

Transcript and presentations from:

**National Park Service
Central and Southwest Alaska Network (CAKN/SWAN)
Inventory and Monitoring Program
Glacier Monitoring Scoping Workshop**

November 13, 2003
Fairbanks, Alaska

Guy Adema and Adam Bucki

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"Research is necessary not only to the preparation of interesting material to serve as a basis of the naturalist and historical service, but it also is fundamental to the actual protection of the natural features of the parks, as enjoined in the acts establishing the parks and in the act of August 25, 1916, creating the National Park Service."

-- Horace M. Albright, 1933

NPS Central and SW Alaska Network Inventory and Monitoring Program

Glacier Monitoring Scoping Workshop

November 13, 2003

**Marble Room, Princess Hotel
Fairbanks, Alaska**

Agenda

- 9:00 Welcome, introductions, and goal of workshop
- 9:15 Overview of NPS Ecological Monitoring Program and Process (MacCluskie)
- 9:35 Overview of glacier monitoring in Denali National Park and Preserve (Adema)
- 9:50 NPS/USGS 2003 Glacier Bay Glacier Inventory Project (Molnia)
- 10:05 INSTAAR GIS Glacier Inventory of Central Alaska Range (via Molnia)
- 10:20 USGS mass balance monitoring in Alaska (March/Trabant)
- 10:30 Break
- 10:40 Discussion of other glacier monitoring efforts in Alaska, particularly parks
(volume change, benchmark sites, Hubbard Glacier, Glacier Bay, etc)
- 11:00 Review of 1991 Glacier Research Workshop
- 11:10 Discussion of potential glacier monitoring themes for NPS programs:
Glacial extents, past and present (Image interpretation, inventory, photography,
etc.)
Mass balance measurements (Benchmark glaciers, Index glaciers, profiling, etc.)
Hydrologic cycle impacts (discharge, turbidity, balance)
Other themes that are identified
- 12:00 Lunch
- 1:00 Prioritize which themes should be monitored in parks, develop goals
- 1:40 Discuss techniques and feasibility of monitoring identified themes
- 2:20 Break
- 2:30 Discuss potential partnerships to accomplish NPS glacier monitoring goals
- 3:10 Develop recommendations from this group to the NPS monitoring groups
- 3:50 Review, next steps, etc
- 4:00 End

Attendees

Guy Adema, Physical Scientist, Denali National Park and Preserve
Danny Rosenkrans, Geologist, Wrangell-St. Elias Park and Preserve
Bruce Giffen, Geologist, NPS Alaska Support Office
Allen Bennett, I&M Program Manager, Southwest Alaska Network
Maggie MacCluskie, I&M Program Manager, Central Alaska Network
Bruce Molnia, USGS
Dennis Trabant, USGS
Rod March, USGS
Daniel Lawson, CRREL
Keith Echelmeyer, UAF-GI
Martin Treuffer, UAF-GI
Roman Motyka, UAF-GI and UAS
Larry Mayo, USGS
Diane Sanzone, I&M Program Coordinator, NW Areas
Adam Bucki, UAF-GI
Carl Bensen, UAF-GI
Matthew Sturm, CRREL
William Harrison, UAF-GI

Logistics

Meeting will be held in the Marble Room of the Princess Hotel, Fairbanks, Alaska (near Airport).
A block of rooms is available at the Princess at a special rate, call 800-777-1725, ext. 2, request group TNC L3316.

Transcript and presentations:

Note: The Central Alaska Network (CAKN) consists of Denali, Yukon-Charley and Wrangell-St. Elias National Parks. The Southwest Alaska Network (SWAN) consists of Kenai Fjords National Park, Lake Clark National Park and Preserve, Alagnak National River, and Aniakchak National Monument and Preserve.

I. Purpose:

1. Identify key components of glacier systems that can be effectively monitored in Alaska's national parks and describe potential applications of resulting data.
2. Gather recommendations for the direction of park service efforts toward glacier monitoring, including the Park Service's role in supporting research efforts. What can NPS do that is simple enough to be sustainable and will provide necessary data to understand change and foster research?
3. Identify potential partnerships for glacier monitoring and identify parties interested in further involvement in program development.
4. Foster communication among researchers working in and near national parks.

II. Description of Inventory and Monitoring Program (I&M):

The NPS I&M program is of national scope and involves the regional-scale cooperation of parks to develop a suitable monitoring program for their respective ecosystems. The impetus for the I&M program is that, presently, parks tend to focus on the management of a single species. This former approach does not fulfill the NPS mandate, which states:

"... The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments and reservations...to conserve the scenery and the natural and historic objects and the wild life...and to provide for the enjoyment...(and)...leave them unimpaired for the enjoyment of future generations."

The revised approach is to manage the ecosystem of each park, rather than a single species. In order to fulfill the mandate, there will be an inventory of the park's natural assets and then identify the "vital signs" of the ecosystem to monitor over the long-term.

III. National Goals of I&M:

1. Determine status and trends in selected indicators (e.g. glaciers, animals, water etc.) of the condition of park ecosystems to allow managers to make better-informed decisions
2. Provide early warning of abnormal conditions of selected resources
3. Provide data to better understand the dynamic nature and condition of park ecosystems
4. Provide data to meet certain legal and Congressional mandates

IV. Specific Goals of CAKN:

1. Better understand the dynamic nature of the eco-systems
2. Proceed with a holistic view of resource change
3. Put program framework in context of extensive/intensive objectives:
 - a. extensive = 'landscape' level inference
 - b. intensive = park-specific or economically infeasible at larger scale

V. Identified Physical “Vital Signs” and Measures for CAKN:

Ecological Footing and Rank	Proposed Vital Sign	Potential Measure
1	Climate/Weather	Temp, precip. , wind
2	Snowpack	Accumulation, timing, spatial distribution
3	Water Quality (lakes & streams)	pH, conductivity, Nitrates, Phosphates, turbidity, temp, alkalinity
4	Permafrost	Active layer depth, distribution
5	Disturbance regime	Fire frequency/intensity, wind, tectonics, geomorphology, volcanism
6	Ice phenology	On/Off timing
7	Stream Flow	Flow rate and temporal variability
8	Glaciers	Mass balance, movement
9	Air quality	Same as existing NPS program

VI. Post Introduction Discussion and Questions:

M. Sturm:

How is the I&M program funded? Is this program likely to disappear when park administration changes?

NPS: The funding for the I&M program comes direct from Washington to the specific park network. It is a general line item appropriation and is not subject to changes in park administration at the level of an individual park.

R. Motyka:

In terms of the broad structure of the program, what is the plan for outreach/cooperation with universities and the public?

NPS: There is no formal plan for outreach and it is expected that cooperative agreements will develop.

B. Molnia:

Glaciers are a major physical driver in both Denali and Glacier Bay. The number one landcover change is that associated with glacial retreat. Glaciers may be the single most important resource in some of the parks.

D. Trabant:

Although there are no glaciers in Yukon-Charley, processes there are driven by permafrost.

VII. Overview of Glacier Monitoring in Denali (G. Adema)

Current glacier monitoring in Denali is funded primarily by the Long-term Ecological Monitoring Program.

1. Mass Balance Measurements
 - a. Index sites on Kahiltna and Muldrow Glaciers (after L. Mayo)
 - b. Benchmark-style monitoring on East Fork Toklat Glacier (4 stakes)
2. Movement measurements
 - a. Muldrow, Kahiltna and East Fork Toklat
 - b. Some measured systematically others as logistics allow
3. Glacial termini mapping with GPS – every 5-10 years
4. Surge Monitoring when possible (e.g. Tokasitna)
5. Comparative Photography and Satellite Imagery
6. Afiliated snow and weather monitoring
7. Support of non-NPS research where possible (e.g. Echelmeyer and others)

A major benefits of a network-based monitoring approach will allow glaciers in more parks to be monitored, rather than just Denali

We encourage any outside researchers to come to Denali for fieldwork and or use NPS data in related research.

IIIX. Review of “Manual for Monitoring Glaciers at DNP, Alaska” Developed for NPS by L. Mayo, 1991 (L.Mayo)

As a result of the last NPS Glacier Scoping meeting held in 1991, L.Mayo developed a manual for monitoring glaciers in Denali. This manual is still used today. The following is the abstract taken from the manual developed by L. Mayo.

ABSTRACT (from manual)

Section A: Glacier monitoring can reveal how climate variations affect glaciers. The glaciers of Denali National Park are large and complex. The mass balance, ice flow, and glacier surface height at such glaciers can be observed relatively easily at index sites using methods developed by the author and colleagues at the U.S. Geological Survey at other glaciers in Alaska. Index sites are selected near the equilibrium lines on two glaciers near Mt. McKinley, one at 1930 m altitude on the high-precipitation southern side of the mountain, and the other at 2,050 m altitude on the drier north side. The effects on the local climate caused by Mt. McKinley can be expected at these sites.

