miles upstream and 1 mile downstream of the park. Six of the US Environmental Protection Agency's (EPA) national databases were used to develop this baseline of water resources information. No monitoring stations were located within the park boundary. Two groups of parameters exceeded screening criteria - dissolved oxygen and sulfate concentrations. Very limited data exist for 11 of the 13 Level I parameter groups in the study area. No data exist for chlorophyll and bacteria. This data inventory indicates a lack of relatively recent observations for all parameters measured in the study area and a complete lack of any data collected within the park. Therefore, in 2003, park surface water resources will be sampled and characterized for the Level I parameter groups by the network water resources group of technical specialists.

Franklin Creek is spring-fed and has some of the coolest water in the Alhambra Watershed. It flows between the Strentzel House and the Adobe House. It may have temperatures low enough in the summer (below 65 degrees F) to support salmonid fish. It also has significant gravel beds, which are also needed by spawning salmonids.

Vegetation Resources. In 1992, at least 253 species of vascular plants were growing on Mt. Wanda (Hunter 1993). Since Mt. Wanda is in the inner coast range, its flora includes species found primarily within the Central Valley. Species with coastal distributions and a number of species at their northern range limits are also found.

Annual grassland and blue oak woodland dominate the vegetation of the Mt. Wanda area although mixed evergreen forest and chaparral communities can also be found.

Annual grassland is concentrated on upper portions of the mountain (64 acres) and is the most diverse vegetation community. Introduced annual grasses with more limited native perennial grasses and a considerable number of native forbs overwhelmingly dominate the grassland. Mulch, the dead biomass at summer's end, reduces light, increases humidity and alters soil surface. Thin mulch layers favor a variety of annual forbs while thicker mulch layers favor taller annual grasses. Heavy spring grazing favors growth of summer. Annual grassland habitats occupy what was once considered pristine native grassland. Although, in 1992, 74 species were observed in this community, seven introduced annual species accounted for 94% of the cover (Hunter *et.al*. 1993).

The blue oak woodlands cover the slopes and occupy approximately 85 acres on Mt. Wanda. In most of the blue oak woodlands, shrubs were absent and the herbaceous layer was similar in composition to the annual grassland with more forbs present. Blue oak seedlings were frequently present, but saplings were absent (Hunter 1993). Relatively closed canopy dense forests dominated by California bay and coastal live oak occupy mesic sites. In drier sites, trees are widely spaced, forming an open woodland or savanna. Seed production is variable with "mast" years of heavy seed crops at 3-year intervals (Koenig *et.al*. 1971).

Mt. Wanda's mixed evergreen forest covers 30 acres, primarily on north-facing slopes and in lower portions of drainages. The tree layer is composed of nearly equal numbers of larger coast live oak and bay trees. On Mt. Wanda, both the shrub and herb layers provide little cover. Saplings of bay and, in some locations, poison oak are the dominant shrubs. Mixed evergreen forest covers large areas in the Outer Coast ranges, but is nearly absent from the Inner Coast ranges.

Chaparral stands are limited to less than 2-acres of dry rocky exposures. The shrub layer on Mt. Wanda is discontinuous and variable in cover. Chamise dominates the chaparral's shrub layer.

Riparian corridors are composed of a mixed hardwood forest. Typically, dominant tree species are the bay, big leaf maple and California sycamore. Oak trees border riparian habitats and may intersperse them. When the riparian corridor is adjacent to annual grasslands, the canopy layers end abruptly. Most of the riparian corridor reaches are oak dominated, in climax maturity states. These habitats provide food, water, and migration and dispersal corridors, and escape, nesting, and thermal cover for an abundance of wildlife.

One rare species was found – *Helianthella castanea* (Asteracea), a bay area endemic, in two populations. One population is near the western chaparral patch and the second, adjacent to the northern chaparral patch. Each population consists of less than 25 individuals. Both populations will be monitored annually.

Wildlife resources. An inventory documenting small mammal and herpetofauna is underway. Large to medium sized mammals photographed included the mule deer, coyote, striped skunk, raccoon, and gray fox (Fellers 2001). The introduced eastern fox squirrel was also photographed. Domestic cats are also being photographed in fairly large numbers and may become an introduced animal needing control. Small mammals have only been live-trapped in the oak woodland. Herpetofauna are documented using cover boards. This study will be completed in the winter of 2002.

Threats and stresses to natural resources

1. **Non-native plants**. In 1874, the Strentzel family acquired Mt. Wanda and planted orchards and as many as 120 ornamental plants. Prior to the Strentzel's ownership, there are no records of ornamental plantings. Thirty seven percent of the species on Mt. Wanda are introduced. Several of the introduced species are invasive and could alter the landscape of Mt. Wanda. Many of these species should be controlled or eliminated. Tree of heaven occupies a considerable area along the roads. Working with adjacent landowners to control the plants on their boundaries could ensure control or eradication. Efforts by the Exotic Pest Management Team, park staff and contractors began in the summer of 2002 to manually control yellow starthistle, artichoke thistle, French broom and tree of heaven.

2. **Fire**. The 326.2 acres of grassland and oak forests on Mount Wanda represents a potential location for wildland fires. The role of wildland fire remains to be determined. Prior to fire suppression, wildland fires were a frequent occurrence in annual grasslands. There is an historic record of a fire in the chaparral in 1887 when the train trestle was constructed. Controlled burns in the chaparral could allow regeneration of some chemise and other plants. No controlled burns should take place in the grasslands or blue oak woodlands unless thatch levels are first reduced below 2500 kg/ha so that native grasses are not killed. (Hunter 1993) A fire history could be recreated by sampling existing tree stumps to infer fire history and current oak age-distribution.

3. **Grazing**. The effects of grazing by domestic livestock remains to be determined. The high density of grazing is thought to have subjected California's vegetation to a different grazing pressure than had herds of the indigenous deer, antelope and elk. Along with livestock came exotic weeds. The Martinez family grazed cattle, horses, sheep and goats. Following the drought of 1860-1, cattle and sheep essentially denuded large areas and most livestock perished. Ranching never recovered. Large areas of land were then brought into cultivation and by 1870, agriculture had replaced ranching on the most fertile bottomlands. Uplands

continued to be grazed and grasslands were also cut for hay. The increased population of Martinez created a demand for fuel wood. Today, most stands of blue oak on the upper portions of Mt. Wanda contain decayed sawn stumps. In 1911, Muir kept 100 pigs and 25 cows on Mt. Wanda and in 1914, there were 500 cattle grazing the mountain. Grazing continued from 1920 until 1996, but was intermittent and moderate in intensity.

4. **Mass wasting and soil erosion**. Slopes greater than 50% with shale or poorly cemented sandstone may slump badly (Alhambra Creek Watershed Inventory 1997). In 2002 a team of park service employees will conclude a geomorphology survey of the watershed focused on bank incision, erosion and flooding.

5. **Flooding**. Potential natural sources of contaminants could come from floodwaters. Franklin Creek flows between the Muir-Strentzel house and the Martinez Adobe house and has been known to overflow its banks creating flood conditions in the vineyard and orchards. Potential anthropogenic sources of contaminants include industrial and municipal wastewater discharges, urban stormwater runoff, pomological activities, and atmospheric deposition.

Flooding has frequently occurred in the watershed located on the south side of Mt. Wanda. The NPS is responsible for managing 44% of this watershed basin. In 2000, the NPS concluded an evaluation of how watershed processes on John Muir lands affect the potential for producing floods (Inglis 2002). Vegetation, channel condition and the presence/absence of stock water detention structures were the management variables evaluated. Flooding will likely occur in the Strentzel Lane neighborhood under current conditions with any flows above an estimated 20-50 cfs. From the model, improving vegetation condition from 50 to 75% cover may reduce peak flow by 10%. Repairing the existing stock ponds on NPS land would not significantly reduce flooding downstream because their upper watershed locations influence only a very small percentage of the total watershed. The most significant reduction of flooding occurred by adding a large detention basin in the lower watershed. The reach around the Strain Ranch is critical because all of the discharge from the watershed passes through it and it is located very near residences and other buildings that are at risk from flooding. A best management practice for this area should be developed. A detailed topographic survey is needed to accurately map the affected area prior to sediment reduction actions or for a restoration design. The goal should be to infiltrate as much water as possible into watershed soils and attenuate the remaining runoff as it leaves the watershed. All stakeholders need to work together to resolve this problem.

Eugene O'Neill National Historic Site

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Appendix 3

Golden Gate Recreation Area/ Point Reyes National Seashore
2002 Vital Signs Workshop Summary

PARK VITAL SIGNS/CONCEPTUAL MODEL SCOPING WORKSHOP

Point Reyes NS and Golden Gate NRA

July 17-18, 2002

Jennifer Bjork
Network Inventory and Monitoring Coordinator
San Francisco Bay Network Inventory and Monitoring Program

PARK VITAL SIGNS/CONCEPTUAL MODEL SCOPING WORKSHOP
Point Reyes NS and Golden Gate NRA
July 17-18, 2002

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PARK VITAL SIGNS/CONCEPTUAL MODEL SCOPING WORKSHOP
Point Reyes NS and Golden Gate NRA
July 17-18, 2002

This document summarizes the process used and the products gained from a Vital Signs Monitoring Workshop conducted by Point Reyes National Seashore, Golden Gate National Recreation Area, and the park units administered by Golden Gate - Fort Point National Historic Area, Muir Woods National Monument, and the Presidio of San Francisco. The workshop was designed to review the proposed vital signs indicators selected through previous workshops, the underlying assumptions about ecosystem function, and the conceptual model about how they interconnect. Key points from discussion, work group discoveries and suggestions are included in this summary.

Introduction

Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS's) ability to manage park resources "unimpaired for the enjoyment of future generations". NPS park managers are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources as a basis for making decisions. They must provide scientifically credible information to select and defend management actions and fulfill legal mandates.

In response to these challenges, the NPS has identified 270 parks with significant natural resources for which inventories will be completed and long-term ecological monitoring will occur. The intent of the NPS monitoring program is to track a subset of park resources and processes, known as "vital signs", that are determined to be the most significant indicators of ecological condition for specific resources that are of greatest concern to each park.

Steps to develop a monitoring program

The NPS Inventory and Monitoring (I&M) Program grouped the 270 parks into 32 vital sign networks linked by geography and shared natural resource characteristics. Each network of parks is required to design an integrated monitoring program that addresses the Service-wide monitoring goals listed above and that is tailored to meet the high-priority monitoring needs of the parks. The basic approach to designing a monitoring program should follow the five basic steps recommended by the service-wide I&M program:

1. Define the purpose and scope of the monitoring program,
2. Compile and summarize existing data and understanding of park ecosystems,
3. Develop conceptual models of relevant ecosystem components,
4. Select indicators and specific monitoring objectives for each; and
5. Determine the appropriate sampling design and sampling protocols.

Point Reyes/Golden Gate workshop process and participants

A two-day workshop was held in lower Ft. Mason in July 2002. The 39 participants included predominantly NPS employees with resource specialties from the five parks. Other invitees included people from other agencies, Universities or individuals working on projects in the parks.

During the first day, many participants were asked to present 3-5 minute-long summaries about the projects that they worked on. Then participants divided into smaller work groups of 5-12 to accomplish the first two steps of the workshop. During the second day, presentations were made about the management needs and issues in both parks. The "straw-dog" conceptual model was presented. Then the same groups formed to evaluate, revise and add to the descriptions. In the afternoon, the groups reviewed the indicators, but we didn't have time to rank them during the workshop. After the workshop using a ranking process through emails, we developed the ranking criteria for the indicators.

Workshop goals

The objective of the workshop was to revise and improve portions of the 2002 Point Reyes/Golden Gate Draft Monitoring Plan to meet NPS service-wide directions by taking the following steps:

1. Review significant natural resources.
2. Review stresses to the natural resources.
3. Review the "straw-dog" conceptual model with interconnections between stressors and resources.
4. Review/prioritize vital signs indicators.

Background

In the past, the parks separately developed I&M projects for single species or groups, such as rare plants, pinnipeds, migratory raptors, and exotic plants. GOGA developed an ecological monitoring program in coastal scrub and grassland habitats in 1988 (Howell 1992).

In 1993, resource management staffs from PORE/GOGA parks decided to develop an I&M program. They decided to work closely with the Channel Islands prototype program since they had similar ecosystems and had prior monitoring experience. Monitoring elements that were initiated included the rocky intertidal monitoring and the salmonid monitoring. A draft inventory and monitoring plan was developed in 1996 at the end of this process, but it was only partially implemented due to lack of funding.

With the initiation of the Natural Resource Challenge, the Monitoring Plan was resurrected for review and modification during this workshop and is attached as an Appendix. Several events occurred that might affect recommendations made in 1996.

The NPS **Natural Resource Challenge** has been implemented to improve how the NPS manages the natural resources under its care. It is an Action Plan that calls for substantially increasing funding for the I&M program, exotic plant management teams, and learning centers.

The Plan includes gathering baseline data on resource conditions, strengthening partnerships with the scientific community, and sharing knowledge. The I&M program developed specific standards for both inventories and vital signs monitoring that participating parks must meet. These standards were not in place when the Point Reyes/Golden Gate parks first developed their long-term monitoring indicators.

The Point Reyes/Golden Gate parks are a major part of the San Francisco Bay Area Network (SFAN). The SFAN was selected as one of the first three Networks in the region to obtain I&M program funds because of need, capacity and existing efforts. In 2000 using I&M funding, this Network began to complete inventories of natural resources for which information was lacking. Therefore, there is new information available to guide the parks since the initial workshops. These natural resource **baseline inventories** allow us to account for park resources and represent "core" sets of information park managers need to effectively protect park resources. Inventories are conducted in accordance with clearly defined protocols and quality-assurance standards. The Service-wide core inventories include:

a) automated bibliography (NRBIB)
b) base cartography
c) species occurrence of vertebrates and vascular plants currently known to occur in parks (species list in NPSpecies)
d) species distribution for species of concern (T&E, exotics)
e) vegetation maps based on recent aerial photography following a standard classification
f) soils maps through a partnership with the Natural Resource Conservation Service
g) geologic maps through a partnership with the US Geological Service and State geological agencies
h) water resources inventory with locations documented digitally
i) water chemistry for all "key" water bodies
j) air quality data summarized into an air quality atlas to assess air quality conditions in parks developed by the NPS Air Resources Division
k) air quality related values (visibility and identification of other resources that may be affected)
l) meteorological data through collection of basic parameters including precipitation and temperature

PORE/GOGA parks developed an Inventory Study Plan that was implemented in FY2000. The first projects that were supported included vegetation mapping, data mining, and a small mammal inventory. An assessment of the herbarium was also initiated. In FY2001, the rare plant inventory started. The bat inventory and coastal intertidal inventory began in FY2002.

Service-wide vital signs monitoring goals

Despite differences that exist among parks, five service-wide goals for vital signs monitoring have been established for the 270 NPS park units with significant natural resources. The goal is to design an integrated monitoring program to:

1. Use selected indicators to determine status and trend of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources,
2. Provide early warning of abnormal conditions and impairment of selected resources to develop effective mitigation measures and reduce costs of management,

3. Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments,
4. Provide data to meet certain legal and congressional mandates related to natural resource protection and visitor enjoyment, and
5. Provide a means to measure progress towards performance goals.

Park monitoring goals and objectives

The first step in developing a monitoring plan is to form monitoring goals which describe why the parks want to monitor. These were developed in 1996 based on the NPS mission, Vail Agenda and parks enabling legislation. The goal of the Point Reyes and Golden Gate parks is to develop and institute a natural resources monitoring program which will:

1. determine present and future ecosystem health,
2. establish empirical limits of resource variation,
3. provide early diagnosis of abnormal condition, and
4. identify potential agents of abnormal anthropogenic change.

The objectives of the park monitoring program are based on the monitoring goals, both service-wide goals and park goals. The following two objectives were developed in 1996:

1. to detect change and quantify trends in resource condition, and
2. to provide a rational, scientific basis for taking actions.

Definition of terms

Indicators are also called vital signs or attributes. They are any measurable feature of the environment that provides insights into changes in the state of the ecosystem. They are intended to track changes in a subset of park resources and processes of greatest concern to the parks. They may occur at any level of organization from landscape, community, population or genetic scales and also either structural (organization and pattern of the ecosystem) or functional (ecological processes).

Ecological effects are the physical, chemical and biological responses to processes and stresses.

Stressors are physical, chemical or biological perterbations to a system that are foreign to that system. Examples include resource extraction, air pollution, fire suppression, and invasive species introductions.

Natural ecosystem processes are the major external driving forces such as climate, fire cycles, biological invasions, hydrologic cycles, and natural disturbance events (e.g., earthquakes, droughts and floods) that have large scale influences. Process examples include succession, deposition/accretion of soils, and marine currents.

Boundary area of concern

The legislative boundaries of the coastal parks of central California extend from Tomales Point, Marin County, on the northern edge south to Milagro Ridge, San Mateo County. The total acreage for all parks is around 150,000 acres. This includes 71,068 acres in PORE, 75,398 acres in GOGA, 554 acres in MUWO, 29 acres in FOPO, and 1,480 acres in PRES. Within the

legislative boundary of PORE are 4,970 acres of inholdings of state, federal and commercial enclaves, and 8,000 acres of designated wilderness.

There are two boundary limits, an inner core which is more protected and an outer limit. The core is composed of areas within NPS boundaries, state parks, and adjacent watersheds. The outer limit is delineated by the broader boundary of the Central California Biosphere Reserve, of which the parks are members; three National Marine Sanctuaries; and the mouth and center of San Francisco Bay. Monitoring in the core area should be expanded to take into account upper and lower reaches of watersheds, which extend beyond the legislative boundaries of the parks. The outer limit of the boundary was developed for widely ranging species and headwaters of streams.

Conceptual model

A conceptual model is a visual or narrative summary that describes the important components of an ecosystem and the interactions among them. Development of a conceptual model helps in understanding how the physical, chemical and biological elements of a monitoring program interact and promotes integration and communication among scientists and managers from different disciplines. Conceptual model development is an iterative and interactive process. Models are expected to change as a network's monitoring program develops and as ecological linkages are better understood.

The PORE/GOGA parks developed a schematic model with a supporting narrative. The high biodiversity due to the moderate Mediterranean climate, topographic variation, convergent oceanic currents, and overlapping ecological regions made it challenging to divide the ecosystems into something that made sense. For conceptual purposes, the ecosystems were divided into four types – marine, terrestrial, wetland, and abiotic. The dominant ecosystem drivers, anthropogenic stressors, and broad-scale indicators were also represented in each model.

In order to review the schematic model, the underlying knowledge and assumptions had to be checked. The workshop participants reviewed the significant resources, natural processes and stresses as a single group. Participants divided by discipline into smaller work groups to review each schematic model and proposed indicators.

STRAW DOG CONCEPTUAL MODEL
Golden Gate NRA and Point Reyes NS
Assumptions or Current Knowledge for the Model

The first step was to document the significant resources that were being conserved for future generations. Legislation and executive orders were used as the first cut in listing significant resources for these park units.

The purpose of Golden Gate NRA as part of the "parks to the people" program:

> "in order to preserve certain areas of Marin and San Francisco Counties, possessing outstanding natural, historic, scenic and recreational values, and in order to provide for the maintenance of needed recreational open space necessary to urban environment and planning…" (1972 enabling legislation)

The purpose of Muir Woods:

> "to protect the grove of coast redwoods because 'the trees are of scientific value because of the primeval character of the forest, the age and size of the trees (and) their location near centers of population and instruction." (1905 enabling legislation)

The purpose of PORE:

"… to save and preserve for the purpose of public recreation, benefit and inspiration, a portion of the diminishing seashore of the United States that remains undeveloped." (1962 enabling legislation)

The group expanded the list and grouped it by functionality. The summary is included below in alphabetic order in Table 1:

Table 1: Significant natural resources

1. Clean air
2. Clean and sufficient water
3. Dark night sky
4. Endemic species and their habitat
5. Geomorphic condition and function
6. Inspiration as part of visitor experience
7. Migratory species support systems
8. Natural soundscape
9. Natural functioning ecosystem
10. Special ecological regions
11. Threatened and endangered species and their habitats
12. Unique soils and geology with their plant communities
13. Viewsheds
14. Wilderness

When the resources of all of the parks are combined, the parks in this Network become an awesome resource:

- one of the largest coastal preserves in the U.S. (over 100,000 acres)
- superlative north Pacific coast landscapes
- important scientific resources
- one of six most significant in the nation for biodiversity
- nearly 60 federal or state listed threatened and endangered species utilize the parks as residents or seasonal migrants
- one of the best birding areas in the U.S. (480 recorded species)
- eleven species of seabirds breed within the parks
- over 80 waterbird and shorebird species were identified during the 1997-99 inventories
- one of eleven mainland breeding areas for northern elephant seals in the world
- 20% of the breeding population of harbor seals in California
- highest density of spotted owls throughout its range
- highest density of red-legged frogs throughout its range

The next step was to identify and document the natural processes. The group began by checking the natural ecological processes first. Processes were assumed to be natural and operate within a normal range of variation.

Table 2. Major natural processes

- catastrophic events (fire from natural ignitions, floods, earthquakes, mass wasting, waves, wind)
- climate (decadal patterns and greater)
- dispersal (seeds, pollen, animals) needing connectivity
- disturbance
- edge effects
- environmental engineering (trampling, burrowing, grazing)
- evolution (affects endemism and genetic diversity)
- landscape/ patch dynamics
- nutrient cycles
- predator/ prey dynamics
- succession
- trophic interactions through the food web

Stressors were thought to be anthropogenic, to potentially have deleterious effects to park resources, and to accelerate rates of change. Processes may be accelerated or modified by anthropogenic causes. There were thought to be eight major sources of stressors to the resources – development, farming, fishing, unnaturally caused fire ignitions, park operations,

pollutants, over 150-years of ranching, and recreation. Most stressors were related to change in land use.

Table 3. Major stressors

- traffic and combustion engines causing air pollution and noise
- increased nutrients from fertilizer use and ranching
- erosion increasing sedimentation in streams and creeks
- lights decreasing dark night sky
- habitat fragmentation disrupting migration and dispersal
- changed fire regimes causing vegetation community structure and composition changes
- trampling from humans and ranching causing soil compaction and erosion
- increased urban to parkland edge
- global warming
- changes in nutrient cycles from fertilizers and pollutants resulting from increased development
- wildlife behavior changes from increased urban interactions and loss of habitat
- loss of viewsheds due to increased patchiness and development
- degraded visitor experience (inspiration) due to degradation of resources
- increased avenues of entry for exotic species
- increased avenues of entry for disease
- increased plastic litter that can be ingested or can entangle
- increased direct take and removal of resources, especially marine resources through fishing

The summary of the processes and stressors affecting the parks in this workshop is also included in Worksheet 1.

Both marine and terrestrial ecosystems overlapped with wetland ecosystems, so the workshop participants decided to define the **boundaries** of the wetland group. No areas bounding the Pacific Ocean were included in the wetland group. The wetland group included entire stream reaches until they flowed into bays/estuaries. All freshwater ponds and impoundment's were included in the wetland group. The Cowardin definition of a "wetland" using the vegetation parameter was also used for the purposes of this discussion.

The participants reviewed the current knowledge and assumptions for which the conceptual model is based. They thought that identifying the knowledge gaps would be helpful to future reviewers, so these were included. All three groups where able to discuss the interconnections between stresses and resources leading to monitoring questions/indicators.

METEOROLOGY AND CLIMATE

The San Francisco Bay Area Network parks are in the Mediterranean climate zone. The moderate climate offers long growing seasons and supports diverse plant and animal communities. This area is assumed to have a predominantly westerly wind receiving a majority of its rainfall during the winter months. There is a high variability in winds. The coastal areas are characterized by fog, precipitation, and steep gradients. Terrestrial areas have pockets of marine-influenced microclimates with intense variation in rainfall and fog, both spatially and temporally (seasonal, annual, long-term, decadal).

There are gaps in both current and legacy meteorological data.

GEOLOGY AND GEOMORPHOLOGY

Elevation across the parks ranges from sea level to 3,300 feet above mean sea level. There is varied topography. Slopes range from almost flat marine terraces and alluvial deposits to steep canyons along some creeks, providing dramatic topography and, therefore, habitat heterogeneity.

The San Andreas Fault, the dominant geological force in the area, is a source of natural disturbance in the form of seismic activity resulting from the interaction of the Pacific and Continental Plates. This geologic activity restructures ecosystems offering unusual habitat for endemics and species at the edge of their range. Geology and soil types are diverse.

There are gaps in knowledge about soil biotic components (mycorrhyzae, invertebrates). A soil map for San Mateo lands is needed.

WATER RESOURCES

Many aquatic resources are significant in an ecological and economic context. Aquatic resources include streams, bays, estuaries, lagoons, lakes, reservoirs, freshwater and estuarine marshes, seeps and bogs. The combinations of marine and freshwater systems support a variety of threatened and endangered species. Four Areas of Special Biological Significance have been established by the state within the legislative boundaries of the San Francisco Bay Area parks. These include the Point Reyes headlands, Bird Rock, Double Point, and the James Fitzgerald Marine Reserve. These areas were chosen based primarily on habitat quality. Commercial operations include a significant herring fishery and a few oyster aquaculture operations.

The hydrologic systems are very flashy, with high runoff in the wet winter, and very low to intermittent flow dominating summer conditions. In response to the flashy hydrologic conditions and the highly active geologic processes associated with the San Andreas Fault, stream channels are typically dynamic.

Watershed conditions vary from coastal wetlands in wilderness areas to urbanized watersheds managed as a public water supply. Watersheds are relatively small ranging from the approximately 9 mi^2 Redwood Creek watershed (GOGA/MUWO) to the approximately 88 mi^2 Lagunitas Creek watershed (PORE/GOGA). Other significant watersheds include Pine Gulch Creek (6.5 mi^2) and Olema Creek (14.5 mi^2) which are included in both PORE and GOGA lands.

Knowledge about how and where the sediment load affects water quality and biota in flowing water is lacking. Research is needed to document sediment load at erosion sources, stream bank erosion rates and sediment fate/transport through the system. Cross-section mapping of selected channel locations is also desirable. Groundwater quantity and quality issues are also complex. Both need to be tied to withdrawals and connectivity to surface waters.

OCEANOGRAPHY

The convergence of oceanic currents rising from the abyssal plain over a steep submarine cliff makes the marine and coastal shoreline habitats complex and diverse. The California coast around Point Reyes is one of only five areas of eastern boundary upwelling currents worldwide. In addition, a plume of warmer, freshwater exiting the San Francisco Bay extends out into the Gulf of the Farallones. The nutrient rich waters support an abundant and diverse fauna. More than one-third of the world's cetacean species occurs in these waters. Significant haulout areas for five species of pinnipeds are used year round.

There are gaps in knowledge about bathymetry, seabed classification, physical nearshore oceanography, sea level change and paleo resources. There is not enough knowledge about the sources of offshore oil, both natural from seeps and anthropogenic from ships and spills.

HABITATS AND COMMUNITIES

According to the habitat classifications by Bailey (1995), the PORE/GOGA parks are located within two biomes. The area south of the Golden Gate Bridge (PRES, FOPO, and GOGA) is within the California Coastal Chaparral Forest and Shrub Province, and the Marin County hills north of the Bridge (PORE, GOGA, and MUWO) are within the California Coastal Step and Redwood Forest province.

Park staff grouped twenty-six micro-clusters (super alliances/assemblages) from the vegetation maps. These clusters were further clumped for a coarser scale view. Major habitat clusters include the redwood, Douglas fir-tanoak, coast live oak, chaparral, and grassland series. Workshop participants assume that the high variability and amount of urban edge produces unique communities and redirects wildlife corridors.

Gaps in knowledge occur for invertebrates (macro and micro), for wide ranging vertebrates, reptiles, amphibians, and for rarer species where relative abundance and distribution are desired. Vascular plant inventories at PORE are probably at the 90% level, but they are not complete at GOGA. There are data gaps for non-vascular plants and invasive species. The terrestrial group thought that research was needed on minimum viable populations and population viability analysis for recovery planning.

EFFECTS OF STRESSORS AT DIFFERENT SCALES

It was assumed that the effects of stressors occur at different scales. The landscape scale was defined by the terrestrial group as being greater than a community, thus having multiple vegetative structures, patches and communities. The overall distribution of populations and habitats can be viewed at the landscape level. Effects at this scale could change patch dynamics, connectivity (migration and dispersal corridors), metapopulation dynamics, increased soil nutrients and decreased soil quality, distribution and quantity of edge, groundwater and surface

water degradation, loss of vegetation communities and changes in disturbance (fire, flood, mass wasting) frequency, intensity and location.

At the community scale, there are other effects including changes in animal and vegetation species composition (richness, diversity, dominants). There are also changes in trophic interactions, soil composition and soil biotic components. Ecological interdependence (symbiotic, parasitic) may be affected. There may be losses and additions of species. Microclimates may change.

At the population scale, impacts may come from disease and evolution. Impacts to animal species may be to reproduction, mortality, behavior, dispersal, movement, activity pattern, age structure and genetic/phenotypic plasticity (resiliency). Impacts to plant species are similar and could affect reproduction, mortality, dispersal and resiliency. Effects may change local abundance and small-scale distribution and habitat selection.

In order to see both significant resources and stresses/processes that cause change at the same time, a spreadsheet was developed. "Worksheet 1 – Effects of Stressors". It contains the significant resources down the left side and the sources of the stresses at the top. This was an attempt to identify the specific stress and connect it to the source(s) and the resource. Four stresses are listed at the bottom of the worksheet because they were significant enough in themselves and couldn't be tied to a single resource.

