CHAPTER 3. SELECTION AND PRIORITIZATION OF VITAL SIGNS

A. Introduction

The National Park Service has defined "vital signs" as a set of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. The elements and processes that are monitored are a subset 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 those resources. Vital signs may occur at any level of organization including landscape, community, population, or genetic level, 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). http://science.nature.nps.gov/im/monitor/glossary.htm

Conceptual ecosystem models (chapter 2) demonstrate that a variety of biological, chemical, and physical factors interact to control the abundance, distribution, and productivity of plants, animals, and their habitats in SWAN. Consequently, the overall condition or "health" of park ecosystems is determined by the interaction of all its physical, chemical, and biological components. Clearly, it is impossible to monitor all these components; and ecosystem condition, like human health, cannot be measured directly. A key challenge is identifying vital signs that characterize entire park ecosystems yet are simple enough to be effectively and efficiently monitored (Dale and Beyeler 2001).

In this chapter we describe the process used to identify, organize, and prioritize a candidate set of vital signs for the SWAN. As described above, these vital signs are intended to characterize ecosystem condition and signal change across multiple scales of space and time. We explain how these candidate vital signs are linked to park resource management and protection issues, conceptual ecosystem models, and the network's monitoring objectives and questions. Finally, we provide some general information on each vital sign, including definition, importance, possible metrics, and how it relates to other vital signs in the context of an integrated monitoring program.

B. Vital Signs Selection

1) Framework - Considerable research and evaluation of ecological indicators has been done during the past decade. This includes several large-scale national level initiatives, as well as many regional and landscape level efforts by governmental and non-governmental organizations. An initial step in developing an approach for selecting vital signs was to review those existing models. Some of the literature and programs reviewed included:

- *Inventory and Prototype Monitoring of Natural Resources in Selected National Park System Units 1999-2000*, NPS, http://science.nature.nps.gov/im/monitor/vsmAdmin.htm#Prototypes
- *Criteria and Indicators: A Hierarchical Tool for Indicator Selection*, USDA Forest Service, 2002 http://www.fs.fed.us/institute/monitoring/framework_factsheet.htm
- *Ecological Indicators for the Nation*, National Research Council (NRC) 2000 http://www.biodiversitypartners.org/im/02.html
- *The State of the Nation's Ecosystems*, the Heinz Center 2002 http://www.heinzctr.org/ecosystems/
- *Categorization and Monitoring of Special Aquatic Habitats in the Sierra Nevada, California,* Pacific Analytics 2001 http://www.statpros.com/Final_Report.pdf
- *Gulf of Alaska Ecosystem Monitoring and Research (GEM) program*, *Exxon Valdez* Oil Spill Trustee Council, 2002 http://www.evostc.state.ak.us/gem/
- *The role of Biological Indicators in a State Water Quality Management Process*, Yoder 1998
- *Ecological Indicators for Narragansett Bay and Its Watersheds*, Kleinschmidt 2003 http://www.ci.uri.edu/Projects/PNB/Chafee-HUD/Indicators_Final.pdf
- *Selection of Indicators for Great Lakes Basin Ecosystem Health*, Bertram 2000 http://www.on.ec.gc.ca/solec/pdf/mainpaper-v4.pdf

Many of the indicator frameworks we reviewed are organized according to a set of predetermined goals or management questions that reflect key resource management issues associated with an ecosystem or ecoregion. Frameworks advocated in the recent Heinz's Center Report (The State of the Nation's Ecosystems, 2002) and The Partnership for Narragansett Bay Report (Ecological Indicators for Narragansett Bay and Its Watershed, 2003) focus on a hierarchy of physical, chemical, and biological indicators. They also use a set of ecosystem characteristics to organize and categorize ecological indicators.

The vital signs selection framework, adopted by the SWAN Technical Committee in May 2002, builds on these two examples and is described and illustrated in the *Goals Section* of each scoping workshop notebook, appendix E. We used this framework and professional judgment to identify candidate vital signs. Conceptual ecosystem models were used to aid selection and to ensure ecological relevance, particularly if the vital sign was a surrogate for the target process or resource. Candidate vital signs were also evaluated for their potential to contribute information as part of an "integrated set" designed to address multiple monitoring questions and to complement vital signs and metrics at other scales and levels of biological organization. Redundancy was permitted, particularly if it improved the likelihood of detecting and understanding changes or provided some unique and critical information.