Section B: A high-precision project grid with permanent monuments at the Kahiltna and Traleika Glacier index sites was established in 1991 as the geodetic control necessary for ice motion and glacier height surveys. The difference between orthometric heights used by GPS and the sealevel datum used in conventional survey was measured at Kahiltna so either GPS or instrument surveys can be used interchangeably. The mass of the mountain raises sealevel measurably.

Section C: Detailed instructions for glacier observations include equipment lists, helicopter logistics, and safety. This field manual serves as a training guide, field work guide, and technical standard for consistently high quality long-term monitoring at Denali National Park. It should be carried during glacier observations.

Section D: Calculating the scientific results from the observations is the final step necessary to present the data in standard tables and graphs. The geodetic calculation routines of the U.S. Geological Survey’s Alaska Glaciology Project are included for efficient data reduction.

The observations from Kahiltna and Traleika Glaciers from 1991 to 1997 are presented. Mass balances show that Mt. McKinley is a climate barrier because the mass balances of the two glaciers do not correlate. Kahiltna Glacier is thinning and its average speed was 210 m/yr and gradually slowing down. Traleika Glacier is thickening and its average speed was 53 m/yr and speeding up. The thickening of Traleika indicates that it is part of the ice storage reservoir of the surge-type Muldrow Glacier. The passage of kinematic waves in both glaciers occasionally interrupts their normal season flow patters.

IX. NPS/USGS 2003 Glacier Bay Glacier Inventory Project (B. Molnia)

1. Creating GIS compatible Geo-registered geospatial products for resource management, science and interpretation.
 - a. Example: Terminus position changes of the advancing John Hopkins Glacier.
 - b. To illustrate how glaciers have changed on century and annual scales? Illustrate the change in area, change in volume and bathymetry.
2. Goal: to develop a joint NPS and USGS program.

3. “Glacierless Glacier Bay” – How has the park changed and how do we present this to visitors?
 - a. Movies (e.g. Johns Hopkins)
 - b. Photographs (B. O’field, 25,000 photographs)
 - c. Annually compiled terminus positions
 - d. Dramatic changes like those observed at
 - i. Geikie Glacier
 - ii. Reid Glacier
 - iii. Lamplugh Glacier
4. There is a need to look at glaciers other than in terms of their mass balance. It is difficult to transfer this type of information to the public, which is essential for a sustainable program within NPS.

X. Review of 1991 Glacier Research Workshop (M. Sturm)

The I&M program started to form in 1991 when D. Taylor needed a plan. And now, 12 years later, we seem to be in a cycle of “needing a plan”. To offer some words of wisdom, think “*sustainable* monitoring”. To have a sustainable monitoring program it is essential to get out of the cycle of “needing a plan”.

- 1) NPS can sustain low-level life blood but cannot contain the expertise for high level stuff. The danger is that too large a lifeblood is developed and then not sustained. The life cycle of a program should have a scope of 10-50 years, rather than the typical 2-5. Keep in mind long term horizon. What is sustainable within NPS and what should be farmed out? This problem of sustainability exists in other NPS monitoring programs.
- 2) Make the monitoring program durable, sustainable and with the ability to expand and contract as needed.
- 3) There is a problem with sustainability of such programs in NPS. Although, there are good intentions-- programs nevertheless fall by the wayside because of turnover of the staff. Build the program around the park service and not around individuals that will leave after 2 to 3 years. Think about who cares for the data after the inevitable turnover of personnel.

XI. Comments and Discussion

D.Trabant:

Lack of “Corporate Memory” is where things get lost because of discontinuity in the program. The evolution of the system should be slow.

M. Sturm:

The value of data increases with time. So, developing a means of maintaining continuity should be core to the discussion.

D. Rosenkrans:

Its been something like 15 years since the last meeting just like this and all the same people that were here 15 years ago are here today...where’s the new blood? Who’s going to preserve these ideas?

M. Sturm:

So how do we maintain continuity in a program, which is subject to high turnover rates?
Should the responsibility fall in the hands of the leaving manager?

D. Trabant:

What about a commitment from NPS to do formal archiving outside of the service? A commitment to the National Snow and Ice Data Center (NSIDC) might help the longevity of the program.

K. Echelmeyer:

The NSIDC itself is not long-term yet! Shouldn't the responsibility for continuity of the programs be with the park superintendent? Presumably, a person that is more likely to be with a particular park over the long-term.

All NPS:

Laughter.

XII Discussion of potential glacier monitoring themes for NPS programs “Who is doing what in Alaska with glaciers...can these things be done in the parks?”

- 1) Geospatial Inventory and Analysis of Glaciers: A Case Study for the Eastern Alaska Range (B. Manley, presented by B. Molnia)

Recent advances in GIS make it possible to assemble large, empirical, multiparameter data sets that bear on environmental variation, process and change. This is a study on the spatial, rather than temporal inventory and analysis. Through GIS the area of glaciers can be determined and most glaciologic parameters are strongly related to AREA. 1) Spatial analysis is complementary to time-series studies 2) 3D glacier inventory represents interaction among climate, topography, and glacier dynamics. 3) Spatial dataset and GIS procedures can be shared to avoid redundant effort and to assure comparability of analysis among regions. 4) Spatial data will be useful for mapping and visualization, derivation of scaling relationships and analysis, modeling of mass balance, retreat, runoff, and hazards and baseline for studies of glacier change.

- 2) Mass balance measurements and the World Glacier Monitoring Service (R. March)

Worldwide compilation of mass balance measurements. Included in this record are the USGS benchmark glaciers, Gulkana and Wolverine. The USGS monitoring emphasizes long-term sustainability and continuity, process oriented monitoring, defining and tracking glacier geometry, defining mass and energy fluxes into and out of glaciers. The USGS collects 1) meteorological data 2) area altitude distributions 3) mass balance 4) glacier surface altitude 5) Ice motion and 6) Terminus position changes.

3) Glacier thickness changes (K. Echelmeyer)

A small lightweight laser altimetry system has been designed by researchers at UAF to collect surface elevation changes (thickness changes) for a high number of glaciers (~100).

This process involves the use of a light aircraft that is capable of measuring surface elevation changes very rapidly and efficiently. Measurements can be made and compared to existing maps or previously acquired profiles. Data collected from this project are useful for climate change studies and determining the influence of melting glaciers on sea level. It has been found that most glaciers are thinning in the lower elevations but in the upper elevations some many glaciers are thickening. Volume change is negative for glaciers except for surge-type glaciers.

4) Effect of deglaciation on plate tectonics (R. Motyka)

Massive deglaciation removes large amounts of ice that previously depressed the earth's crust. The removal of this ice causes the crust to rebound. A project at UAF measures uplift rates near Glacier Bay National Park. Rates of uplift are 2-4 cm per year in the area in and near Glacier Bay. Presently, this program has 5-7 years of GPS measurements and a growing archive of recorded raised shorelines. The uplift in the area is driven by crustal rebound. Other projects include the advance of Hubbard Glacier and the subsequent damming of Russel Fjord.

5) Glacier Bay CRREL research (D. Lawson)

On going research in G.B. National Park includes the repeating of photographs originally taken by B Ofield. New photo positions are established as well. GPS measurements of ice margin measurements, repeat hydrologic measurements, water column measurements, repeat bathymetry in fjords to acquire sedimentation rates, Climate change in East and West portions of park have different history as indicated by stable isotope analysis, maintain 24 pseudo-climate stations and determination of past glacier positions using tree cores and emerging forests. CRREL is also involved with work on Matanuska glacier.

XIIV. Comments and Discussion

D. Rosenkrans:

Reconstructing the Holocene record is important! For parks this is essential to relate present conditions.

D. Lawson:

The Holocene was climatologically very active but it is logistically difficult to do, yet very important.

D. Trabant:

Getting the information to tourists about glacial retreat and wastage is difficult. Tourists visit to see advancing glaciers. Cruise ships to Hubbard etc, which are out of phase with what is really happening.

XIV. Planning and Scoping (open discussion)

Goal: To prioritize which themes should be monitored in the parks and develop goals to work toward.

NPS:

What direction should NPS take in monitoring glaciers that would be most useful to the research objectives of other glaciologist and climatologists? Also, what can the park do to develop the initiative?

K. Echelmeyer:

Insure that any records are cared for in a way that they are continuous and so that others have easy access to these records.

R. Motyka:

Denali National Park has the best track record in the park service for a park-based monitoring program. What is it about Denali that makes this possible?

G. Adema:

- 1) Funding makes it work. Money is given to Denali on a non-competitive basis to keep up a monitoring effort.
- 2) There are people with time to do it.

D. Rosenkrans:

Initially there were plans for multiple parks to develop similar programs but only Denali had the cash cow to do it. It was just difficult in other parks because of the lack of funding.