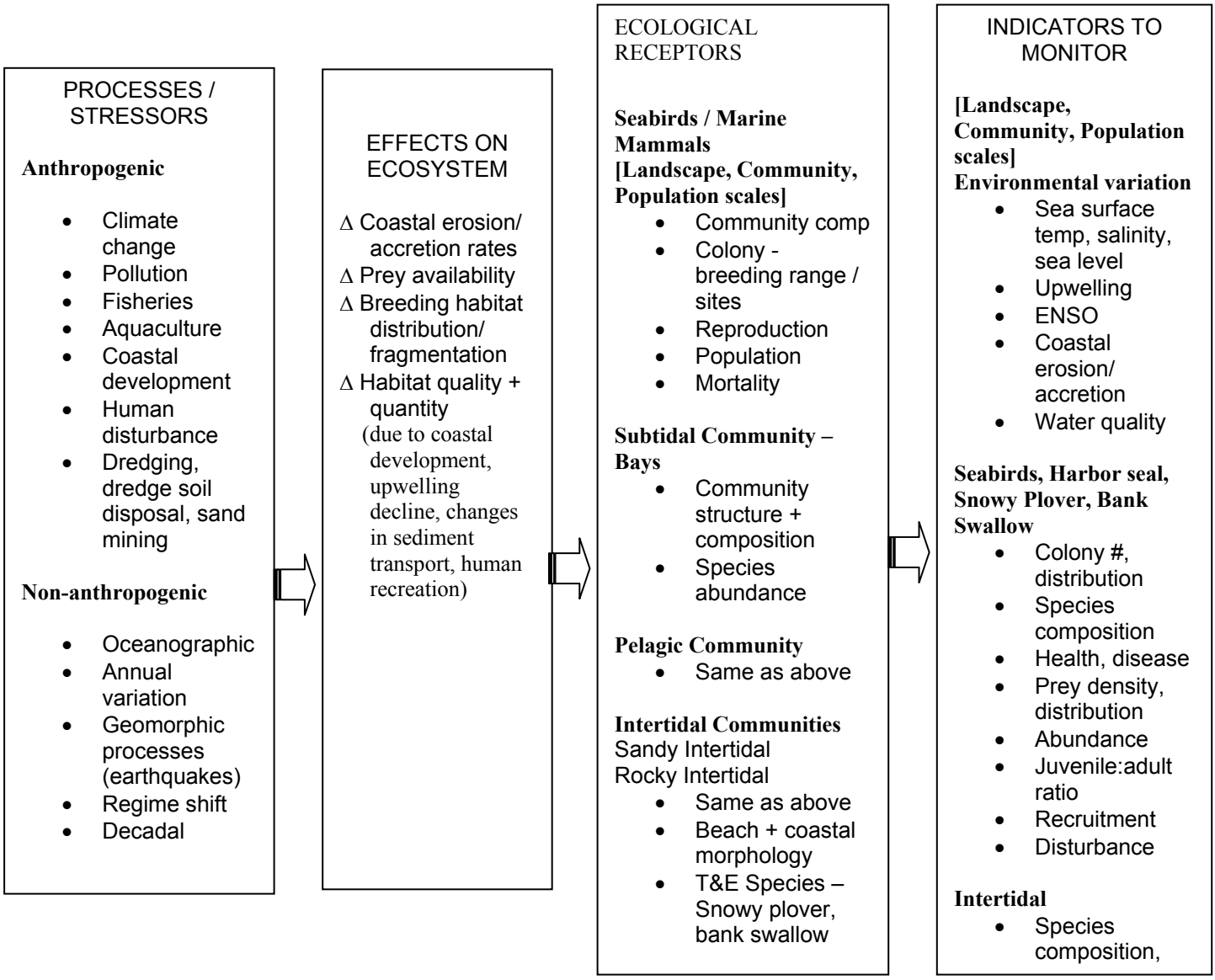
1 PORE/GOGA WORKSHOP – Worksheet 1. Stresses and Processes 7/17-18/2002

Stressors:

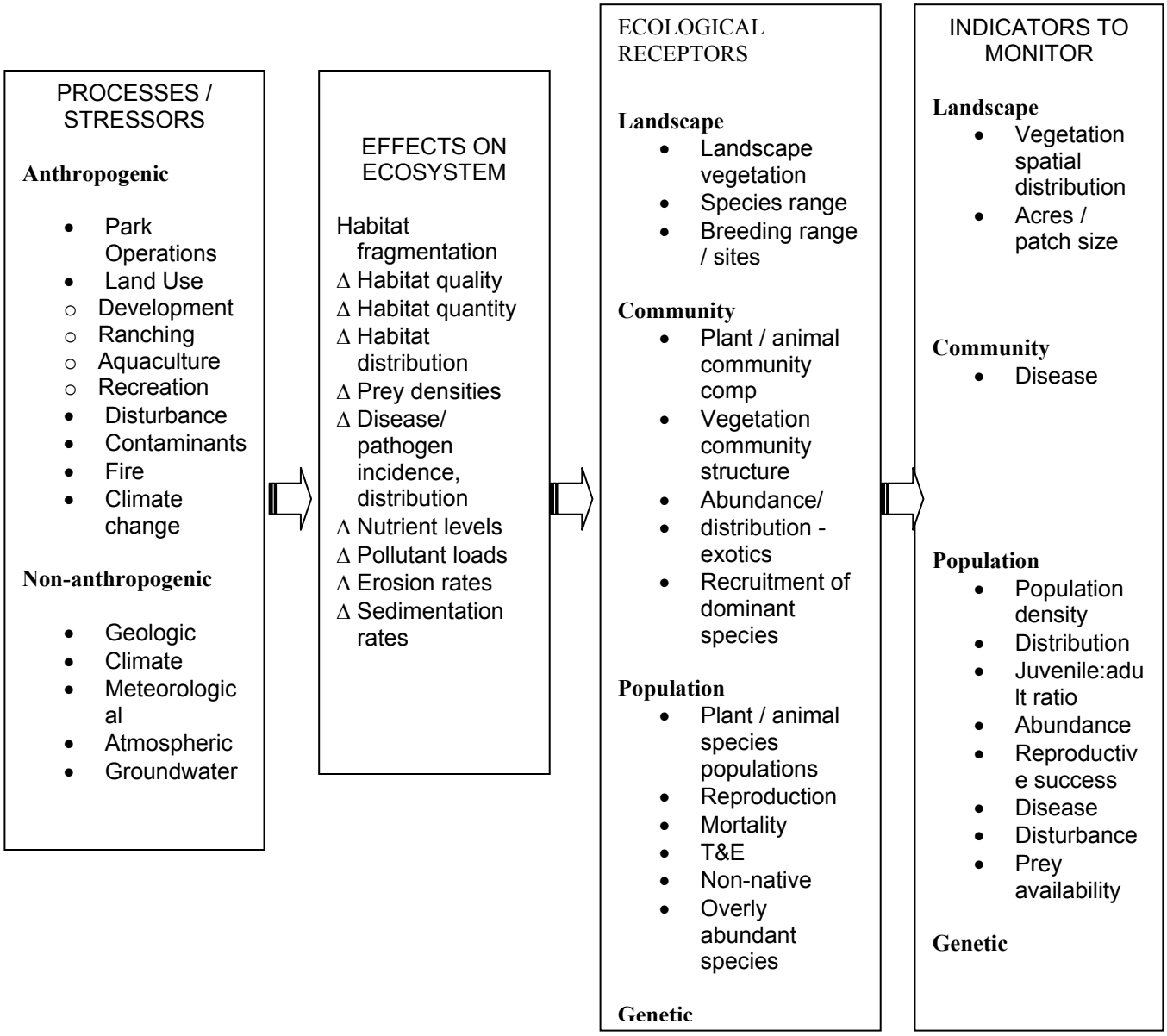
Significant Resources	Development	Farming	Fire	Fishing/ Aquaculture	Park Operations	Pollutants	Ranching	Recreation
Clean air	traffic motor.equip	X	X		traffic	combust. engines	X	traffic
Clean water	sewers fertilizer pesticide	nutrients	erosion sediment	X	X		X	X
Dark sky	lights			X	X			X
Endemics & their habitat	X	X		X	X		X	X
Migratory species support systems	habit.frag	X		X	X		X	X
Natural soundscape	noise			X	X			X
Naturally functioning ecosystem								
Connectivity	habit.frag	X			X		X	X
Dispersal	habit.frag	X	wild.beh	X			X	wild.beh
Disturbance (fire, erosion, seismic…)	X	X	X		fire			fire
Edge effects	X	X					X	
Environmental engineering (trampling…)	X				trampl		X	trampl
Evolution (endemism & genetic diversity)				X		X		
Geology		soil chem.				soil chem		
Hydrology	X	wat.quant.		X	X	quality	nutrients	
Landscape/patches		X	veg.struc veg.comp. habit.frag.		X		veg.comm	habit.frag
Meterology						global warm		
Nutrient cycles	X	X				X		
Predator/prey dynamics			wild.beh	X	wildlife beh			wildlife beh.
Succession			X	X				
Trophic interactions			X	X		X		
Special ecological regions	X				X			
T&E species and habitats	X			X	X			
Unique soil/geology w/plant communities	X	soil chem.	X erosion		compact erosion		X	compact erosion
Viewsheds	X	X	X		X		X	
Wilderness	aircraft		X		X			
Inspiration (visitor experience)	X	X	X		X			X
<u>Stressors</u> Exotic species	X	X	X		X		X	X
Disease	X				X		X	X
Litter (plastic)	X	X		X	X	X		X
Direct take and consumption			X	X				

The four schematic models that Sarah Allen and Daphne Hatch developed for the workshop based on the previous workshops were presented. They each contain the significant resources, the natural processes and stressors, and are based on the above knowledge and assumptions.

MARINE RESOURCES MODEL



TERRESTRIAL RESOURCES MODEL



PHYSICAL RESOURCES MODEL

STRESSORS

Anthropogenic

- Development (External and internal)
  - Roads, utilities
  - Buildings
  - Water withdrawals
  - Transportation
- Fire
- Farming
- Global climate change
- Hydrological changes (dams..)
- Park operations
- Past land use
- Pollution
- Ranching
- Recreation

Non-Anthropogenic

- Dispersal (seed, animals, pollen)
- Disturbance (fire, flood, drought, mass wasting…)
- Environmental engineering (trampling, burrowing, grazing)
- Evolution
- Nutrient cycles
- Plate tectonics
- Succession
- Weather (fog, El Nino)

SIGNIFICANT RESOURCES

- Biodiversity
- Clean air and water
- Dark sky
- Endemics and their habitats
- Migratory species support system
- Naturally functioning ecosystems
- Natural soundscape
- T&E species
- Unique soil/geologic types and their plant communities
- Viewsheds
- Wilderness

EFFECTS ON RESOURCES

Δ Air quality degradation
Δ Community composition/ structure
Δ Connectivity of habitats
Δ Exotic species/disease dispersal
Δ Fire frequency/intensity
Δ Habitat fragmentation
Δ Populations (reproduction, behavior, dispersal, genetic resiliency)
Δ Soil erosion – coastal & upland
Δ Water quality degradation

INDICATORS TO MONITOR

Physical resources

- Acid deposition
- Air quality (ozone, particulates, SO2, nitrates, visibility)
- Carbon dioxide emissions
- Dark night sky
- Natural sound
- Toxins (PCB, dioxin, mercury)
- Weather – temp, precip…

Water resources (see Aquatic grp)

Geologic resources

- Disturbance event (seismic frequency, fire, flood, mass wasting..)
- Erosion/accretion rates
- Land use
- Soil

Biotic resources

- Disease
- Invertebrate richness
- Landscape – vegetation distribution, connectivity, edge
- Plant community
  - distribution
  - composition (richness)
- Select non-native species
- Select T&E species/habitat

Wilderness values

WETLAND RESOURCES MODEL

PROCESSES / STRESSORS

Anthropogenic

- Contaminants
- Pollutants
- Dams
- Impoundments
- Dredge/ fill
- Development/
- Land use

(External and internal)

- Runoff
- Septic systems
- Water withdrawal
- Global climate change
- Nutrient enrichment
- Ranching
- Resource extraction
- Fisheries

Non-anthropogenic

- Climate cycles & variation
- Environmental engineering (trampling, burrowing, damming)
- Evolution
- Geomorphic distribution
- Hydrologic cycles
- Nutrient cycles
- Oceanic circulation & tides
- Plate tectonics
- Sediment distribution
- Sediment chemistry
- Water quality
- Water quantity

EFFECTS ON ECOSYSTEM

- Δ Coastal erosion/ accretion rates (shoreline change)
- Δ Community composition & structure
- Δ Connectivity of habitats
- Δ Exotic species/ disease dispersal
- Δ Floodwater retention
- Δ Habitat fragmentation
- Δ Habitat quality & quantity
- Δ Plant/animal species composition
- Δ Water quality degradation
- Δ Wetland function

ECOLOGICAL RECEPTORS

Landscape

- Species range & distribution
- Watershed hydrologic function

Community

- Composition
- Habitat distribution
- Structure

Population

- Distribution
- Reproduction

INDICATORS TO MONITOR

Landscape

- **Habitat distribution**
- Sea level rise/ shoreline change
- Watershed hydrologic function

Community (Watershed)

- Aquatic invertebrates
- Fish – salmonids
- Geomorphology
- Hydrologic function
- Riparian songbirds
- Waterbirds
- Water quality/quantity

Population

- Riparian songbird nest success
- T&E species
  - amphibians
  -
- Yellowthroat nesting sites

The models were thought to be fairly complete as is. The participants suggested that the next iteration of the schematics should have minor modifications. Participants thought that there was a strong connection and dependence of the biotic resources on the physical resources; therefore, information from the physical model should be woven into the biotic models leaving only three schematics. The schematics could be enhanced with the inclusion of the significant resources, perhaps grouped in a meaningful way. It was thought that a feedback loop was necessary from the vital signs indicators to the effects, since monitoring is supposed to assist in the mitigation of effects and general protection of resources. The groups spent some time trying to describe more specific effects and receptors of the stressors. The models will be updated for our next workshop.

Discussion of potential vital signs monitoring indicators.

MARINE GROUP (Rebecca Beavers, Ben Becker, Darren Fong, Stephanie Egan, Dale Roberts)
In order to systematically review all marine resources and stressors, this group combined marine resources into four functional/form categories. Each resource category had the same stressors and significant resources. The categories were sandy beach, rocky intertidal, bay/estuary and ocean (with the sub-groups of soft bottom and rocky bottom).

The group felt that it was important to monitor actual distribution and acreage of these habitat types. General vital signs indicators that were thought to be important but were addressed under separate indicators or by other groups included air quality, disease, disturbance, predator–prey interactions, recruitment and water quality.

In developing the potential vital signs indicators, the marine group used several criteria. Legal considerations included the enabling legislation and external regulations such as the Marine Mammal Protection Act, the Marine Sanctuaries Act, and the Endangered Species Act. Ecological importance of the potential indicator was critical. If there was a partnership opportunity with other organizations and a high feasibility of success in conducting the monitoring, the indicator was given greater consideration. The group was able to identify seven areas needing monitoring. They also identified why the monitoring was important and what attributes would be monitored. These areas are listed below.

1. Monitor and evaluate species community composition, distribution and abundance of rocky intertidal vertebrates and invertebrates. Intertidal invertebrate monitoring in the rocky intertidal zone is currently being conducted. The reasons for this monitoring are to assess climate change through sea level change; to assess the impact of human trampling; to detect invasive species, oil and hazardous materials spills, and impacts and incidence of disease; and to monitor ecological change on a community level. Rocky intertidal monitoring includes monitoring both intertidal assemblages at the landscape & community level, and individual species at the population level.

2. Monitor and evaluate nearshore subtidal conspicuous fishes and invertebrates. This monitoring has not yet started. The inventory is not yet complete. Nearshore monitoring will help assess the effectiveness of marine protected areas, overfishing, and presence and influence of invasive species. It will also detect the impacts and incidence of disease and monitor ecological change on a community level. It is anticipated that fish and

invertebrate assemblages, particularly sport and commercial species, will be monitored using direct observation techniques, e.g. SCUBA or ROV.

3. Monitor and evaluate the distribution and size of habitat types.
   This type of monitoring will assist with evaluation of effects of climate change, especially sea level change. It will also detect invasive species, oil spill and other pollution events, and impacts and incidence of disease. In rocky intertidal areas, the monitoring will also assist in evaluating the impact of human trampling. Monitoring of ecological change will be done on a community level. Monitoring along the shoreline will use LIDAR and satellite imagery to detect change in habitat. Change in substrate types will be done through seabed classification.

4. Assess the effects of invasive species on communities.
   Invasive species tend to displace native species, particularly T&E species. Other affects that could be detected include changes in hydrography, physical habitats, natural landscape, and food webs. Invasive species are generally undesirable and may hybridize with native species. The marine group thought it important to monitor presence/absence as well as distribution and abundance of species. Impacts will be monitored at the community level. The California State List was recommended as a source for candidate species.

5. Detect and evaluate change in physical oceanography and climatology.
   Physical oceanography and the climate are closely linked; therefore, the marine group put them together. Two examples of parameters to monitor were developed, although there may be more.
   a) Monitor change in sea level (linked to the habitat mapping indicator).
      Sea level was chosen as a potential indicator because sea level change has so many affects. Change can destroy or create habitats, drain or inundate wetlands, affect shoreline habitat, threaten public and private infrastructure, and create hazards to navigation. Attributes to monitor include sea level height, current patterns, and shifts in availability of various habitats.
   b) El Nino System Oscillation
      The El Nino system affects food webs and species ranges. It can even lead to a greater incidence of heavy storms. Attributes to monitor include water temperature, upwelling intensity, and rainfall amounts. Habitat change can also be monitored, i.e., the loss of seal haul outs among others.

   NOTE: The NPS may not be the primary source for these data. NOAA and other institutions collect much of this information. The NPS can interpret these data on scales appropriate to I&M network and park issues.

6. Detect and evaluate change in water quality
   The good condition of water quality is the basis for all marine life. The quality of the water affects food webs, plant and animal populations and structure, and human recreational opportunities including swimming and fishing. It can even affect air quality as deep vents outgas hydrogen sulfide gases. Three parameters were thought to be important indicators. Chlorophyll A is a measure of phytoplankton blooms. The general species composition of phytoplankton is the base of the marine/estuarine food web. Presence of pathogenic bacteria, such as coliform bacteria, has enormous health consequences.

TERRESTRIAL GROUP (Dawn Adams, Marc Albert, Maria Alvarez, Erin Boydston, Peter Brastow, Tom Elliott, Natalie Gates, Amy Fesnock, Paul McLauglin, Barbara Moritsch, Judy Rocchio, Will Russell, Dave Schirokauer, Craig Scott, Jessica Shors, and Katrina Strathmann) This group also decided on a method to help them sort through the diverse terrestrial resources in a systematic way. For their potential vital signs indicators, they grouped resources into five large categories: abiotic, natural disturbance, social/anthropogenic factors, vegetation and wildlife.

1. Abiotic resources

   Since the Aquatic group dealt with water quality, only three areas within this category were discussed for monitoring: air quality, soil and weather.

   a) Detect and assess degradation of air quality

      Five attributes of air quality were considered important for vital signs monitoring. For each of these attributes monitoring should include the total emission level and the distance and direction from the source.

      - Acid deposition could affect resource health, development of both plants and animals, and modify all other pollution sources. The source is primarily industrial.
      - Carbon dioxide emissions were considered important due to the contribution to global climate change and as one of the parameters with measurable standards in the Clean Air Act. Sources of carbon dioxide were thought to be from mobile sources (vehicles, lawn mowers), stationary sources (industry, power, oil refineries), and the general area (temperature inversion created smog).
      - Contaminants or toxins to monitor include PCB, dioxin, and mercury. Industrial and agricultural areas are the primary sources of contaminants.
      - Ozone, sulfur dioxide and nitrates were thought to come from park operations, development, and fire. They were considered important indicators due to the potential adverse effects on resources and to meeting standards in the Clean Air Act.
      - Particulates and visibility were also considered important indicators. In addition to general adverse affects to resources, particulates degrade the viewshed. Park operations, development and fire are the most important sources of particulates. Viewsheds are significant resources in all parks and in the enabling legislation of most.

   b) Detect and assess change in soils

      Soils are critical to the formation of the structure and type of vegetation community, which in turn support particular wildlife communities. That interdependence makes soils a critical component to monitor, although not frequently (every 10+ years). Vital signs indicators were thought to be:

      - Chemical composition including nutrients
      - Soil macro and micro-biota (microryhizae)
      - Soil distribution (map)
      - Soil structure including compaction
      - Soil texture including depth of topsoil and development rates

   c) Detect and assess change in weather and climate

      Like soil, weather determines the type of vegetation community that will succeed. Global climate change is affecting normal seasonal and decadal cycles of weather patterns to

which the vegetation and wildlife have adapted. Vital signs monitoring should include temperature and rainfall at the local, regional and landscape scales.

2. Natural disturbance and resiliency.
   The terrestrial group identified three types of natural disturbances with pulsed effects that create drastic and rapid changes to the ecosystem. Anthropogenic stresses modify these natural processes/disturbances and accelerate the rates and intensity of change. Long-term vital signs monitoring should include basic documentation of the disturbance: occurrence, size, aerial extent, intensity, and date. Monitoring should also include the response and resilience of the vegetative community to adapt to the disturbance.
   a) Monitor change in fire regime
      The fire regime, therefore fire adapted communities, has been drastically changed. Nearly every ignition is put out, even natural ignitions. Closeness of park resources to the urban interface makes human safety the top priority.
   b) Monitor resiliency to flood
   c) Monitor resiliency to geologic hazards (landslides, earthquakes, mass wasting)

3. Social/anthropogenic factors.
   There were three resources important to visitor aesthetics that were also important to ecosystem function and condition.
   a) Document and assess loss of dark night sky
      Inclusion of this resource type is fairly new to our thinking. Effects of light pollution are not well understood. Bright lights may affect nocturnal wildlife such as bats and vegetative growth (photoperiodicity). From the human and scientific standpoint, there are very few areas for viewing and studying stars. Core areas of parks are important areas of dark night sky. The terrestrial group thought that it would be important to monitor both the total amount of light and the location of bright light sources.
   b) Document and assess degradation of viewsheds
      Viewshed and superlative views are a significant resource in both parks. Degradation of viewsheds comes from air pollution, development, deforestation, and land use change. Important viewsheds include:
      - selected views of the ocean and shoreline
      - selected views of rolling hills and pastoral settings
      - selected views of coastal scrub
   c) Monitor Wilderness values (PORE)
      Wilderness values include natural quiet, solitude, wonderment, wildlife viewing, lack of vehicles, and the opportunity to do orienteering and test physical prowess. Many wilderness values are also important outside the wilderness and are primary reasons people visit the parks. It is important to monitor selected values in order to maintain wilderness values for all visitors. The group decided that monitoring should include:
      - number of visitors using different areas of wilderness
      - number/location of social trails using remote sensing
      - natural quiet

   Since animal behavior may be affected by stressors such as too much light and unpulsed/ random sounds, monitoring select animal behavior may prove important although time consuming.

4. Terrestrial vegetation resources

Long-term monitoring of the terrestrial vegetation was divided by scale into landscape, community, and population level monitoring.

a) Monitor and evaluate change in plant communities at the landscape scale

The use of aerial photography was identified as a tool in monitoring plant community distribution on a landscape scale. The landscape scale was defined as containing multiple vegetative structures, patches, communities and was therefore greater than a single community. Topics and issues that could be examined at this scale included fire frequency, metapopulation dynamics, soil distribution, distribution and quantity of edge, disturbance, habitat fragmentation and connectivity.

b) Monitor and evaluate change in plant community composition

Plant community composition includes attributes such as richness, diversity and dominants. At this scale, other factors to consider and monitor included trophic interactions and change, loss of and addition of species, ecological interdependence (symbiosis, parasitism), and biotic components in soil and changes in it's composition. Changes in invertebrate communities were considered important to monitor. Microclimate changes may affect vegetation communities and change plant dominance and non-native plant invasions.

Specific plant communities were considered unique or special; therefore should be monitored. These included serpentine soil communities and bishop pine communities. T&E habitat was thought to be important at the community scale.

c) Monitor and evaluate change in plant species distribution or relative abundance

Issues that could be examined at the population level included plant reproduction, mortality, dispersal and genetics. Three groups of plants were discussed: keystone plants (bishop pine, coastal live oak, redwoods, lichens), non-native plants, and threatened and endangered plants. The group thought that it was important to monitor specific taxa at the population scale, but to consider effects to the ecosystem on the community scale.

d) Detect and assess the spread of plant disease. Sudden oak death has made this an important vital signs monitoring category. Monitoring should be proactive, therefore transects through oaks should be monitored at a regular frequency. In addition, the location and spread of disease should be monitored.

5. Terrestrial wildlife resources

Wildlife monitoring was also divided by scale.

a) Monitor and evaluate change in animal community distribution at the landscape scale

At the landscape scale, the most important stressor to monitor was the loss of corridors for connectivity and migration. The resultant fragmentation and isolation of larger megafauna may cause genetic bottlenecks. The use of vegetation maps and evaluation of the vertical component of vegetation structure may be helpful in this monitoring endeavor. Other issues were similar to those discussed under plants.

b) Monitor and evaluate change in animal community distribution

Species richness was considered important at the community scale. Species richness is a measure of biodiversity, a characteristic that makes this Network important. Since invertebrates are at the bottom of the food chain, they were considered particularly important indicators for long-term monitoring. Trophic level interactions and

microclimate changes were also discussed as being important. Animal community composition contains attributes such as diversity and dominants. Other factors were similar to those discussed in vegetation.

c) Monitor and evaluate change in animal population distribution or relative abundance
Three specific animal groups were discussed:
   1) keystone animals (spotted owls)
   2) non-native animals (cats, axis and fallow deer, argentine ants, red fox, pigs, rats, dogs, turkeys), and
   3) threatened and endangered animals and their habitat (tule elk, spotted owls, snowy plover, mission blue butterflies, bank swallows, San Francisco garter snake, bats, and red legged frogs).

The group thought that it was important to monitor specific taxa at the population level, but to consider affects to the ecosystem on the community scale.

d) Detect and assess the spread of disease
Several diseases have the potential to spread and become problematic. These include Johne's, West Nile virus, chronic wasting disease, Hanta virus, and Lymes disease. Several of these have the potential to affect human health.

AQUATICS GROUP (Lorraine Parsons, Brannon Ketcham, Leslie Allen, Marie Fontaine, Tom Gardali, Daphne Hatch, Steve Schwarsback, Terri Thomas, Kristen Ward)
Since this eco-type was dependent on water, the group divided their resources into two primary groups, surface water and groundwater. Surface water was either flowing or non-flowing. As the complex inter-relatedness of abiotic and biotic components was discussed, there was a regrouping into biotic and abiotic resources.

1. Abiotic resources
   a) Assess the effect of atmospheric deposition
      Since the Terrestrial group was developing potential indicators for air quality, the aquatics group only dealt with effects of contaminants and acid deposition. Monitoring of particulates, nitrogen deposition and acidification were thought to be the most important for understanding impacts to wetland systems.

   b) Monitor and evaluate changes in groundwater
      In order to monitor condition of groundwater, several measurements were considered of primary importance:
      - Contaminants or pollutants
      - Nitrate, an indicator of leaching
      - Quantity of water
      - Salinity, an indicator of saltwater intrusion

      Water quantity was considered to be complex. It was realized that it had to be tied to withdrawals and connectivity to surface water. Contaminant monitoring may be taken care of through the EPA's HAZMAT or Superfund programs.

   c) Monitor and evaluate the condition of surface water
      Surface water was separated into flowing water and non-flowing water. Most of the metrics discussed for long-term monitoring of condition were the same for both and included pH (acidity), pollutants, salinity/conductivity, nutrients (ammonia, nitrite, phosphorus), dissolved oxygen, and sediment load.

      For flowing waters, the measurement of flow needed to be understood and characterized. Continuous measurements were needed using stream gauges, tide gauges, and precipitation measurements. For both surface water and groundwater, measurements of water use, a stressor, were needed. Three user groups had to be monitored in order to get measures of total water use: NPS water use, illegal unpermitted withdrawals, and legal permitted withdrawals.

   d) Measure and assess changes in sediment load
      Sediment load in flowing water affects water quality and biota. It was also considered to be a complicated issue. In order to describe the current baseline sediment load condition, research was needed to document sediment load at erosion sources, stream bank erosion rates at selected locations, and sediment fate/transport through the system. Sedimentation studies would need to use sedimentation tables, topographic surveys, and Feldspar markers. Cross-section mapping of selected channel locations was also considered to be necessary.

2. Biotic resources
   Understanding of aquatic habitat and community change was based on scale, the same as the terrestrial resource grouping.

   a) Monitor and evaluate change in community at the landscape scale
      Aerial photography was the best tool for monitoring the wetland/riparian ecosystems at the landscape level. It was thought that aerial photography as a coarse level assessment tool could be improved upon through the addition of stream habitat assessment.

   b) Monitor and evaluate change in habitats and communities
      Habitat quality descriptions have many factors and metrics to consider. These include structure of the community, native/non-native species composition, biodiversity measurement, connectivity/fragmentation, and edge effect. Selection of specific taxa such as salmonids or benthic macroinvertebrates could be used as an indication of stress or pristine state. The biotic component of habitat quality was based on geology; therefore, abiotic monitoring must be included as a component. The abiotic component of habitat monitoring includes geomorphic function, structure and complexity, substrate description, hydrology and hydroperiod and topography.

   c) Monitor and evaluate change in populations
      Particular metrics at the population scale include species composition, presence/absence, relative abundance, diversity, distribution, and density. Demography of the population has additional metrics including survival, sex ratios, reproductive success and recruitment. Grouping and understanding special taxa, i.e. native/non-native and seasonal, was thought to be important.
      Several factors were thought to affect species composition and condition. It was thought that these needed to be understood and, perhaps, monitored also. These include edge affects, predator/prey densities, disease/pathogens (especially for amphibians and fish), and water nutrient levels.

<u>Selection of potential vital signs monitoring indicators</u>

The following list contains suggested candidates for vital signs long-term ecological monitoring developed by each group. Those in bold were thought by each group to be the most important. Workshop participants did not have time to use a multi-disciplinary discussion of all potential indicators and do a 1st-pass numeric ranking. Therefore, the indicators are presented in no particular order. Listed attributes were thought to be important, but not all attributes have to be measured for each indicator.

MARINE INDICATOR	ATTRIBUTE
1. **Rocky intertidal community**	percent cover, species composition, dominance
❑ Algal assemblages	
❑ **Starfish** (*Pisaster*)	keystone species
❑ Barnacle assemblages	
2. Sandy intertidal community	percent cover, species composition, dominance
❑ **Dune vegetation**	
❑ Snowy Plover	
❑ *Ammophila*	
❑ Sand Crabs *(Emerita)*	
3. **Shoreline habitat**	distribution by substrate type, habitat, size, location
❑ Seal haulouts	T&E species
❑ **Sea level height**	
4. Physical oceanography	water temperature, current patterns, upwelling intensity
❑ El Nino events	
5. Ocean community	presence/absence, distribution, relative abundance
❑ Seabirds.	
❑ Marine mammals	harbor seals and elephant seals at haul outs (reproductive success)
❑ **Rockfish**	particularly *Sebastes paucispinis, S. auriculatus*, and all species of juveniles as a measure of recruitment success
❑ Krill	primarily *Euphausia superba* and *E. pacifica*
6. Bay/Estuary community	presence/absence, distribution, relative abundance
❑ Submerged aquatic vegetation (e.g. eelgrass).	
❑ **Herring** distribution, abundance, fecundity (San Francisco Bay, Tomales Bay).	
❑ Shellfish.	
❑ Shore birds.	
❑ Aquatic birds.	
7. Marine invasive species	presence/absence, percent cover, relative abundance, distribution
❑ Green Crabs	
❑ Smooth Cord Grass	
❑ *Spartina*	
❑ *Ammophila*	
❑ Ice Plant	
❑ Zebra Mussels	
❑ Asian Clam	

TERRESTRIAL INDICATOR	ATTRIBUTE
1. **Air quality**	acid deposition, carbon dioxide, contaminants, ozone, sulfur dioxide, nitrates, particulates, visibility
2. **Soil**	nutrients, texture, chemical composition, moisture, temperature, depth of top soil, compaction
❑ Map	
❑ Macro & micro-biota	
3. **Weather**	temperature, rainfall, relative humidity
❑ Micro-climates	
4. Natural disturbance	event documentation (date, location, acreage, intensity…) resiliency of vegetative recovery (monitor as in #6)
❑ Fire	
❑ Flood	
❑ Mass wasting, landslides	
❑ Earthquakes, earth movement (USGS monitors)	
5. Social/anthropogenic stress	
❑ Dark night sky	location and intensity of light pollution
❑ Viewshed	photo-points
❑ Wilderness values	soundscape, visitor use
6. Terrestrial vegetation	
❑ **Habitat distribution**	aerial photography, richness, diversity, dominance
❑ Bishop pine	
❑ Lichens	air pollution
❑ Serpentine communities	
❑ Oaks	
❑ Disease	sudden oak death
❑ Chaparral	
7. Terrestrial wildlife	
❑ **Connectivity corridors**	
❑ Animal communities	species richness
Invertebrates	
❑ Trophic level interactions	
❑ Predator/prey relations	
❑ **Songbird guild**	
❑ Disease	West Nile virus, chronic wasting disease, Hanta virus, Lymes disease, Johne's

AQUATIC INDICATOR	ATTRIBUTE
1. **Water quality**/ quantity	pH, dissolved oxygen, salinity, conductivity, nutrients, contaminants (mercury), sediment, flow by depth to surface
2. Sediment quality/ topography	texture, pH, moisture, salinity, nutrients, contaminants, surface elevation, compaction
3. Aquatic invertebrates	general species composition, presence/absence, general abundance/density, species diversity, non-native species, keystone species, special status species, bioaccumulation
❑ **Benthic macroinvertebrates**	
4. Fish	same as aquatic #3
❑ **Salmonids**	keystone species
❑ Tidewater goby	T&E
❑ Syncharis pacifica	
5. Mammals	same as aquatic #3
❑ **Amphibians**/reptiles	
❑ **Riparian songbirds**	foraging guilds, riparian songbird nesting success
❑ Neotropical migrants	
6. Aquatic & riparian vegetation	species composition, percent cover, structure/canopy complexity, keystone species, special status species, presence/absence, non-native species, species diversity
❑ Phytoplankton	
❑ Macroalgae	
❑ **Vascular riparian plants**	include shading
❑ Cape ivy	invasive plant
❑ Spartina	invasive plant
❑ Eel grass	
7. Aquatic habitats	landscape level using aerial photography, gap analysis,
❑ Habitat fragmentation	pool/riffle ratio
❑ Stream habitat surveys	
❑ Riparian corridor connectivity	
❑ Wetland distribution	
8. **Geomorphic form**	bank/stream erosion rates, channel cross-section, progradation, gravel beds

The exercise to identify potential vital signs indicators ended the workshop. The next step was to identify criteria to rank the indicators and go through a quantitative exercise to actually rank them.