2) Identification and Organization - Candidate vital signs were chosen during a series of scoping workshops held between August 2002 and April 2003 (chapter 1). These

workshops were "managed" brainstorming sessions built around three objectives; a) review and refine draft conceptual ecosystem models, monitoring objectives, and monitoring questions; b) identify natural and human-related drivers of change and why it is important to understand them; and c) identify candidate vital signs to monitor that provide informative signals about ecosystem condition. Workshop participants included a diverse group of experts; and developing a list of vital signs was not a difficult process, although knowing when to quit proved challenging.

Scoping workshop notebooks were a key element and provided background information, context, and guidelines for vital sign selection. Although individual workshops had an "ecosystem" focus (i.e., coastal, freshwater lakes and rivers) the fields of discussion and opportunities for choosing vital signs were unbounded. Redundancy was anticipated (encouraged) and played a role in reinforcing the importance of specific ecosystem drivers or components across systems and helping to generate an integrated set of vial signs. Vital signs identified at one workshop were often reexamined in greater detail at subsequent workshops.

Candidate lists of vital signs were summarized after each workshop (appendix F). In October 2003, the SWAN Technical Committee assigned three members to review and merge the vital signs into a single list. The TC empowered this "vital signs workgroup" to edit candidate vital signs that were not widely supported by experts during the workshops or by technical reviewers of the workshop summaries. The workgroup also revised and merged the network's monitoring objectives and questions to incorporate suggestions by workshop participants; and in some cases consolidate questions.

The initial combined list that emerged from the scoping workshops contained 61 vital signs. This list was reduced to 38 after duplicate entries were removed, similar indicators were merged under a single vital sign, or weakly supported vital signs removed (table 3-1). Vital signs considered, but not included:

Candidate Vital Sign	Rationale for Not Considering at this Time
Fire	localized occurrence in one network park unit
Floods	captured by other hydrologic vital signs
Landslides	localized occurrence
Relative sea level	captured by shoreline position
Fish kills	captured under ancillary event documentation
Wood frog	narrow distribution in network, captured by ancillary observations
Phytoplankton diversity	weak support by workshop experts and difficult to measure
Rocky intertidal Invertebrates	high interannual variability
Sea lion distribution	wide-ranging pelagic species not tied to near coastal
Native insect diversity	weak support by workshop experts and difficult to measure
Pika, Marmot	unknown distribution
Soundscapes	narrow application

The remaining 38 vital signs were evaluated with respect to clarification and consistency to ensure that each was clearly stated and understandable. We considered this step

important because vital signs that are confusing or not readily understood cannot be evaluated or prioritized objectively.

Table 3-1. Draft vital signs and rankings, Southwest Alaska Network.

No.	Rank	Category and Vital Sign	No.	Rank	Category and Vital Sign
Climate			***Marine Biota***		
1	5	Weather and climate	19	3	Shorezone habitat
Geologic and Hydrologic Processes			20	10	Saltmarsh
2	24	Lake and coastal ice	21	21	Kelp and eelgrass
3	15	Glaciers	22	16	Marine intertidal invertebrates
4	13	Snow cover	23	20	Sea otter and harbor seal
5	29	Streamflow	24	26	River otter
6	34	Stream and lake suspended sediments	25	31	Seabirds
7	37	River channel morphology	***Terrestrial Biota***		
8	27	Surface water hydrology	26	4	Vegetation Composition / Structure / Phenology
9	25	Coastal shoreline position	27	11	Sensitive vegetation Communities
Chemical			28	2	Brown and black bear
10	18	Water quality	29	12	Large and medium carnivores
11	35	Air quality	30	38	Landbirds
Disturbance Regimes			31	9	Ungulates
12	32	Earthquake activity	32	22	Bald eagle
13	17	Volcanic activity	***Human (Stressors)***		
14	19	Insect & disease outbreaks	33	8	Land cover and land-use change
Freshwater Biota			34	6	Visitor use
15	23	Resident fish	35	7	Resource harvest for subsistence and sport
16	1	Salmon	36	36	Marine debris and animal carcasses
17	30	Beaver	37	28	Bioaccumulated toxic contaminants
18	33	Aquatic birds	38	14	Exotic Species