G. Adema:

Doing something long-term is difficult in the park service so developing cooperation agreements with other agencies is imperative for longevity.

C. Benson:

Two people have stuck with the park service for a long time, Danny Rosenkrans and Phil Breeze. This sort of “sticktuitiveness” is required for long-term projects. What is it about these guys that they’ve stuck around for so long?

D. Rosenkrans:

A long-term successful program must not only depend upon people but PARTNERSHIP. Partnerships are essential for the long-term.

M. Truffer:

Continuity comes through protocol. The development of a protocol would seem to help NPS achieve a long-term objective.

G. Adema:

The Park Service is a deep bureaucracy, and most people have a difficult time dealing with it. Additionally, what drives the superintendent are immediate management issues...not long-term objectives.

M. MacCluskie:

The program can't be directed at "crisis-danger", the program has to be directed toward long-term. The harder and more complex a program is the more difficult it will be to maintain.

C. Benson:

In addition to inflation there are other pressures.

D. Rosenkrans:

The management issues take priority in the park.

R. Motyka:

Where are the geo-types in Katmai and Glacier Bay? These parks were founded on scientific objectives, why aren't these people in these parks?

G. Adema:

Ecosystem monitoring program.

A. Arendt:

It seems that relating issues of the influence of habitat change influence is important for a sustainable program. Tying glacier changes to habitat change would perhaps make for a sustainable and durable program.

M. Truffer:

The Park's role could be to monitor in a broad sense. Universities can't do this sort of monitoring because they are limited by funding cycles. The NPS role, assuming consistent budgets, could be something of a broad scope and then universities can do short-term projects, such as research on surging glaciers.

B. Molnia:

This would maybe be a good time to bring up the Global Fiducial System. The civil application committee developed this system. This program provides high resolution photographs as a scientific resource. Already in Alaska there are several glacier sites including Bering, Traleika and Kahiltna glaciers. Access to these images requires a top-secret clearance but is available without clearance through an agency like NPS or USGS. Only, images are at a degraded level of ~1m resolution.

G. Adema:

What is the importance of areal photographs? NPS could provide the service of archiving and serving of imagery. Through the Global Fiducial System, we can acquire entire glacier coverage, stereo-pairs, late-season images and meta-data for each image.

Would the platform of imagery matter? At present, we acquire 1:40,000.

R. Motyka:

Photos taken at 10-15 year intervals are very useful for dynamics. High quality air photos would be a great contribution to research.

C. Benson:

Archiving could be done at UAF-GI Geodata center. GI has an archivist for long-term projects.

D. Trabant:

Maybe the Park Service needs a 1st order “sexy” product to keep project funded and provide a service to the visitors and general public. How do we sell these ideas to administrators?

R. Motyka:

We could write up examples to show long-term values to present to administrators.

C. Benson:

How do you get this info from NPS to public in a society where people in N. Dakota don't know where S. Dakota is?! The only way to illustrate change is to document it. This concept needs to be emphasized to administrators.

D. Lawson:

A part of this will have to prove to administrators the value on a year to year basis that the program is important. Anything done in the park has to get to the visitors via the park interpreters.

G. Adema:

What is the application of ground based photo points? What is the use of this beyond public consumption?

B. Molnia:

This type of photo is very important. You can do a lot that you can't do with vertical photos.

D. Trabant:

Much more quantitative information will come out of vertical photos than is available from ground-based photos.

C. Benson:

The overall selling point can be to come back to why the park was started, i.e. science. Additionally,

- 1) The only agency that has the ability for long-term is the government. As part of the government you have responsibility to monitor for the long-term.
- 2) Early photos are priceless
- 3) A descriptive pamphlet could be given to the public that highlights this.

D. Rosenkrans:

What NPS needs is to know is what can it do to study glaciers. Tell me what I can do – there's a cash cow coming. Should I pick a boring glacier for index glaciers or fascinating tidewater glaciers?

G. Adema:

What about benchmark-style glaciers? Would a NPS program that monitors a few glaciers using glaciological mass balance methods be useful to other researchers?

D. Trabant:

A single glacier in and among many others is not necessarily representative of the others. What you do and how it is done depends on what you want to learn. Because of the logistics involved it is better to not use your time finding a “representative glacier” but rather pick a glacier, monitor it well and then use climate modeling to determine how the monitored glacier responds to perturbations. This can then be used as a regional guideline.

As a note: We at the USGS have found that a near ELA mass balance series (see Mayo, 2001) agrees well with multiple stakes. However, accumulative series is not adequate for accumulative balance. We as a research community are not sure of the cause and effect ties.

A single stake at ELA is not sufficient. We use 3 stakes on both Wolverine and Gulkana Glaciers. This configuration seems to give us good results. If you already have 1 stake on a glacier and you need to go there, how much more work is it to do a couple more?

M. Truffer:

Is it feasible to begin with a more intensive study then minimize?

D. Trabant:

It would be better to use fewer glaciers but then a few more stakes on each glacier...rather than just the one at/near the ELA.

B. Molnia:

How do you do representative monitoring?

D. Trabant:

There is no “representation” Look for a glacier and figure out how it relates to others in the region. Complimenting a network of MET stations and snow courses with glacier data would be great. From this information, glacial response can be modeled.

G. Adema:

NPS is working on a MET station network. In Denali we have been and will continue to install stations. Several of these will have GOES transmitter units.

How do you assess glacier change?

M. Truffer:

On the regional scale: mapping

Annual scale: hydrologic measurements

The trouble is that 100s of glaciers are needed to see what is actually going on. This is the advantage of Keith's laser altimetry unit, which can measure changes in many glaciers quickly.

G. Adema:

Presently, we occasionally do centerline profiles of some glaciers, such as Muldrow. Are these useful?

K. Echelmeyer:

Glaciers are pretty complicated. Surface elevation is not enough, there good if you can do them but there may be more important things for shorter time scales.

R. Motyka:

Is there a mechanism within NPS to make sure that things happen correctly?

G. Adema:

No. We hope that an inter-network collaboration will promote quality control.

D. Trabant:

Is there some sort of data quality checking system within the park?

A. Bennet:

Absolutely it will happen, but it hasn't happened yet.

D. Trabant:

Will there be a committee or something similar?

Benchmark glaciers/ Index sites → Is this a good opportunity for collaboration?

B. Molnia:

Are there rivers being gauged within the parks?

G. Adema:

No.

D. Trabant:

Air photos and Index glacier for a regional idea can be used as a reference for others.

G. Adema:

What about climate reconstruction? What are the proxy information needs for monitoring?

What is the contribution that the park can make to on-going and future research?

K. Echelmeyer:

The park service did an outstanding job supporting some research logistics in the past. By providing an environment that supports researchers to come in and have projects there would be a great.

XIV: Building Partnerships

The scientific community is aware, and becoming more aware of the beauocratic problems within NPS. NPS has begun a new program called the Cooperative Ecosystems Study Unit (CESU). There is a coordinator in NPS for universities and this will allow NPS to get university expertise.

R. Motyka:

A problem with funding from NPS is that universities charge large overheads. Will CESU circumvent this?

G. Adema:

It should help to at least get a reduced overhead.

K. Echelmeyer:

Logistical support is great! If NPS can provide vehicles, housing this would be a huge contribution.

G. Adema:

Right now things like vehicles and housing are easy to do. The problem right now comes with permitting. In Denali there is a good atmosphere for research. However, we do have obligations to management issues.

D. Rosenkrans:

When proposing research, think about how the public might benefit from the research you're doing. This is an important element for NPS research.

G. Adema:

We need to think about how we are going to get this stuff done and what sort of partnerships are possible with the different organizations. A long time series is invaluable and building partnerships will hopefully promote long-term projects.

M. Truffer:

The Geophysical Institute is not really good for monitoring. Our strengths are over the short-term. Things like surging glaciers..."Emergency things.

D. Trabant:

The USGS is very good for long-term monitoring.

The key thing is knowing people within the organizations. The high turnover typical of NPS is detrimental to this.

XV: Prioritizing Potential NPS Glacier objectives.

G. Adema:

The NPS wants to decide where to put its effort in glacier monitoring. We need to decide what things the Park Service can do to best contribute to the scientific community and at the same time balance our own needs with visitors. I would like to take some time to discuss the potential ways that NPS can contribute.

(The following list of themes resulting from open discussion. This represents potential contributions of NPS.)

- Archival of Imagery
- Climate Data
- Comparative Photography
- Stream Discharge Measurements
- Specialized research monitoring
- Terminus measurements
- Comparative photography
- GIS Inventories
- Glacial Geology/History
- Airborne Profiling
- Index glaciers

Geo-Hazards

The following is a list compiled through open discussion that prioritizes potential contributions.