Through emails immediately following the workshop, the participants identified and ranked the criteria for use in selecting and ranking the indicators. Using comments from the participants, the long list of criteria was sub-divided by function. One grouping of criteria will be used as a means of ranking the level of threat to the significant resource for vital signs monitoring purposes:

Severity of threat	3 (most important)
Significance of resource	2
Health and safety	1

The list was also useful for identifying and ranking several characteristics of a good monitoring protocol:

Repeatable over time	4	
Quality assurance	3	exists and is accepted.
Natural variability understood	2	
Knowledge about indicator known	1	general biology, function, niche…

The criteria that the participants developed for ranking the vital signs indicators follows in Table 3. The last step the parks need to take is to rank the indicators.

TABLE 3. Ranking criteria for vital signs indicators.

CRITERIA	WEIGHTING FACTOR	EXPLANATION
Relevance to the resource at risk	5.0	Does the indicator represent the resource?
Accuracy for measuring the attribute	4.5	Can the indicator be measured accurately ?
Sampling simplicity	4.0	Is the protocol simple for sustainability?
Sample size	3.5	Is the sample size small yet robust?
Umbrella species	3.0	Is this a guild with species in different niches?
Feasibility to implement	2.5	Are logistics, equipment, and protocols easy?
Sensitivity to detect change	2.0	How long will it take? What level of change?
Cost effectiveness	1.5	Is the cost low enough to sustain?
Comparison to other areas	1.0	Can the data be rolled-up to a larger context?

Participant List

Science and the Ecological Model

Golden Gate NRA and Point Reyes

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Appendix 4

San Francisco Bay Area Network
Vital Signs Workshop Summary
March 2003

San Francisco Bay Area Network
Vital Signs Workshop Summary
Draft

March 19-20, 2003
Golden Gate Club, Presidio, San Francisco

San Francisco Bay Area Network (SFAN)
Eugene O'Neill National Historic Site (EUON)
Fort Point National Historic Site (FOPO)
Golden Gate National Recreation Area (GOGA)
John Muir National Historic Site (JOMU)
Muir Woods National Monument (MUWO)
Pinnacles National Monument (PINN)
Point Reyes National Seashore (PORE)
Presidio of San Francisco (PRES)

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Introduction

Monitoring Rationale

Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS's) ability to manage park resources "unimpaired for the enjoyment of future generations." National Park managers across the country are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources as a basis for making decisions and working with other agencies and the public for the benefit of park resources. Simultaneously, park managers must provide scientifically credible information to select and defend management actions and fulfill legal mandates. The National Parks Omnibus Management Act of 1998, for example, includes a Congressional mandate for Parks to provide information on the long-term trends in the condition of their natural resources.

In response to these challenges, the NPS has identified 270 parks with significant natural resources for which inventories will be completed and long-term ecological monitoring will occur. Natural resource monitoring provides site-specific information needed to understand and identify change in complex, variable, and imperfectly understood natural systems and to determine whether observed changes are within natural levels of variability or may be indicators of anthropogenic influences. This broad-based, scientifically sound information can then find application in management decision-making, research, education, and promotion of public understanding of park resources.

The intent of the NPS monitoring program is to track a subset of park resources and processes, known as "vital signs," that are determined to be the most significant indicators of ecological condition for specific resources that are of greatest concern to each park. Because of the tremendous variability among parks in ecological condition, size, and management capabilities, it has been recognized that adoption of a "one size fits all" design is not an effective monitoring approach for the NPS. Rather, parks have been given the flexibility to integrate inventory and monitoring programs into existing park operations and management agendas to facilitate efficiency and cost-effectiveness. Parks also have been encouraged to incorporate partnerships with external agencies and institutions into the Vital Signs Monitoring Program to effectively understand and manage resources and threats that extend beyond park boundaries.

Service-wide Vital Signs Monitoring Goals

Despite the differences that exist among parks, five Service-wide Goals for Vital Signs Monitoring have been established for the National Park Service. While no single piece of legislation specifically defines these monitoring goals, they are derived from the mandates of the National Parks Omnibus Management Act of 1998 and the goals established by prototype monitoring parks and the long-term ecological monitoring program. These goals are to:

- Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions and impairment of selected resources to help develop effective mitigation measures and reduce costs of management.

- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.

Steps to Developing a Network Monitoring Program

The 270 parks identified for the Inventory and Monitoring Program have been grouped into 32 vital sign networks linked by geography and shared natural resource characteristics. Each network of parks is required to design an integrated monitoring program that addresses the monitoring goals listed above and that is tailored to the high-priority monitoring needs and partnership opportunities for the parks in that network. The basic approach to designing a monitoring program should follow five basic steps, which are further discussed in the Recommended Approach for Developing a Network Monitoring Program:

1. Define the purpose and scope of the monitoring program.
2. Compile and summarize existing data and understanding of park ecosystems.
3. Develop conceptual models of relevant ecosystem components.
4. Select indicators and specific monitoring objectives for each; and
5. Determine the appropriate sampling design and sampling protocols.

Monitoring program development is an iterative process. As a network's monitoring program evolves, management issues and monitoring objectives may change to accommodate increased understanding of ecological processes, ecosystem conditions, and human interactions with the environment. Likewise, improvements in technology may alter the ability to assess ecological change. Consequently, a network's conceptual models most likely will be refined, and sampling design and protocol may be adjusted to reflect advances in understanding and technology. This process is an integral part of an adaptive management approach.

Peer Review

Peer review is a key component of a successful network monitoring program. Monitoring program materials should be critiqued by park managers, subject experts, and interested stakeholders within the NPS and from external agencies and institutions. Critical input, suggestions, and understanding gained from peer review ensures that monitoring meets the most critical information needs of each park and produces scientifically credible results that are clearly understood and accepted by scientists, policy makers, and the public. A standard procedure for peer-review will be developed by the network with guidance from the national program.

Document Purpose

This document summarizes the process used and the products gained from a Vital Signs Monitoring Workshop conducted by the San Francisco Bay Area Network Parks. The workshop was designed to review conceptual models and proposed indicators, provide an initial indicator prioritization, and collect preliminary sampling information for high priority indicators. Key

points from both large and small group discussions, comments, and suggestions are included in this summary.

Background

The San Francisco Bay Area Network (SFAN)

The San Francisco Bay Area Network (SFAN) is one of eight networks formed in October 2000 in the Pacific West Region of the National Park Service. The SFAN is composed of eight park units: Eugene O'Neill National Historic Site (EUON), Fort Point National Historic Park (FOPO), Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Muir Woods National Monument (MUWO), Pinnacles National Monument (PINN), Point Reyes National Seashore (PORE), and the Presidio of San Francisco (PRES). FOPO, GOGA, MUWO, and PRES are administered as one unit by GOGA. EUON and JOMU are managed jointly. PRES and EUON were not originally selected by WASO as part of the 270 parks nationwide with significant natural resources; however, the SFAN steering committee decided that natural resource issues within theses parks were sufficient to be included in the network. The SFAN was selected as one of the first three networks in the region to obtain monitoring funds because of need, capacity, and existing monitoring effort.

Network Setting and Ecological Significance

The abundance and diversity of ecosystems and taxa in the SFAN are remarkable, owing to the Mediterranean climate, convergent oceanic currents, topographic variation, and overlapping ecological regions.

The moderate Mediterranean climate offers long growing seasons and supports diverse plant and animal communities, including over 1200 plant species. Important vegetation alliances include coastal dune, coastal terrace prairie, serpentine chaparral and bunchgrass, chaparral, native grasslands, oak woodland, ancient redwood forests, Bishop pine forests, and Douglas-fir forests. Nearly 60 federal or state listed threatened and endangered species occur as residents or seasonal migrants.

The convergence of oceanic currents rising from the abyssal plain over a steep canyon makes the marine and coastal shoreline habitats complex and diverse. The California coast is one of only five areas of eastern boundary upwelling oceanic currents worldwide. In addition, a plume of warmer, freshwater exiting the San Francisco Bay extends out into the Gulf of the Farallones. These nutrient rich waters support an abundant and diverse fauna. More than one-third of the world's cetacean species occur in these waters. Significant haul-out areas for five species of pinnipeds are used year round and represent one of only eleven mainland breeding areas for northern elephant seals in the world and 20% of the mainland breeding population of harbor seals in California. Eleven species of seabirds breed within the parks and over 80 waterbird and shorebird species were identified in the parks during the 1997-99 inventories (Kelly and Etienne 1999).

Elevation across the parks ranges from sea level to 3,300 feet above mean sea level. The San Andreas Fault, the dominant geological force in this area, is a source of natural disturbance in the form of seismic activity resulting from interaction of the Pacific and the Continental Plates. This geologic activity re-structures ecosystems offering unusual habitat for endemics and species at the edge of their range as coastal California from Pinnacles through Point Reyes slides northward. Plate movement created and continues to create a fractured landscape with unique geology and soil types. Volcanic activity created the Pinnacles rock formations, and plate tectonics thrust the rock spires upward. Associated cave formations provide habitat for many unique species. Slopes range from almost flat marine terraces and alluvial deposits to steep canyons along some creeks, providing dramatic topographic and, therefore, habitat heterogeneity. Consequently, the SFAN parks are located within three terrestrial ecological regions:

1. The Central California Coast contains coast live oak, chamise, valley oak, redwood, Douglas fir-tanoak, chaparral and grassland series of vegetation communities,
2. The Northern California Coast contains redwood, Douglas fir-tanoak, coast live oak, chaparral, and grassland series; and
3. The Central California Coast Range contains coast live oak, chamise, valley oak, and mixed chaparral series (Bailey 1994).

The SFAN parks represent an area designated as one of the six most significant in the nation for biodiversity (The Nature Conservancy 2000). Notably, the parks support endemic species and communities despite close proximity to large urban areas and are listed as the eighth most significant "hot spot" in the world for biodiversity at risk from rapid human population growth (Cincotta and Engleman 2000). With a current population of 6.9 million, the metropolitan centers of San Francisco, Oakland, and San Jose are forecast to have a population of 8 million by 2020 (Assoc. of Bay Area Governments 2000). Recognizing the extraordinary significance and exposure to threats in the region, the UNESCO Man in the Biosphere program designated the Central California International Biosphere Reserve in 1988, encompassing five of the eight parks. Preserving biologically and geologically diverse habitats and their associated species, as well as providing opportunities for recreation, education, and aesthetic enjoyment to a large urban population, is a difficult balancing act. The need to mitigate impacts and preserve these natural resources based on scientific recommendations from a wisely developed monitoring program is urgent.

Previous Monitoring Workshops

In 1993 prior to the formation of park networks, the resource management staffs from the GOGA and PORE park cluster decided to develop a comprehensive Inventory and Monitoring (I&M) Program. These parks had separately developed I &M projects for single species or species groups such as rare plants, pinnipeds, migratory raptors, and exotic plants. Also, GOGA had independently developed an ecological monitoring program in coastal scrub and grassland habitats in 1988 (Howell 1992). None of the parks, though, had initiated an integrated ecological monitoring program.

The parks coordinated efforts to identify and complete several of the design elements identified in the I&M program developed by Gary Davis for the Channel Islands National Park prototype program given Channel Islands' similar ecosystems and its monitoring experience.

A draft inventory and monitoring plan was developed in 1996 at the end of this process but was only partially implemented because of lack of funds. With the initiation of the Natural Resource Challenge, the GOGA/PORE draft plan was resurrected and modified during an I&M scoping workshop in July 2002.

The SFAN held three Vital Signs Monitoring Workshops in FY02. PINN held a workshop in September 2001 (Appendix A). EUON and JOMU jointly held workshops in January and August 2002 since both parks are in close proximity, have similar natural resources and issues, and are administered jointly (Appendix B). Because of their previous collaborative efforts and the overlap in resources and management issues, the parks administered by GOGA and PORE jointly held a workshop in July 2002 (Appendix C). In each of these workshops, participants identified significant resources in the parks, identified key processes and stressors affecting the parks, potential monitoring questions, and recommended Vital Signs indicators that could address the monitoring questions. An initial prioritization of Vital Signs indicators and development of a conceptual model also were addressed. Participants included Park Service managers and staff, external natural resource managers, and scientists.

Subsequently, the SFAN Steering Committee integrated the findings and recommendations from the separate workshops into a conceptual model for the network that includes significant natural resources, key processes and stressors, and monitoring questions with suggested indicators. The SFAN Vital Signs Workshop held March 19-20, 2003, was organized to review the SFAN integrated model and its related components and move forward with the selection of network-wide Vital Signs indicators.

<u>SFAN Monitoring Program</u>

The five aforementioned NPS Service-wide monitoring goals provide the overall direction for the SFAN monitoring program. The SFAN Vital Signs Workshop was a step toward reaching these goals. In part, the workshop considered:

1. Present and future ecosystem condition,
2. Empirically identified normal limits of resource variation,
3. Early diagnosis of abnormal condition, and
4. Potential agents of abnormal anthropogenic change.

SFAN Vital Signs Workshop Objectives (March 2003)

The three main objectives for the March 2003 Vital Signs Workshop were to:

1. Review and critique the SFAN integrated conceptual models,
2. Review and critique the proposed indicators (general and specific),
3. Provide an initial indicator prioritization based on stressor relationships, and
4. Provide information relevant to indicator selection (e.g., methods, expertise, references, and threshold values).

Additionally, indicator prioritization activities were designed to collect preliminary sampling information for high priority indicators.

Vital Signs Workshop Framework

Selection of Workshop Participants

Workshop participants were selected from lists of previous park-based workshop attendees. Both park and non-park representatives were selected to include other federal agencies, state agencies, and scientists that have had research and management interests within or adjacent to the parks. Among some of these groups, diverse fields of expertise were targeted. The number of participants was limited to approximately 40-50 individuals to facilitate productive and efficient discussions in both large and small work groups. A list of participants and their affiliations can be found in Appendix D.

Website Postings and Workshop Materials

Upon invitation, participants were notified that workshop materials would be posted to the SFAN website prior to the workshop and available for review. These documents included:

- A workshop agenda,
- A list of participants,
- Directions to the workshop,
- Introductory materials and Network Conceptual Models,
- Individual park Vital Signs Workshop Summaries,
- A list of management issues and monitoring questions,
- Tables of general indicators and related stressors for each resource realm,
- Indicator ranking criteria,
- A sampling protocol questionnaire with definitions and examples,
- An Inventory and Monitoring timeline, and
- A network map.

Color-coded handouts were given to participants at the workshop with a different color corresponding to each workshop objective and discussion session. Upon arrival, participants received:

- A workshop agenda,
- Introductory materials (I&M justification and model definitions),
- The generalized conceptual model,
- Spatial scale representations,
- Ecosystem conceptual models (marine, aquatic/wetland, terrestrial), and
- A conceptual model example for a specific indicator (prairie falcon).

At the end of the first day, the handouts for the second day's activities were distributed (Appendix E). Participants received:

- Tables of general indicators and related stressors for each resource realm,
- A list of management issues and monitoring questions,
- Indicator ranking criteria,
- A list of specific indicators, and
- A sampling protocol questionnaire with definitions and examples.

Vital Signs Workshop Format and Agenda

The SFAN Vital Signs Monitoring Workshop was an essential step in the synthesis of a Network Monitoring Program, providing the opportunity for the SFAN to present initial materials for its program development in a public forum for peer review. Workshop sessions designed to promote progress toward a network-wide monitoring program were organized around the three workshop goals. Five sessions were spread over one and one-half days and included:

1. Background and orientation to NPS I&M Program and the SFAN parks,
2. Review and criticism of the SFAN integrated conceptual models,
3. Review and criticism of the proposed indicators,
4. An initial indicator prioritization based on stressor-indicator relationships, and
5. Discussion of indicator protocols.

The terms "indicators" and "vital signs" were used synonymously throughout the workshop to refer to any measurable feature of the environment that provides insights into changes in the state of the ecosystem (see Glossary of Workshop Terms).

Forty-six participants attended the first day of the workshop. A few of these participants were unable to attend the second day's session whereas four new participants attended the second day's sessions only. Many of the participants have been actively involved in the I&M Program at the park level, but a few participants were new to the NPS I&M process. To ensure that all participants were familiar with the Program, an overview of the NPS Inventory and Monitoring Program was presented by the Regional Coordinator as part of the opening session. Similarly, a brief description of the individual parks within the network and a synopsis of the management issues confronting the parks were presented on the first day to provide context for the workshop sessions.

The SFAN integrated conceptual model and associated definitions were presented to the entire group as part of the initial session. The SFAN model is hierarchical, with each layer of the model becoming increasingly more specific. The SFAN model presented includes:

1. A general conceptual model,
2. Three ecosystem models representing the dominant ecosystem types in the network--marine, terrestrial, and aquatic/wetland ecosystems, and
3. A matrix representing the relationship between drivers and stressors and general indicator categories grouping similar ecosystem components and processes.

Coarse indicator categories were used at this level of the model to create indicators that were more comparable for ranking purposes. As the program develops, more refined diagrams will be created depicting understood and hypothesized relationships between drivers/stressors and specific indicators selected for monitoring purposes. Based on these fine-scale layers of the model, specific indicators can be ranked from a subset of high-priority, general indicator categories. Nested spatial and temporal scale diagrams also were included to emphasize the importance of selecting indicators that may be used to evaluate ecosystem integrity at various levels of ecological organization.

After an orientation to the I&M Program, the SFAN parks, and the SFAN Conceptual Model, participants were placed into one of three ecosystem discussion groups the first afternoon based on the individual's area of expertise (marine, terrestrial, or aquatic/wetland ecosystems). Groups ranged in size from six to twelve people including group leaders and recorders. Ecosystem groups reviewed the general conceptual model and the ecosystem model relevant to their discussion group. Discussion comments, criticisms, and suggestions were recorded on flip charts to facilitate group discussion and electronically for reporting purposes.

On the second day, SFAN management issues and monitoring questions were presented to link the conceptual model diagrams discussed on the previous day to the driver/stressor-indicator matrix being reviewed that same day. For the sake of clarification, general indicator categories and specific indicators were differentiated. Ranking criteria that would be used throughout the indicator selection process were defined. Generally, indicators would be ranked based on their management significance, ecological significance, and cost-effectiveness. The day's workshop activities were outlined as well.

For the second day's discussion sessions, participants were organized into groups representing their expertise in one of four resource realms—atmosphere/lithosphere, hydrosphere, biosphere (faunal group), or biosphere (vegetative group)—as defined by the SFAN conceptual model (see Glossary of Workshop Terms). The atmosphere and lithosphere realms were combined because of a limited number of participants with the required expertise. Conversely, the biosphere group was divided in two because of the large number of participants within this field of expertise. Work groups ranged in size from six to twelve people.

The initial task was to review the relationships between the various drivers and stressors listed in the model and the proposed general indicator categories, revising the matrix as necessary. Participants also were requested to evaluate the relative strength of these relationships to assist in

prioritizing general indicator categories. General indicator categories with the greatest number of strong, scientifically valid relationships to ecosystem drivers and stressors were the highest priority. Because of a variety of conceptual problems associated with the stressor/general indicator matrix, none of the discussion groups adhered to this process. Ranking was conducted by each group, but different methodologies were used.

Discussions in the afternoon were devoted to prioritizing specific indicators from among the high-priority general indicator categories discussed in the morning. Ideally, protocol questionnaires detailing sampling and monitoring information were completed for each specific indicator found to be a priority within each resource realm. Again, difficulties encountered earlier in the process led to different approaches to ranking specific indicators and completing questionnaires. Nevertheless, the tasks were accomplished.

Small group reports and a workshop summary were used to bring closure to the workshop at the end of each day. The Workshop Agenda can be found in Appendix F.

Following the workshop, steering committee members and NPS contributors met to review the workshop process and products and to discuss future needs and assignments of the SFAN I&M program.

Ecological Conceptual Models

An ecological conceptual model is a visual or narrative summary that describes the important components of an ecosystem and the interactions among them. Development of a conceptual model helps in understanding how the physical, chemical, and biological elements of a monitoring program interact, and promotes integration and communication among scientists and managers from different disciplines. Ecological conceptual models also need to define relevant spatial and temporal scales to provide an appropriate context for the ecosystem components and processes being considered. Conceptual model development is an iterative and interactive process. Models are expected to change as a network's monitoring program develops and as ecological linkages are better understood. Details will be added to models after indicators have been selected and prioritized.

General Conceptual Model

A generalized conceptual model was presented to workshop participants to introduce the organizational structure of model subcomponents (Appendix E). For conceptual purposes, ecosystems within the SFAN were divided into three types--marine, wetland, and terrestrial—with each ecosystem type having associated subsystems or forms. Ecosystems were further divided into dominant resource realms (atmosphere, biosphere, hydrosphere, and lithosphere) to assist in organizing similar ecosystem processes and components. Key natural processes (drivers) and anthropogenic stressors are also represented in this model acting on the different ecosystems along pathways associated with each resource realm. Note that socio-political forces influence anthropogenic stressors.

Ecosystem Models

Individual conceptual models were presented for each ecosystem type. Represented in each model are the dominant ecosystem drivers and anthropogenic stressors proposed for the SFAN. Natural and anthropogenic forces produce changes in ecosystem processes and components through their interactions with the forms associated with each ecosystem. Example effects resulting from these interactions are listed in the models. Examples of broad-scale indicators that may assist in monitoring the effects of ecosystem drivers and anthropogenic stressors on ecosystems also are depicted in the models. Indicators are organized by resource realm and ecosystem form. Note that the Biosphere realm is subdivided to reflect the need to monitor different levels of ecological organization. Ecosystem models are included in Appendix E.

Management Issues and Monitoring Questions

The SFAN's significant management issues and corresponding monitoring questions were tabulated and presented to workshop participants (Appendix E). Monitoring questions (or objectives) were generated in previous I&M scoping workshops and through discussions with park staff. Monitoring questions direct managers and scientists toward the selection of indicators that will not only assist scientists in assessing the ecological integrity of park ecosystems but will also aid decision makers in addressing the parks' management issues. Thus, monitoring questions provide a link between management issues and ecological indicators.

Stressor/General Indicator Matrix

Potential relationships between broad-scale (general) indicators and drivers and anthropogenic stressors were presented in matrix format (Appendix E). General indicators were organized by resource realm and by category (e.g., air quality, water quality, disturbance events) along the vertical axis. Drivers and stressors were aligned along the horizontal axis. An "x" was placed in any box where an indicator intersected with a driver or stressor with which there existed a potentially significant relationship. Information collected from previous scoping workshops, inventory study plans, resource management plans, and from discussions with resource managers was used to construct the matrix. The parks for which these relationships held potential application also were noted. General indicators rather than specific indicators were used to limit the model's complexity and to simplify the initial indicator prioritization process for this layer of the model. The intent was to compare general indicators qualitatively by assessing the relative strength and validity of the relationships established in the matrix for each indicator.

Specific Indicators

Each participant was provided with a list of specific indicators (Appendix E). For each general indicator within a given resource realm, relevant specific indicators were listed along with a list of parks in which the indicators could be applied. Appropriate ecosystem types also were listed. Indicator lists were compiled from previous scoping workshops, inventory study plans, and resource management plans. It will be necessary to design more detailed conceptual models focusing on high priority indicators (Vital Signs) in the future. An example of a conceptual model for a specific indicator (prairie falcon) is included in Appendix E.

Criteria for Indicator Selection

Participants were asked to consider three criteria when prioritizing general and specific indicators: management significance, ecological significance, and cost effectiveness. Criteria for the SFAN follow Tegler and others (2001) and were defined for participants during the workshop (Appendix E). A refined version of these criteria will be used by the SFAN steering committee and park staff in the final prioritization process.

Protocol Questionnaire

Resource realm working groups were asked to complete protocol questionnaires for each of the high priority indicators identified by their group. Essential information requested on the questionnaire includes: indicator name, ecosystem type, metric, methods (including frequency, timing and scale), basic assumptions, constraints, and references. Appendix E contains definitions for questionnaire categories and an example. Information obtained from completed questionnaires will be used in future prioritization steps and to develop monitoring protocols.

Workshop Session Summaries and Revisions

The following information summarizes the comments and suggestions captured in the SFAN Vital Signs Monitoring Workshop. Comments and revisions are organized by discussion group and according to the workshop agenda. More detailed comments were recorded throughout the workshop.

Ecosystem Discussion Groups

General Conceptual Model Comments

Ecosystem discussion groups found the General Conceptual Model to be acceptable with minor revisions. Most suggestions addressed stylistic or organizational issues. Several reviewers recommended that the model was too general and that a network boundary needed to be defined to differentiate it from others. Reviewers also recommended that specific reference to local components and processes be made (e.g., Mediterranean climate instead of climate). Feedback loops also should be represented in the model.

Marine Ecosystem Model Revisions

Note: The boundary for marine ecosystems should extend beyond the NPS's ¼ mile limit.

Revised List of Drivers

Climate/Weather
Oceanographic Processes
Biological Processes & Species Interactions
Coastal Processes
Geologic Processes
Hydrology
Disturbance
Nutrient Cycles

Revised List of Stressors

Altered Water/Air Quality
Habitat and Population Fragmentation
Disturbance
Invasive Alien Species
Unsustainable Use
Disease

This group ranked the relative importance of the drivers and stressors:

High:	Climate, Disturbance, Hydrology (bays and estuaries), Nutrient Cycles (bays and estuaries), Oceanographic Processes, Biological Processes and Species Interactions
Medium:	Coastal Processes
Low:	Geologic Processes, Hydrology, Nutrient Cycles

Revised List of Forms

Ocean	Soft bottom
	Hard bottom
	Sea mounts
	Islands
	Canyons
	Persistent Oceanographic Features
Intertidal	Rocky Intertidal
	Sandy Beach
Bay Estuary	Mudflats
	Salt Marshes
	Mouth of Estuaries

Indicator Revisions

No revisions were suggested for indicators.

Wetlands/Aquatic Ecosystem Model Revisions

Revised List of Drivers

- Climate/Weather
- Biological Processes and Species Interactions
- Coastal Processes
- Geologic Processes
- Hydrology
- Disturbance
- Nutrient Cycles

Revised List of Stressors

- Light Pollution
- Noise Pollution
- Water Quality Degradation
- Air Quality Degradation
- Altered Disturbance Regimes
- Climate Change
- Disease
- Engineered Structures
- External Development/Demographic Change
- Fire Management
- Habitat Fragmentation/Alteration
- Land Use Change
- Non-native Invasive Species
- Nutrient Enrichment
- Park Development/Operations
- Park Management
- Recreational Use
- Resource Extraction/Introduction
- Water Quantity Alteration

Revised List of Forms

Running Water	Streams
	Rivers
Standing Water	Lake
	Pond
	Vernal Pool
	Wetland
Groundwater	Seeps

Indicator Revisions

Add Ground Subsidence to Lithosphere
Add Hydroperiod to Hydrosphere
Add Water Table to Groundwater
Add Wetland Distribution to Landscape under Groundwater

Terrestrial Ecosystem Model Revisions

Revised List of Drivers (Natural Processes)

Climate/Weather
Coastal Processes
Biological Processes and Species Interactions
Tectonic Processes
Surficial Processes
Hydrology
Disturbance
Nutrient Cycles

Revised List of Stressors

Air Quality Degradation
Altered Disturbance Regimes
Climate Change
Disease
Engineered Structures
External Development/Demographic Change
Fire Management
Habitat Fragmentation/Alteration
Land Use Change
Non-native Invasive Species
Nutrient Enrichment
Park Development/Operations
Park Management
Recreational Use
Resource Extraction/Introduction
Water Quality Degradation
Water Quantity Alteration
Native Species Extirpation
Lack of Public Understanding/Awareness
Legal Changes
Indigenous Land Management Practices

Revised List of Forms

Grasslands
Shrublands
Woodlands
Unique Habitats

Indicator Revisions

Consolidate boxes with redundant indicators
Add Seasonal Flux to Hydrosphere
Add Genetic Variation to Population Level
Change Light Pollution to Light Quality
Add Meta-population Dynamics and Habitat Arrangement to Landscape box under Unique Habitats

Resource Realm Discussion Groups

Two different approaches were used by discussion groups to evaluate the relationship between drivers and stressors and potential indicators. Biosphere groups selected the most significant drivers and stressors for each indicator, whereas the Atmosphere/Lithosphere and Hydrosphere groups identified significant indicators for dominant drivers and stressors. Not all drivers, stressors, and indicators were evaluated. Scale limitations and other selection parameters were defined by individual groups. In addition to the driver and stressor changes suggested by ecosystem discussion groups, resource realm discussion groups recommended combining Park Management and Park Development, combining External Development and Land Use, and adding Soil Alteration.

Biosphere—Faunal Group

Revised General Indicator List

Species Distribution and Abundance
Native Species of Special Interest
Species at Risk
Exotic Species/Disease
Patch Size and Proximity
Community Area and Distribution
Land Use Patterns

Dominant Drivers and Stressors

For each faunal indicator, the dominant drivers and stressors are listed by ecosystem.

Species Distribution and Abundance

Marine Ecosystems:

Drivers--Climate/weather, natural disturbance, biological processes
Stressors—Altered disturbance regimes, engineered structures, habitat alteration, non-native invasive species, resource extraction/introduction, water quality degradation

Terrestrial Ecosystems:

Drivers—Climate/weather, natural disturbance, biological processes
Stressors—Altered disturbance regimes, habitat alteration, external development/land use change, non-native invasive species, park development and management, water quantity alteration

Aquatic/Wetland Ecosystems:

Drivers—Climate/weather, natural disturbance, nutrient cycles, biological processes
Stressors—Engineered structures, habitat alteration, non-native invasive species, nutrient enrichment, water quality degradation, water quantity alteration

Native Species of Special Interest

Marine Ecosystems:

Drivers--Biological processes, cyclic climatic/oceanic events
Stressors—Engineered structures, habitat alteration, non-native invasive species, resource extraction/introduction, water quality degradation

Terrestrial Ecosystems:

Drivers—Climate/weather, biological processes
Stressors—Altered disturbance regimes, habitat alteration, external development/land use change, non-native invasive species, park development and management, water quantity alteration

Aquatic/Wetland Ecosystems:

Drivers—Biological processes
Stressors—Engineered structures, habitat alteration, non-native invasive species, nutrient enrichment, water quality degradation, water quantity alteration

Species at Risk

Marine Ecosystems:

Stressors—Altered disturbance regimes, engineered structures, habitat alteration, non-native invasive species, resource extraction/introduction, water quality degradation

Terrestrial Ecosystems:

Stressors—Altered disturbance regimes, habitat alteration, external development/land use change, non-native invasive species, park development and management, water quantity alteration

Aquatic/Wetland Ecosystems:

Stressors—Engineered structures, habitat alteration, non-native invasive species, nutrient enrichment, water quality degradation, water quantity alteration

Exotic Species/Disease

Marine Ecosystems:

Stressors—Altered disturbance regimes, climate change, habitat alteration, park development and management

Terrestrial Ecosystems:

Stressors—Altered disturbance regimes, fire management, habitat alteration, non-native invasive species, park development and management, resource extraction/introduction, water quality degradation

Aquatic/Wetland Ecosystems:

Stressors—Altered disturbance regimes, habitat alteration, non-native invasive species, park development and management

Specific Indicators

Top level carnivores	Deer
Common species	Feral cows
Amphibian guild	West Nile virus
Pacific tree frogs	Chronic wasting disease
Freshwater fish community	Lizards/small mammals
Abalone	Owls
Mussels	Butterflies
Barnacles	Terrestrial invertebrates
Limpets	Tabling bees
Chitons	Pinnipeds
Anemones	Centrarchids
Bumble bees	Cetaceans
Ants	Bullfrogs
Tidewater goby	Bats
Shrimp	Earthworms
The Nature Conservancy species	Turkey
Sturgeon	Starlings
Rockfish community	Cowbirds
Songbirds—riparian, chaparral, coastal scrub	Pea fowl
Shorebirds	Water birds
Seabirds	Warm-water fish

Comments The Biosphere/Faunal group selected the five most significant drivers and stressors for each indicator for each ecosystem. They defined temporal and spatial scales to be 20 yrs and 20-50,000 acres (100 km for marine

ecosystems), respectively. Participants suggested that the monitoring program be flexible, incorporate indicators at various levels of ecological organization, and include redundancy. Additionally, representative species from the following groups should be included as part of the indicator selection process:

- Common species,
- Charismatic species,
- Practical species (on-going or cooperative studies),
- Exploited species,
- Keystone species,
- Endemic species,
- Species with special legal status, and
- Alien species.