We had many options for organizing ecological indicators (Bertram and Stadler-Salt 2000), but we chose to build on the format presented in the holistic model of the network (figure 3-3). This organization is useful because it categorizes vital signs into "driving variables" (natural and human-related) and "response variables" (ecosystems, communities, and species). Climate, disturbance regimes, and geologic and hydrologic processes are uncontrollable driving variables that influence ecosystems. Human activities are controllable variables that can act as stressors to ecosystems. Biological and ecological conditions, such the existence and areal extent of a plant community or relative abundance of a species of animal, represent response variables. In the statistical context, both uncontrolled and controlled driving variables are the

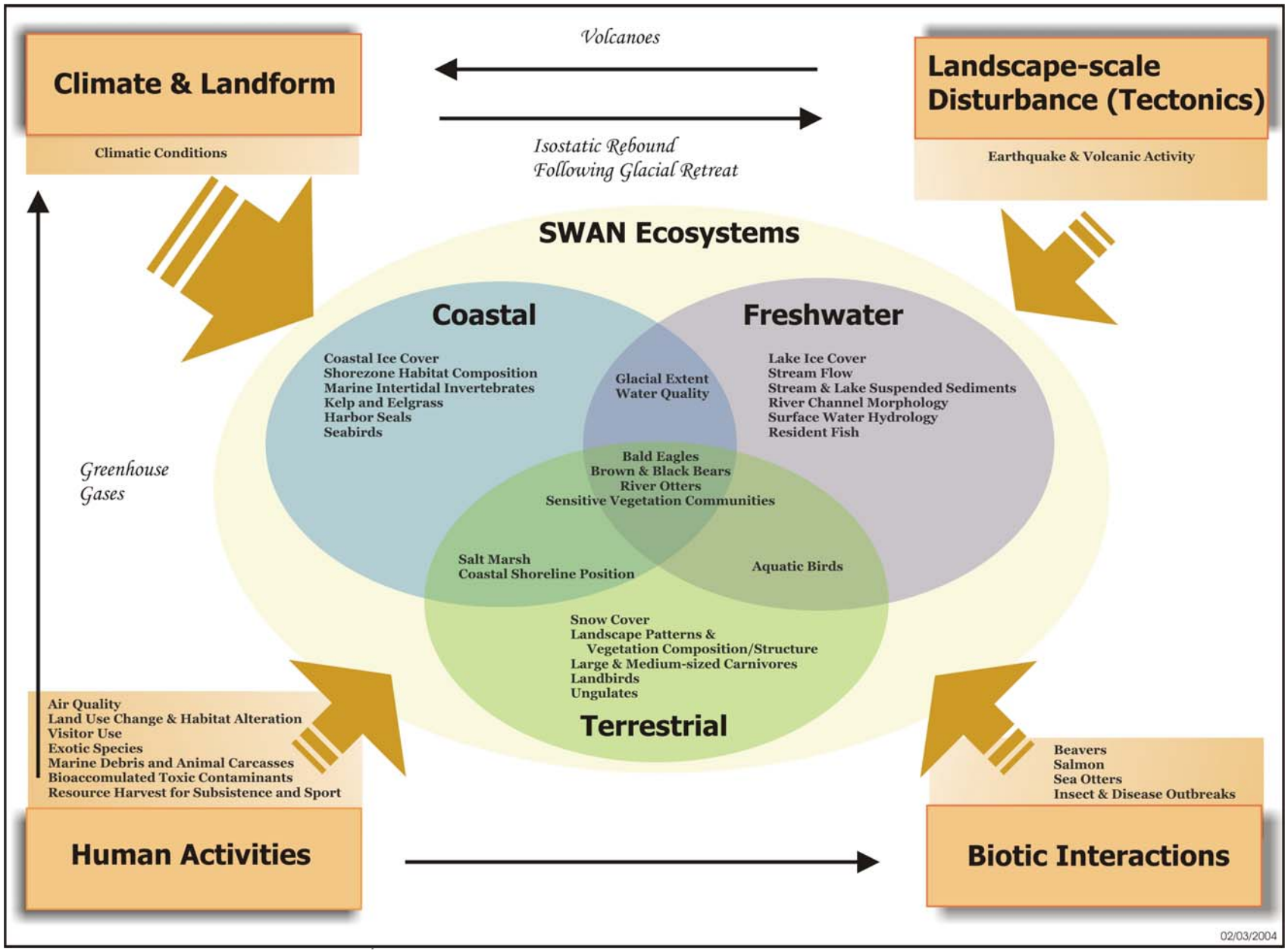

Figure 3-3. Holistic conceptual model, depicting drivers, ecosystems, and draft vital signs, Southwest Alaska Network.

independent (explaining or predictor) variables, while response variables are the dependent (effect or response) variables. Water and air quality are often considered intermediate variables that can play both roles, depending on the question under consideration (Vos et.al 2000).