- A. Airphoto/Imagery Archive
- B. Climate Data
- C. Simple sustainable projects (Benchmark Glaciers)
- D. Support research and serve data
- E. Continuity in program
- F. Long-term historical record.

List of Attendees:

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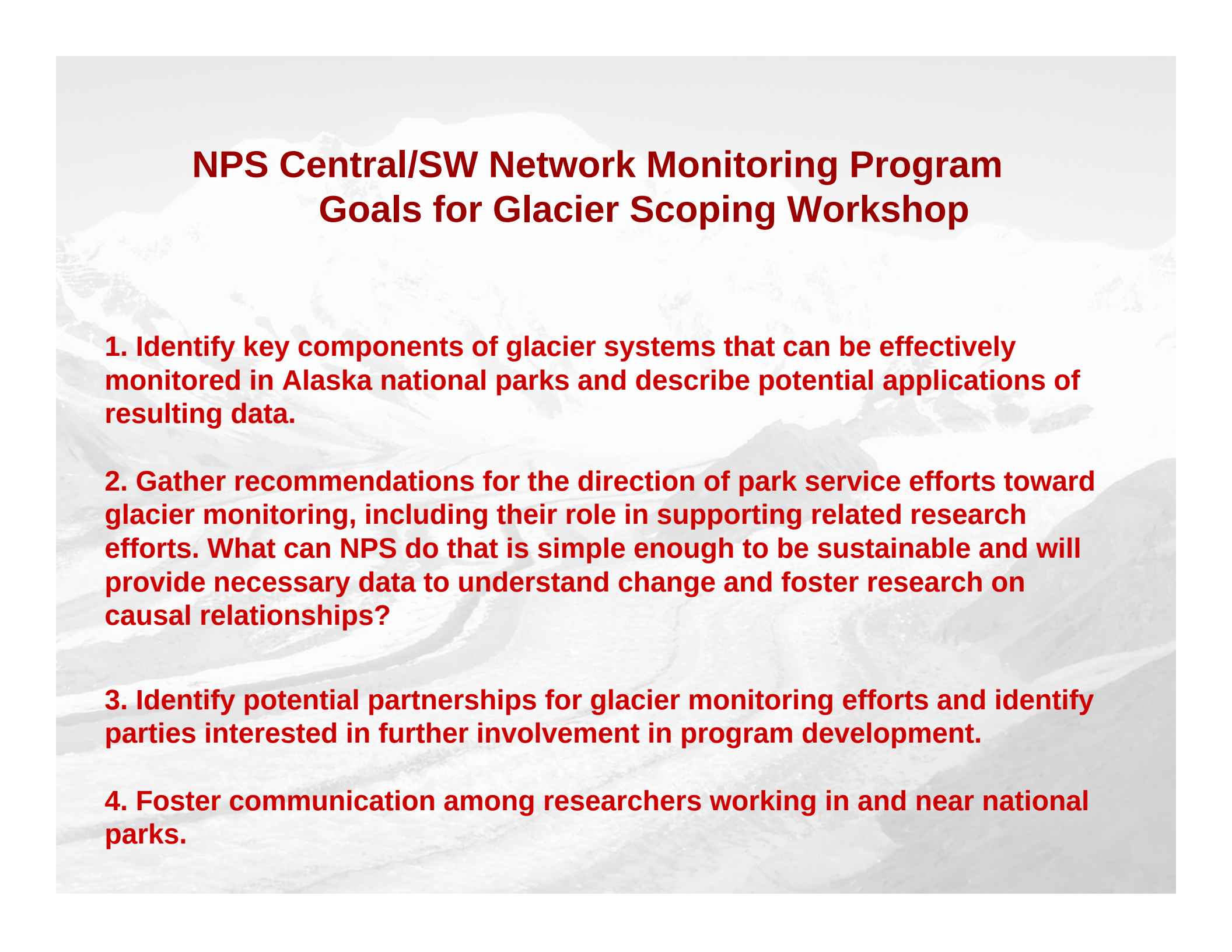
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NPS Central/SW Network Monitoring Program Goals for Glacier Scoping Workshop

- 1. Identify key components of glacier systems that can be effectively monitored in Alaska national parks and describe potential applications of resulting data.**
- 2. Gather recommendations for the direction of park service efforts toward glacier monitoring, including their role in supporting related research efforts. What can NPS do that is simple enough to be sustainable and will provide necessary data to understand change and foster research on causal relationships?**
- 3. Identify potential partnerships for glacier monitoring efforts and identify parties interested in further involvement in program development.**
- 4. Foster communication among researchers working in and near national parks.**



Goals

- Provide national context of the I&M program
- Describe the Central Alaska Network
- Present conceptual models

Impetus Behind Creation of the I&M Program

- Parks focused on single species management
- Realization this did not fulfill the mandate of NPS
- Recognized need to manage ecosystems of parks
- To do so, must know what's there and how it's doing

"Vital Signs" Inventory and Monitoring Program

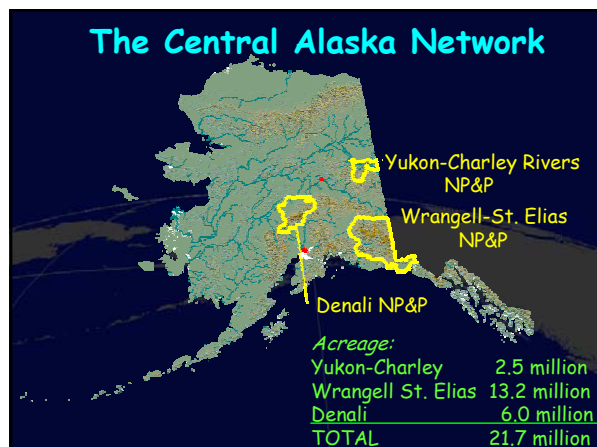
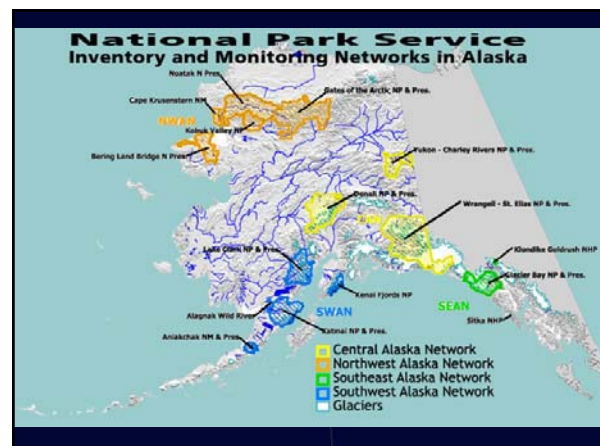
- To explain program to Congress, used analogy of human vital signs
- Identify the 'vital signs' of a system so that breakdown of system is detectable
- Translate this to fundamental ecological parameters that indicate ecosystems function
- Networks interpret this differently

National Program Goals

- Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions
- Provide early warning of abnormal conditions of selected resources
- Provide data to better understand the dynamic nature and condition of park ecosystems
- Provide data to meet certain legal and Congressional mandates

National Structure

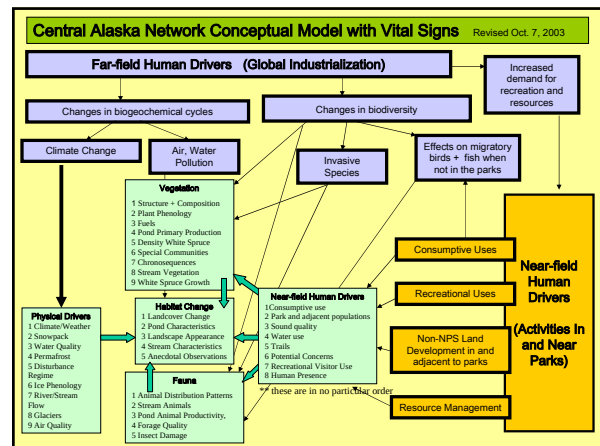
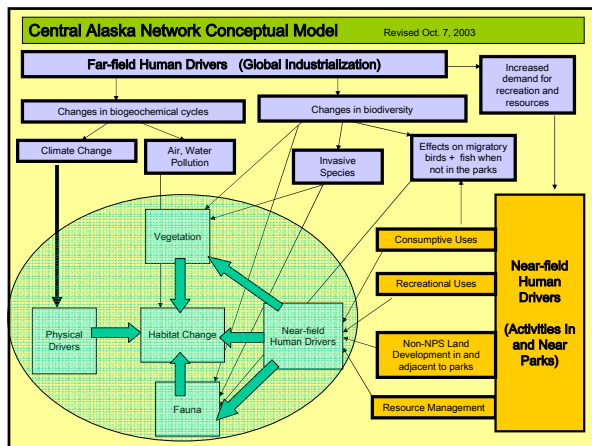
- Approximately 252 park units with significant natural resources
- Impossible to have a full I&M staff at each unit
- Creation of 32 "networks" of parks
- Each network has a minimum staff of coordinator and data manager