Biosphere—Vegetation Group

Revised General Indicator List

Species Richness and Diversity
Native Species of Special Interest
Species at Risk
Exotic Species/Disease
Vegetation Composition and Structure
Community Assemblages
Fragmentation and Connectedness
Land Use Patterns
Phenology
Biological Processes (Species Interactions)

Dominant Drivers and Stressors

For each vegetation indicator, the dominant drivers and stressors are listed below.

Species Richness and Diversity

Drivers--Climate/weather, hydrology, natural disturbance, biological processes

Stressors—Altered disturbance regimes, fire management, habitat alteration, land use change, non-native invasive species, water quantity alteration, climate change

Native Species of Special Interest

Drivers—Climate/weather, hydrology, natural disturbance, biological processes

Stressors—Altered disturbance regimes, fire management, habitat alteration, non-native invasive species, water quantity alteration

Species at Risk

Drivers—Climate/weather, natural disturbance regimes, biological processes

Stressors—Altered disturbance regimes, disease, fire management, habitat alteration, non-native invasive species, water quantity alteration

Exotic Species/Disease

Drivers--Natural disturbance, biological processes

Stressors—Altered disturbance regimes, disease, external development/demographics, fire management, habitat alteration, land use change, non-native invasive species, nutrient enrichment, park management, water quantity alteration, soil alteration

Vegetation Composition and Structure

Drivers—Climate/weather, natural disturbance, biological processes

Stressors—Altered disturbance regimes, fire management, habitat alteration, land use change, non-native invasive species, water quantity alteration

Community Assemblages

Drivers—Climate/weather, natural disturbance, biological processes

Stressors—Altered disturbance regimes, climate change, fire management, habitat alteration, land use change, non-native invasive species, water quantity alteration

Fragmentation and Connectedness

Drivers—Natural disturbance

Stressors—Altered disturbance regimes, external development/demographics, fire management, habitat alteration, land use change, water quantity alteration

Land Use Patterns

Drivers—None ranked high

Stressors—External development/demographics, habitat alteration, land use change, non-native invasive species, recreational use, resource extraction, water quantity alteration

Specific Indicators

A combination of community assemblages/structure, species richness, and native species of special concern is needed to properly evaluate vegetative characteristics.

Comments Spatial scale was defined to be at the park level or larger for the Biosphere/Vegetation group. Ratings for drivers and stressors apply only to parks where the indicators occur. Most group members felt it was not necessary to sort dominant drivers and stressors by ecosystem because their ratings would be similar across ecosystem types.

Atmosphere / Lithosphere Group

Revised General Indicator List

Air Chemistry - contaminants
Air Chemistry - nitrogen/sulfur deposition
Air Chemistry - ozone
Air Chemistry - carbon dioxide, methane
Air Quality - fine particles (human health, visibility concerns)
Weather/Climate Change
UVB
Lightscapes
Soundscapes
Habitat Patterns/Surficial Processes
Soil Biota
Soil Chemistry and Contaminants
Soil Structure and Texture
Soil Erosion and Deposition (Paleoclimate)
Shoreline Shifts
Earthquakes
Mass Wasting

Dominant Indicators for Associated Drivers and Stressors

For each relevant driver or stressor, the high-ranking indicators are listed below (rated 3 or higher on a scale of 1-5, 1 being the highest).

Drivers

Climate/Weather

Weather/climate change, soil erosion and deposition (paleoclimate), mass wasting, shoreline shifts, habitat patterns/surficial processes

Coastal Processes

Weather/climate change, soil erosion and deposition (paleoclimate), mass wasting, earthquakes, shoreline shifts, habitat patterns/surficial processes

Geologic Processes

Weather/climate change, soil erosion and deposition (paleoclimate), mass wasting, earthquakes, shoreline shifts, habitat patterns/surficial processes

Hydrology and Flooding

Weather/climate change, soil structure and texture, habitat patterns/surficial processes, earthquakes

Nutrient Cycles

Weather/climate change, soil chemistry, soil structure and texture, flooding, nitrogen/sulfur deposition, habitat pattern/surficial processes

Stressors

Air Quality Degradation

All air quality indicators, weather/climate change, soil chemistry

Engineered Structures

Soil structure and texture, lightscapes, soundscapes, habitat pattern/surficial processes, mass wasting, earthquakes, shoreline shifts

Fire Management

Air quality, weather/climate change, habitat patterns/surficial processes

Climate Change

Air quality, weather/climate change, soil erosion and deposition (paleoclimate), mass wasting

The following stressors were not ranked: Altered Disturbance Regimes (Flooding), Disease, External Development/Demographics, Habitat/Geomorphic Processes, Land Use Change, Non-native Species Invasions, Nutrient Enrichment, Park Development /Operations, Park Management, Recreational Use, Resource Extraction, Water Quality Degradation, and Water Quantity Alteration.

High priority broad-scale indicators include:

- Mass wasting,
- Soil erosion and deposition, and
- Habitat patterns/surficial processes.

Specific Indicators

UVB	Other Soil Biota
Lightscapes	Soil Carbon Content
Soundscapes	Watershed Characterization
Habitat Pattern/Geomorphology	Landform Mapping
Paleoclimate	Mycorrhizae
Evapotranspiration	Cryptobiotic crust
Columnar Water Vapor	Depth to Bedrock
Hydrophobicity	

Comments The Atmosphere/Lithosphere group ranked indicators based on their relationship to drivers and stressors by examining all indicators for each driver or stressor. There was consensus among the group that the Air Resources Division (ARD) would have significant input on the Air Quality Indicators, so discussion was limited in this area. ARD standard protocols could be used for monitoring air quality. There was some difficulty differentiating among Engineered Structures, Park Management, and Altered Disturbance Regimes. The group also noted that these resources are important for their inherent contribution to the overall health of a system and not as a resource for another resource, which is why they changed the broad-scale indicator Habitat to Surficial Processes.

Hydrosphere Group

Revised General Indicator List

Water Chemistry
Water Clarity
Water Contaminants
Pathogenic Bacteria
Surface Water Dynamics
Groundwater Dynamics
Oceanographic Physical Parameters
Flooding
Waves
Drought

Dominant Drivers and Stressors

For the drivers or stressors considered to be most important, the high-ranking indicators are listed below (rated 3 or higher on a scale of 1-5, 1 being the highest).

Drivers

Climate/Weather

Water chemistry, water clarity, water contaminants, pathogenic bacteria, surface water dynamics, groundwater dynamics, oceanographic physical parameters, flooding, waves, drought

Coastal Processes

Water chemistry, water clarity, pathogenic bacteria

Stressors

Climate Change

Water chemistry, pathogenic bacteria, surface water dynamics, oceanographic physical parameters, flooding, waves, drought

Habitat Alteration

Water chemistry

Non-native Invasive Species

No indicators ranked high for this stressor.

Resource Extraction

Water clarity, surface water dynamics, groundwater dynamics, flooding

Engineered Structures

Water chemistry, water clarity, surface water dynamics, groundwater dynamics, oceanography (currents), flooding, waves

Water Quality Degradation

Water chemistry, water clarity, water contaminants, pathogenic bacteria

Water Quantity Alteration

Water chemistry, water clarity, water contaminants, pathogenic bacteria, surface water dynamics, groundwater dynamics, flooding, drought

Air Quality Degradation

No indicators ranked high for this stressor.

Recreational Use

Water clarity, water contaminants, pathogenic bacteria

Specific Indicators

Surface Water Chemistry	Oceanography
Ocean Water Chemistry	Flooding
Water Contaminants	Drought
Pathogenic Bacteria	Groundwater Dynamics
Surface Water Dynamics	Surface Water Use

Comments The Hydrosphere group considered three kinds of water: groundwater, surface water, and ocean water. Limited consideration was given to groundwater issues because of a lack of expertise in this area. In general, groundwater was not considered by any of the groups and should be addressed as the process continues. Several of the proposed relationships between indicators and drivers and stressors were determined to be insignificant. These changes will be reflected in the model revisions.

Protocol Questionnaire Summary

Protocol Questionnaires were filled out by the resource realm workshop groups for the following indicators:

- Soil erosion/deposition
- Weather/climate
- Soil structure, texture, and chemistry
- Soil biota
- Shoreline shift
- Mass wasting
- Watershed characterization
- Landform mapping
- Stream channel characterization
- Air quality
- Surface Water Dynamics (flow, discharge)
- Pathogenic Bacteria
- Oil/Hydrocarbons (Water Quality)
- Nutrients (Water Quality)
- HAB (Harmful Algal Blooms)
- Clarity (Turbidity and Siltation)
- Oceanography
- Water Quality
- Surface Water Dynamics (Use)
- Lichens
- Vegetation Composition and Structure
- Riparian/Woodland Edge Plant Community
- Dune Habitat Assemblages
- Amphibians
- Small birds
- Trailmaster cameras for mammals
- Raptors

General Discussion

The following comments were suggested as ways to enhance the SFAN Conceptual Model and improve the indicator selection process:

- Specifically define spatial boundaries and temporal scales for the SFAN parks.
- Characterize each driver and stressor to differentiate among similar categories.
- Clearly distinguish between a driver and a stressor.
- Match monitoring questions or management objectives with relevant indicators to provide context for indicator selection.
- Include more specific, local ecosystem components and processes in the model to create a stronger link to proposed indicators.

- Utilize standard techniques/protocols when they exist (e.g.—ARD, WRD).
- Focus the tasks for workshop participants on answering questions about specific indicators or sampling designs.

Future SFAN Vital Signs Program Development

Over the next several months, the SFAN Steering Committee and I&M staff will be using information gained from the workshop to assist in the development of the SFAN's Vital Signs program. Specifically, workshop information will be used to:

- Develop an indicator database derived from completed protocol questionnaires.
- Prioritize Vital Signs indicators.
- Revise conceptual model components.
- Develop appropriate sampling designs and monitoring protocols.

These objectives are summarized below.

<u>Protocol Questionnaire Data Entry</u>
Workshop participants were requested to complete at minimum priority categories highlighted on the protocol questionnaire form (Appendix E). Information from these key categories and any additional information provided will be reviewed by members of the SFAN Steering Committee and I&M staff. Indicator protocols used by individual parks will be integrated with those obtained from the workshop and entered into the Network database. Additionally, vegetation, faunal, and abiotic working groups will convene after the Vital Signs Workshop to refine the indicator protocol questionnaires by incorporating workshop comments and suggestions. All of this information will be used to prioritize indicators for the individual parks and for the SFAN.

<u>Prioritizing Vital Signs Indicators</u>
Indicator prioritization is an iterative process. The SFAN prioritization process involves park scoping activities, network VS workshop review, initial prioritization based on indicator quality, and a second round of prioritization based on practical considerations such as cost and feasibility. The list of indicators and protocol questionnaires generated from this workshop will be used to select vital signs. Indicators will be ranked based on criteria determined by the Steering Committee. First-round criteria include management significance and ecological significance. The second round also includes cost effectiveness. (See Appendix E for descriptions of each criterion.) The resulting list of vital signs will be included in the Phase II draft report and include details of the process used to select SFAN Vital Signs. The list of Vital Signs is subject to change as fiscal resources and management issues change, and subsequent monitoring results provide feedback on the efficacy of the selected indicators. Monitoring program reviews will be conducted approximately every five years. Adjustments to the program then can be made accordingly.

Conceptual Model Revisions

Comments, suggestions, and revisions listed in this document and expressed elsewhere will be amalgamated and then integrated into the Conceptual Model chapter of the Phase I revisions and the Phase II draft report. These reports will be peer reviewed starting in June 2003.

Sampling Design and Monitoring Protocols

Information obtained from protocol questionnaires will assist the SFAN in developing appropriate sampling designs and monitoring protocols for the Vital Signs Monitoring Program. Continued cooperation from workshop participants and scientists also will be necessary to ensure that a scientifically rigorous program is developed. Internal and external review will be conducted throughout this process as an essential part of the SFAN Vital Signs Monitoring Program.

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Glossary of Workshop Terms

The following terms were used throughout the workshop as defined. Where noted by a footnote, definitions have been updated to be consistent with Service-wide usage of the terms.

Resource realms: Four major resource realms— biosphere, hydrosphere, atmosphere, and lithosphere—were used to conceptualize broad categories of interrelated ecosystem processes and components.

Ecosystems: Three main ecosystems were identified for the network of parks; terrestrial, wetland and marine. Within each ecosystem are sub-categories or forms. Marine forms include ocean, sandy beach, rocky intertidal, bay/estuary; wetland forms include running water, standing water and ground water; and terrestrial forms include grassland, shrubland, woodland and distinct landforms (e.g., serpentine).

[1]Natural ecosystem processes and drivers: Drivers are major external driving forces such as climate, fire cycles, biological invasions, hydrologic cycles and natural disturbance events (e.g., earthquakes, droughts and floods) that have large scale influences. Process examples include succession, deposition/accretion of soils, and marine currents.

[2]Anthropogenic stressors: Physical, chemical or biological perturbations to a system that are either a) foreign to that system or b) natural to the system but applied at an excessive (or deficient) level. Stressors cause significant changes in the ecological components, patterns and processes in natural systems. Examples include resource extraction, air quality degradation, land use changes, water quality degradation, water quantity alteration, human population increase or behavioral change, invasive species introductions, and fire regime alteration.

Socio-political forces: Laws, mandates, economic pressures and environmental perception influence political decisions bear upon anthropogenic stressors, and thereby, have a cascading effect on ecosystem function. These can include environmental laws (ESA, CWA, etc.), budgets, and changing social values.

Ecological effects: Are the physical, chemical and biological responses to drivers and stressors.

[3]Indicators: Also called "vital signs" or attributes, are any measurable feature of the environment that provides insights into changes in the state of the ecosystem. Indicators are intended to track changes in a subset of park resources and processes that are determined to be the most significant indicators of ecological condition of those specific resources that are of greatest concern to the parks. Indicators may occur at any level of organization including landscape, community, population or genetic levels, and 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).

Notes

[1] **Ecosystem drivers** are major external driving forces such as climate, fire cycles, biological invasions, hydrologic cycles, and natural disturbance events (e.g., earthquakes, droughts, floods) that have large scale influences on natural systems. **Natural ecosystem processes** include both external and internal forces and processes (e.g., herbivory, respiration, productivity).

[2] **Stressors** are physical, chemical, or biological perturbations to a system that are either (a) foreign to that system or (b) natural to the system but applied at an excessive [or deficient] level (Barrett et al. 1976:192). Stressors cause significant changes in the ecological components, patterns and processes in natural systems. Examples include water withdrawal, pesticide use, timber harvesting, traffic emissions, stream acidification, trampling, poaching, land-use change, and air pollution. **Anthropogenic stressors** are those perturbations to a system that directly result from human activity.

[3] **Attributes** are any living or nonliving feature or process of the environment that can be measured or estimated and that provide insights into the state of the ecosystem.

The term **Indicator** is reserved for a subset of attributes that is particularly information-rich in the sense that their values are somehow indicative of the quality, health, or integrity of the larger ecological system to which they belong (Noon 2002). Indicators are a selected subset of the physical, chemical, and biological elements and processes of natural systems that are selected to represent the overall health or condition of the system, known or hypothesized effects of stressors, or elements that have important human values.

Vital Signs, as used by the National Park Service, are the subset of indicators chosen a by park or park network as part of the Vital Signs Monitoring Program. They are defined as any measurable feature of the environment that provides insights into changes in the state of the ecosystem. Vital signs are intended to track changes in a subset of park resources and processes that are determined to be the most significant indicators of ecological condition of those specific resources that are of the greatest concern to each park. This subset of resources and processes is part of the total suite of natural resources that park managers are directed to preserve "unimpaired for future generations," including water, air, geological resources, plants and animals, and the various ecological, biological, and physical processes that act on these resources. Vital signs may occur at any level of organization including landscape, community, population, or genetic levels, and 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).

Appendices (These items are linked to web-posted materials.)

Appendix A. PINN 2001 Vital Signs Workshop Summary
Appendix B. EUON/JOMU 2002 Vital Signs Workshop Summary
Appendix C. GOGA/PORE 2002 Vital Signs Workshop Summary
Appendix D. List of Workshop Participants
Appendix E. Workshop Handouts
Appendix F. Workshop Agenda

Appendix 5

Brief Descriptions of Parks in the San Francisco Bay Area Network

Brief Descriptions of Parks in the San Francisco Bay Area Network

Eugene O'Neill National Historic Site was established in 1976 to honor the only Nobel Prize winning playwright from the United States and the architect of modern American theater. O'Neill lived at this site in the hills above Danville from 1937 to 1944 in Tao House. It was here that he wrote his final and most successful plays; "The Iceman Cometh," "Long Days Journey Into Night," and "A Moon For the Misbegotten." Since 1980, the NPS has been restoring Tao House, its courtyard and orchards and telling the story of O'Neill, his work and his influence on American theater. EUON encompasses 13 acres of historical buildings, gardens and orchards, and is adjacent to several hundred acres of protected lands in Briones State Park.

Fort Point National Historic Site is managed by Golden Gate National Recreation Area. Designated as a National Historic Site in 1970, Fort Point consists of 29 acres bordering the mouth of San Francisco Bay at the south side of the Golden Gate. The U.S. Army Corps of Engineers constructed Fort Point between 1853 and 1861 to prevent entrance of a hostile fleet into San Francisco Bay. The Fort was occupied throughout the Civil War. Today the site receives over 1.5 million visitors a year. Fort Point is particularly noteworthy for several rare and endemic plant species. Native plant communities still cling to the precipitous slopes above the Fort. Freshwater seeps at Fort Point support the rare San Francisco fork-tailed damselfly. The site also includes the waters of San Francisco Bay within ¼ mile of shore, which serve as important wintering sites for thousands of terns, loons, grebes and cormorants. Recreational fishing and crabbing are popular resource dependent activities at Fort Point.

Golden Gate National Recreation Area comprises approximately 75,000 acres of coastal lands in the San Francisco Bay Area including the mouth of San Francisco Bay, one of the largest ports in the United States. GOGA was established in 1972 as part of the "parks to people" program, and the enabling legislation stated that the lands were founded "in order to preserve for public use and enjoyment certain areas …possessing outstanding natural, historic, scenic and recreational values." This long, narrow park is divided by the Golden Gate entrance to the San Francisco Bay, which separates the northern Marin County lands from the southern San Francisco and San Mateo County lands. The legislative boundary encompasses the Marin Headlands north of and ocean shoreline south of the Golden Gate, Alcatraz Island, and all of the coastal watersheds south and east of Point Reyes National Seashore, including Mt. Tamalpais, Samuel P. Taylor, Angel Island, and Tomales Bay State Parks. In addition, the park has a scenic and recreational easement over the 20,000 acre San Francisco Watershed lands. The Presidio of San Francisco is also within the park. GOGA leases submerged and tidal lands along the open coast and within the San Francisco Bay from the State of California. GOGA is bordered by two National Marine Sanctuaries and is part of the Central California International Biosphere Reserve (UNESCO Program). The complex geology, topography and microclimates of GOGA support a diverse array of native habitats. The degree of threat to these resources is a result of the park's juxtaposition within the urban landscape and the extensive urban / wildland interface within the park. Invasive species, plant and animal, terrestrial and aquatic, are one of the most significant threat to the long-term sustainability of the park's native ecosystems. Containing the impacts of intense human use of the park is a constant challenge.

John Muir National Historic Site was set aside in August 1964 as a national memorial to the preservationist, John Muir. Located in Martinez, JOMU is part of the rapidly expanding urban-suburban-industrial San Francisco Bay Area complex. JOMU encompasses 345 acres, only 8.9 acres of which include the house area and the adjacent ranch where John Muir made his home. The Muir House area includes historic buildings and trees, orchards, a vineyard, and the park visitor center. JOMU recently acquired Muir's gravesite (1.3 acres), which encompasses nine family graves surrounded by a historic pear orchard. The Mt. Wanda area (326 acres) adjacent to JOMU is included within the boundaries of the park and is characterized by grassland and oak woodland vegetation. It also contains remnants of a historic fruit orchard and an ephemeral stream that drains into Alhambra Creek. Resource management concerns at JOMU include the effects of long-term fire suppression, accelerated erosion in disturbed areas, lack of fire ecology research and a comprehensive fire management program, lack of information on visitor use impacts, non-native species invasions, and lack of basic ecological data for the management and monitoring of natural resources. There have been incidental surveys within the site for birds and plants, but a formal, systematic inventory has not been conducted.

Muir Woods National Monument was established in 1908 by this proclamation: "An extensive growth of redwood trees (*Sequoia sempervirens*) embraced in said land is of extraordinary scientific interest and importance because of the primeval character of the forest in which it is located, and the character, age and size of the trees, are hereby preserved from appropriation and use of all kinds under public land laws of the United States and set apart as a national monument, to be known and recognized as the Muir Woods National Monument" (NPS 1908). The monument, located in Marin County only 17 miles north of San Francisco, encompasses only 554 acres but receives nearly 900,000 visitors a year. MUWO is managed by the Golden Gate National Recreation Area. The dominant vegetation of MUWO is old-growth redwood growing in uneven-aged stands with trees ranging up to 800 years old within a mosaic of redwood, Douglas-fir, hardwood, scrub and grassland. The largest trees within MUWO grow within the flood plain of Redwood Creek. This fragment of old-growth habitat harbors four federally listed threatened species, including coho salmon, steelhead trout, California red-legged frog and the northern spotted owl. Other rare or sensitive species within MUWO include monarch butterflies, California bottlebrush grass and several species of bats. The Redwood Creek hydrologic system within MUWO has been disturbed by past activities and developments including parking lots, stream bank protection, in-stream grading, and removal of woody debris from the streambed, water withdrawals, agriculture, logging (outside of MUWO), as well as intense recreational use. These activities and developments have altered the stream course, the amount of overland flow and/or the quantity and quality of aquatic habitat. Habitat quality downstream of MUWO directly affects the threatened and endangered species present within MUWO. Redwood Creek watershed and MUWO are currently the focus of a variety of activities including watershed planning, transportation planning, a Visitor Experience and Resource Protection study, water quality and water rights investigations, sensitive wildlife species inventory, sensitive species monitoring, aquatic system and riparian restoration, invasive non-native plant removal and habitat restoration, and GIS mapping of all watershed features. Inventory and monitoring data are critical inputs to all planning efforts and the long-term sustainability of this isolated fragment of old-growth redwood habitat.

Pinnacles National Monument occupies 24,000 acres in Monterey and San Benito Counties, 40 miles inland from the Pacific Ocean in central California. PINN was decreed a National Monument in 1908 to protect its unique assortment of rocks, cliffs, and caves formed by ancient volcanic activity. In January 2000, President Bill Clinton, acting under the Antiquities Act passed by Congress in 1906, proclaimed expansion of PINN by nearly 8,000 acres, increasing the size of the park by 50%. The adjacent public lands have been transferred from the Bureau of Land Management to the NPS. Approximately 75% of PINN is Congressionally designated wilderness with an additional 10% designated as potential wilderness. As the human populations in California continue to grow and move toward PINN, these wilderness areas will increase in importance. Nearly six million people live within a 100-mile radius of PINN and about 20 million within a 200-mile radius, making it easily accessible to people living in the major California metropolitan centers of Los Angeles and the San Francisco Bay Area. The cool temperatures, moist conditions, abundant wildflowers and flowing streams attract a large percentage of PINN's visitors in the winter and spring months. Although the immediate area is sparsely populated, PINN is adjacent to an expanding urban population, making tourism a primary component of the local economy. PINN lies at the southern end of the Gabilan Mountains, which are early Paleozoic in age (around 510 million years old) and consist primarily of granite, gneiss, schist and marble. The topography of PINN ranges from rolling hills to rock spires, crags and other points of sharp relief. Elevations in the monument range from less than 1,000 feet along South Chalone Creek to 3,304 feet at the summit of North Chalone Peak. Pinnacles NM is a refuge for many species associated with coastal California communities. Species richness is high with many representatives of the same genera present in small but unbroken ecosystems. Recent investigations have recorded 410 different bee species and a strong migrant, bird population in PINN in the early spring. The broadleaf chaparral ecoregion supports abundant populations of vegetation and wildlife, which contribute to PINN's generic diversity. Years of fire suppression and adjacent land management practices have altered the wildlife habitat making it difficult to sustain populations of large predators such as bears, mountain lions, and coyotes. The expansion of PINN's boundary includes habitat types that were not represented in the core area of the park and will greatly increase the potential for sustainable management of populations with large home ranges.

Point Reyes National Seashore, located in Marin County, California, is approximately 40 miles northwest of San Francisco. Established by Congress in 1962, this geologically unique peninsula encompasses 71,046 acres of sandy beaches, coastal cliffs and seastacks, marine terraces, coastal uplands of mixed grassland, coastal scrub, mixed hardwood/Douglas-fir forests, and stands of the rare Bishop pine, and 22,000 acres of estuarine and marine waters. Migrating northward along the San Andreas Fault, the Seashore has appropriately been called an "Island in Time." Approximately 19,000 acres of Point Reyes National Seashore have been retained in agricultural production within a "pastoral zone." Within this zone, six active dairies graze a total of 7,700 acres. An additional 11,200 acres are in beef cattle grazing. The Northern District of GOGA, which is administered by PORE, contains an additional 10,500 acres that are in beef cattle grazing. In 1976, Congress designated 32,000 acres of PORE as wilderness. Located near the San Francisco metropolitan area, this area is one of the most accessible within the United States wilderness system. The marine environment, influenced by the rugged topography of the peninsula, drives the climate of Point Reyes and significantly adds to the abundance and diversity of wildlife. Point Reyes is the center of one of only five coastal upwelling marine

ecosystems in the world. Located at the convergence of a number of ocean currents, adjacent waters are rich in nutrients and support an abundant fishery and associated fauna. Several marine areas along the Point Reyes coastline have been recognized for their biological significance and receive some protection. The Point Reyes Headlands Reserve and Estero de Limantour Reserve are within the Seashore boundary and are administered by the California Department of Fish and Game (CDFG). Additionally, the California State Water Resources Control Board designated four "Areas of Special Biological Significance" within the Seashore: Tomales Point, Point Reyes Headlands, Double Point, and Duxbury Reef. Similar to GOGA, PORE is bordered by two National Marine Sanctuaries and is part of the Central California International Biosphere Reserve (UNESCO Program). PORE supports a unique and varied landscape that has been subject to a broad range of human and natural events. As with GOGA, invasive species, plant and animal, terrestrial and aquatic, are one of the most significant threats to the long-term sustainability of the park's native ecosystems. Saved from development by its inclusion within the National Park Service System, Point Reyes is unique not only in its assemblage of natural and cultural features, but also in its proximity to a major urban population. This juxtaposition makes the Seashore's resources and recreational opportunities readily accessible to a large number of people.

The Presidio of San Francisco was designated a National Historic Landmark District in 1962 and became part of GOGA in 1994. Since 1998 the Presidio of San Francisco has been jointly managed by the National Park Service and The Presidio Trust, a special public-private governmental agency tasked with managing most of the buildings of the Presidio and making the park financially self-sufficient by 2013. The Presidio encompasses 1,480 acres, more than 500 historic buildings, a collection of coastal defense fortifications, a national cemetery, an historic airfield, 300 acres of historic forests, beaches, native plant habitats, coastal bluffs and newly restored Crissy Field tidal wetland and coastal dunes. Eleven rare or endangered plant species inhabit the dune and serpentine areas of the Presidio. Many of these species' distributions are extremely limited or occur only on the Presidio. Over 200 species of birds, including 50 nesting species, have been documented on the Presidio. The extent of native habitat and diversity of native plants, birds, fish and invertebrates is increasing dramatically with community-based efforts to restore tidal wetlands, a freshwater lake, riparian habitat, coastal dunes and serpentine bluff habitat throughout the Presidio. Invasive non-native plants, non-native aquatic plants, fish and invertebrates, and unnaturally elevated populations of native wildlife (e.g. skunks and raccoons) pose a significant threat to Presidio natural resources. Intense human use of the Presidio also takes its toll on the Presidio's fragile natural resources.

Appendix 6

Water Quality Planning Meeting Discussion Questions and Summary

SFAN WATER QUALITY PLANNING MEETING DISCUSSION QUESTIONS

***Desired Outcome**: Gather needed information so that key issues can be identified and discussed. Address monitoring questions, establish objectives based on key issues, and begin the prioritization process.*

Land Use & Natural Resources

1. Where are equestrian operations located within park watersheds?
2. Where is there cattle grazing within park watersheds?
3. Is there documentation of salmonids or other T& E species in the watersheds?
4. Are there maps of wells and springs?
5. Where do water withdrawals occur?
6. Is there a roads and trails inventory (including culvert crossings)?
7. Where does water-contact recreation (swimming, etc.) occur?

Facilities & Utilities

1. Where are the stormwater outfalls and their drainage basins?
2. Is there known or suspected contamination from sewer systems or storm drain overflows?
3. Are there stormwater monitoring requirements for these parks?
4. Do we have documentation of all septic systems and leachfields located on (or adjacent to) parklands?
5. Is there known or suspected contamination (fecal bacteria, nutrients, MBAS) from septics?
6. Does the park treat any of its water?
7. To where do the parking lots drain?
8. Is there known or suspected contamination from parking lots?
9. Where are vehicles washed?

Wastes & Contaminants

1. What is the chemical application policy?
2. What lands have pesticide application?
3. What types of chemicals are used in the park (include name and purpose)?
4. Where are hazardous wastes stored?
5. Are there any landfills on park lands?
6. Are there suspected issues with heavy metals in water?
7. Are there potential water quality concerns related to mines or quarries?
8. Is there a landslides inventory?

Water Quality Monitoring

1. What types of monitoring efforts are on-going or have occurred in park watersheds?
2. What is our level of involvement with outside agencies?
3. What water quality data (technical support) is needed to support existing projects?
4. What are the priority water resources to monitor for water quality?
5. What resources are available to implement the monitoring?

SUMMARY OF WATER QUALITY PLANNING MEETINGS

Primary Network Water Quality Issues:

1. Agriculture (ranching, farming, viniculture, mariculture)
2. Recreational Use (beaches, stable operations, dog walks)
3. Erosion and Sedimentation (roads, trails, landslides, etc.)
4. Water Supply (flooding, overwithdrawal)

Park Specific Priorities and Needs:

Pinnacles NM

1. Sample for baseline water quality sampling and trend analysis.
2. Gain feedback on data.
3. Determine whether basic monitoring can answer management questions.
4. Determine whether adjustments to the sampling strategy are needed.
5. Park-community interaction (outreach) needs to be initiated.
6. Data (results and analysis) needs to be in a cohesive, understandable form to begin discussions with the community.
7. Install ISCO sampler on Sandy Creek (or initiate a sediment sampling procedure).
8. Staff is needed to implement monitoring activities.

Golden Gate NRA and Muir Woods NM

1. Analysis of existing data is a huge need (there is a large amount of data and several projects dependent upon this data).
2. Feedback on monitoring data is needed so that the park can prioritize management issues.
3. An inventory of water resources and potential pollution sources for the GOGA southern lands is needed.
4. Long-term monitoring stations need to be established in the northern lands (possibly including baseline sites plus sites applicable to large, long-term projects, stormwater monitoring, or other project specific/permitting needs).
5. Coordinate with park hydrologist and aquatic ecologist to choose monitoring locations.
6. A comprehensive dataset for overall water quality is needed.
7. Coordination on stormwater monitoring is needed (this may or may not be a network task).

John Muir NHS and Eugene O'Neill NHS

1. Stabilization of Strentzel Canyon including technical assistance on erosion/sedimentation issues is needed.
2. Coordination with local groups is needed.
3. Septic system concerns (Franklin Creek) need to be addressed (differentiate indicator bacteria sources (human vs. animal).
3. The ultimate goal is to achieve high standards of water quality on Franklin Creek (the importance of leading the way and setting an example was stressed).
4. Installation of water level monitor on Franklin Creek is needed.
5. Water quality data for the stock pond (wetland restoration project) at EUON is needed.
6. Aquatic habitat surveys in Franklin Creek are needed.