Collectively, vitals signs drawn from all categories improve diagnostic power of monitoring and provide context and insight into the mechanisms of change. This feature distinguishes vital signs monitoring from programs that focus only on response variables, such many national bird monitoring programs.

During scoping workshops, monitoring objectives, questions, and conceptual ecosystem models were intended to focus discussions and assist in the identification of vital signs. To evaluate how well the list of vital signs addresses monitoring objectives, we assigned vital signs to relevant monitoring questions (table 3-2). In most cases multiple vital signs provide information of direct or indirect relevance to an individual monitoring question. No "unmatched" questions or vital signs emerged during this evaluation.

Recently, an NPS program-wide organization framework for vital signs was developed to facilitate communication and reporting among all 32 networks (table 3-3). The framework consists of three levels (Level 1, Level 2, and Level 3 categories) within which all network vital signs are grouped.

3) Prioritization of Vital Signs- The SWAN Technical Committee met on December 17-18, 2003, to review and prioritize the draft vital signs. In preparation for this meeting, the vital signs workgroup produced several summary documents:

- List of vital signs by category
- Ecosystem conceptual models from chapter 2 with vital signs highlighted
- Revised holistic model (figure 3-3) with vital signs inserted
- Natural resource protection issues paired with vital signs (appendix B) http://www.nature.nps.gov/im/units/swan/index.cfm?theme=monitoring_plan#appendices
- Monitoring objectives and questions paired with vital signs (table 3-2)
- One-page definition and statement of importance for each vital sign (appendix K)

During session one of the prioritization meeting, the technical committee reviewed each vital sign in the context of why it was selected and how it contributes to the network's goals and objectives for monitoring. They also discussed candidate vital signs that emerged from scoping workshops that were not recommended by the SWAN vital signs working group. No additions or deletions resulted from this discussion, and the importance of each vital sign was reaffirmed. However, for some vital signs, such as river otter, committee members acknowledged that more information is needed on network-wide distribution and scope of inference as an "indicator" before final confirmation. In some cases vital signs were assigned to a different category or changes were made to the "possible metrics" listed for a vital sign. Committee members elected to rank water quality level 2 parameters and adopt the "core suite" without ranking.

Table 3-2. Relationship of candidate vital signs to monitoring objectives and questions.

SWAN Monitoring Objectives and Questions	Candidate Set of Vital Signs
Climate and Weather	
Objective A. Understand the natural range of variation in weather patterns across the SWAN parks.	
1. What is the annual variability in quantity, timing and form of precipitation in network park ecoregions?	Climatological conditions, streamflow, landscape patterns and vegetation composition/structure, sensitive communities
2. What are the patterns of direction, strength, and timing for storm tracks and wind? How do these affect storm surges on coastal systems?	Climatological conditions, shorezone habitats, coastal shoreline position
3. What are the ranges and timing of seasonal temperature fluctuations?	Climatological conditions, landscape patterns, and vegetation composition/structure
Objective B. Understand general climate trends in network parks, including changes due to Pleistocene ice retreat and global climate change.	
1. How are current climate trends contributing to glacial retreat (and possible advances)?	Climatological conditions, glacial extent
2. Are there general trends in warming (cooling) and/or increased (decreased) precipitation? Are these trends affecting volume and timing of river flows and coastal storms?	Climatological conditions, lake and coastal ice, snow cover, streamflow
Dynamic Landform Processes and Patterns	
Objective A. Understand how movements of the North Pacific and North American plates are affecting park terrains.	
1. How do ongoing earthquake activity and resultant uplift and subsidence affect park lands, especially coastal zones?	Earthquakes, coastal shoreline positions, shorezone habitats, salt marshes, kelp and eelgrass, marine intertidal invertebrates, sensitive communities
2. What are the short and long term/ongoing effects of volcanism and ash (re)deposition on park ecosystems?	Volcanoes, suspended sediments, water quality, air quality, landscape/landcover changes, sensitive communities
Objective B. Understand effects of Pleistocene and Little Ice Age glaciations on SWAN ecosystems.	