- ## The "M"
- Guidance from Washington to develop program:
 - Structural - charters, etc.
 - Process - workshops, etc.
 - High accountability
 - Generally, "take it slow and do it right"
 - Latitude in choosing what to monitor



- ## Goals of CAKN
- Servicewide Goal #3: Better understand dynamic nature....
 - Network Goal: a holistic view of resource change
 - Program framework in context of extensive/intensive objectives
 - extensive = 'landscape' level inference
 - intensive = park-specific or economically infeasible at larger scale



Physical Vital Signs and Measures

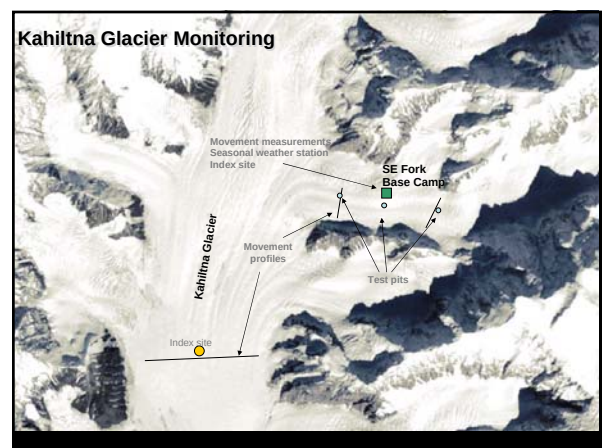
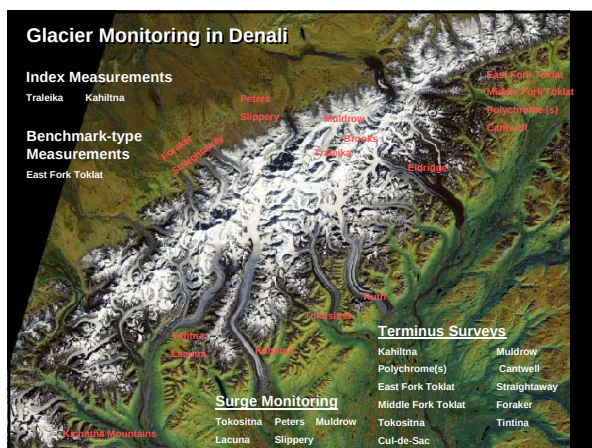
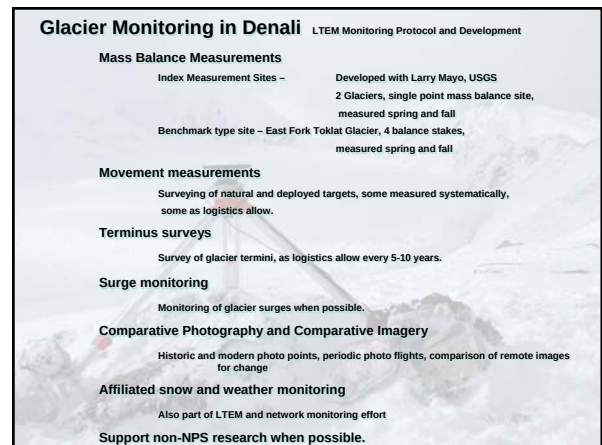
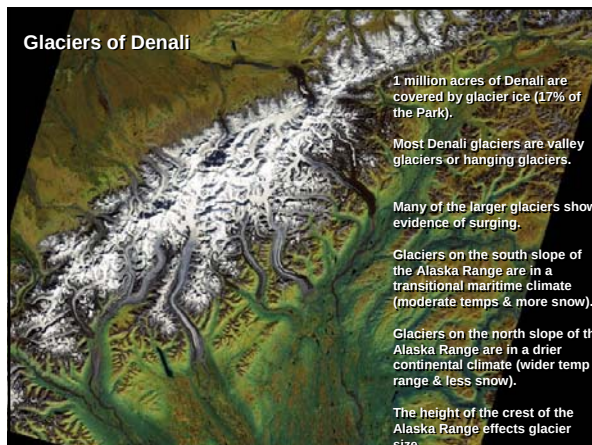
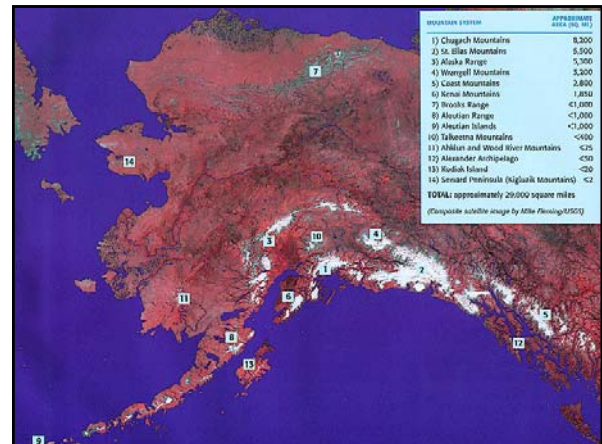
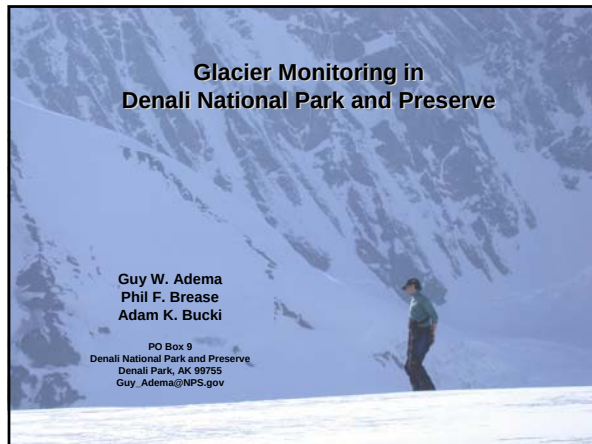
Ecological Footing and Rank	Proposed Vital Signs	Potential Measures
1	Climate/Weather	Temperature, precipitation, wind
2	Snowpack	Total accumulation, timing, geographic extent
3	Water quality – ponds & streams	pH, conductivity, total N, total P, turbidity, temperature, alkalinity
4	Permafrost	Active layer depth, presence/absence
5	Disturbance regime	Fire frequency/intensity, wind, tectonics, geomorphology, volcanism
6	Ice phenology	On/off timing
7	River/stream flow	Flow rate, timing
8	Glaciers	Mass balance, movement
9	Air quality	Measures of existing NPS program