Presidio of San Francisco

1. Coordination on stormwater monitoring is needed (this may or may not be a network task).
2. Monitoring of Crissy Air Field receiving waters (marsh) is needed due to herbicide concerns.
3. Pre-restoration monitoring for the Tennessee Hollow and Mountain Lake projects is needed.
4. Development of a long-term surface water quality monitoring plan that includes Lobos Creek, Tennessee Hollow, Dragonfly Creek, and Mountain Lake is needed.

Point Reyes National Seashore

1. Monitoring for land use impacts is a primary concern.
2. Monitoring for the TMDL program is a priority.
3. Recreational monitoring needs to be continued (staff are needed for this).
4. Data analysis for problem solving is a large need.
5. Monitoring corrective actions is also a need.
6. Baseline testing for metals and antibiotics should be considered.
7. Participation in water quality monitoring activities above the park service level (i.e., involvement with local watershed groups) is large need.

Main Points from Meetings and Suggestions for the Long-Term Monitoring Plan:

The network's primary needs are:

- Outreach,
- a forum for discussing long-term water quality,
- coordination of monitoring efforts,
- baseline water quality monitoring (including aquatic bioassessment),
- a flexible plan because of the uncertainty of future problems and needs,
- a water quality database,
- data analysis and feedback,
- pollutant source differentiation,
- a list of water quality related references,
- a data "advocate" to ensure that data is sound and meets needs and to work with regulators and other agencies, and
- a way to meet the needs of the parks and the overall Vital Signs monitoring as well as relate to specific projects.

Appendix 7

Potential Indicators, Monitoring Questions, and Response Options for the SFAN Parks

Potential Indicators, Monitoring Questions, and Response Options for the SFAN Parks

Each park was established to protect and preserve unique natural and cultural resources contained within its boundaries while providing for public enjoyment of these resources. Park staff are directed via the park's enabling legislation and Resource Management Plans to identify management goals to protect and manage their natural and cultural resources. Management goals are a necessary step towards fulfilling the park's founding purposes. More specific management objectives are required to identify specific, obtainable tasks that will fulfill the park's management goals. For those objectives that are less well understood, more information may be required over time to make informed decisions. Park managers must, therefore, construct monitoring questions, identify potential indicators, and formulate response options that will provide them with the information they need to make informed decisions. An extensive list of monitoring questions and corresponding potential indicators identified by the network can be found in the following table.

Indicator	Monitoring Question(s)	Response
Air Quality	Is there a measurable rate of change in air quality? What are the trends in contaminant emissions? Is visibility impaired?	To undertake research, to increase monitoring or to take action to reduce pollution and minimize the effect of air contaminants on natural resources and park infrastructure. To mitigate internal sources of air pollution. To coordinate with State agencies for a change in air basin abatement status. To educate and inform the public.
Amphibians and Reptiles	What are the trends and status of the herpetofauna guild? Are selected amphibians or reptiles reproducing successfully? What is the natural level of variation in herpetofauna population distribution and abundance?	Habitat enhancement, identify stressors.
Aquatic Invertebrates	What are the trends and status of the aquatic invertebrate guild? Are selected invertebrates reproducing successfully? What is the natural level of variation in the aquatic invertebrate population distribution and abundance?	Habitat enhancement, identify stressors.
Bank Swallow	What is the status and trend of the bank swallow colony at Fort Funston? How are coastal erosion, climatic patterns and human disturbance affecting colony size and location?	
Bat guild	Are the distribution, species composition and relative abundance of bats changing? Does climate change affect the distribution or species composition of bats? What is the natural level of variation in bat guild distribution, species composition and relative abundance?	
Birds-Landbirds	What are the trends and status of the landbird guild? Are selected landbirds reproducing successfully? What is the natural level of variation in landbird population distribution and abundance? What are the trends and status of the small bird guild? Are selected small birds reproducing successfully?	Recruitment/survival rates indicative of “source” population, initiate research if populations are “sinks”.
Birds-Seabirds	What are the trends and status of the seabird guild? Are selected seabirds reproducing successfully? What is the natural level of variation in seabird population distribution and abundance? What seabirds are vulnerable to fishing activities or oil spills and where are these incidents most likely to occur?	
Birds-Shorebirds	What are the status and trends of the shorebird guild? Are selected shorebirds reproducing successfully? What is the natural level of variation in shorebird population distribution and abundance?	
Birds-Waterbirds	What are the trends and status of the waterbird guild? Are selected waterbirds reproducing successfully?	

Indicator	Monitoring Question(s)	Response
Black-tailed Deer	Is distribution, abundance or condition of black tailed deer changing?	Change harvest level (established by CDFG), predator control and habitat (forage) improvement likely by surrounding landowners.
Catastrophic Event Documentation	Is the distribution, occurrence frequency, intensity, or magnitude of the disturbance type changing over time?	Investigate the cause of change and develop a mitigation plan. Educate the public on ecosystem resilience and projected changes of the ecosystem. Cooperate with other agencies and managers required.
Cave Communities	Is the distribution or abundance of cave community populations changing?	To reduce visitation, to do research, to work with adjacent (upstream) communities, and to educate the public.
Cetaceans	Are the presence/absence and abundance of cetaceans changing at the parks? Is human activity such as fishing boats or pleasure boats affecting the presence/absence of cetaceans? Is climate change affecting the presence/absence of cetaceans?	
Coast Horned Lizard	Is distribution, abundance or condition of the coast horned lizard changing?	
Corvids	What are the status and trends of the Corvid guild? What is the natural level of variation in Corvid population distribution and abundance?	
Dune Vascular Plant Assemblages	Are the distribution, abundance and diversity of native dune plants changing over time in response to anthropogenic stressors? Are rare dune plants persisting? Are non-native plants spreading?	To actively remove *Ammophila*, to control/manage visitor access, and to protect rare plant areas. To educate the public on the value of unique dune communities.
Estuarine Fish	What are the trends and status of the estuarine fish guild? Are selected fish reproducing successfully? What is the natural level of variation in the estuarine fish population distribution and abundance?	Habitat enhancement/management changes.
Feral Pigs and Habitat Damage	Are feral pigs expanding their range in PINN? Is habitat destruction increasing?	If pig sign encountered, re-initiate hunting/trapping efforts, if recovery not documented, initiate research project
Freshwater Dynamics	What are the long-term hydrologic trends for stream flow and water level? Are changes in water levels within a natural range of variation? What are flood recurrence levels?	To share data with others to affect change, to work with adjacent landowners and municipalities to alleviate water diversion impacts, and to increase education about water use.
Freshwater Quality	Are the baseline levels of core water quality parameters changing? Are levels of contaminants decreasing? Are water quality levels in compliance with beneficial uses? What are the trends in water quality parameters?	Determine if source differentiation is needed. Implement best management practices (for waste management, erosion control, etc.) Solicit research activities where applicable (if necessary to answer specific questions about contaminant fate and transport or other monitoring questions).
Grassland Plant Communities	Are the distribution, abundance, composition and/or diversity of native grassland plants and habitat types changing over time?	Investigate the cause of change and develop a mitigation plan.

Indicator	Monitoring Question(s)	Response
	Are rare grassland plants persisting? Are non-native plants spreading?	
Groundwater Dynamics	Are water storage levels in existing aquifers decreasing? Are groundwater levels or quality impacting riparian habitat and wildlife?	Encourage adjacent landowners to reduce groundwater withdrawals Coordinate with CDWR (California Dept. of Water Rights) to ensure park's water rights.
Invasive Plant Species	Are exotic plant populations expanding their range in the parks? Which species are of greatest concern? What is the most common invasion vector?	Increase staff levels until data indicates the target values will be attainable, assess cost versus threat for exotic species control program, educate public on exotic species issues/problems.
Landform Type	What is the baseline resource condition (landform habitat type and abiotic process)? Are the landforms changing? Do the landform processes affect change on a natural scale?	Landform maps help management make informed decisions.
Lichens	Is there a change in the lichen community structure (diversity, abundance, and distribution with respect to air pollution? Is air pollution affecting Class I areas (PINN, PORE)?	Investigate the source of increased pollution and pursue action in accordance with regulatory legislation/guidelines.
Marine Oceanography	What are the long-term trends in physical oceanographic parameters? Are the physical oceanographic parameters changing marine biotic communities or populations? What is the frequency of El Niño-System Oscillation (ENSO), ADO, NADO? How are physical oceanographic parameters correlated with changes in the parks' biological resources?	To work with partners, initiate research, and improve education. To utilize information to educate how we use the ocean and foster stewardship.
Marine Water Quality	Are the baseline levels of core parameters changing? Are water quality levels in compliance with beneficial uses? Is there excessive D.O.N., which could feed a harmful algal bloom? What are the trends in water quality parameters?	If high numbers of contaminants (nutrients, bacteria, oil) are detected, attempt to identify the sources. Initiate a response to prevent a disease, algae bloom, or other problem. Expand education. (Much of this is threats-based monitoring.)
Mass Wasting (Landslide)	Is the distribution, occurrence, frequency, intensity or magnitude of mass wasting changing over time?	To take action to minimize the effect of anthropogenic stressors on landslide processes and to minimize the effect of landslide processes on park resources and infrastructure.
Medium to Large Carnivores	What are the trends and status of medium to large carnivores? What is the natural level of variation in select carnivore population distribution and abundance?	Specific research to detect presence and distribution of species. Verification of loss of species would trigger focused studies.
Natural Lightscape	Where is the natural dark nightscape? Is this changing over time?	To initiate research, to educate surrounding municipalities and the visiting public, and to take action to reduce lighting.
Natural Soundscape	Is the natural soundscape affected by anthropogenic stresses?	To undertake research, to increase monitoring or to take action to minimize the effect of unnaturally caused sounds on natural behavior of park fauna.
Non-native animals (includes feral animals)	Is the species present? In what numbers? Is population stable or changing? What are impacts of non-native species on native	Control of non-native species, its habitat, and resources/conditions favoring the species.

Indicator	Monitoring Question(s)	Response
	ecosystems? What is incidence of disease in non-native species and risk to native species?	
Non-Native Fish	Is the distribution and abundance of exotic fish in the streams of PINN changing?	Implement monitoring protocol, followed by eradication protocol
Northern Spotted Owl	Is distribution, abundance or condition of northern spotted owls changing?	Assess current nesting habitat conditions relative to habitat analysis information. Investigate potential disease issues. Investigate competitor or predation issues.
Oak Woodlands Regeneration	Is there a change in oak woodland recruitment and reproduction? Is the distribution, abundance, composition or richness of oak woodlands changing?	To enhance establishment of young trees by protecting seedlings, seedbanking acorns, and planting out park-genetic stock nursery-grown pole oaks. To manage invasive weedy annuals for oak seedling survival. To educate and inform the public. To collaborate in area oak retention efforts and research efforts.
Ozone (O3) Sensitive Vegetation	Are high levels of O3 impacting biological resources in PINN? Are other airborne contaminants affecting plants and wildlife'? What are the patterns of change?	Investigate the source of increased O3 and pursue action in accordance with regulatory legislation.
Pelagic Wildlife	What are the trends and status of the pelagic wildlife guild? What is the natural level of variation in population distribution and abundance of abundant species such as common murre, rhino auklet, sooty shearwater, albatross, harbor porpoise, minke whale, humpback whale, gray whale and blue whale?	
Pinnipeds	What are the status and trends of the pinniped guild? Are selected pinnipeds reproducing successfully? What is the natural level of variation in the pinniped population distribution and abundance?	Implement higher levels and additional habitat protection measures in growing or new colonies.
Plant community change at multiple scales	What are the effects of land use change within the region? What is the effect of global climate change on a landscape level? What is the status of wildlife corridors within the I & M Network? What is the effect of landscape level stressors - such as fire, flooding, disease, etc?	Initiate research to understand the impacts or consequences of changes in plant community composition. Implement or redirect invasive species programs. Educate and inform public of learned relationship. Remove barrier to native species colonization.
Plant Species At The Edge Of Their Range	Is distribution, abundance or condition of plant species at the edge of their range changing?	Investigate cause of change and proceed from there.
Raptors	Is distribution, abundance or condition of prairie falcons changing? Migrating raptors- what is the long-term status and trend in raptor populations on a landscape/west coast North America scale? What is survival rate of raptor species over the larger landscape?	If data indicate the decrease in population is related to human disturbance, upgrade advisory closures to mandatory closures and increase public education efforts. If data do not indicate recreational human use as the likely cause, consult with other agencies with prairie falcon populations to determine if population declining overall or just locally. Follow with initiating research. If data indicates increased egg toxicity or if

Indicator	Monitoring Question(s)	Response
		consultation with other agencies indicate statewide problem, initiate research.
Resilience Monitoring - Fire	Are vegetation communities re-establishing after a wildland fire? Is the chaparral community undergoing a type conversion? Are other community assemblages (birds, hymenoptera, small mammals) changing?	Investigate the cause of change and develop a mitigation plan. Educate the public on ecosystem resilience and projected changes of the ecosystem.
Resilience Monitoring - Flood	Are riparian communities able to survive flooding or quickly re-establish themselves after an event? Has riparian ecosystem function changed? Are floods operating within a natural range of variability?	If geomorphic data indicate flooding outside of normal variation, initiate the removal of man-made structures altering the stream hydrology and morphology. Investigate the cause of change and develop a mitigation plan. Educate the public on ecosystem resilience and projected changes of the ecosystem.
Riparian Habitat	Is riparian habitat size or distribution changing? Is vegetation community structure functioning within a natural range of variability (i.e. habitat for wildlife species, as a stabilizer for the stream bank, and as a nutrient and contaminant sink)?	Investigate the cause of change and develop a mitigation plan.
Rocky Intertidal Community	Is there a change in the rocky intertidal species abundance, composition and distribution? Is the change within the range of natural variation? Is climate change affecting the species composition and distribution of intertidal species?	To initiate research to Identify stressors.
Salmonid and Stream Fish Assemblages	What are the trends and status of the freshwater fish guild? Are salmonid and stream fish reproducing successfully? Is there a change in fish abundance, composition and distribution throughout stream reaches and between streams? What is the natural level of variation in freshwater fish population distribution and abundance?	Habitat enhancement/change in management.
Sandy Intertidal Community	Is there a change in the native species abundance, richness, composition and distribution? Is the change within the natural range of variation?	To do research to identify stressors and to mitigate impacts.
Shoreline Shift	Is the shoreline changing? Is the mean sea level changing?	To initiate monitoring, to increase awareness about dynamic shoreline processes, and to share data with the community.
Small Mammals and Herpetofauna	What are the trends and status of the terrestrial vertebrate guild? Are selected vertebrates reproducing successfully? What is the natural level of variation in the terrestrial vertebrate population distribution and abundance?	
Soil Biota	Are soil biota distribution and composition changing? Do engineered structures and other anthropogenic stresses have an affect on soil biota?	Capability to use soil biota data for incoming incident management teams, and for doing resource management assessments. When decreases in diversity, distribution or

Indicator	Monitoring Question(s)	Response
		abundance reach threshold limits, research is needed and so may a change in management actions.
Soil Erosion/Deposition	Is soil eroding or accreting in specific locations at a measurable rate? Do engineered structures and other anthropogenic stresses have an affect on soil loss or gain?	Use maps for incoming incident management teams and for doing resource management assessments. When map information becomes dated or incorrect, remap.
Soil Structure, Texture and Chemistry	Do engineered structures and other anthropogenic stresses have an affect on soil structure, texture and chemistry? Is soil texture, structure or chemistry changing? Can future vegetation communities be supported by the soil in its present condition?	Capability to use soil biota data for incoming incident management teams, and for doing resource management assessments. Since these parameters are generally very stable, when a change is suspected, research and resampling will be needed and so may a change in management actions.
Stream Channel and Watershed Characterization	Is stream channel shape and size changing? Is the change affecting stream flow or sediment transport? (Where and at what rate of change?) Is the change within or outside the natural range of variability?	To undertake research, to increase monitoring or to take action to avoid disruption of natural stream processes.
Sub-tidal monitoring	Is distribution, relative abundance, species composition changing in the sub-tidal habitat? Does climate change affect the distribution and species composition of sub-tidal species? What is the natural level of variation in marine sub-tidal species distribution, species composition and relative abundance?	To be determined
Sudden Oak Death	Is sudden oak death spreading in the park's oak woodland (and other) community(ies)? Are plants surviving? What species are affected?	Control disease/spread of methods available. Educate and inform staff and public. Possibly seedbank acorns and plant out park genetic stock nursery-grown pole oaks. Collaborate/initiate research efforts. Potential substitution of non-susceptible tree spp. in order to maintain oak woodland-dependent fauna.
Terrestrial Invertebrate Community (non-T&E)	What are the trends and status of terrestrial invertebrate communities? Are vegetation communities responding to changes in pollinators, seed predators, herbivorous insects or non-native insect invasion? What is the natural level of variation in terrestrial invertebrates?	Investigate cause of change and proceed from there.
Threatened and Endangered (T & E) Butterflies	Is distribution, abundance or condition of T&E butterflies changing?	Additional habitat restoration.
Threatened and Endangered (T&E) Plant Species	Is distribution, abundance or condition of T&E plants changing?	Investigate cause of change and proceed from there.
Townsend's Big-Eared Bats	Is distribution, abundance or condition of Townsend's big-eared bats changing?	Decrease visitor access to cave until roosting behavior returns to "normal", decrease visitor access to cave until population levels increase or stabilize, increase ranger patrols of the area to assure visitor compliance with closures/opening of cave system, initiate research to validate changes in roost and

Indicator	Monitoring Question(s)	Response
		population levels related to visitor use and not another factor.
Tule Elk	Is distribution, abundance or condition of tule elk changing?	See Tule elk management plan (1998).
Viewshed	Are important scenic views from the park changing? Is the view into and of the park changing?	To initiate research, to educate surrounding municipalities and the visiting public, and to consider obtaining scenic easements.
Weather/Climate	How are climate and weather changing over time?	To undertake research, to increase monitoring or to take action to effectively respond to weather variability (e.g. increased fire danger) and to minimize and/or manage the effect of climate change on natural resources and park infrastructure (e.g. plan for decreased summertime water availability for visitor needs).
Western Snowy Plover	Is distribution, abundance or condition of western snowy plover changing? Are human activities affecting plover productivity? Are oil spills affecting plover mortality? Is mercury prevalent in the plover population at PORE?	Implement additional habitat protection measures, predator management, and visitor education.
Wildlife Diseases	Which diseases are present (baseline data)? Do these diseases fluctuate in incidence, virulence, and presentation? What is population or species wide effect of the disease? What are risks to other species, including humans?	Disease dependent

1

Appendix 8

Brief Descriptions of Current and Historic Monitoring Programs within the SFAN Parks

Monitoring Programs in the Golden Gate/Point Reyes Administered Parks

Monitoring programs currently exist under the parks vital signs model developed in 1997 that include the marine, freshwater, and terrestrial plant and vertebrate components. Several threatened or endangered (T&E) species, plant communities, water quality, air quality, geologic processes, and non-native invasive plants and animals are currently monitored. Most of these monitoring programs require a review of protocols before being included in the SFAN long-term monitoring program.

Air/Meteorology: Point Reyes, a Class I Air Quality park, has monitored air quality for over 20 years. The Interagency Monitoring of Protected Visual Environments (IMPROVE) program has been in operation since 1988 and includes the measurement of the composition and concentration of fine particles produced. The Bay Area Air Quality Management District (BAAQMD) operates an air quality station at Fort Cronkite that monitors dioxin.

PORE has maintained weather records from the Point Reyes Lighthouse since approximately the 1910's. Rainfall data at Bear Valley Headquarters have been kept since 1964. The current weather station at Bear Valley records rainfall, wind speed, wind direction, relative humidity, and temperature. An additional weather station was recently deployed on Inverness Ridge (PORE) and a station is expected to be deployed on Sweeney Ridge (GOGA). Rainfall data also are currently collected at the lighthouse and in the Olema Creek, Pine Gulch Creek, Redwood Creek, and Easkoot Creek Watersheds. A database is being created for weather data within the parks.

There are also weather stations in Point Reyes that are managed by other agencies (such as the U.S. Coast Guard, Scripps Institute of Oceanography, and the Department of Health Services).

Geologic Resources: Because the parks lie along several earthquake faults, the USGS Geological Resource Division monitors seismic events continuously at Point Reyes and Golden Gate.

Water Resources: Comprehensive water quality monitoring is currently ongoing at PORE and GOGA. This includes ambient monitoring at 33 sites in PORE (since 1999) and 23 in GOGA (since 2000). Additionally, monitoring has also been conducted at about 15 sites in PRES within various time frames. Aquatic bioassessment for macroinvertebrates has been conducted at 10 sites within PORE, as well as sites within GOGA and PINN.

Water quality parameters monitored included temperature, pH, dissolved oxygen, salinity, specific conductance, nitrates, nitrites, orthophosphates, fecal/total coliform, and total suspended solids. Detailed results of PORE monitoring efforts are presented in the Point Reyes National Seashore Water Quality Monitoring Report (NPS-PORE, 2001). Results indicate that 33% of samples exceeded the non-contact recreational limit for fecal coliform (2,000 MPN/100mL). Ammonia levels toxic to aquatic species occurred in 3.1% of the samples. However, the majority of samples were collected during winter storm events when non-point source pollution from agricultural areas (including dairy and beef operations) occurred. Under most other conditions, water quality criteria were met. Management actions stemming from the water quality monitoring program have been implemented at pastoral sites within PORE.

Recreational monitoring programs are in place at PORE and GOGA. The Marin County Public Health Department (coordinating with PORE staff) has been monitoring three beaches at the Seashore. Three additional recreational water bodies have been monitored by PORE since 1999. Four beaches have been monitored by NPS staff at GOGA (since 1998). Four additional GOGA recreational sites have been monitored by the City and County of San Francisco.

Beaches were typically monitored weekly or bi-weekly from May through November with monthly monitoring the remainder of the year. One pond at PORE was posted for exceeding contact recreational fecal coliform standards (200 MPN/100mL). PORE staff also assisted in monitoring efforts within the Tomales Bay Watershed. These efforts resulted in postings at four sites within the watershed (but outside of the Seashore).

Vegetation: Vegetation mapping for all of the parks has been conducted over the past five years and is near completion with an accuracy assessment in final draft. Many of the plots developed for this map could be used for long-term monitoring. Several rare plant species have been monitored within the parks over the past several years. Each park has a weed management database, which is used to document occurrences (species, location and extent), plan restoration and record removal efforts. PORE has conducted rangeland monitoring plant composition and biomass since 1998,

Wildlife: Primarily species of special concern or federally listed species have been monitored annually in the last 5 + years within the parks (SFAN Phase II draft, Table 1.10), including Northern spotted owl, Western snowy plover, coho salmon and steelhead trout, mission blue butterfly, Myrtle's silverspot butterfly and bank swallows. At selected sites, red-legged frog populations have been monitored since 1993. The Tule elk population at PORE has been extensively monitored since 1972; the exotic fallow and axis deer populations have been surveyed sporadically. There are also several long-term monitoring studies (10-30 years) of landbirds by Point Reyes Bird Observatory (PRBO) at select locations in the parks and of waterbirds/shorebirds by Audubon Society and PRBO. The U.S. Fish and Wildlife Service monitored the common murre breeding population at Point Reyes Headlands from 1996 – 2002. Monthly counts of Townsend's big-eared bats have been monitored at two locations since 1990.

Marine: Nearshore ocean productivity is monitored by University of California Bodega Marine Lab using Coastal Ocean Dynamics Application Radar (CODAR) and an Acoustic Doppler Current Profiler (ADCP) between Point Reyes Headlands and Bodega Head. Intertidal communities have been monitored at select sites along the shorelines of GOGA and PORE by the respective parks and by NOAA for at least the since 1996. Marine surveys by NOAA have been conducted annually from Point Arena to Monterey Bay since 1985. This dataset includes seabird, pinniped, and cetacean sightings in the waters of PORE and GOGA. Pinnipeds have been counted biweekly at Point Reyes headlands since 1995 and the breeding populations of harbor seals and elephant seals have been monitored at PORE and GOGA since 1976 and 1981, respectively.

Multi-Species Inventory and Monitoring at Point Reyes NS: An inventory program for amphibians, reptiles, and small/medium mammals was implemented at Point Reyes National

Seashore in 1998. The project was funded by USGS monitoring funds and more recently, by SFAN I&M program funds. The goal of this work has been to determine whether fairly simple, yet scientifically based techniques could be used to track vertebrate populations across a variety of habitats including grasslands, riparian, scrub, and coniferous forests. Using a combination of three types of traps, artificial cover boards, and remote-triggered cameras, the presence of 58 species of vertebrates has been documented during the first three years of operation. The protocol worked well in the variety of habitats sampled and could easily be applied to other situations. The program is cost effective and can be implemented with a single field person. Modifications to the trapping scheme are being tested to further improve efficiency and effectiveness.

Multi-Species Inventory and Monitoring at Golden Gate NRA: Begun in 1988, GOGA started surveying small vertebrate amphibians, reptiles and mammals in many habitats (Howell 1992). The protocols applied include a stratified random sampling design based on habitat type as classified by the California Department of Fish and Game (CDFG 1988). This project was funded by a number of sources over the years including GOGA, Earthwatch, and the California Department of Fish and Game. Surveys have been conducted using line transects, variable circular plots, live traps, Sherman box traps. Pitfall traps are used if determined necessary based on field observations. Over 500 plots have been sampled and an additional 20 plots in upland habitat, forests, and around coastal lagoons will be completed this year. The additional funds applied from the SFAN I&M funds in 2000 supplement funds from the USGS State Partnership Program and completes the inventory.

Current Monitoring Programs in Pinnacles NM

Air/meteorology: The Monument has been designated as a Class I Air Quality area. Under the Air Quality Act (1977) Class I areas have the most severe restrictions, and should maintain the cleanest, most uncontaminated air. Typically Pinnacles has superb "Class I" air quality. Occasionally, north winds and a persistent inversion layer draw air pollutants from the Santa Clara Valley into the Monument. The NPS Air Quality Office and EPA established a monitoring station near the east entrance in 1987. An air clarity study has been completed, but particulate and ozone monitoring continues. Despite occasional hazy days, the air quality at the Monument is a defining feature and an important resource.

The Monument has an official weather station located at the base of Condor Gulch. This station has provided long-term data, but the spatial variation in weather and climate has not been examined. The air quality station also provides meteorological data, but data are available only after the station's establishment in 1987.

Geologic: Seismic activities in the Monument continue to be monitored by the US Geological Survey. There is a seismometer along the Chalone Creek Fault and a corresponding seismometer in the Beach Gulch Visitor Center that provides a continuous record of seismic activity. The purpose of continued monitoring is to learn more about earthquake phenomena. The information provides staff with data to illustrate and interpret the natural processes still shaping the Pinnacles.

Raptors

Small mammals

Small birds

Exotic plant species

Night skies

Appendix 9

Existing and Potential Monitoring Partnerships in the San Francisco Bay Area Network

Existing and Potential Monitoring Partnerships

The potential for conducting collaborative monitoring programs in the San Francisco Bay region is high. Organizations, agencies, and institutions ranging from watershed management councils to state and federal agencies have existing monitoring programs in the area. In fact, many of the SFAN's existing monitoring efforts, some of which have been ongoing for decades, are the result of partnerships with these agencies and organizations (Table 1.11). Research institutions are the most common partner and include the Point Reyes Bird Observatory, the Golden Gate Bird Observatory, the University of California and the U.S.G.S. Biological Research Division. These partnerships provide the NPS the opportunity to play a key role in the development of a region-wide natural resources assessment and monitoring effort.

Significant monitoring programs in the San Francisco Bay Area include the San Francisco Bay Estuary Project (http://www.abag.ca.gov/bayarea/sfep/sfep.html) which was established by the National Estuary Project. They have developed a wide array of monitoring protocols for San Francisco Bay. The CALFED Bay-Delta Program is another large scale program in the region which was established "to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System" (http://calfed.ca.gov/Programs/Science/Science.shtml).

Additionally, the Point Reyes Bird Observatory (PRBO), a wildlife research group located at PORE, has several large-scale bird monitoring efforts for most taxa. For example, PRBO is currently developing monitoring protocols for shorebirds in conjunction with U.S. Shorebird Conservation Plan (http://www.manomet.org/USSCP/) and has been involved in the development of the BBIRD Protocol and MAPS, which are being used in many national parks servicewide.

The U.S. National Marine Fisheries Service has large scale, long-term monitoring studies of marine mammals and fish in the region. The parks currently participate in various studies of pinnipeds, including harbor seals and northern elephant seals.

The U.S. Fish and Wildlife Service also has large scale, long-term monitoring studies focused on water birds and seabirds at Golden Gate and Point Reyes. Both of these parks benefit from over 20 years of data developed and analyzed by this agency.

Other groups manage open space and undeveloped lands. They may be interested in partnering with the SFAN in long-term monitoring to improve preservation and understanding of resource condition and trends. These groups include:

1. Bay Area Open Space Council. The group is a collective of public and non-profit land management agencies and organizations with a broad initiative to improve the use and management of conservation easements in and around the cities in the San Francisco Bay Area.
2. California State Parks. The 6 state parks and the SFAN have similar missions–preservation, recreation, and education. Personnel resources are limited for these parks, but they would welcome monitoring locations within their parks to add to the understanding of the wider region.

3. Los Padres National Forest. Los Padres encompasses nearly two million acres in the coastal mountains of central California. The north division around Monterey and Santa Lucia is directly east of Pinnacles.
4. Marin Agricultural Land Trust. MALT works to preserve undeveloped, agricultural lands in Marin County, and much of these lands are adjacent to GOGA and PORE. They are also interested in obtaining migratory corridors to connect protected lands, increasing water quality, and preserving riparian habitat for neotropical migrants.
5. Marine Life Refuges. The State of California is presently collaborating with other state and federal agencies to establish protected marine areas along the coast. The National Park Service and the NOAA Sanctuary Programs office are working with state agencies to identify areas of special significance. Protected areas will range in level of protection. Within PORE, there are three sites identified for inclusion in this program. Also, the Bodega Marine Life Refuge bounds Point Reyes and Golden Gate. The University of California conducts research in the Refuge.
6. Mid-peninsula Regional Open Space District. The District currently manages nearly 50,000 acres of land in twenty-six open space preserves. Their purpose is to permanently protect and restore lands that they acquire, forming a regional open space greenbelt. The District is neither a city nor county government but has the same powers. They are often defined by their functional characteristics, such as watershed protection districts and open space districts.
7. Muir Heritage Land Trust. The Trust works to preserve undeveloped lands to provide a buffer between cities and suburbs of Contra Costa County. They are also interested in establishing migratory corridors to connect protected lands. One of two current campaigns is to protect 1,500 acres of land linking ridge lands from the Carquinez Strait, extending south to Briones Regional Park, and continuing to areas near Las Trampas Regional Wilderness. This may help provide some connectivity for Eugene O'Neill and John Muir.
8. National Marine Sanctuaries. The U.S. National Oceanographic and Atmospheric Administration manages three large refuges off central California. The Gulf of the Farallones includes nurseries and spawning grounds for commercially valuable species of fish and at least 26 species of marine mammals including one-quarter of California's harbor seals. The Farallon Islands are home to the largest concentration of breeding seabirds in the continental United States. This 1,255 square mile protected area abuts Point Reyes and a portion of Golden Gate. Monterey Bay Marine Refuge, the nation's largest marine sanctuary, spans 5,300 square miles with an array of habitats from rugged rocky shores and lush kelp forests to one of the deepest underwater canyons on the west coast. It abuts portions of Golden Gate and is west of Pinnacles. Cordell Bank National Marine Sanctuary is located 40 miles west of Point Reyes and is a significant seamount where many marine species of PORE and GOGA forage. The refuges are a focal point for research. One of the current projects is to monitor coastal ecosystem change. Each of these sanctuaries is presently conducting inventories and identifying what elements to monitor. The SFAN is already cooperatively monitoring several marine species including seabirds, marine mammals and oceanic productivity. To ensure data compatibility, the data manager at PORE is a shared position with NOAA.
9. Peninsula Open Space Trust. This nonprofit group is dedicated to preserving the beauty, character and diversity of the coastal areas of the San Francisco Peninsula. Since its

founding twenty years ago, it has protected more than 40,000 acres of San Francisco Bay open space.