SWAN Monitoring Objectives and Questions	Candidate Set of Vital Signs
1. How rapidly are glaciers retreating now, relative to former eras? How are icefields changing in area and extent?	Glacial extent, snow cover, sensitive communities, landscape/landcover changes
2. How are refugia and nunataks affecting patterns of plant and animal colonization?	Sensitive communities, landscape/landcover changes, landbirds, ungulates
3. How are changes in freshwater balance and sediment loads from glacial streams affecting coastal estuaries and large lake systems?	Streamflow, suspended sediments, surface hydrology, coastal shorelines, water quality, resident fish, salmon, marine intertidal invertebrates
Marine Coastline - fjords and bays	
Objective A. Understand long-term changes in the physical and chemical features of coastal habitats	
1. What are annual trends in salinity and freshwater inflows?	Water quality, shorezone habitats, marine intertidal invertebrates, streamflow
2. Are sediment supply and rates of accretion adequate to maintain estuarine habitats?	Water quality, shorezone habitats, suspended sediments, salt marshes, kelp and eelgrass
3. How is the relative composition of shorezone habitats changing (physical morphology and biotic communities)?	Earthquakes, shoreline position, shorezone habitats, salt marshes, kelp and eelgrass, marine invertebrates, sensitive communities
Objective B. Understand how key marine species and communities are responding to changes in habitat	
1. Is the distribution of coastal salt marshes changing, or are vegetation zones within salt marshes migrating?	Earthquakes, salt marshes, shorezone habitats, sensitive communities
2. How does the distribution and relative abundance of marine mammals fluctuate spatially or temporally?	Sea otters and harbor seals
3. How are changes in nearshore coastal food resources affecting species that live in the supratidal, but forage in estuaries and the intertidal?	Sea otters and harbor seals, river otters, marine invertebrates, seabirds
4. Are key species successfully reproducing?	Bald eagles, seabirds

SWAN Monitoring Objectives and Questions	Candidate Set of Vital Signs
Aquatic Systems- large rivers and lakes	
Objective A. Understand long-term changes in the physical and chemical features of large rivers and lake systems.	
1. How is water quality, including temperature, dissolved oxygen, conductivity and pH, changing temporally?	Water quality, resident fish, salmon
2. How are the thermal dynamics of large lakes changing in relation to the duration or lack of winter ice cover, changes in seasonal runoff, and storm frequency/intensity?	Lake and coastal ice, climatic conditions, streamflow, suspended sediments
3. How are seasonal discharge and sediment regimes of rivers shifting? (i.e., higher winter flows and lower spring and summer flows?)	Streamflow, river channel morphology, suspended sediments, resident fish, salmon
Objective B. Understand how ecological relationships are changing in rivers, lakes, and wetlands.	
1. How is environmental warming affecting the physical and biological structure of lakes?	Climatological conditions, lake and coastal ice, surface hydrology, water quality, resident fish, salmon
2. How are aquatic and riparian plant and animal communities responding to changes in the duration and extent of ice cover, lake levels, or sediment regimes?	Sensitive communities, resident fish, salmon, beavers, aquatic birds, suspended sediments, streamflows, lake and coastal ice
3. How are anadromous salmon abundance and productivity changing?	Salmon
4. How is the composition and abundance of resident fish changing? How are changes in resident fish influenced by cycles of salmon abundance?	Resident fish, salmon
Ecoregion and Biological Diversity	
Objective A. Document rates and types of change in vegetation in response to environmental factors and human effects.	
1. How are plant and animal communities changing across the SWAN region in response to the primary environmental drivers of climate, natural disturbances, biotic interactions, and human activities?	Landscape/landcover changes, sensitive communities, climatological conditions, earthquakes, volcanoes, insect and diseases, land-use changes, visitor uses, exotic species
Objective B. Observe and understand ecological relationships and how the occurrence and distribution of fauna species and communities are changing.	