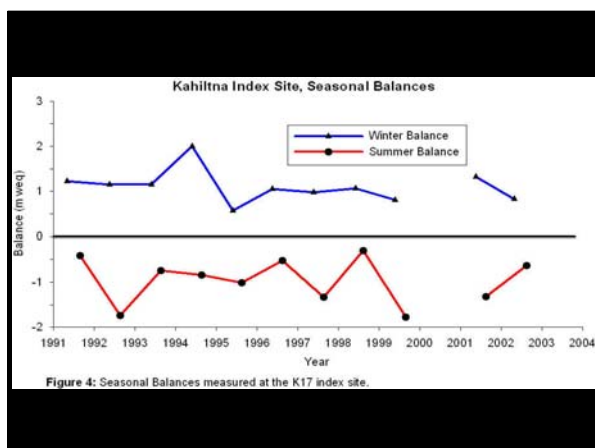
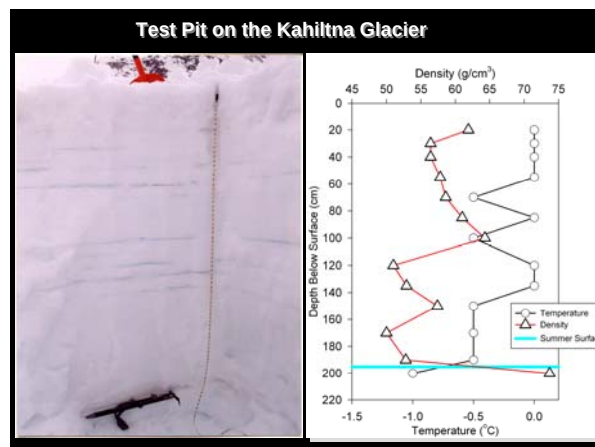
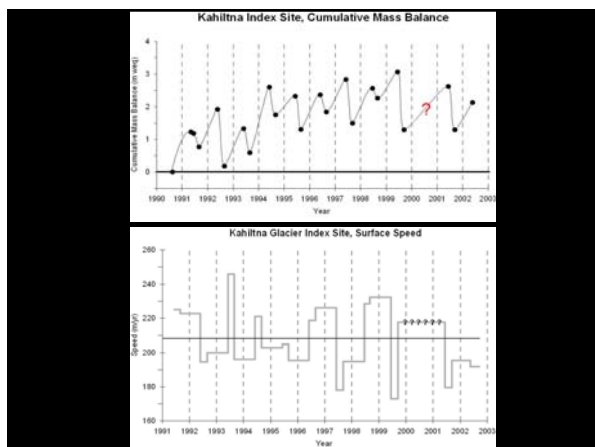
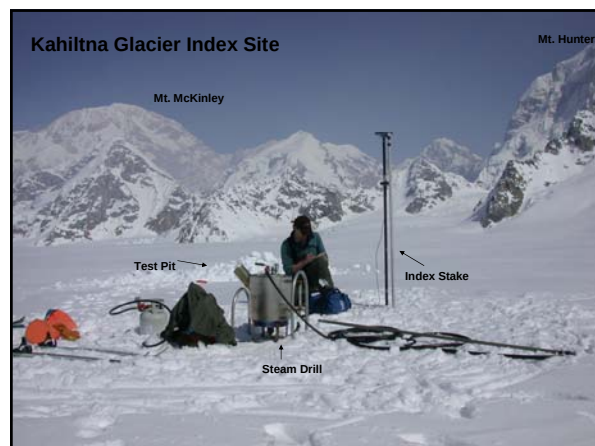
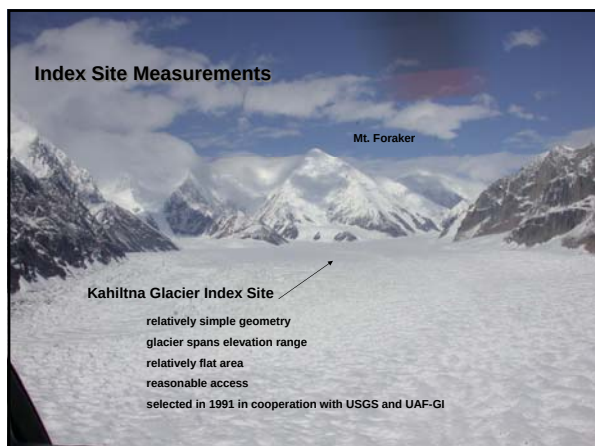
Some form of a rotating schedule

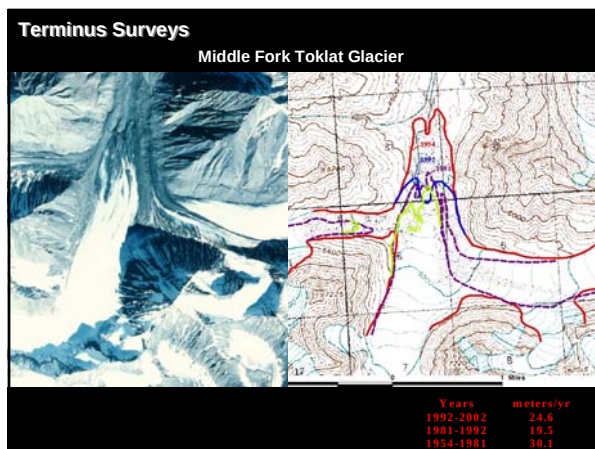
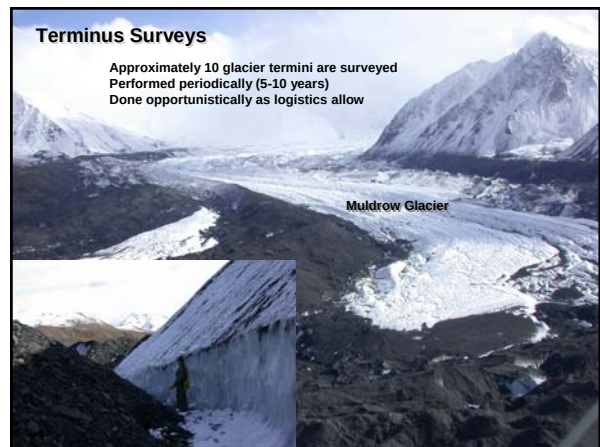
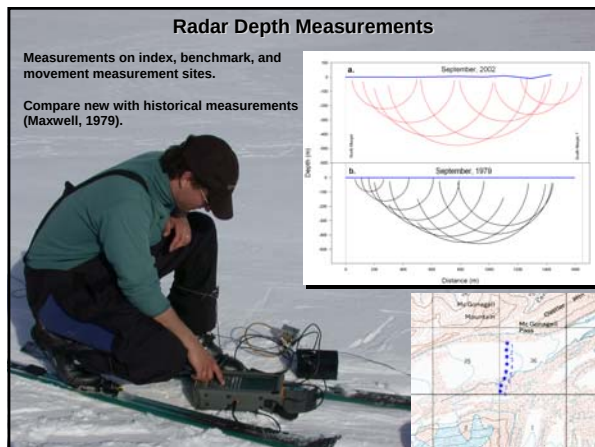
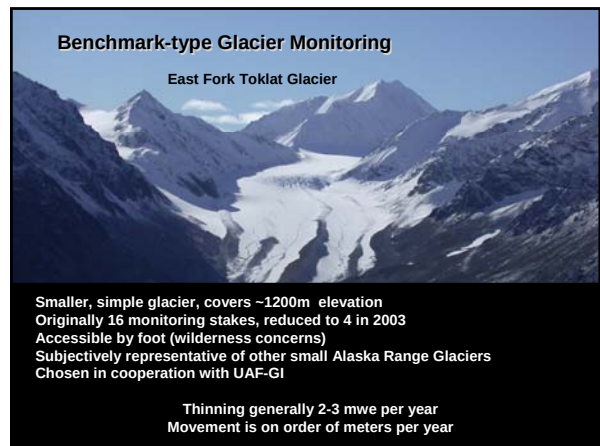
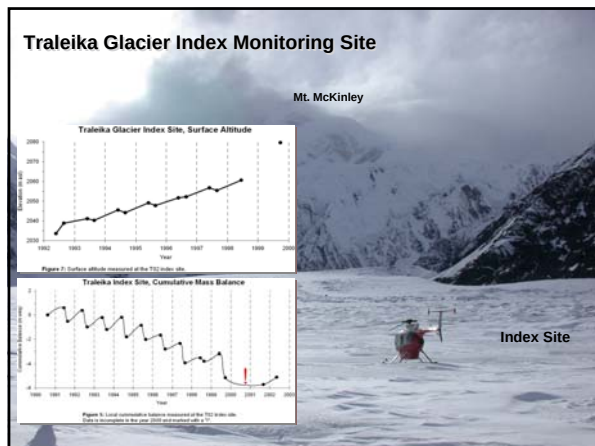
Measure	yr.	1	2	3	4	5	6	7	8	9	10
Species diversity		YUCH	WRST	DENA					YUCH	WRST	DENA
Glacier movement		X	WRST			X	WRST				X
Water Quality				X	YUCH			X	YUCH		
Remote sensed winter precip		X	X	X	X	X	X	X	X	X	X
Vegetation struc./comp.			DENA		YUCH			WRST			

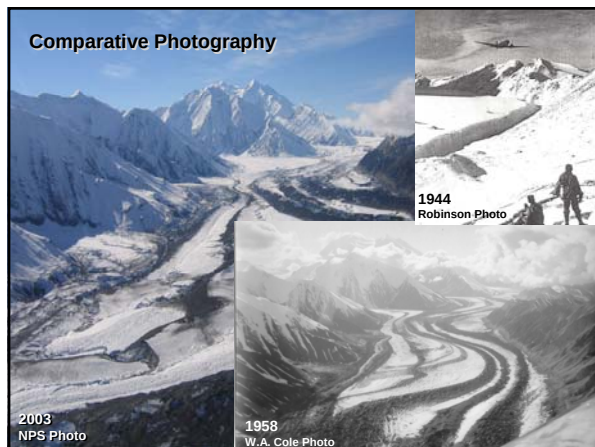
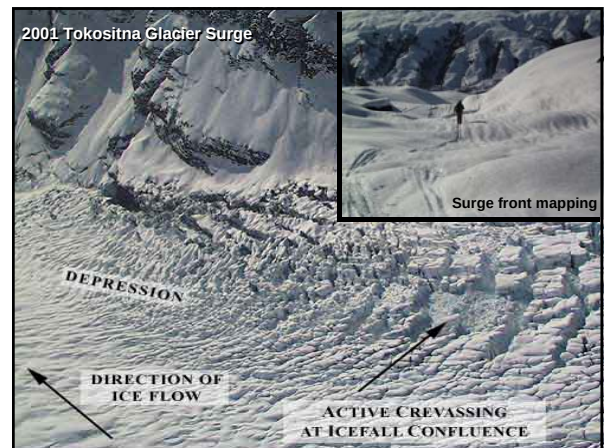
Final Points