Appendix 10

San Francisco Bay Area Network
Vital Signs Prioritization Meeting Summary
July 2003

San Francisco Bay Area Network
Vital Signs Prioritization Meeting Summary
Draft

July 29-30, 2003
Golden Gate Club, Presidio, San Francisco

San Francisco Bay Area Network (SFAN)
Eugene O'Neill National Historic Site (EUON)
Fort Point National Historic Site (FOPO)
Golden Gate National Recreation Area (GOGA)
John Muir National Historic Site (JOMU)
Muir Woods National Monument (MUWO)
Pinnacles National Monument (PINN)
Point Reyes National Seashore (PORE)
Presidio of San Francisco (PRES)

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Introduction

Monitoring Rationale

Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS's) ability to manage park resources "unimpaired for the enjoyment of future generations." National Park managers across the country are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources as a basis for making decisions and working with other agencies and the public for the benefit of park resources. Simultaneously, park managers must provide scientifically credible information to select and defend management actions and fulfill legal mandates. The National Parks Omnibus Management Act of 1998, for example, includes a Congressional mandate for Parks to provide information on the long-term trends in the condition of their natural resources.

In response to these challenges, the NPS has identified 270 parks with significant natural resources for which inventories will be completed and long-term ecological monitoring will occur. Natural resource monitoring provides site-specific information needed to understand and identify change in complex, variable, and imperfectly understood natural systems and to determine whether observed changes are within natural levels of variability or may be indicators of anthropogenic influences. This broad-based, scientifically sound information can then find application in management decision-making, research, education, and promotion of public understanding of park resources.

The intent of the NPS monitoring program is to track a subset of park resources and processes, known as "vital signs," that are determined to be the most significant indicators of ecological condition for specific resources that are of greatest concern to each park. Because of the tremendous variability among parks in ecological condition, size, and management capabilities, it has been recognized that adoption of a "one size fits all" design is not an effective monitoring approach for the NPS. Rather, parks have been given the flexibility to integrate inventory and monitoring programs into existing park operations and management agendas to facilitate efficiency and cost-effectiveness. Parks also have been encouraged to incorporate partnerships with external agencies and institutions into the Vital Signs Monitoring Program to effectively understand and manage resources and threats that extend beyond park boundaries.

Service-wide Vital Signs Monitoring Goals

Despite the differences that exist among parks, five Service-wide Goals for Vital Signs Monitoring have been established for the National Park Service. While no single piece of legislation specifically defines these monitoring goals, they are derived from the mandates of the National Parks Omnibus Management Act of 1998 and the goals established by prototype monitoring parks and the long-term ecological monitoring program. These goals are to:

- Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions and impairment of selected resources to help develop effective mitigation measures and reduce costs of management.

- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.

Steps to Developing a Network Monitoring Program

The 270 parks identified for the Inventory and Monitoring Program have been grouped into 32 vital sign networks linked by geography and shared natural resource characteristics. Each network of parks is required to design an integrated monitoring program that addresses the monitoring goals listed above and that is tailored to the high-priority monitoring needs and partnership opportunities for the parks in that network. The basic approach to designing a monitoring program should follow five basic steps, which are further discussed in the Recommended Approach for Developing a Network Monitoring Program (http://science.nature.nps.gov/im/monitor/index.htm).

6. Define the purpose and scope of the monitoring program.
7. Compile and summarize existing data and understanding of park ecosystems.
8. Develop conceptual models of relevant ecosystem components.
9. Select indicators and specific monitoring objectives for each.
10. Determine the appropriate sampling design and sampling protocols.

Monitoring program development is an iterative process. As a network's monitoring program evolves, management issues and monitoring objectives may change to accommodate increased understanding of ecological processes, ecosystem conditions, and human interactions with the environment. Likewise, improvements in technology may alter the ability to assess ecological change. Consequently, a network's conceptual models most likely will be refined, and sampling design and protocol may be adjusted to reflect advances in understanding and technology. This process is an integral part of an adaptive management approach.

Peer Review

Peer review is a key component of a successful network monitoring program. Monitoring program materials should be critiqued by park managers, subject experts, and interested stakeholders within the NPS and from external agencies and institutions. Critical input, suggestions, and understanding gained from peer review ensures that monitoring meets the most critical information needs of each park and produces scientifically credible results that are clearly understood and accepted by scientists, policy makers, and the public.

Standard procedures have been adopted by the San Francisco Bay Area parks, with guidance from the national program, that incorporate peer review into the network's monitoring program. These procedures include: inclusion of scientific experts, managers, and stakeholders in the vital sign's scoping process and conceptual model development; knowledge, experience, and criticism from these participants concerning scientifically sound monitoring procedures; input from participating scientists, managers, and stakeholders in the indicator selection and prioritization

process; and review of network reports by the Technical Steering Committee, Board of Directors, Regional Coordinator, National Coordinator, and selected external reviewers.

Document Purpose

This document summarizes the process used, the issues considered, and the products generated during the selection and prioritization of the San Francisco Bay Area Network's proposed vital signs indicators. Key points from the network's Vital Signs Prioritization Meeting discussions, comments, and suggestions are included in this summary along with the recommended list of prioritized vital signs.

Background

The San Francisco Bay Area Network (SFAN)

The San Francisco Bay Area Network (SFAN) is one of eight networks formed in October 2000 in the Pacific West Region of the National Park Service. The SFAN is composed of eight park units: Eugene O'Neill National Historic Site (EUON), Fort Point National Historic Park (FOPO), Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Muir Woods National Monument (MUWO), Pinnacles National Monument (PINN), Point Reyes National Seashore (PORE), and the Presidio of San Francisco (PRES). FOPO, GOGA, MUWO, and PRES are administered as one unit by GOGA. EUON and JOMU are managed jointly. PRES and EUON were not originally selected by WASO as part of the 270 parks nationwide with significant natural resources; however, the SFAN Technical Steering Committee decided that natural resource issues within theses parks were sufficient to be included in the network. The SFAN was selected as one of the first three networks in the region to obtain monitoring funds because of need, capacity, and existing monitoring effort.

Network Setting and Ecological Significance

The abundance and diversity of ecosystems and taxa in the SFAN are remarkable, owing to the Mediterranean climate, convergent oceanic currents, topographic variation, and overlapping ecological regions.

The moderate Mediterranean climate offers long growing seasons and supports diverse plant and animal communities, including over 1200 plant species. Important vegetation alliances include coastal dune, coastal terrace prairie, serpentine chaparral and bunchgrass, chaparral, native grasslands, oak woodland, ancient redwood forests, Bishop pine forests, and Douglas-fir forests. Nearly 60 federal or state listed threatened and endangered species occur as residents or seasonal migrants.

The convergence of oceanic currents rising from the abyssal plain over a steep canyon makes the marine and coastal shoreline habitats complex and diverse. The California coast is one of only five areas of eastern boundary upwelling oceanic currents worldwide. In addition, a plume of warmer, freshwater exiting the San Francisco Bay extends out into the Gulf of the Farallones. These nutrient rich waters support an abundant and diverse fauna. More than one-third of the

world's cetacean species occur in these waters. Significant haul-out areas for five species of pinnipeds are used year round and represent one of only eleven mainland breeding areas for northern elephant seals in the world and 20% of the mainland breeding population of harbor seals in California. Eleven species of seabirds breed within the parks and over 80 waterbird and shorebird species were identified in the parks during the 1997-99 inventories (Kelly and Etienne 1999).

Elevation across the parks ranges from sea level to 3,300 feet above mean sea level. The San Andreas Fault, the dominant geological force in this area, is a source of natural disturbance in the form of seismic activity resulting from interaction of the Pacific and the Continental Plates. This geologic activity re-structures ecosystems offering unusual habitat for endemics and species at the edge of their range as coastal California from Pinnacles through Point Reyes slides northward. Plate movement created and continues to create a fractured landscape with unique geology and soil types. Volcanic activity created the Pinnacles rock formations, and plate tectonics thrust the rock spires upward. Associated cave formations provide habitat for many unique species. Slopes range from almost flat marine terraces and alluvial deposits to steep canyons along some creeks, providing dramatic topographic and, therefore, habitat heterogeneity. Consequently, the SFAN parks are located within three terrestrial ecological regions:

4. The Central California Coast contains coast live oak, chamise, valley oak, redwood, Douglas fir-tanoak, chaparral and grassland series of vegetation communities,
5. The Northern California Coast contains redwood, Douglas fir-tanoak, coast live oak, chaparral, and grassland series; and
6. The Central California Coast Range contains coast live oak, chamise, valley oak, and mixed chaparral series (Bailey 1994).

The SFAN parks represent an area designated as one of the six most significant in the nation for biodiversity (The Nature Conservancy 2000). Notably, the parks support endemic species and communities despite close proximity to large urban areas and are listed as the eighth most significant "hot spot" in the world for biodiversity at risk from rapid human population growth (Cincotta and Engleman 2000). With a current population of 6.9 million, the metropolitan centers of San Francisco, Oakland, and San Jose are forecast to have a population of 8 million by 2020 (Assoc. of Bay Area Governments 2000). Recognizing the extraordinary significance and exposure to threats in the region, the UNESCO Man in the Biosphere program designated the Central California International Biosphere Reserve in 1988, encompassing five of the eight parks. Preserving biologically and geologically diverse habitats and their associated species, as well as providing opportunities for recreation, education, and aesthetic enjoyment to a large urban population, is a difficult balancing act. The need to mitigate impacts and preserve these natural resources based on scientific recommendations from a wisely developed monitoring program is urgent.

Previous Monitoring Workshops

In 1993 prior to the formation of park networks, the resource management staffs from the GOGA and PORE park cluster decided to develop a comprehensive Inventory and Monitoring (I&M)

Program. These parks had separately developed I&M projects for single species or species groups such as rare plants, pinnipeds, migratory raptors, and exotic plants. Also, GOGA had independently developed an ecological monitoring program in coastal scrub and grassland habitats in 1988 (Howell 1992). None of the parks, though, had initiated an integrated ecological monitoring program.

The parks coordinated efforts to identify and complete several of the design elements identified in the I&M program developed by Gary Davis for the Channel Islands National Park prototype program given Channel Islands' similar ecosystems and its monitoring experience.

A draft inventory and monitoring plan was developed in 1996 at the end of this process but was only partially implemented because of lack of funds. With the initiation of the Natural Resource Challenge, the GOGA/PORE draft plan was resurrected and modified during an I&M scoping workshop in July 2002.

The SFAN held three Vital Signs Monitoring Workshops in FY02. PINN held a workshop in September 2001. EUON and JOMU jointly held workshops in January and August 2002 since both parks are in close proximity, have similar natural resources and issues, and are administered jointly. Because of their previous collaborative efforts and the overlap in resources and management issues, the parks administered by GOGA and PORE jointly held a workshop in July 2002. In each of these workshops, participants identified significant resources in the parks, identified key processes and stressors affecting the parks, potential monitoring questions, and recommended vital signs indicators that could address the monitoring questions. An initial prioritization of vital signs indicators and development of a conceptual model also were addressed. Participants included Park Service managers and staff, external natural resource managers, and scientists.

Subsequently, the SFAN Technical Steering Committee integrated the findings and recommendations from the separate workshops into a conceptual model for the network that includes significant natural resources, key processes and stressors, and monitoring questions with suggested indicators. The SFAN Vital Signs Workshop held March 19-20, 2003, was organized to review the SFAN integrated model and its related components and move forward with the selection of network-wide vital signs indicators. To help expedite the prioritization process and to prepare for future sampling design and protocol development, participants also were asked to complete protocol questionnaires for each of the high priority indicators identified by their workshop group (Table1). Essential information requested on the questionnaire includes: indicator name, ecosystem type, metric, methods (including frequency, timing and scale), basic assumptions, constraints, and references (Table 1). Information from these key categories and any additional information provided was reviewed by members of the SFAN Technical Steering Committee and Network I&M staff. Indicator protocols used by individual parks were integrated with those obtained from the workshop and from information generated by a geology working group that met in October 2002. Additionally, vegetation and faunal working groups convened after the March 2003 Vital Signs Workshop to refine the indicator protocol questionnaires by incorporating workshop comments and suggestions. This information was entered into the network database which was used, in turn, as the foundation for the network's web-based vital

Table 1. SFAN protocol questionnaire template with category definitions.

Protocol Questions – definitions

(**Note:** Please be sure to address items in **bold** as these denote areas of **essential** information.)

INDICATOR: Specific indicator

Type: Is the indicator a basic resource component/value, a stressor within the system, or in some cases, both.

Indicator Category: Is the link in the indicator matrix?

Ecosystem(s): Links the indicator to ecosystems within the parks.

Park(s): Identifies what park(s) the indicator is associated with.

Metric(s): Refers to the elements to be measured and the data to be collected.

Method: Provides a short description of a methodology or references a developed protocol. Please include reference to frequency, timing, and scale as described below.

- **Frequency:** Stipulates how often the indicator should be measured.
- **Timing:** Specifies the time of year that data collection should occur.
- **Scale:** Three scales will be identified: 1) indicates at what level the data will be collected in the nested spatial system, 2) on what scale the process or element operates and 3) at what scale can the analysis be inferred.

Monitoring Question(s): Provides justification as to the importance of measuring this indicator.

Basic Assumptions: Specifies the underlying assumption(s) that if not true, would possibly invalidate this indicator/methodology.

Research Need(s): Identifies any known research need(s) that would facilitate understanding of how this indicator fits within the ecosystem model.

Management Goal: Desired future condition.

Threshold/ Target Value: Stipulates the resource condition (numerically if possible) and the amount of variation from this condition that will be tolerated (accepted as natural variation).

Management Response: Specifies what management action is recommended if the threshold or target is not met.

Constraints: Lists issues/concerns about the indicator related to its successful implementation.

Status: Identifies whether monitoring is proposed, in development, or on-going.

References: Contacts, experts or literature relevant to the indicator.

signs indicator ranking tool. Previous workshop invitees and relevant Park Service staff were invited to use the web-based instrument to rank the network's indicators. The results of this ranking process were the focus of the July 2003 Vital Signs Prioritization Meeting.

Previous workshop summaries and related information can be found on the SFAN website (http://www.nature.nps.gov/im/units/nw27/report.htm).

SFAN Vital Signs Prioritization Meeting Objectives

The goal of the July 2003 Vital Signs Prioritization Meeting was to develop a prioritized list of vital signs indicators to implement over the first five years of the SFAN monitoring program. The main objectives for the meeting were to:

5. Review the SFAN prioritization process and associated assumptions and biases,
6. Examine the web-based database structure and ranking results,
7. Compare weighted mean scores to alternative score calculations and data sorts,
8. Delineate high, medium, and low priority groupings for discussion purposes,
9. Review and discuss indicators with high score variability or significant variation in rank order among different data sorts,
10. Identify gaps in monitoring needs, ecological scale, and indicator types, and
11. Adjust the prioritized list accordingly and justify any changes made.

Indicator prioritization activities also were designed to consider existing and potential partnership information as well as to assess the status of monitoring protocols for each of the prioritized vital signs.

Selection of Meeting Participants

Twenty-three NPS employees attended the July 2003 Vital Signs Prioritization Meeting on the first day, and fourteen employees attended on the second day (Appendix A). Invited participants included all SFAN Technical Steering Committee members, the SFAN Board of Directors, and NPS employees with expertise in fields of study that would aid in detailed discussions of the ranked list of vital signs. The Board of Directors was represented by Glenn Fuller (JOMU/EUON Superintendent) during the morning of July 29 and by Brian O'Neill (GOGA Superintendent) during the morning of July 30.

SFAN Vital Signs Prioritization Process

Selection of Ranking Participants

All NPS and non-NPS staff, natural resource managers, and scientists invited to participate in any of the previous SFAN scoping or vital signs workshops were asked to take part in the web-based vital signs prioritization process developed by the SFAN database manager. Approximately 120 people representing diverse organizations, institutions, and specialty areas were requested to participate. The invitees are listed in Appendix B.

Vital Signs Indicator Database

All available information from existing and recently complied indicator worksheets (Table 1) was entered into a network database developed by the Network Data Manager and based on a data structure provided by the National Monitoring Coordinator. Any information gaps were identified and addressed while worksheet information was being entered into the indicator database. This information was refined using technical expert focus groups (i.e., vegetation, wildlife, geology, and water resources). The focus groups combined potential indicators so that comparisons could be made between larger groups of indicators (e.g. visibility was combined with the air quality indicator, and red-legged frogs were combined with the amphibian/reptile indicator). The focus groups also completed a worksheet for each indicator grouping that provides in-depth information about why they were selected, what they will monitor, how monitoring will be done, assumptions, constraints and thresholds for the monitoring, as well as management actions if the thresholds are reached or exceeded. Information for each category for each indicator was not available in all cases. Along with worksheet information, network parks and ecosystems in which the indicator may be applicable were noted.

The SFAN database was linked to dynamic web pages posted on the network web site with the intent of using the web pages to enter indicator data and to perform the initial ranking process. This linkage allowed many revisions to be immediately incorporated into the web page. The indicator database and linked web pages also served as the foundation for the SFAN ranking instrument.

Criteria for Prioritizing Vital Signs

The four criteria utilized to rank vital signs indicators reflect important qualities of an effective vital signs monitoring program and were modified from the Cumberland-Piedmont Network ranking criteria, Jackson et al. (2000), Tegler et al. (2001), and Andreasen et al. (2001) (Table 2). Sub-criteria describe the decisive factors associated with each primary criterion, and the prioritization scheme defines the rationale behind assigning a given value to each criterion. Only NPS staff were provided with a password that gave them access to the Legal Mandates criterion. Each criterion was weighted to reflect its relative contribution to the selection of SFAN Vital Signs.

Table 2. Criteria for prioritizing San Francisco Bay Area Network indicators.

Primary Criteria	Sub-criteria*	Prioritization Scheme
Ecological Significance	o There is a strong, defensible linkage between the indicator and the ecological function or critical resource it is intended to represent. o The indicator represents a resource or function of high ecological importance based on the conceptual model of the system and the supporting ecological literature. o Data from the indicator are needed by the parks to fill gaps in current ecological knowledge. o The indicator provides early warning of undesirable changes to important resources. It can signify an impending change in the ecological system. o The indicator has a high signal to noise ratio and does not exhibit large, naturally occurring variability. o The indicator is sufficiently sensitive; small changes in the indicator can be used to detect a significant change in the target resource or function. o Reference conditions exist within the region, and/or threshold values are specified in the available literature that can be used to measure deviance from a desired condition. o The indicator complements indicators at other scales and levels of biological organization.	*Very High*—I **strongly agree** with at least 7 of these statements. *High*—I **strongly agree** with at least 5 of these statements. *Moderate*—I **strongly agree** with at least 4 of these statements. *Low*—I **strongly agree** with at least 1 of these statements. *Very Low*--This is an important indicator to monitor, but I do not **strongly agree** with any of these statements. *No opinion*--I do not know enough about this criterion for this indicator to rank it.

Primary Criteria	Sub-criteria*	Prioritization Scheme
Management Significance	o There is an obvious, direct application of the data to a key management decision, or for evaluating the effectiveness of past management decisions. o The indicator will produce results that are clearly understood and accepted by park managers, other policy makers, research scientists, and the general public, all of whom should be able to recognize the implications of the indicator's results for protecting and managing the park's natural resources. o Data are badly needed to give managers a better understanding of park resources so that they can make informed decisions. o Monitoring results are likely to provide early warning of resource impairment, and will save park resources and money if a problem is discovered early. o In addition to addressing a specific management decision, data provide information that strongly support other management decisions. o Data are of high interest to the public. o There is an obvious, direct application of the data to performance (GPRA) goals.	*Very high*—I **strongly agree** with at least 6 of these statements. *High*—I **strongly agree** with at least 5 of these statements. *Moderate*—I **strongly agree** with at least 3 of these statements. *Low*—I **strongly agree** with at least 1 of these statements. *Very Low*— Some of the statements above apply to some degree, but I do not **strongly agree** with any of these statements. *No opinion*—I do not know enough about this criterion for this indicator to rank it.
Legal Mandate	This criterion is part of 'Management Significance' but is purposely duplicated here to emphasize those indicators and resources that are required to be monitored by some legal or policy mandate. The intent is to give additional priority to an indicator if a park is directed to monitor specific resources because of some binding legal or Congressional mandate, such as specific legislation and executive orders, or park enabling legislation. The binding document may be with parties at the local, state, regional, or federal level.	*Very High*—The park is **required** to monitor this specific resource/ indicator by some specific, binding, legal mandate (e.g., Endangered Species Act for an endangered species, Clean Air Act for Class 1 airsheds), or park enabling legislation. *High*—The resource/indicator is specifically covered by an Executive Order (e.g., invasive plants, wetlands) or a specific Memorandum of Understanding signed by the NPS (e.g., bird monitoring), as well as by the Organic Act, other general legislative or Congressional mandates, and NPS Management Policies. *Moderate*— There is a GPRA goal specifically mentioned for the resource/indicator being monitored, or the need to monitor the resource is generally indicated by some type of federal or state law as well as by the Organic Act and other general legislative mandates and NPS Management Policies, but there is no specific legal mandate for this particular resource.

Primary Criteria	Sub-criteria*	Prioritization Scheme
		Low— The resource/indicator is listed as a sensitive resource or resource of concern by credible state, regional, or local conservation agencies or organizations, but it is not specifically identified in any legally-binding federal or state legislation. The resource/indicator is also covered by the Organic Act and other general legislative or Congressional mandates such as the Omnibus Park Management Act and GPRA, and by NPS Management Policies. *Very Low*— The resource/indicator is covered by the Organic Act and other general legislative or Congressional mandates such as the Omnibus Park Management Act and GPRA, and by NPS Management Policies, but there is no specific legal mandate for this particular resource. *No opinion*—I do not know enough about this criterion for this indicator to rank it.
Cost and Feasibility	o Sampling and analysis techniques are cost-effective. Cost-effective techniques may range from relatively simple methods applied frequently or more complex methods applied infrequently (e.g., data collection every five years results in low annual cost). o The indicator has measureable results that are repeatable with different, qualified personnel. o Well-documented, scientifically sound monitoring protocols already exist for the indicator. o Implementation of monitoring protocols is feasible given the constraints of site accessibility, sample size, equipment maintenance, etc. o Data will be comparable with data from other monitoring studies being conducted elsewhere in the region by other agencies, universities, or private organizations. o The opportunity for cost-sharing partnerships with other agencies, universities, or private organizations in the region exists.	*Very High*—I **strongly agree** with all 6 of these statements. *High*—I **strongly agree** with at least 4 of these statements. *Moderate*—I **strongly agree** with at least 3 of these statements. *Low*—I **strongly agree** with at least 1 of these statements. *Very Low*—This is an important indicator to monitor, but I do not **strongly agree** with any of these statements. *No opinion*—I do not know enough about this criterion for this indicator to rank it.

1

Initial Prioritization Process and Ranking Instrument

The initial prioritization process was conducted using a web-based ranking methodology. The SFAN database and associated web pages functioned as the source of indicator ranking information and as the receptacle for ranking scores and participant comments. The dynamic nature of the database-web page linkage not only provided the SFAN with a tool for ranking indicators, but it also gave the network the opportunity to export a standard yet flexible tool to other networks that can be adapted to their ranking needs.

Participants from previous workshops, additional subject experts, regional NPS staff, and other selected agency officials were sent a background statement, instructions, and descriptions of ranking criteria via email. All invited participants were given a password, giving them access to the ranking website (www.nature.nps.gov/im/units/nw27/database/loginname.cfm) which also contained links to the background and instructional materials. Login names and passwords were used to provide sufficient security during the ranking process. Upon reviewing the instructions and ranking criteria, participants were asked to rank each indicator from very low to very high with respect to each criterion. Participants also had the option of choosing "no opinion" for each criterion if they had insufficient knowledge about the criterion or the indicator to evaluate it. Participants could view the existing data for each indicator, print any or all of the information, rank indicators in accordance with the SFAN criteria, review their scores, and change them as often as the participants wished during the two week window that the database was open. Ranking instructions sent to all participants are included in Appendix C.

Additionally, participants were given two locations in which to provide feedback. The comment box under the ranking scores could be used to justify ranking scores. A comment box at the bottom of the indicator information was intended for information on citations or methods that were not included in the worksheet. Comments were taken into consideration as indicator ranking results were analyzed and will be considered during protocol development.

Figure 1 depicts an example ranking dialog box for the air quality indicator. Within the dialog box, underlined text provided hyperlinks to protocol database information for the indicator as well as descriptive information for each ranking criterion. Protocol information specific to each indicator was found immediately below the dialog box on the ranking website.

Air Quality

Air Quality	You have already ranked this indicator. Any changes you make will be posted to the database Management: ☐ Very High ☐ High ☐ Medium ☐ Low ☐ Very Low ☉ No Opinion Ecological: ☐ Very High ☐ High ☐ Medium ☐ Low ☐ Very Low ☉ No Opinion Cost Effectiveness: ☐ Very High ☐ High ☐ Medium ☐ Low ☐ Very Low ☉ No Opinion Legal: ☐ Very High ☐ High ☐ Medium ☐ Low ☐ Very Low ☉ No Opinion Rank Ranking Comments:

Parks where monitoring would be conducted

☑ EUON ☑ FOPO ☑ GOGA ☑ JOMU ☑ MUWO ☑ PINN ☑ PORE ☑ PRES

Figure 1. Example of an indicator ranking dialog box. Underlined text indicates a hyperlink to descriptive materials.

Vital Signs Prioritization Meeting Format and Agenda

The Vital Signs Prioritization Meeting held at the Presidio's Golden Gate Club, July 29-30, 2003, was designed to review the process used by the network to identify and prioritize vital signs indicators, review the results of the web-based ranking, compare the rank order of indicators using different methods of calculating indicator scores and different methods of categorizing the indicators, identify monitoring gaps in the prioritized list, adjust the order of the indicators as necessary, and justify any changes made to the prioritized list.

The first day's discussion included members of the Technical Steering Committee and Board of Directors, and NPS staff whose expertise was pertinent to the discussion of potential vital signs. The day's discussion focused primarily on the scientific and ecological context of the vital signs indicators and encompassed three components:

- Explanation of the ranking process and the calculation of the prioritized list based on weighted mean scores,
- Comparison of the mean weighted scores to alternative score calculations and other data sorts, and
- Alterations to the prioritized list based on noticeable trends in the data or information gaps.

Discussion on the second day was designed to address in more detail management issues, monitoring scale, potential partnerships, the status of existing and potential indicator protocols, and other factors associated with the realities of vital signs planning and implementation. The second day's discussion included members of the Technical Steering Committee and Board of Directors only.

A detailed meeting agenda is listed in Appendix D.

SFAN Web-based Ranking Results

Participant Response Rate

Of the 120 people invited to rank the proposed SFAN vital signs, 55 people participated. Thirty-five (35) of the 55 participants were NPS employees and 20 were non-NPS scorers. It should be emphasized that only NPS staff had the option to rank the legal mandate criterion. It is also noteworthy that not all people who participated in the prioritization process ranked all 64 indicators.

Calculation of Weighted Mean Scores

The 64 SFAN indicators were ranked using weighted mean scores for an initial comparison. Weighted mean scores were calculated from raw data scores submitted by each participant for each indicator. An individual participant's scores were weighted for each criterion, where management significance received a weight of 3, ecological significance received a weight of 2, and both cost effectiveness and legal status received weights of 1. Although the importance of ecological significance was recognized by the SFAN Technical Steering Committee,

management significance was given the highest weight because of the integral role management plays in the long-term sustainability of ecological monitoring programs.

After the participant's scores were weighted for each indicator, the scores were then standardized so that the weighted values would continue to range between 1 and 5 [i.e., the data for each criterion were multiplied by the appropriate weight factor as a fraction (3/7, 2/7, 1/7, 1/7, respectively) rather than as a whole number (3, 2, 1, 1, respectively) such that the cumulative value of the fractions for all criteria was equal to 1]. Weighted and standardized values for the four criteria were then summed to calculate a participant's weighted score for a specific indicator. Missing values or null values entered by participants were accounted for by altering the fraction used to standardize the scores based on which score(s) were missing or null (e.g., the weighted fractions would be 3/6, 2/6, and 1/6 if cost effectiveness was missing or null).

Descriptive statistics (e.g., mean, standard deviation, range, and number of responses (N)) were calculated for each indicator across all participants' scores for that indicator. N, the number of responses for each indicator, varied since not all participants ranked all of the indicators.

Key Assumptions and Biases

The SFAN vital signs selection and prioritization process is not a perfect representation of a rigorous scientific study. Rather, it was designed as tool to assist decision-makers in distilling complex natural resource management issues into a flexible yet effective monitoring program. The SFAN prioritization process, therefore, has several inherent assumptions and biases. Consequently, interpretation of the results has been complicated by the fact that:

- We assumed all significant management issues have been captured,
- We assumed all significant indicators have been represented,
- We assumed all perspectives have been represented,
- We assumed descriptive statistics were adequate for ranking the SFAN vital signs,
- Participating scorers were a pre-selected group (i.e., not random),
- Participants were selected by the SFAN,
- Not all data fields were complete for each indicator,
- The sample size (number of people who scored indicators) was low,
- The number of scorers (N) varied for each indicator, and
- Response rate for each indicator may have been affected by the order of the list of indicators (alphabetical).

Alternative Score Calculations and Data Comparisons

Weighted scores also were calculated using two other methodologies (i.e., by averaging scores for each criterion and without accounting for missing values). The resulting rank order of indicators did not differ appreciably from the initial calculation suggesting that the results were relatively robust. In particular, the positions of the ten highest ranking indicators and three lowest ranking indicators changed very little. Most shifts in rank position from one calculation type to another occurred between adjacently ranked indicators and were the result of slight differences in the second, third, or even fourth decimal place (accuracy beyond the limits of the data but useful for display purposes).

Similarly, indicator rankings were sorted and compared based on management significance (only), ecological significance (only), NPS or non-NPS status, participants' areas of expertise, indicator categories, and spatial scale. Although comparisons were also made with non-weighted mean scores, no comparisons were made with scores unadjusted for missing values. The consensus was that missing values would skew the data appreciably. Descriptive statistics were calculated and displayed for all data permutations.

Selection of High, Medium, and Low Priority Groups

Ranked indicators were divided based on mean weighted scores into high, medium, low priority groups for discussion purposes. Dividing points were determined using a graph of mean weighted scores (and associated standard deviation values) for the indicators in rank order (Figure 2). Where appreciable inflection points occurred along the graph, divisions were noted. The high priority group included the first 18 indicators in rank order (weighted mean scores > 3.5). The medium priority group included indicators ranked 19-44 (weighted mean scores < 3.5). The low priority group included indicators ranked 45-64 (weighted mean scores < 3.0). Because the differences between mean scores was small, priority group assignments were merely approximate. Nonetheless, the divisions aided discussion.

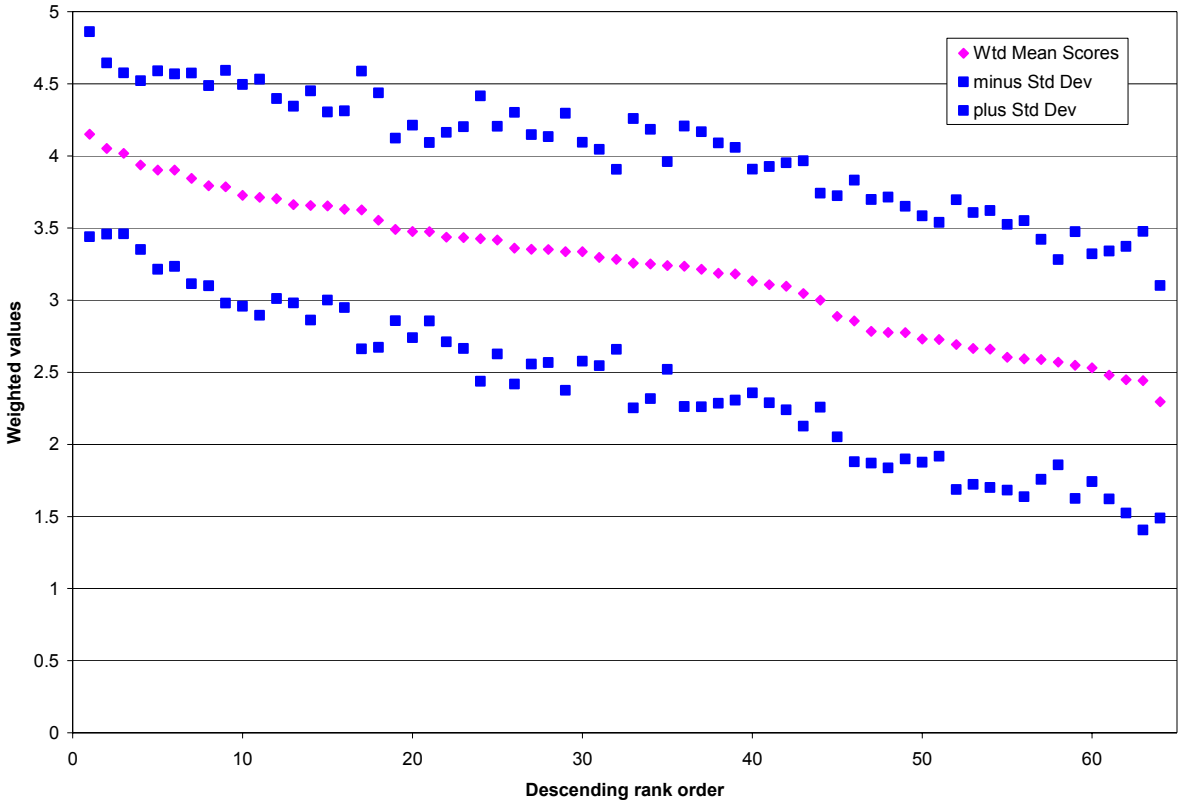

Figure 2. Comparison of indicators in rank order by mean weighted scores.