SWAN Monitoring Objectives and Questions	Candidate Set of Vital Signs
1. Are species range shifts occurring, and are they occurring evenly among habitats?	Landscape/landcover changes, carnivores, ungulates, landbirds
2. Do nonnative species occur, and is their distribution increasing?	Exotic species, sensitive communities
3. How is the composition of bird and mammal communities changing?	Sea otter and harbor seals, river otters, seabirds, carnivores, landbirds, ungulates, bald eagles, subsistence patterns
Wilderness dependent wildlife and species interactions	
Objective A. Understand how species sensitive to humans are responding to habitat fragmentation, harvest, and increased human presence within or near parks.	
1. How are the distribution and/or relative abundance of large and medium sized carnivores changing?	Carnivores, subsistence patterns, brown and black bears
2. How are assemblages of carnivore prey species and vegetation communities changing temporally and spatially?	Landscape/landcover changes, sensitive communities, ungulates, salmon
3. How is habitat connectivity changing for wide ranging wilderness species such as wolves?	Landscape/landcover changes, Land-use changes, Visitor use, Carnivores, Bears
Human Activities	
Objective A. Understand how park and preserve ecosystems are affected by local and regional human activities.	
1. How are methods and locations of human access changing?	Land-use changes, visitor uses, landscape/landcover changes
2. How are visitor numbers and activities changing, and which resources are at risk from these changes?	Visitor uses, sensitive communities, brown and black bear DLPs, carnivores
3. What land developments are occurring near and on park lands, and how do these affect park resources?	Land-use changes, exotic species, sensitive communities, carnivores, brown and black bear DLPs
5. Are hydrocarbons and other toxins bioaccumulating in marine invertebrates or freshwater fish?	Bioaccumulated toxins, marine debris and animal carcasses
Objective B. Understand how park and preserve ecosystems are affected by global human development activities.	

SWAN Monitoring Objectives and Questions	Candidate Set of Vital Signs
1. How are network ecosystems responding to global climate change?	Climatological conditions, landscape/landcover changes, air quality,
2. How are changes in the north Pacific Ocean and Bering Sea affecting animals in and near park lands?	Climatological conditions, salmon, seabirds, sea otter and harbor seals, bald eagles, marine debris
3. How are far field human development activities affecting air and water quality in and surrounding network parks?	Water quality, air quality
4. Are atmospherically deposited or biotransported pollutants, such as PCB's and methyl mercury accumulating in fish; and do their concentrations show geographic gradients?	Bioaccumulated toxins, resident fish, salmon

Table 3-3. Southwest Alaska Network vital signs in the context of the program-wide vital signs organization framework of the National Park Service.

Southwest Alaska Network									
Level 1	**Level 2**	**Level 3**	**SWAN VS Name**	**Measures**	**ALAG**	**ANIA**	**KATM**	**KEFJ**	**LACL**
Air and Climate	Air Quality	IMPROVE-Visibility and particulate matter	**Visibility and particulate matter**	IMPROVE suite for visibility and fine particles		X			X
	Weather and Climate	Weather and Climate	**Weather and Climate**	Air temperature, precipitation, surface wind, solar radiation, relative humidity, snow depth	X	X	X	X	X
			Snow cover	Landscape-scale patterning; snow-cover date and snow-free date	X	X	X	X	X
Geology and Soils	Geomorphology	Glacial features and processes	**Glaciers**	Areal extent of glacial ice, photo points of selected glaciers		X	X	X	X
		Coastal / oceanographic features and processes	**Geomorphic coastal change**	Georeferenced position of the shoreline, beach profiles		X	X	X	X
		Marine features and processes	**Shorezone habitat**	Type and area (km) of coastline habitat classified by physical and biological criteria (i.e. sand flat, mud flat, bedrock platform)		X	X	X	X
		Stream / river channel characteristics	**River channel morphology**	Channel cross sectional profile	X	X	X	X	X
		Lake features and processes	**Lake and coastal ice**	Areal extent and duration of Ice cover	X	X	X	X	X
	Subsurface Geologic Processes	Volcanic features and processes	**Volcanic activity**	Frequency, intensity		X	X		X
		Seismic activity	**Earthquake activity**	Frequency, intensity	X	X	X	X	X