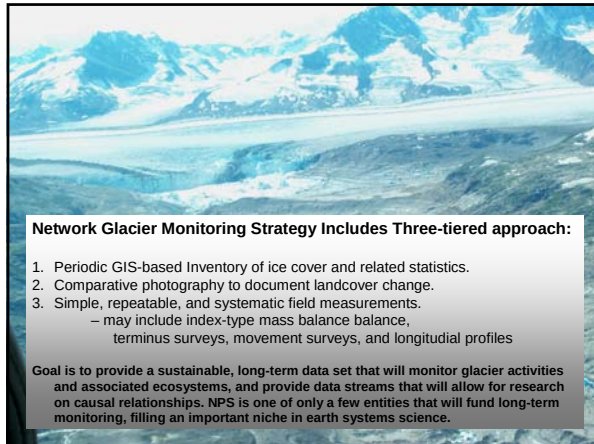
- Networks have wide latitude in structuring their monitoring programs
- Regionally hoping to keep some commonalities in monitoring components
- Focus on further defining vital signs and creation of network monitoring program











Network Glacier Monitoring Strategy Includes Three-tiered approach:

1. Periodic GIS-based Inventory of ice cover and related statistics.
2. Comparative photography to document landcover change.
3. Simple, repeatable, and systematic field measurements.
 - may include index-type mass balance balance, terminus surveys, movement surveys, and longitudinal profiles

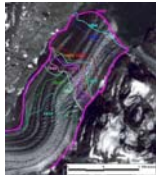
Goal is to provide a sustainable, long-term data set that will monitor glacier activities and associated ecosystems, and provide data streams that will allow for research on causal relationships. NPS is one of only a few entities that will fund long-term monitoring, filling an important niche in earth systems science.

INVENTORYING THE GLACIERS OF GLACIER BAY NATIONAL PARK, ALASKA - - CREATING GIS-COMPATIBLE GEO-REGISTERED GEOSPATIAL PRODUCTS FOR RESOURCE MANAGEMENT, SCIENCE, AND INTERPRETATION

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(2) National Park Service, Geologic Resources Division, 12795 West Alameda Parkway, P.O. Box 25027, Denver, CO 80225-0287



INTRODUCTION

- The glaciers of Glacier Bay National Park (GLBA) are the most studied within U.S. national parks. They have a history of repeated scientific observations and systematic monitoring dating from the late 19th century. However, GLBA's glaciers have never been systematically inventoried.

- During FY2003, a joint NPS - USGS investigation of Glacier Bay National Park (GLBA) commenced. Its primary purpose was to inventory the glaciers within GLBA and to produce a variety of geospatial and interpretative products documenting both long-term and short-term change.

- The goal of the inventory-phase of this project is to determine the present distribution, number, area, elevation range, and health of GLBA's glaciers. Additionally, the study will compile a summary of mid-19th century - present temporal and spatial changes of GLBA's glacier to document their response to changing climate.

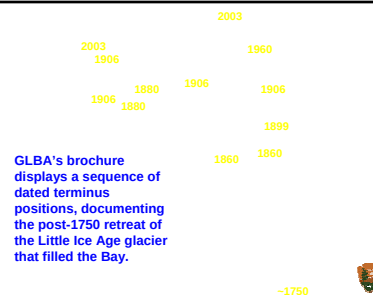
- A key aspect of the investigation focused on providing visual documentation of these changes by comparing historical and modern photographs taken from identical locations. In addition to documenting glacier change, these photo pairs demonstrate landscape evolution and vegetative succession.



GLACIER BAY - MODIS - August 2003

ANTICIPATED PRODUCTS

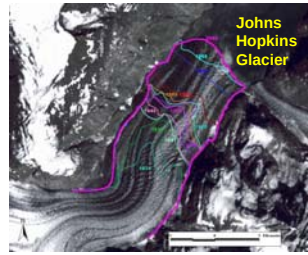
- 1) Geo-registered, geospatial data documenting glacier distribution and characteristics in 2003, capable of generating 1:100,000-scale maps;
- 2) Additional coverages, compatible with the first data set, documenting glacier distribution at decade to quarter-century intervals since ~ 1750. Included will be digital glacier terminus coverages, that were previously compiled by GLBA staff;



3) On a fiord by fiord basis, data documenting historic changes in each fiord, capable of generating 1:50,000-scale maps;

4) For selected glaciers, data documenting historic changes of individual glaciers since the late-19th century, capable of generating 1:20,000-scale maps;

5) A bibliography of glacier research and exploration dating from the late 18th century to present;



Example of Coverages Depicting Historic Terminus Positions - - 1929 - 2000



6) Modern and historic pairs of photographs, taken from identical locations, documenting changes in individual glaciers from the late 19th century to present. These will be used in outreach products, such as lectures, touch-screen displays, and web sites.

7) An annotated website with historic and modern photo pairs, location maps, terminus position maps, and background information about each glacier depicted.



GEIKIE INLET



Geikie Glacier – 1906 – Wright #323



September 2003

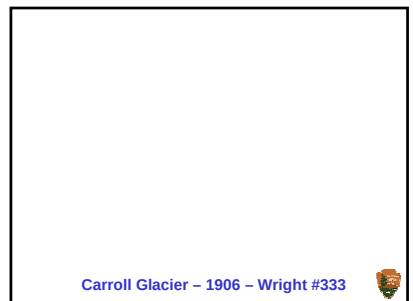
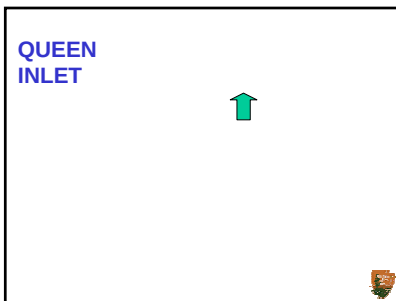
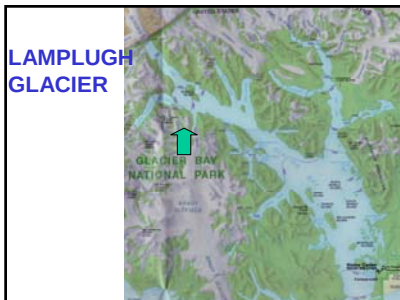
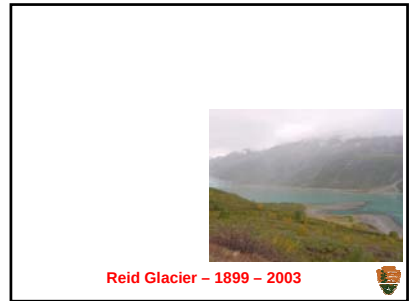
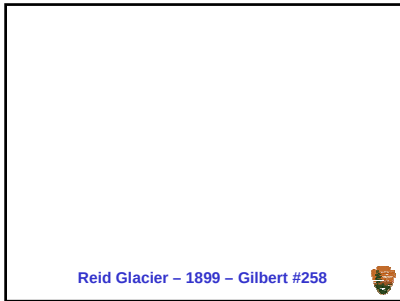


Geikie Glacier – 1906 – 2003



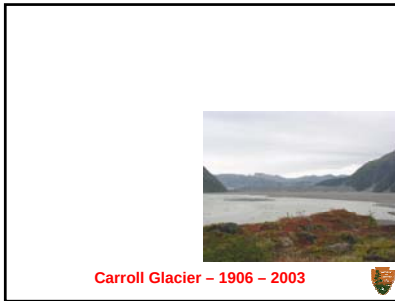
REID INLET



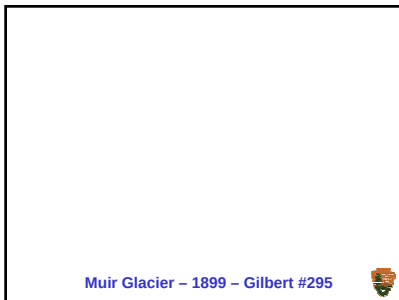
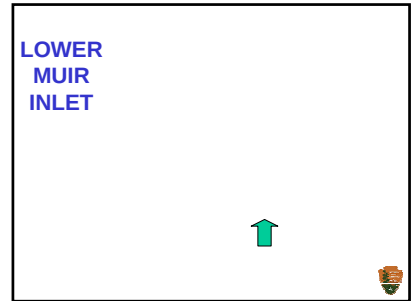