Frequency Distributions for Mean Weighted Scores

Examples of frequency histograms for mean weighted scores were presented to give participants a visual representation of the distribution types typical of the data (i.e., normal distribution, bimodal, or widely ranging distribution of scores). By examining the indicator histograms, indicators were identified that warranted discussion because they lacked consensus in their scores (i.e., bimodal distributions or widely ranging scores). For the sake of efficiency, examples from each priority group and representations of the various distribution types were displayed rather than displaying all 64 frequency histograms (Appendix E). Indicators requiring further discussion because of variable distributions were noted (Table 3).

Table 3. Indicators requiring further investigation based on frequency distributions.

Rank	Indicator ID	Indicator	Mean	SD	N	Reason*
18	62	Non-Native Fish	3.55458	0.88283	26	WD
24	21	Weather/Climate	3.42613	0.98913	37	WD
26	26	Air Quality	3.35969	0.94229	43	BM
29	35	Tule Elk	3.33571	0.9602	28	BM
33	20	Sudden Oak Death	3.25637	1.00285	31	WD/BM
36	11	Rocky Intertidal Community	3.2351	0.97244	27	WD
37	7	Oak Woodlands Regeneration	3.21429	0.95353	31	WD
38	5	Groundwater Dynamics	3.18687	0.90218	33	BM
39	30	Catastrophic Event Documentation	3.18198	0.87619	37	WD/BM
43	22	Shoreline Shift	3.04609	0.91943	28	WD
44	45	Corvids	2.99985	0.74188	31	WD

*BM = bimodal distribution; WD = wide distribution

Indicators Ranked by Selection Criteria

Weighted mean scores were compared to non-weighted mean scores, mean management scores (only), and mean ecological scores (only) to evaluate the influence of the heavily weighted criteria. The focus of the comparisons was on the top 15 ranked indicators which approximated the high priority group. Discrepancies among the different ranking methods were highlighted for further discussion (Table 4). In general, additions from the ecological significance (only) list resulted from indicators that had broad application across the parks and encompassed community to landscape scale issues. The influence of legal significance and management significance to the ranking was apparent to the meeting participants (i.e., the list for management significance (only) was very similar to the mean weighted scores). Participants also noted that the legal significance criterion was redundant with the management significance criterion, resulting in

inflated scores for indicators protected under the Endangered Species Act or similar legislation. Because a species is either protected or it is not under relevant legislation, participants found it unnecessary to "rank" an indicator's legal significance when this information could have been included in the indicator database and the criterion could have been incorporated into the management significance criterion.

Table 4. Comparison of weighted mean scores with non-weighted, management, and ecological scores for the first 15 ranked indicators. Indicators in italics were not in the top 15 for the mean weighted scores list. Indicators in bold dropped out of the top 15 as a result of score differences.

	Weighted (n=55)	Non-Weighted (n=55)	Management (n=55)	Ecological (n=55)
1	Invasive Plant Species	Freshwater Quality	Invasive Plant Species	Invasive Plant Species
2	Freshwater Quality	Amphibians and Reptiles	Freshwater Quality	Plant community change
3	Salmonid and Stream Fish	Salmonid and Stream Fish	T&E Plant Species	Freshwater Quality
4	T&E Plant Species	Northern Spotted Owl	Salmonid and Stream Fish	Salmonid and Stream Fish
5	Northern Spotted Owl	T&E Plant Species	Western Snowy Plover	Amphibians and Reptiles
6	Amphibians and Reptiles	Invasive Plant Species	Non-native animals	*Weather/Climate*
7	Western Snowy Plover	Western Snowy Plover	*Feral Pigs*	Riparian Habitat
8	Pinnipeds	T & E Butterflies	Northern Spotted Owl	Freshwater Dynamics
9	Plant community change	*Air Quality*	Plant community change	Birds-Landbirds
10	T & E Butterflies	Birds-Landbirds	Pinnipeds	*Marine Oceanography*
11	Non-native animals	Freshwater Dynamics	T & E Butterflies	Non-native animals
12	Freshwater Dynamics	Pinnipeds	Amphibians and Reptiles	*Dune Vascular Plant*
13	Riparian Habitat	*Birds-Seabirds*	Raptors	*Birds-Seabirds*
14	Birds-Landbirds	Non-native animals	Riparian Habitat	Pinnipeds
15	Raptors	*Birds-Shorebirds*	Freshwater Dynamics	*Medium/Large Carnivores*
	Off	**Plant community change** **Riparian Habitat** **Raptors**	**Birds-Landbirds**	**T&E Plant Species** **Northern Spotted Owl** **Western Snowy Plover** **T & E Butterflies** **Raptors**

Indicators Ranked by NPS Status

The top 15 indicators ranked by NPS scorers were compared to a similar list for non-NPS scorers. For the sake of relative comparison, these lists were simultaneously compared to the top 15 indicators ranked by mean weighted scores. These lists were similar with only minor shifts in the position of indicators (Table 5).

Table 5. Comparison of weighted mean scores with NPS scores and non-NPS scores for the first 15 ranked indicators. Indicators in italics were not in the top 15 for the mean weighted scores list. Indicators in bold dropped out of the top 15 as a result of score differences.

	Weighted (n=55)	NPSWeighted (n=35)	Non-NPSWeighted (n=20)
1	Invasive Plant Species	Freshwater Quality	Invasive Plant Species
2	Freshwater Quality	Invasive Plant Species	Salmonid and Stream Fish
3	Salmonid and Stream Fish	Northern Spotted Owl	Western Snowy Plover
4	T&E Plant Species	Salmonid and Stream Fish	T&E Plant Species
5	Northern Spotted Owl	T&E Plant Species	Pinnipeds
6	Amphibians and Reptiles	Amphibians and Reptiles	Non-native animals
7	Western Snowy Plover	Freshwater Dynamics	Raptors
8	Pinnipeds	Western Snowy Plover	Amphibians and Reptiles
9	Plant community change	Plant community change	Birds-Landbirds
10	T & E Butterflies	*Feral Pigs*	Plant community change
11	Non-native animals	Pinnipeds	Freshwater Quality
12	Freshwater Dynamics	T & E Butterflies	T & E Butterflies
13	Riparian Habitat	Riparian Habitat	Northern Spotted Owl
14	Birds-Landbirds	*Dune Vascular Plant*	*Non-Native Fish*
15	Raptors	Non-native animals	Riparian Habitat
		Birds-Landbirds	**Freshwater Dynamics**
	Off	**Raptors**	

Indicators Ranked by Participants' Specialties

The top 15 indicators also were compared by the participants' areas of specialty (or expertise). Participants were divided into ecologists, botanists, wildlife biologists, geologists, and hydrologists, although many participants did not fit neatly into these categories. The biological groups (e.g., ecologists, wildlife biologists, botanists) accounted for approximately 81% of the scorers and, therefore, produced lists similar to the weighted mean list (Table 6). The geologists and hydrologists both generated different lists than the biologists and the weighted mean list. In fact, the top six indicators on the geologists' list were not even in the top 15 on the weighted mean indicator list. These results were attributed to the fact that in most cases only one person scored indicators for the geologist group. Results from the geologist group, therefore, should be considered with caution. Both the geologist group and the hydrologist group were under-represented, so due care was required in assessing both sets of results.

Table 6. Comparison of scores based on participants' specialty areas for the first 15 ranked indicators. Indicators in italics were not in the top 15 for the mean weighted scores list. Indicators in the "off" box dropped out of the top 15 as a result of score differences. Indicators in the "not" box were not ranked by that group. Numbers in parentheses are the rank position of that indicator for that specialty list.

	Ecologists n=16	Botanists n=14	Wildlife n=13	Geo "ists" n=5	Hydro "ists" n=5
1	Invasive Plants	Invasive Plants	Freshwater Quality	*Oak woodlands reg.*	Freshwater Quality
2	Freshwater Quality	Plant comm.change	T&E plants	*Rocky intertidal com*	Amphibians/reptiles
3	Salmonid & fish A	***Marine water qual.***	W.snowy plover	*Corvids*	Freshwater dynamic
4	Pinnipeds	Salmonid & fish A	Freshwater dynamics	***Stream/watershed***	W.snowy plover
5	***Feral pigs/habitat***	T&E butterflies	Pinnipeds	***Dune vasc.plants***	N.spotted owls
6	Amphibians/reptiles	Pinnipeds	Salmonid & fish A	*Resilience - Fire*	***Marine water qual***
7	Raptors	*Dune vasc.plants*	N.spotted owls	Non-native animals	T&E plants
8	T&E plants	Non-native animals	Landbirds	T&E plants	Salmonid & fish A
9	Riparian habitat	T&E plants	Invasive Plants	*Terr.invert.com*	Catastro.event doc.
10	N.spotted owls	Raptors	Non-native animals	*Landform type*	***Stream/watershed***
11	Landbirds	***Shorebirds***	***Feral pigs/habitat***	*Sub-tidal monitoring*	***Air quality***
12	Non-native animals	Amphibians/reptiles	*Seabirds*	Invasive Plants	*Aquatic inverts.*
13	*Non-native fish*	N.spotted owls	Riparian habitat	Pinnipeds	***Shorebirds***
14	Plant comm.change	Freshwater Quality	Amphibians/reptiles	Plant comm.change	T&E butterflies
15	Freshwater dynamics	*Med.to lg.carnivors*	***Air quality***	T&E butterflies	*Estuarine fish*
OFF	W.snowy plover (16)		T&E butterflies (17)	Amphibians/rept (19)	Non-native anim (17)
			Raptors (19)	Freshwater qual.(20)	Plant comm.chg (18)
	T&E butterflies (23)	Riparian habitat (23)		Freshwater dyn.(24)	Riparian habitat (19)
		W.snowy plover (24)		Raptors (26)	Invasive plants (20)
			Plant comm.chg (27)	Riparian habitat (30)	Pinnipeds (30)
		Landbirds (33)		Landbirds (34)	Raptors (31)
		Freshwater dyn (44)		N.spotted owls (39)	Landbirds (32)
Not				Salmonid & fish A W.snowy plover	

Indicators Organized by Indicator Category

Indicators were also sorted into 10 categories to assist in identifying monitoring needs:

- Air quality, visibility, and sound,
- Community assemblages,
- Disturbance events and recovery,
- Geology, geomorphology, and soils,
- Guilds,
- Landscape patterns,
- Species of special interest,
- Stressors,
- Water quality and quantity, and
- Weather and climate.

Four of the ten indicator categories were not included in the top 15 indicators as ranked by weighted mean scores – air resources, disturbance events and recovery, geology/geomorphology/soils, and weather/climate. Biological guilds and community assemblages were well represented on the weighted mean list. The first 34 indicators were required to represent all ten indicator categories.

Indicators Organized by Spatial Scale

The top 15 indicators ranked by mean weighted scores also were evaluated based on their representation of nine ecological spatial scales:

- Habitat,
- Community,
- Sub-watershed,
- Watershed,
- County,
- Region,
- Coast range,
- State, and
- Floristic province.

Although there was some controversy over the appropriate designation of scale to a few indicators, all scales were represented by the top 15 indicators. More specifically, this list contained indicators that could be monitored in all parks in the network.

Discussion of Ranking Results

Summary of Discrepancies Among Data Comparisons

The alternative score calculations and data comparisons used to evaluate the weighted mean indicator list produced several indicators requiring further discussion (Table 7). Discussion was not limited to this group of indicators, but the list highlighted discrepancies among the data comparisons that were performed during the analysis of the data.

Table 7. Summary of discrepancies among indicator rankings from several data sorts (i.e., management significance, ecological significance, NPS status, and participant discipline). Comparisons were limited to the top 15 indicators for each data sort and based on mean weighted scores. Numbers following the indicator name refer to the indicator's rank within the list for that data sort. Note that the "Geo-ist" and "Hydro-ist" disciplines were combined because of low respondent numbers for each category.

	SELECTION CRITERIA		**AGENCY**		**DISCIPLINE**				
	Management Significance	Ecological Significance	NPS	non-NPS	Ecologist	Botanist	Wildlife	Geo-ist	Hydro-ist
Add to top 15							Air quality 15		
									Aquatic inver12
									Catast.evt doc 9
								Corvids 3	
		Dune v.plant 12	Dune v.plant 14			Dune v.plant 7		Dune v.plant 5	
	Feral pigs 7		Feral pigs 10		Feral pigs 5		Feral pigs 11		
								Landform 10	
		Marine ocean.10							
						Mar.wat.qual.3			Mar.wat.qual.6
		Med-lg.carniv. 15				Med-lg.carniv.15			
				Non-nat.fish 14	Non-nat. fish 13				
								Oak wood 1	
								Rocky inter 2	
		Seabirds 13					Seabirds 12		
						Shorebirds 11			Shorebirds 13
								Stream/wat.4	Stream/wat.10
								Sub-tidal 11	
								Terr.inverts 9	
		Weather 6							
Drop from top 15								Amph/rept 19	
								Freshwat.qua 20	
		Freshwater dyn.		Freshwtr dyn 26		Freshwat.dyn 44		Freshwat.dyn 24	
									Inv.Plants 20
	Landbirds		Landbirds17			Landbirds 33		Landbirds 34	Landbirds 32
									Non-nat.anm.17
								N.spot.owls 39	
							Plant com.27		Plant com.18
									Pinnipeds 30
	Raptors		Raptors21				Raptors 19	Raptors 26	Raptors 31
						Riparian hab. 23		Riparian hab 30	Riparian hab 19
					W.sn.plover 16	W.sn.plover 24			
					T&E butterflies 23		T&E butter.17		

Proposed Changes and Their Rationale

Alterations made to the initial weighted list of indicators were based on the need to cover a range of ecological scales, a variety of spatial scales, various monitoring objectives, and different indicator types. The indicators listed in Table 7 were discussed along with several other proposed changes over the course of the two-day Vital Signs Prioritization Meeting. While a variety of changes were proposed, the most significant changes and their associated justifications are listed below. Those indicators that were promoted in rank are highlighted in boldface type. Any changes made in the order of the indicators, of course, affected the rank of all other indicators. Several name changes and other alterations to the list of mean weighted indicators were proposed. Comments elicited from ranking participants during the ranking process were consulted throughout the prioritization discussion and influenced several decisions. The resulting

changes are reflected below and in the recommended list of prioritized vital signs submitted to the Board of Directors.

- **Weather/Climate** – This indicator was moved from position #24 to #1 because the data from this indicator are essential to and support most other indicators, it is network-wide, and it ranked high on the ecological significance criterion list. It was believed that this indicator may have received low scores because another agency is doing most of the monitoring (which should not have affected the significance of the indicator). It also scored in the middle because it does not have high management significance scores.
- **Air Quality** – This indicator was moved from #26 to #4 because of legal mandates (two Class I airsheds in the network), because of ecological importance (affects water and terrestrial resources), and because of significant contributions from partners. Again, it was proposed that some scorers did not understand that whether it is being monitored currently or not should not influence its monitoring significance. It is important enough that the network would try to do the monitoring if it were not already being done. It was high on the non-weighted, wildlife and hydrologist lists.
- **Shoreline Shift** (now Coastal Dynamics)– This indicator was moved from #43 to #19 because it is a significant management issue, resources may be lost because of it, baseline information exists, and the Geologic Division will cover most costs. It links to catastrophic events, climate change, and soil erosion/deposition.
- **Marine Oceanography** – This indicator was moved from #44 to #21. It is the physical driver for oceans. NOAA currently collects the data. It is monitored offshore, whereas Marine Water Quality is monitored nearshore. It is high on the ecological significance list.
- **Soil Erosion/Deposition** – This indicator was moved upwards from #42 to #20 because it is the top priority for JOMU and is an issue in all network parks. It encompasses similar issues as Water Quality and Stream Channel/Watershed indicators.
- **Natural Soundscapes** – This indicator was moved from #61 to #29 in response to new legislative mandates for monitoring soundscapes. GOGA will need to monitor sounds in coming years. The FAA will fund some of the monitoring.
- Tule Elk – This indicator remained relatively unchanged (moved from #29 to #28). It is a significant management issue at PORE, is an ecological driver for the ecosystem (grazing), and involved legal issues.
- Oak Woodlands Regeneration (now Oak Woodlands)– This indicator also remained relatively unchanged (moved from #37 to #38). It encompasses both rare and invasive species. It ranked higher than the other three community-based plant indicators. It is not monitored every year. Oaks occur in all parks. Regeneration is sporadic, so the regeneration monitoring was removed from the protocol for this indicator.
- Sudden Oak Death – This indicator changed from #33 to #40. Because it is a relatively new stressor, our understanding of it is limited currently. JOMU will implement monitoring of this indicator while they monitor oak woodlands.
- Rocky Intertidal Community – This indicator was moved from #36 to #32. It is monitored throughout the West Coast, so there are many potential partners. Monitoring has led to NRDA damage assessments. A good baseline exists for post-catastrophic events.

- Groundwater Dynamics – This indicator moved from #38 to #43. It is expensive and issue-specific rather than a form of general monitoring. There is opportunity for funding elsewhere.
- Catastrophic Event Documentation – This indicator was left relatively unchanged (moving from #39 to #44) because it only captures sporadic events. Protocols are needed describing the parameters to measure and standard methodologies to collect data when an event occurs are also needed. This includes data storage and management. This indicator documents how the events affect the ecosystem. Weather and water flow are pre-event; this is post-event. Monitoring data leads to adaptive management. The hydrologist group ranked it in their top ten.
- Corvids – This indicator was left unchanged (moving from #44 to #47) because of uncertainty surrounding monitoring methodology. But, it stays well situated for partnering.
- Shorebirds, Seabirds and Waterbirds were to remain in relative order to each other in the upper medium group because birds act as good indicators, and each one represents a different ecosystem.
- Aquatic Invertebrates were demoted from #31 to #62 because *California Freshwater Shrimp were removed and added to the Salmonid/Fish Assemblage* indicator (which most likely boosted the ranking of Aquatic Invertebrates). It would require a significant effort to develop a baseline for this indicator.

Participants also were given an opportunity to group, rename and identify indicators that we missed earlier in the process. The following changes were made:

- Plant Community Change at Multiple Scales was divided into two indicators – 1) Regional Landscape and Land Use Change (remote sensing) which was placed at #12, and 2) Plant Community Change (field crew mapping and measurement) which was placed at #11. There were two different scales, methodologies, and potential funding sources involved. Though divided, these indicators remained relatively unchanged in their ranking.
- ***Wetlands*** indicator was added. Wetlands include not only plant communities but the hydrologic regime and the physical aspects of the land. Additionally, eelgrass is the marine component and involves a significant legal issue. Wetlands are related to riparian habitat and to freshwater dynamics, so it was placed on the list in that grouping.
- *Non-native fish were added to non-native animals*.
- Marine fish were added to estuarine fish. *The name was changed to Marine and Estuarine Fish*.
- Phytoplankton. *We need to ensure that it is part of Marine Water Quality*.

<u>Potential Partnerships and Protocol Status</u>

The Meeting ended with a short discussion identifying what will be needed for implementation strategies. Partnerships will assist the SFAN in implementing more vital signs monitoring projects than would be possible without assistance. Consequently, identification of current and potential partnerships was considered important. Some partners have already been identified in the indicator worksheets developed by the technical focus groups. The Technical Steering

Committee will continue identifying potential partnerships for each indicator, especially those that are high on the list.

Peer-reviewed protocols also will be needed before monitoring is implemented. Participants, therefore, identified the status of monitoring protocols for each indicator (Table 8).

Recommended List of Prioritized Vital Signs

Comments from the Vital Signs Prioritization Meeting were incorporated into the list of prioritized vital signs recommended to the SFAN Board of Directors (Table 8). The prioritized list is presented in its rank order. It is necessary to emphasize that many indicators, especially those indicators in the middle of the range, had virtually identical mean weighted scores. It is also understood that selection of vital signs is an iterative process. Selected vital signs are subject to change as fiscal resources and management issues change. Adjustments to the monitoring program also may occur as subsequent monitoring program reviews conducted approximately every five years provide feedback on the efficacy of the selected indicators. Therefore, indicators may be chosen for monitoring out of rank order if partnerships present themselves, management issues change, ecological information is updated, or linkages between high-ranked and low-ranked indicators allows for efficient and effective monitoring.

Table 8. Recommended list of prioritized vital signs for the San Francisco Bay Area Network. Boldface indicators represent major adjustments.

New Rank	Previous Rank	Indicator Name	Protocol Status*
1	24	**Weather/Climate**	2
2	1	Invasive Plant Species (terrestrial & aquatic)	1
3	2	Freshwater Quality	3
4	26	**Air Quality**	4
5	3	Stream T&E Species & Fish Assemblages (Salmonids)	3
6	4	Rare, Threatened, and Endangered (T&E) Plant Species	2
7	5	Northern Spotted Owl	3
8	6	T&E Amphibians and Reptiles	3
9	7	Western Snowy Plover	3
10	8	Pinnipeds	3
11	9	Plant community change at multiple scales	2
12	9	Regional landscape & land use change (evolved from Plant Community Change at Multiple Scales)	3
13	10	Threatened and Endangered (T & E) Butterflies	2
14	12	Freshwater Dynamics	2
15	**New**	**Wetlands**	2
16	13	Riparian Habitat	2
17	14	Birds-Landbirds	3
18	15	Raptors and Condors	3
19	43	**Coastal Dynamics (formerly Shoreline Shift)**	3
20	42	**Soil Erosion/Deposition**	2

21	41	**Marine Oceanography**	4
22	16	Dune Vascular Plant Assemblages	1
23	17	Feral Pigs and Habitat Damage	3
24	11	Non-Native Animals (includes terrestrial & aquatic)	2
25	19	Birds-Shorebirds	3
26	20	Birds-Seabirds	3
27	21	Birds-Waterbirds	3
28	29	Tule Elk	3
29	61	**Natural Soundscapes**	2
30	22	Medium to Large Carnivores	2
31	23	Stream Channel and Watershed Characterization	3
32	36	**Rocky Intertidal Community**	4
33	25	Marine Water Quality	2
34	27	Townsend's Big-Eared Bats	3
35	46	Bank Swallow	2
36	28	Small Mammals and Herpetofauna (inc. Coast Horned Lizard)	3
37	31	Grassland Plant Communities	2
38	37	**Oak Woodlands--note change in title**	2
39	32	Marine and Estuarine Fish (changed name)	2
40	33	Sudden Oak Death	3
41	34	Resilience Monitoring – Fire	1
42	35	Bat guild	2
43	38	Groundwater Dynamics	2
44	39	Catastrophic Event Documentation	1
45	48	Sub-tidal monitoring	2
46	40	Lichens	3
47	44	Corvids	2
48	45	Cave Communities	1
49	47	Terrestrial Invertebrate Community (non-T&E)	1
50	49	Resilience Monitoring – Flood	1
51	50	Pelagic Wildlife	3
52	51	Wildlife Diseases	2
53	52	Landform Type	3
54	53	Natural Lightscape	3
55	54	Ozone (O_3) Sensitive Vegetation	2
56	55	Soil Biota	3
57	56	Black-tailed Deer	3
58	57	Mass Wasting (Landslide)	2
59	58	Plant Species At The Edge Of Their Range	1
60	59	Sandy Intertidal Community	2
61	60	Cetaceans	3
62	31	**Aquatic Invertebrates**	3
63	62	Soil Structure, Texture and Chemistry	3
64	63	Viewshed	3

*1= nothing available; 2= being developed; 3= standard methodologies exist; 4= needs review; 5= reviewed.

Future SFAN Vital Signs Program Development

Review and Comment by the Board of Directors

Following the July 2003 Vital Signs Prioritization Meeting, the Network Inventory and Monitoring Coordinator summarized the meeting's discussions and forwarded the Technical Steering Committee's recommendations to the Board of Directors for review and comment. The Technical Steering Committee recommended that the Board of Directors approve the list of prioritized vital signs that resulted from the meeting. The Board may change the prioritized list. Any changes made to the prioritized list will require documentation so that the final list of SFAN vital signs may be justified appropriately and the decision-making process recorded as part of the SFAN Inventory and Monitoring Phase II report.

Incorporate Revisions into Phase II Report

Selection of ecological indicators and their prioritization are significant steps forward in the development of a network-wide monitoring program (see Steps to Developing a Network Monitoring Program, p. 7). Because of their importance, the National Program requires the network to document the process by which the vital signs were selected and prioritized in addition to recording the prioritized list. Any changes made to the process or the list also require documentation and justification. This information is then incorporated into the network's Phase II report which summarizes the steps the network has undertaken in developing its monitoring program. The information outlined herein will be incorporated into the SFAN Phase II report.

Phase II Report Regional and National Review

Upon completion of the vital signs selection and prioritization process, internal review of the network's progress to-date occurs via the Phase II report. Following internal review, regional and national peer review of the network's monitoring program development takes place also by way of the Phase II report. This step incorporates a degree of external review which ensures that the management needs of each park are met and that the developing monitoring program is scientifically sound and broadly accepted (see Peer Review, p. 7). Review at this stage in the network's monitoring program development also allows for adjustment and inclusion of oversights prior to the decisive stages of sampling design and protocol development.

Sampling Design and Monitoring Protocols (Phase III)

Sampling design and monitoring protocol development are the next steps in the evolution of the network's monitoring program following peer review of the vital signs selection stage. Information obtained from protocol questionnaires used to develop the network's indicator database will assist the SFAN in developing appropriate sampling designs and monitoring protocols for the Vital Signs Monitoring Program. Continued cooperation from workshop participants and subject-specific scientists also will be necessary to ensure that a scientifically rigorous program is developed. Internal and external review will be conducted throughout this process as an essential part of the SFAN Vital Signs Monitoring Program.

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Appendix A

List of Participants
in the July 2003
Vital Signs Prioritization Meeting

Appendix A. List of participants in the July 2003 Vital Signs Prioritization Meeting.

Participant	Title
Dawn Adams*	PORE I & M Coordinator
Sarah Allen*	Senior Science Advisor at PORE
Jennifer Bjork*	SFAN I & M Coordinator
Mary Cooprider*	SFAN Water Quality Specialist
Amy Fesnock*	PINN Wildlife Biologist
Darren Fong*	GOGA Aquatic Biologist
Glenn Fuller	JOMU/EUON Superintendent
Jay Goldsmith	PWR Wildlife Biologist
Sue Fritzke	GOGA Plant Ecologist
Daphne Hatch*	GOGA Chief of Natural Resources
Brannon Ketcham*	PORE Hydrologist
Amy Langston	SFAN Biological Technician
Tom Leatherman*	PINN Chief of Natural Resources
Bill Merkle	GOGA Wildlife Biologist
Susan O'Neil*	SFAN Biological Science Technician
Brian O'Neill	GOGA Superintendent
Lorraine Parsons	PORE Wetland Specialist
Judy Rocchio	PWR Geology Liaison
Jane Rogers	PORE Plant Ecologist
Bill Shook	PORE Chief of Natural Resources
Brad Welch	SFAN Ecologist
Tamara Williams	GOGA Hydrologist
Brian Witcher*	SFAN Data Manager

*SFAN Technical Steering Committee member

Appendix B

List of Participants
Invited to Take Part in the
SFAN Web-based Ranking Process

Appendix B. List of participants invited to take part in the SFAN web-based ranking process.

First Name	Last Name	Title	Organization
Myla	Ablog	Assistant Monitoring Manager	NPS-GOGA
Steve	Acker		NPS-OLYM
Dawn	Adams	Park I&M Coordinator	NPS-PORE
Sarah	Allen	Senior Science Advisor	NPS-PORE
Leslie	Allen	Wetlands Ecologist	NPS-PORE
Maria	Alvarez	Plant Ecologist	NPS-GOGA
Roberto	Animas		
Michael	Baefsky	Landscape Ecologist	Diablo Valley College
Sue	Bainbridge		Jepson Herbarium
Grant	Ballard		PRBO Conservation Science
Keith	Barker		NPS-FIRE
Reginald	Barrett		UC Berkeley
Jonathan	Bayless	Museum Curator	NPS-GOGA
Rebecca	Beavers	Coastal Geologist	NPS-GRD
Ben	Becker	Marine Ecologist	NPS-PORE
Jayne	Belnap	Professor	USGS-BRD Moab
Shelly	Benson	Rare Plant	NPS-PORE
Jennifer	Bjork	Network I&M Coordinator	NPS-SFAN
Erin	Boydston	Research Ecologist	USGS-BRD GOGA Field Sta.
Peter	Brastow	NR Specialist	NPS-GOGA
John	Brock	Oceanographer	USGS
Linda	Brown		
Ray	Budzinski		East Bay Regional Parks
Lane	Cameron	Medit. Coast Network Coordinator	NPS I&M
Janet	Caprile		UC Cooperative Extension
Harry	Carter		
Bob	Case		USDA
Mary K.	Chase	Terrestrial Science Coordinator	Point Reyes Bird Observatory
Leslie	Chow		USGS-WERC
Ed	Connor	Biology Professor	San Francisco St. Univ.
Mary	Cooprider	Water Quality Specialist	NPS-SFAN
Dan	Crocker		
Marsha	Davis		NPS- PWR
Gary	Davis	Senior Scientist	NPS-CHIS
Kathy	Dickey		Jepson Herbarium
Joe	Didonato		East Bay Regional Parks
Stefanie	Egan		NPS-SFAN
Tom	Elliott	Restoration Coordinator	GGNPA
Debbie	Elliottfisk		UC Davis
Barbara	Ertter		Jepson Herbarium
Steve	Fancy	National I&M Coordinator	NPS-WASO I&M
Dr. Gary	Fellers	Research Scientist	USGS-BRD
Amy	Fesnock	Wildlife Biologist	NPS-PINN
Dale	Flowers	Facilitator	Facilitator
Darren	Fong	Aquatic Ecologist	NPS-GOGA

First Name	Last Name	Title	Organization
Marie	Fontaine	Botanist	GGNPA
Sharon	Franklet	Plant Ecologist	NPS-PINN
Glenn	Fuller	Superintendent	NPS-JOMU/ EUON
Tom	Gardali	Biologist	PRBO Conservation Science
Natalie	Gates	Wildlife Biologist	NPS-PORE
Frank	Gehrke		State Dept. of Water Resources
Geoff	Geupel		PRBO Conservation Science
Peter	Gogan		
Jay	Goldsmith	Wildlife Biologist	NPS-PWRO
Rick	Golightly	Wildlife Biologist	Humboldt State Univ.
Dave	Graber	Scientific Advisor	NPS-SEKI
Russell	Graymer		USGS
Deanna	Greco		NPS-GRD
Terry	Griswald	Entomologist	Utah Bee Lab Researcher
Edwin	Grosholz	Professor, Dept. Env. Science/Policy	UC Davis
Frances	Gulland		
John	Hafernik	Entomologist	San Francisco St. Univ.
Julie	Hammon		BLM
Jim	Harvey		
Daphne	Hatch	NR Chief	NPS-GOGA
Peggy	Herzog	Fire ecologist	NPS-Fire ecologist
Rainer	Hoenicke	Director	California Legacy Project
Pete	Holloran		Calif. Native Plant Society
Mark	Homrighausen	Range Management	NPS-PORE
Dan	Howard	Assistant Manager	NOAA-Marine Sanctuary
Roy	Irwin		NPS- WRD
Bill	Jackson	Chief, WASO Operations Branch	NPS-WASO
Kurt	Jenkins		
Eric	Jepsen		Point Reyes Bird Observatory.
Michelle	Jesperson	Associate Regional Director	Nat'l Parks & Conserv. Assoc.
Paul	Johnson	Biologist	NPS_PINN
Todd	Keeler-wolf		
Jon	Keeley		USGS-BRD
Carol	Keiper		
John	Kelley		Audubon
Joanne	Kerbavaz	Dist. Ecologist, Bay Area	Calif. State Parks
Brannon	Ketcham	Hydrologist	NPS-PORE
Mietek	Kolipinski		NPS-PWRO
Penny	Latham	Regional I&M Coordinator	NPS-PWR
Tom	Leatherman	Chief, Resource Management	NPS-PINN
Gretchen	Lebuhn	Biology Professor	San Francisco St. Univ.
Wilde	Legard		East Bay Regional Parks
Howard	Levitt	Assistant Superintendent	NPS-GOGA
Jeff	Lovich	Center Director	USGS-BRD
Ken	Mabery		NPS-Regional Ecosystem Office
Mary Ann	Madej		
Michael	McGowan	Professor, Biology./Fisheries	San Francisco St. Univ.