Southwest Alaska Network									
Level 1	**Level 2**	**Level 3**	**SWAN VS Name**	**Measures**	**ALAG**	**ANIA**	**KATM**	**KEFJ**	**LACL**
Water	Hydrology	Surface water dynamics	**Surface water hydrology**	Areal extent and variability in surface water area	X	X	X	X	X
			Stream and lake suspended sediments	Areal extent, patterns, and phenology of turbidity	X	X	X	X	X
			Streamflow	Discharge or gauge/stage height	X	X	X	X	X
		Water chemistry	**Water quality core parameters**	Temperature; conductivity; pH; DO, (salinity ppt); nitrate, nitrite, phosphorous, organic nitrogen, dissolved organic carbon (DOC), chloride, silica, sulfate, chlorophyll, total suspended solids (TSS); volcanic markers	X	X	X	X	X
Biological Integrity	Invasive Species	Invasive/Exotic plants	**Invasive/Exotic plants**	Occurrence and distribution of non-indigenous plants	X	X	X	X	X
		Invasive/Exotic animals	**Invasive/Exotic animals**	Occurrence and distribution of non-indigenous animals	X	X	X	X	X
	Infestations and Disease	Insect pests	**Insect and disease outbreaks**	Species, timing, and areal extent	X	X	X	X	X
	Focal Species or Communities	Marine communities	**Kelp and eelgrass**	Presence and distribution		X	X	X	X
		Marsh/Estuary communities	**Saltmarsh**	Extent and composition, sediment accumulation rate		X	X	X	X
		Marine invertebrates	**Marine intertidal invertebrates**	Composition and distribution of infauna		X	X	X	X
		Fishes	**Resident fish**	Composition, abundance, and distribution	X	X	X	X	X
			Salmon	Abundance of adult spawners	X	X	X	X	X
		Birds	**Landbirds**	Composition and distribution patterns	X	X	X	X	X
			Aquatic birds	Selected species presence and distribution	X	X	X	X	X
			Bald eagle	Occurrence and productivity	X	X	X	X	X
			Seabirds	Occurrence, colony size, or productivity of Kittiwakes, Guillemots, Gulls, Kittlitz's		X	X	X	X

Southwest Alaska Network									
Level 1	**Level 2**	**Level 3**	**SWAN VS Name**	**Measures**	**ALAG**	**ANIA**	**KATM**	**KEFJ**	**LACL**
				Murrelet					
		Mammals	**Beaver**	Presence and distribution of active colonies	X	X	X	X	X
			River otter	Occurrence and relative abundance	X	X	X	X	X
			Brown and black bear	Abundance and sex-age composition at concentration sites; Defense of Life and Property Killings	X	X	X	X	X
			Large and medium carnivores	Occurrence and distribution of wolf, wolverine, lynx, and marten	X	X	X	X	X
			Ungulates	Distribution patterns of moose, caribou, Dall sheep, and mountain goats	X	X	X	X	X
			Sea otter and harbor seal	Distribution and relative abundance		X	X	X	X
		Vegetation communities	**Vegetation Composition / Structure / Phenology**	Species composition, spatial distribution, spatial extent, onset of greenness, senescence of greenness, snow free date, snow-cover date, berry production (biomass)	X	X	X	X	X
		Terrestrial communities	**Sensitive Vegetation Communities**	Areal extent and composition of refugia, alpine, riparian, south-facing steppe bluffs	X	X	X	X	X
Human use	Non-point Source Human Effects	Non-point source human effects	**Bioaccumulated toxic contaminants**	Type and level of concentration	X	X	X	X	X
			Marine debris and animal carcasses	Location and type of debris or carcass, frequency of occurrence	X	X	X	X	X
	Consumptive Use	Consumptive use	**Resource harvest for subsistence and sport**	Type and number of permits, species and volume of resource harvested	X	X	X		X
	Visitor and Recreation Use	Visitor usage	**Visitor use**	Type, level, and distribution	X	X	X	X	X
Ecosystem Pattern and Processes	Land Cover / Land Use	Land cover / Land use	**Landcover and land-use change**	Type, location, and areal extent of land cover types; areal extent and relative proportions of land use types on park and adjacent lands	X	X	X	X	X

During session 2, committee members ranked each of the vital signs based on ecological significance and relevance to park resource management and protection. The purpose of this ranking was to identify at the onset vital signs that the network considered most important without considering in detail the methods of measurement or their feasibility. The ranking is not intended to establish a numerical order in which vital signs will be implemented. For many vital signs, feasibility is closely tied to sampling design and will be addressed during Phase 3 planning. Prioritization criteria used by other national programs, including other NPS-Vital Signs Monitoring Networks, were modified for use by SWAN (figure 3-2).

Vital Sign Ranking Criteria

Ecological Significance

1. Importance as a controller or integrator: How important is the vital sign in controlling ecosystem function or structure, or how centrally is it linked to other attributes in the conceptual models? [3=high importance, 2=moderate importance, 1=low importance]
2. Usefulness as an indicator: How useful is the attribute in explaining the condition of network ecosystems; that is, how sensitive would it be as an indicator of change? [3=extremely useful, 2=moderately useful, 1=minimally useful]
3. Linkage: How closely linked is the vital sign to other attributes in network ecosystem models; or is the vital sign linked to important resources regionally? [3=many strong links, 2=few strong links or many weak links, 1=few weak links]

Park Management Significance

1. Legal/policy mandate: How important is monitoring this resource/vital sign for satisfying legal or policy mandates? [3=high importance (required), 2=moderate importance (specifically identified), 1=low importance (generally identified)]
2. Potential to support management decisions: Does monitoring this vital sign directly link to the information needed for carrying out a key management decision or evaluating the outcome of a management decision? [3=strong application, 2=moderate application, 1=weak application]
3. Importance of resource management: How important (for management) is the resource or issue represented by the vital sign, relative to other resources or issues in the park? [3=high importance, 2=moderate importance, 1=low importance]

http://science.nature.nps.gov/im/monitor/docs/CriteriaExamples.doc

Figure 3-2. Criteria the Southwestern Alaska Network used to rank draft list of vital signs.

A Microsoft Access database was prepared to summarize scores and produce a ranking. Vital signs were ranked overall and within categories. Summary statistics were generated to assist in evaluating which vital signs accounted for the greatest deviation among committee members. During the final session (day 2), committee members reviewed and discussed the overall ranking and individual scores. Given the importance of several key focal species in SWAN, it is not surprising that salmon and bears emerged as the highest ranked vital signs. Coastal and terrestrial habitats ranked third and fourth, followed by human activities that affect habitats and animals. Physical processes and disturbance regimes, despite their importance as drivers of change, were not ranked among the top 10 vital signs.

Bird assemblages consistently ranked lowest in each biota category, and some vital signs that may be relatively simple and inexpensive to monitor were ranked low. At the close of discussions, committee members agreed to adopt this ranking contingent upon a 30-day review by themselves and other staff in their parks. No changes were submitted after this internal park review.

Following TC approval of the vital signs a preliminary draft of sections A and B of this chapter was prepared. This draft, along with appendix K, was provided to the board of directors in early February 2004. During March, a one day meeting was held at each of the three parks with the superintendent, chief of resource management, and other staff. The purpose of these meetings was to review the steps that the network followed in selecting and prioritizing vital signs, discuss individual vital signs, and provide an opportunity for park staff to comment on the process and vital signs. Park-based meetings were chosen, instead of one meeting at a central location because it allowed more staff to participate and provided greater opportunity for the network coordinator to review and discuss the program with two superintendents who only recently (December 2003) became members of the board of directors.

Board members expressed satisfaction with the network's vital sign selection process and outcome. Questions centered around the challenges and costs of monitoring in large remote parks, vital signs that are currently being monitored by partnering agencies, the relationship of concurrently funded pilot projects to the list of vital signs, and the directions the planning process will take next. Park staff acknowledged that the list of vital signs represents an "optimum program," not all of which may be achieved with network funding and that additions or deletions may occur during the coming year as new information becomes available. Board members approved the list of vital signs and signed the Phase II report.

C. Conclusions

Candidate vital signs were chosen during a series of scoping workshops held between August 2002 and April 2003. The initial combined list that emerged from the scoping workshops contained 61 vital signs. This list was reduced to 38 after duplicate entries were removed, similar indicators were merged under a single vital sign, or weakly supported vital signs removed. The technical committee reviewed each vital sign in the context of why it was selected, how it relates to conceptual ecosystem models, and how it contributes to the network's goals and objectives for monitoring. Committee members numerically ranked each of the vital signs, based on ecological significance and relevance to park resource management and protection issues. The board of directors reviewed the selection process and rankings and approved the draft list of vital signs in March 2004.

D. Plans for Phase III

During the next year we will review and evaluate vital signs based on feasibility. Vital signs will be retained if we think they can be measured with sufficient resolution and

provide the information required to detect or predict changes in a timely fashion. Compelling reasons for adding vital signs to the list will also be considered. Other planning efforts will address chapters 4-10 and include:

- an overall sampling design framework;
- development of sampling protocols or protocol development summaries;
- a data management plan for entering, editing, storing, and archiving data collected by the various components of the monitoring program, including metadata procedures;
- administrative and staffing framework;
- implementation strategy and schedule;
- and a budget projection for operational monitoring,