First Name	Last Name	Title	Organization
Paul	McLaughlin	Crissy Field Leader	NPS-Presidio
Dr. Mario	Menesini		Environmental Alliance
Mia	Monroe	Muir Woods-Site Supervisor	NPS-GOGA
Tom	Moore		Calif. Dept. Fish & Game
Chad	Moore	Geomorphologist	NPS-PINN
David	Morafka		California St. Univ.
Barbara	Moritsch	Plant Ecologist	NPS-YOSE
Cicely	Muldoon	Superintendent	NPS-PINN
Bonnie	Murchey		USGS
Don	Neubacher	Superintendent	NPS-PORE
Greg	Newman	Researcher	Col. St. Univ., NR Ecol. Lab
Susan	O'Neil	Biological Technician	NPS-SFAN
Brian	O'Neill	Superintendent	NPS-GOGA
Becky	Ota		Calif. Dept. Fish & Game
Vicki	Ozaki	Geologist	NPS-REWO
Gary	Page		
Ed	Pancoast		Urban Creeks Council
Steve	Pardieck		Muir Heritage Land Trust
Mike	Parker		
Tom	Parker	Professor	San Francisco St. Univ.
Lorraine	Parsons	Wetland Ecologist	NPS-PORE
Dale A.	Pierce	Field Supervisor	US FWS
Ellen	Porter	Liaison for I&M program	NPS-Air Res. Div.
Vanessa	Rashbrook		Bodega Marine Lab
Kelly	Redmond		
Paul	Reeberg	Fire Management	NPS-PWRO
Dale	Roberts	Data Manager	NPS-PORE/NOAA
Judy	Rocchio	Air Quality	NPS-PWR
Regina	Rochefort		
Jane	Rodgers		NPS-PORE
Bruce	Rogers	Geologist	USGS
Jan	Roletto		NOAA
Kerry	Rost		Calif. NRCC
Will	Russell	Ecologist	USGS-BRD
Howard	Sakai	Wildlife Ecologist	NPS-REDW
Daniel	Sarr	Klamath Network Coordinator.	NPS I&M
Ray	Sauvajot	Chief, Science & Planning	NPS-SAMO
Dave	Schaub		
Dave	Schirokauer	GIS Biologist	NPS-PORE
Steve	Schwarzbach		USGS
Craig	Scott	GIS Specialist	NPS- GOGA
Steve	Shackelford	I&M Coordinator	USGS-BRD
Mack	Shaver		Contractor
Bill	Shook	Chief, Resource Management	NPS-PORE
Jessica	Shors		NPS-GOGA
Bobbi	Simpson	Liaison EPMT	NPS-PORE
Dave	Smith		USDA

First Name	Last Name	Title	Organization
Del	Smith		Modesto Jr. College
Larry	Soenen	District Conservationist	
Bob	Soost		Calif. Native Plant Society
Tom	Stohlgren	Professor, Colorado St. Univ.	USGS-BRD NR Ecol Lab
Katrina	Strathmann	Natural Resources Specialist	NPS-GOGA
Bill	Sydeman		
Terri	Thomas	Natural Resources Manager	NPS Presidio Trust
Diane	Thomson		UC Davis
Minda	Troost	Physical Scientist	NPS-PINN
Brian	Twedt		NPS-PORE
Mike	Vasey	Professor	San Francisco St. Univ.
Kristen	Ward	Monitoring Ecologist	NPS-GOGA
Samantha	Weber	Strategic Planning	NPS-YOSE
Brad	Welch	I&M Ecologist	NPS- Fort Collins
Tamara	Williams	Hydrologist	NPS-GOGA
Brian	Witcher	Network Data Manager	NPS-SFAN
Roy	Woodward		Calif. State Parks

Appendix C

Web-based Ranking Instructions

Appendix C. Web-based ranking instructions.

We are soliciting your assistance in developing a large-scale, long-term ecological monitoring program for the National Parks in the Bay Area. Through the San Francisco Bay Area Network's (SFAN*) Inventory and Monitoring Program, you may have been invited to one of our past Scoping Workshops. We have determined what our key resources are and what indicators we can use to monitor change of those resources in the Parks. We now need to prioritize the important indicators since we cannot monitor everything on the list.

We ask that you read the background information attached to this e-mail and refer to the directions below. We have set up a web-site that we would like you to use in order to weigh in on this important decision. Each indicator has as much information as we could provide regarding scale, methods, etc. You are asked to review each indicator and rank it with respect to ecological significance, management significance and cost effectiveness. NPS staff will also be asked to rank with respect to legal mandate. Descriptions of the criteria to use when ranking these categories are available as an attachment to this e-mail as well as on the ranking website:
http://www.nature.nps.gov/im/units/nw27/ranking.htm

Background for ranking process.c Ranking criteria.doc

After analysis, results from this process will be summarized and submitted to the SFAN Steering Committee and Board of Directors for review and comment. Results will be available for ranking participants to view after August 15, 2003.

Please keep this email and let us know if you have problems or questions regarding the web-site. This is a time consuming process and we sincerely appreciate the time and effort you put forward in this endeavor.

*Network includes: Eugene O'Neill National Historic Site (EUON), Fort Point National Historic Site (FOPO), Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Muir Woods National Monument (MUWO), Pinnacles National Monument (PINN), Point Reyes National Seashore (PORE), and the Presidio of San Francisco (PRES)

If you have questions or experience problems with the website please contact Brian Witcher at (415) 331-5734 or Susan O'Neil at (415) 331-3679
Brian_Witcher@ nps.gov, Susan_O'Neil@nps.gov

Directions:

You have over two weeks to complete the ranking process: **June 27 to July 11, 2003**. Use the **password: SFANrank1!** (case sensitive) to access the web-site:
http://www.nature.nps.gov/im/units/nw27/ranking.htm

1. Identify yourself by entering your personal information in the blanks provided.
2. Read the criteria for prioritizing indicators carefully and refer back to it when ranking.
3. The indicators are listed in alphabetical order, but you don't need to stick with that pattern when completing this activity.

4. Read all of the information provided about the indicators before ranking. This will reduce ranking based solely on assumptions taken from the name of the indicator.
5. Rank each indicator criteria from very low to very high. The no opinion value should be used if you don't know enough about the criteria or indicator to rank it. When ranking, be relatively conservative with your scores. We consider all of these indicators important, but cannot monitor them all.
6. After ranking the first indicator, return to the main page and select the next indicator of your choice. You may rank them in any order you choose.
7. To exit the web-site click on the "x" (close window) button in the upper right hand corner of the screen. Your results will be saved on our server.
8. You may log-in to the site as many times as necessary to finish ranking or change your scores.
9. You are given two locations in which to provide us feedback. The comment box under the ranking scores is provided if you'd like to justify your ranking. Comments at the bottom of the indicator information are to give us information on citations or methods that were not included in the worksheet. We will look at these for future work when developing protocols.

Appendix D

Vital Signs Prioritization Meeting Agenda

Appendix D. Vital Signs Prioritization Meeting agenda.

Ranking Meeting – VS Indicators
San Francisco Bay Area Network

Meeting objective**: To use the results and discussions of the web-based ranking in the development of a prioritized list of vital signs indicators to use for the first five years of the monitoring program.**

Day 1 (9:30 am – 4 pm)
Invited Participants (20 + Board):

Adams, Dawn *	PORE I&M Coordinator	wildlife
Allen, Sarah *	Research Scientist	ecology
Bjork, Jennifer *	SFAN I&M Coordinator	ecology
Cooprider, Mary *	SFAN Water Quality Specialist	water
Fesnock, Amy *	PINN Wildlife Biologist	wildlife
Fong, Darren *	GOGA Fisheries Biologist	ecology
Goldsmith, Jay	PWR Wildlife	ecology
Franklet, Sharon	PINN Botanist	vegetation
Fritzke, Sue	GOGA Botanist	vegetation
Hatch, Daphne *	GOGA NR Division Chief	wildlife
Ketcham, Brannon *	PORE Hydrologist	water
Leatherman, Tom *	PINN NR Division Chief	botany
Moore, Chad	PINN Physical Scientist	geology, air
O'Neil, Susan *	SFAN Biological Technician	vegetation
Parsons, Lorraine	PORE Wetland Specialist	water
Rocchio, Judy	PWR Geology Liason	air
Rogers, Jane	PORE Botanist	vegetation
Bill Shook	PORE Chief Natural Resources	
Welch, Brad	SFAN Ecologist	ecology
Tamara Williams	GOGA Hydrologist	water
Witcher, Brian *	SFAN Data Manager	geology

* Steering Committee Member

Board Member Attendees:

O'Neill, Brian	GOGA Superintendent
Fuller, Glenn	JOMU/EUON Superintendent
Muldoon, Cicely	PINN Superintendent
Neubacher, Don	PORE Superintendent

Please remember:
- All indicators that were ranked are important, but some need to be selected to go first.
- The response to the web-based ranking was not random. We selected participants based on participation in the process, therefore the database that has been developed already has biases.

- Not everyone who tried to rank (n=4) was able to get onto the web page.
- Let's complete the process and see how it turns out before making any wild changes.

1. **Review the process** to identify and rank the indicators used to date. Review the process that will be used today. We will eventually have a chance to discuss each indicator and come to a concensus on the mean rank and priority group. (J.Bjork) (15 mins)

2. **Review the basic database contents and structure**. (B.Witcher) (15 mins)
   Database, original (with comments?)

3. **Review the list of indicators and determine priority groupings**. Review the results of the web-based ranking and how to read the graphical box plots. All data sorts include mean, mode, standard deviation (SD), range, number of ranks (n). The indicators will be listed by mean scores. The mode or standard deviation can be used to break ties. (B.Welch) (2 hrs)

   a) Review the weighted list of indicators. This is the primary list as decided by the Technical Steering Committee on 7/10. It will be available on the web prior to the close of business 7/24 at http://www.nature.nps.gov/im/units/nw27/ranking.htm
      Data sort 1, mean rank list using weighted criteria
      Weights: Management significance = 3
      Ecological significance = 2
      Legal significance = 1
      Cost effectiveness/partnerships = 1

   b) Compare three other data sorts to the primary list.
      Data sort 2, mean rank list using all 4 criteria.
      Data sort 3, mean rank list using ecological significance criteria only
      Data sort 4, mean rank list using management significance criteria only
      Adjust the weighting of the primary list, if necessary. (Brian will adjust the database on screen)

   c) Group the primary list into high, medium and low priority using natural breaks in mean scores.
      Use the adjusted data sort from above (3b)

   d) Break the ties in priority rank of the indicators using the mode or another statistic.

4. **Should the mean score stand**? Discuss each indicator in the high and medium priority group to determine if the mean score is appropriate or it should be adjusted moving the indicator up or down in the list. A justification is needed for any adjustments. (J.Bjork) (45 mins)

   a) Review the standard deviations (SD). We want a concensus for the highly ranked indicators, in particular. If the SD for the mean scores is low, most people scored the

indicator the same way. Therefore, there is already a general concensus on the mean score. If the SD is high, the scoring for the indicator fluctuated in value and needs evaluation and discussion to find out why. Review the group of indicators one by one looking at the SD. Most of the discussion will probably be around indicators in the medium group due to higher variation in scores.
Use selected data sort from above (3d).

b) Use the following data sorts to discuss indicators in 4a. Did a particular group rank the indicator differently and should that mean score stand? The list of the high and medium indicators will be grouped by technical specialty and by agency. Discuss the individual indicators in the medium priority group for the following two issues and, if necessary, adjust the mean score. Justify why any indicator is moved up or down on the list.
Data sort 5, mean scores grouped by technical specialty (wildlife, botany, water, air, geo-"ist")

Data sort 6, mean scores grouped by NPS and non-NPS

5. **What's missing in the high priority list?** Using the adjusted list of high and medium priority indicators from #4, discuss the two topics below to "tweek" the high priority list of indicators. Justify why any indicator is moved up or down on the list. (B.Witcher) (45 mins)

a) Are there indicators in the high priority group that reflect all indicator types? Can gaps be grouped into existing indicators?
Data sort 8, mean scores grouped by indicator type

b) Are there indicators that can be interpreted and used at different scales?
Data sort 9, mean scores grouped by scale

The scoring process is now complete. The priority list that has been generated completes the second round of ranking and adjusting of scores.

6. **Logistics, partnerships and cost.** In order to be of assistance during the second day of discussion, the convened group will add to the comments in two data fields, partnerships and logistics. Go down the list of high and medium priority indicators and identify which portions of monitoring are being done by others, can be augmented by other funding, and/or can be done with another indicator logistically? (J.Bjork)

Priority list of indicators from #5 with 3 columns – partnerships, additional funding, logistical combination

Day 2 (8 am – noon)
Participants: Technical Steering Committee and Board of Directors
Voting members (one vote per individual): Dawn Adams representing PORE, Amy Fesnock representing PINN, Daphne Hatch representing GOGA, MUWO, FOPO and PRES, Susan O'Neil representing EUON and JOMU. Ties will be broken by the Network I&M Coordinator

Objectives for the day: Develop a list of vital signs indicators in rank order to submit to the Board of Directors for the initial vital signs monitoring program (years 1-5). The list and justifications are needed in the Phase II Report and will be used during the August Steering Committee meeting to develop FY04 Annual Monitoring Work Plan. Document all changes made to yesterdays priority list.

1. **Management priority**. Identify monitoring projects that can rapidly influence management actions. These projects can be used to demonstrate effectiveness of vital signs monitoring. Review the previous day's list of indicators. (J.Bjork)

   Use priority list of indicators from the previous day
   Document any adjustments with a justification

2. **Implementation strategies**. Evaluate the list of high and medium ranked indicators from #1 using the following discussion points to adjust the ranked list of indicators.

   a) Monitoring frequency (B.Witcher)
      List indicators with greater than annual monitoring frequency from least frequent to most
      Develop a timeline of monitoring
   a) Ability to partner (J.Bjork)
      List of indicators with partnerships and low cost
   b) Logistics – can two projects be done at the same time? (J.Bjork)
      List of indicators

3. **Check justifications.** Review the list of indicators to develop a justification for why they are ranked where they are. If the ranking was not adjusted, we can use the justification that the scores were obtained from the web-based ranking process. (J.Bjork)

END

The I&M Coordinator will prepare the adjusted list of indicators with a cover memo for the Board of Directors. This list is the recommended long-term, vital signs monitoring program for SFAN for the next 5-years. It is anticipated that the Board may decide on adjusting the list. It is anticipated that changes may be made every 5-years after a programmatic review of the monitoring plan, indicator evaluation, and resulting management actions.

Appendix E

Frequency Histogram Examples

Appendix E. Frequency histogram examples.

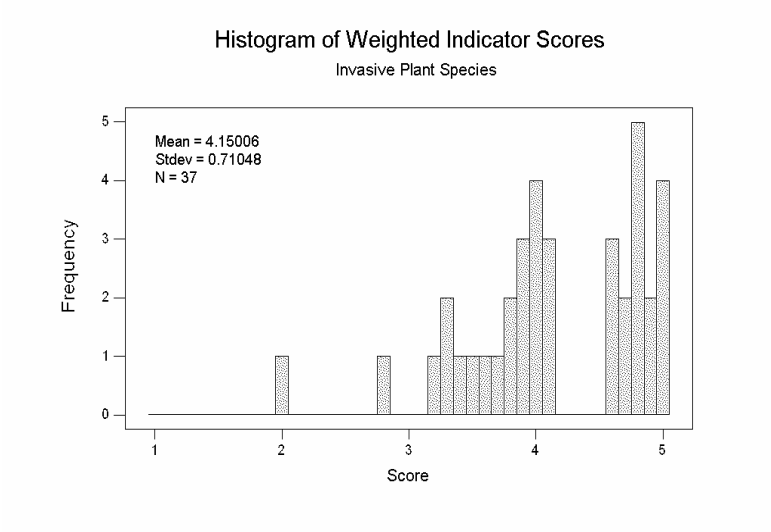

Figure E.1. Example of a high priority frequency histogram.

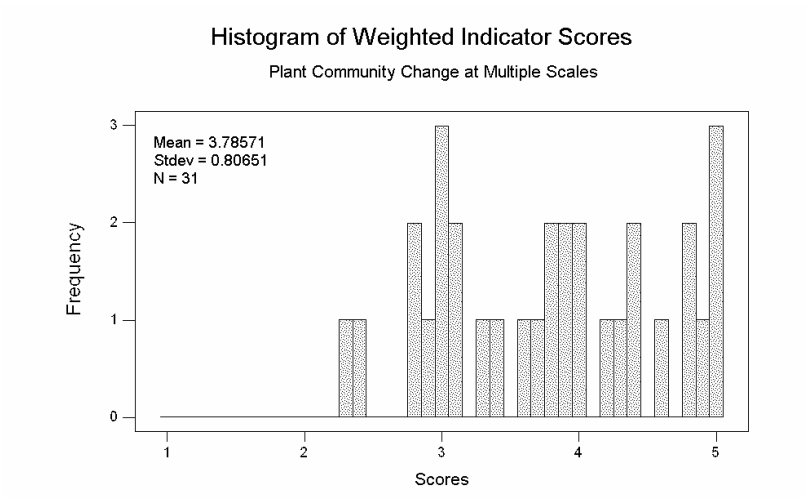

Figure E.2. Example of a wide distribution in the high priority group.

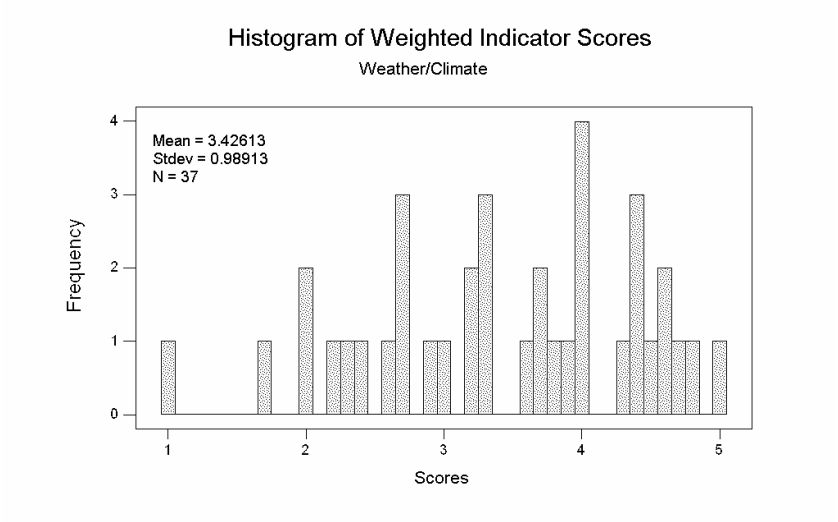

Figure E.3. Example of a wide distribution in the medium priority group.

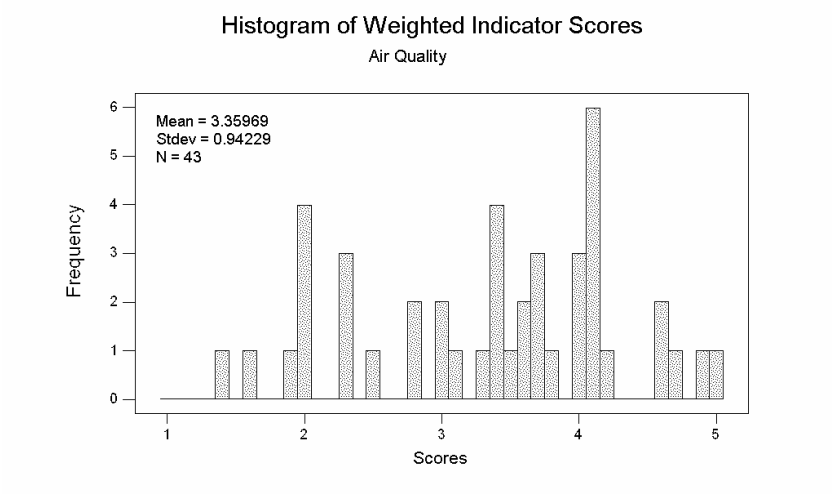

Figure E.4. Example of a bimodal distribution in the medium priority group.

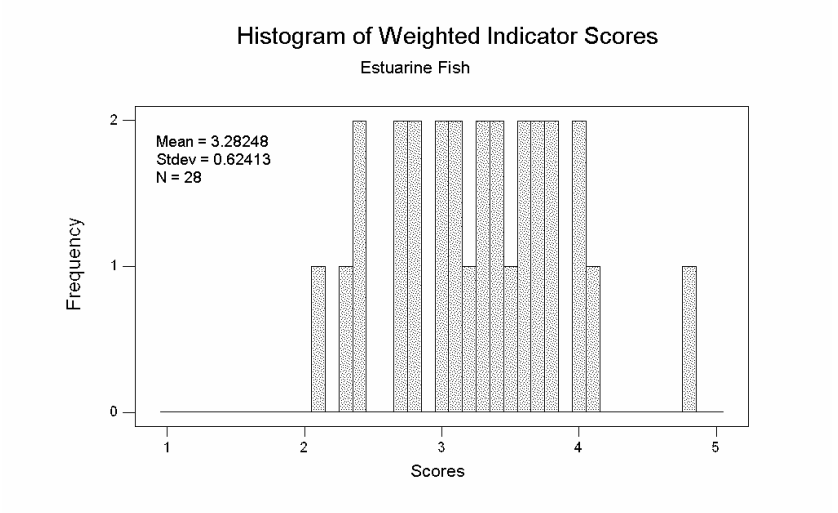

Figure E.5. Example of a relatively normal distribution in the medium priority group.

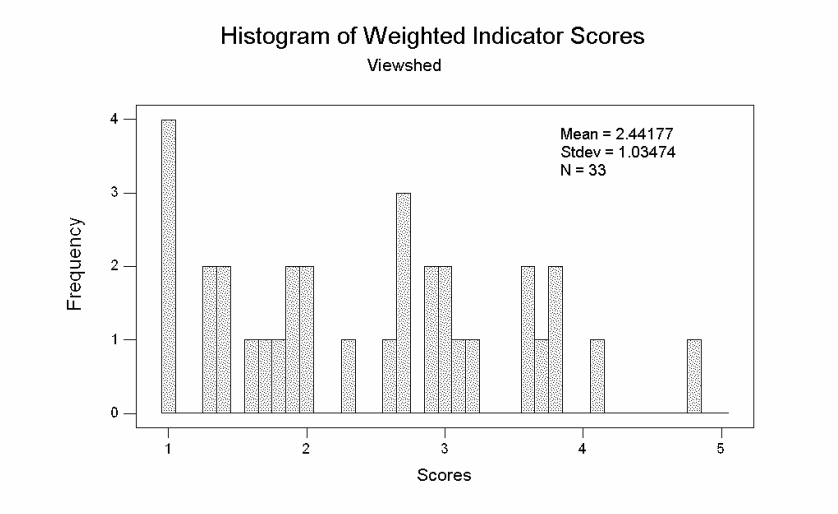

Figure E.6. Example frequency histogram for a low priority group indicator.

Appendix 11

Specific Measurable Objectives, Threshold Values, and Management Responses for the SFAN's First 21 Vital Signs Indicators

1

Rank	Indicator Name	Measurable Objectives	Threshold Value	Management Response
1	Weather/Climate	To integrate weather and climate monitoring and knowledge into the decision process and in the understanding of natural resources and processes.		To undertake research, to increase monitoring or to take action to effectively respond to weather variability (e.g. increased fire danger) and to minimize and/or manage the effect of climate change on natural resources and park infrastructure (e.g. plan for decreased summertime water availability for visitor needs).
2	Invasive Plant Species	Determine range expansion and extent of target non-native plant populations. Detect introductions of new invasive non-native plants into parks.	Ability to detect 15% change in population size or in location. Be able to detect 80% of new species introductions within 2 years of introduction	Seek funding to initiate removal efforts to contain populations. For new introductions this information is critical to reduce long-term costs for control efforts by catching species early.
3	Freshwater Quality	Elements and "contaminants" to remain within the natural range of variability and/or water quality to improve (not degrade) over time.	See the San Francisco Bay Regional Water Quality Control Board's Water Quality Control Plan for water quality criteria.	Determine if source differentiation is needed. Implement best management practices (for waste management, erosion control, etc.) Solicit research activities where applicable (if necessary to answer specific questions about contaminant fate and transport or other monitoring questions).
4	Air Quality	To minimize the effects of air pollutants, to maintain or improve visibility for visitor experience, and to improve the understanding of natural resources and processes.	California State and Federal ambient air quality standards and the National Visibility Goal. PINN and PORE are rated as Class 1 areas by the Clean Air Act and are protected by strict air quality regulations. Evidence of adverse ecosystem impact form air pollution initiates management action. The rest of the parks in the SFBN are Class 2 areas and pollution regulations are less strict. However, in some instances federal land managers apply the 'precautionary principle' and treat Class 2 areas with the same standards as Class 1 Areas.	To undertake research, to increase monitoring or to take action to reduce pollution and minimize the effect of air contaminants on natural resources and park infrastructure. To mitigate internal sources of air pollution. To coordinate with State agencies for a change in air basin abatement status. To educate and inform the public.
5	Stream T&E Species	Ensure persistence of species (long-	Some state of dynamic equilibrium.	Habitat enhancement/change in

Rank	Indicator Name	Measurable Objectives	Threshold Value	Management Response
	and Fish Assemblages (Salmonids)	term success)		management
6	Threatened and Endangered (T&E) Plant Species	· Detect change in population size (aerial extent and/or number of individuals) · Maintain or establish stable populations · Maintain or increase the number of populations within the park and the size and/or range of existing populations.	This may depend on the species and the effectiveness of the monitoring strategy. Usually a 20% change in the population initiates management action.	Investigate cause of change and proceed from there.
7	Northern Spotted Owl	To sustain the native forest ecosystems of the parks. To protect and restore endangered species.	To detect a 25% reduction in the breeding population of Northern spotted owls over a three year period.	Assess current nesting habitat conditions relative to habitat analysis information. Investigate potential disease issues. Investigate competitor or predation issues.
8	T&E Amphibians and Reptiles	Sustainable populations	Identified in protocols	Habitat enhancement, identify stressors
9	Western Snowy Plover	To protect and restore snowy plovers within the parks; to restore the species within its range.	Ability to detect a 10% change in the breeding population and 20% change in the wintering populations.	Implement additional habitat protection measures, predator management, visitor education.
10	Pinnipeds	Protect marine mammals, threatened and endangered species, and other sensitive natural resources found within the seashore. To provide an early warning of ecosystem condition based on exposure of marine mammals to climate change, human disturbance, oilspills, or fishing activities.	Ability to detect a 15% reduction in the productivity in Northern elephant seals and Pacific harbor seals. Ability to detect additional breeding sites for elephant and harbor seals.	Implement higher levels and additional habitat protection measures in growing or new colonies.
11	Plant community change at multiple scales	Understand the range of natural variation in the structure and composition of plant communities within a landscape. To document change in plant locations over time. To monitor spread or retreat of non-native and native species.	Any vegetation-type changes that fall outside the historic range of variation. Increases in the percent cover of certain invasive exotic species.	Initiate research to understand the impacts or consequences of changes in plant community composition. Implement or redirect invasive species programs. Educate and inform public of learned relationship. Remove barrier to native species colonization.
12	Regional landscape and land use change	To understand the natural variation of environmental conditions that	Any changes in landscape composition and arrangement that fall outside the	Initiate research to understand the impacts or consequences of changes in

Rank	Indicator Name	Measurable Objectives	Threshold Value	Management Response
		plant species, communities and landscapes. To track changes in landscape patterns and land use patterns and correlate them with changes in community composition.	historic range of variation.	landscape patterns and land use. Educate and inform public of learned relationship. Remove barrier to native species colonization
13	Threatened and Endangered (T&E) Butterflies	Restore additional habitat for the MBB and MSB	Increase habitat and populations of the butterflies by 50%.	Additional habitat restoration
14	Freshwater Dynamics	To document water use. To compare trends in water flow, discharge and use with trends in biotic freshwater resources. To work with adjacent landowners and municipalities to address water diversion issues.	An amount of water sufficient to maintain a healthy aquatic ecosystem.	To share data with others to effect change, to work with adjacent landowners and municipalities to alleviate water diversion impacts, and to increase education about water use.
15	Wetlands	New indicator—being developed.	New indicator—being developed.	New indicator—being developed.
16	Riparian Habitat	To maintain function riparian ecosystems. To have a better understanding of the riparian resources present in our parks, including their condition (e.g., functionality and degree of disturbance) and the role that natural temporal and spatial variation plays. To determine changes in functionality over time and determine cause, if possible. To correct or reduce problems when possible or feasible.	Loss of ecosystem function, increase in non-native percent cover or species.	Investigate the cause of change and develop a mitigation plan.
17	Birds-Landbirds	To maintain sustainable ecosystems with landbirds in the terrestrial and wetland ecosystems. To monitor trends in species composition, distribution and abundance. Enhance native species abundance.	In a review of Channel Islands Long-term Landbird Monitoring Program, reviewers found that it is difficult to identify a biologically meaningful amount of change in a relatively short period of time, particularly in highly variable Mediterranean ecosystems. Another problem is that important changes might be missed in a sparse data set. Relying solely on a power-	Recruitment/survival rates indicative of “source” population, initiate research if populations are “sinks”

Rank	Indicator Name	Measurable Objectives	Threshold Value	Management Response
			induced trigger might be misleading for those species. Another approach might be to graph and visually inspect the data, looking for deviations from a pattern, downward trends or wild fluctuations in abundances or in variances. One goal of the annual reporting should be to look for "red flags" indicating trouble with a species or with a data collection scheme.(McEachern 2000)	
18	Raptors and Condors	Maintain population levels, maintain chick production at a "source" level. Reduce human-raptor interactions. Migration-protect sustainable raptor flyway, provide visitor education and viewing opportunities to research in action, train volunteers in monitoring methodologies.	In any given year, < 6 territories nest, in two subsequent years, less than < 8 territories nest, in two subsequent year, average chick production <= 2.4 chicks/nest, declining trend for 3 years, not source chicks for more than 2 years.	If data indicate the decrease in population is related to human disturbance, upgrade advisory closures to mandatory closures and increase public education efforts. If data do not indicate recreational human use as the likely cause, consult with other agencies with prairie falcon populations to determine if population declining overall or just locally. Follow with initiating research. If data indicate increased egg toxicity or if consultation with other agencies indicate statewide problem, initiate research.
19	Coastal Dynamics	To minimize the impact of shoreline change on park resources and infrastructure	Event-based	To initiate monitoring, to increase awareness about dynamic shoreline processes, and to share data with the community.
20	Soil Erosion/ Deposition	To understand the background range, to monitor future changes, and to use that information to guide best management practices.	Currently unknown	Use maps for incoming incident management teams and for doing resource management assessments. When map information becomes dated or incorrect, remap.
21	Marine Oceanography	To evaluate the effects of sea level rise and other physical oceanic parameters on habitats and associated species.	ENSO triggers closer evaluation of erosion, productivity of seabirds and pinnipeds.	To work with partners, initiate research, and improve education. To utilize information to educate how we use the ocean and foster stewardship.

1