September 2003



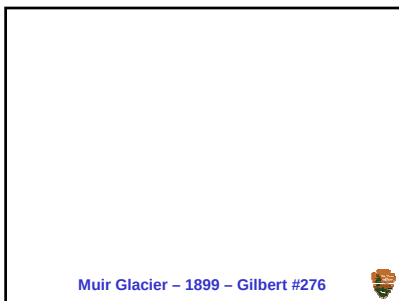
Carroll Glacier - 1906 - 2003



September 2003



Muir Glacier - 1899 - 2003

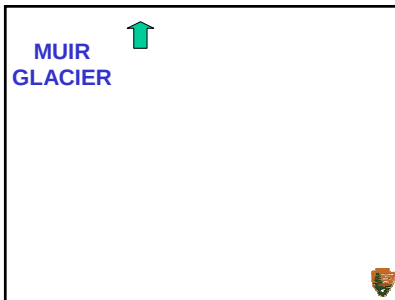
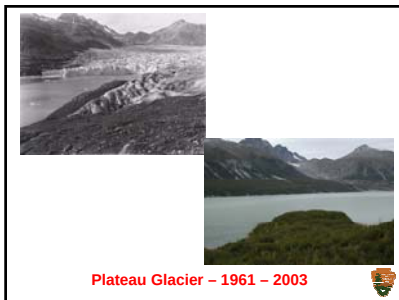
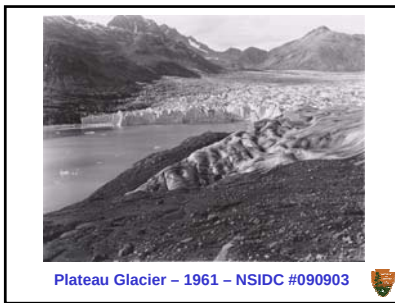
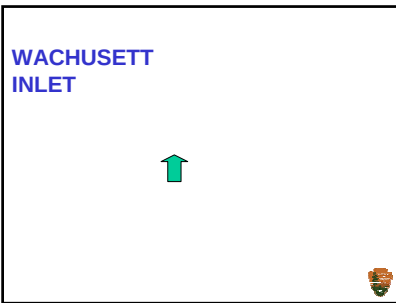


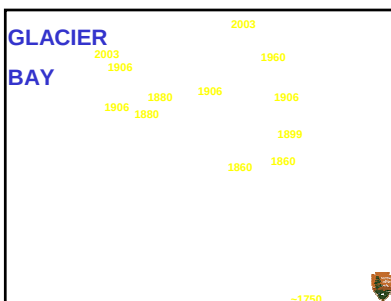
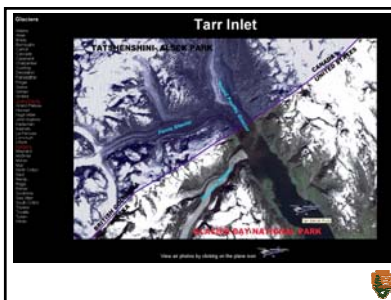
September 2003



Muir Glacier - 1899 - 2003







RESULTS

- Photo comparisons document numerous examples of glacier change, rapid landscape evolution, and vegetative succession. They reveal many areas where rapid sedimentation has filled deep fiords, where plant succession has transformed bare bedrock into dense forest, and where new habitat has developed that now supports complex ecosystems.

- Photo comparisons document that following an initial, rapid post-Little-Ice-Age retreat, individual glaciers demonstrated unique behaviors, with some continuing to retreat, some advancing, and some fluctuating.



- Photo comparisons document a complex pattern of glacier variation and change ranging from temporal variations in individual glaciers to simultaneous variation between different regions within the Bay. For example, Grand Pacific Glacier retreated into Canada during the early 20th century, then advanced into the US. Now, it is thinning, stagnating, and beginning to retreat. Continued retreat could make Glacier Bay an international navigable waterway.



- Vegetation becomes established very rapidly following ice retreat, generally within a decade, and quickly transforms the landscape.



- Different regional glacier behavioral patterns are seen in different areas of the Bay. During the last century, the differences in the patterns of individual glacier behavior observed within GLBA, appear to be in response to complex regional variations in climate, and not to a single global driver.



- This cooperative study can serve as a prototype for other parks that have not yet conducted a systematic evaluation of their glacier resources. With additional funding, other outreach products, such as an illustrated volume documenting the histories of individual glaciers will be produced.



Geospatial Inventory and Analysis of Glaciers:
A Case Study for the Eastern Alaska Range

William Manley wmanley@alaska.edu

Introduction

Study Area

Study Area

Data Sources and Processing

Unedited ice polygons over DRG

Ice polygons edited, and ice divides identified.

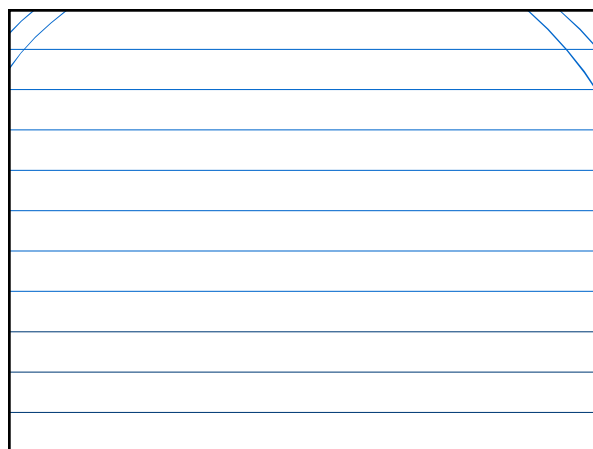
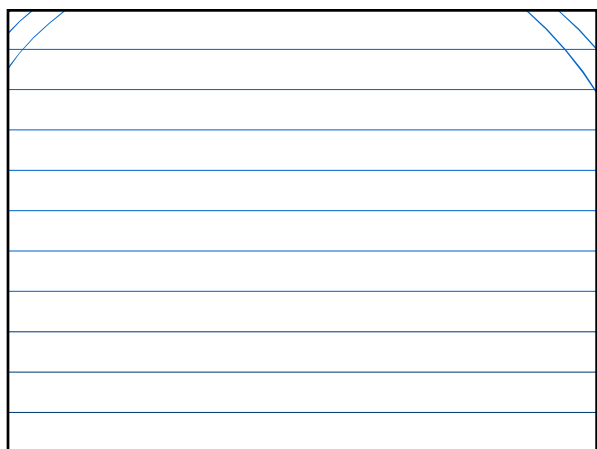
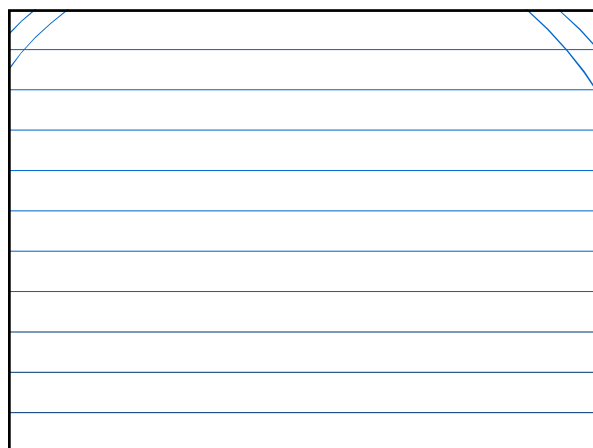
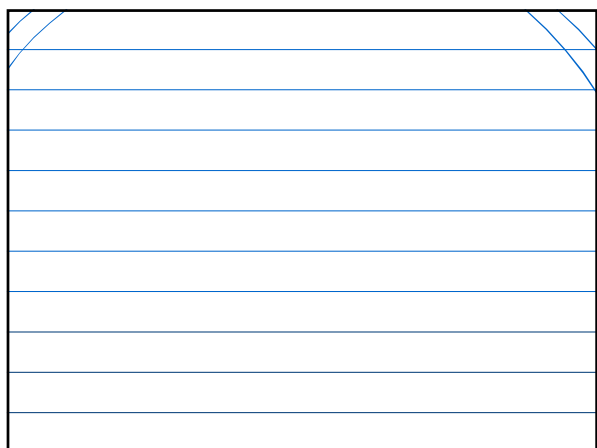


Glacier polygons over DEM



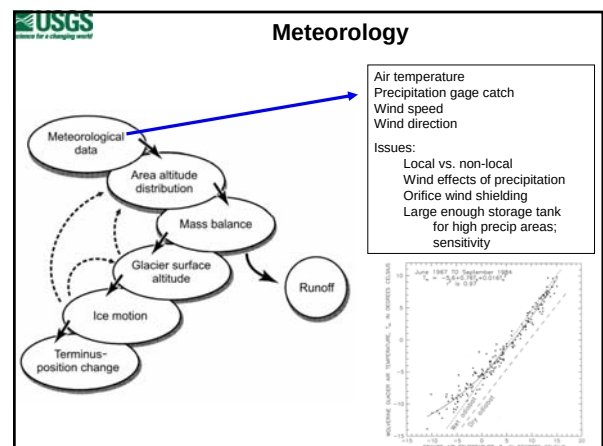
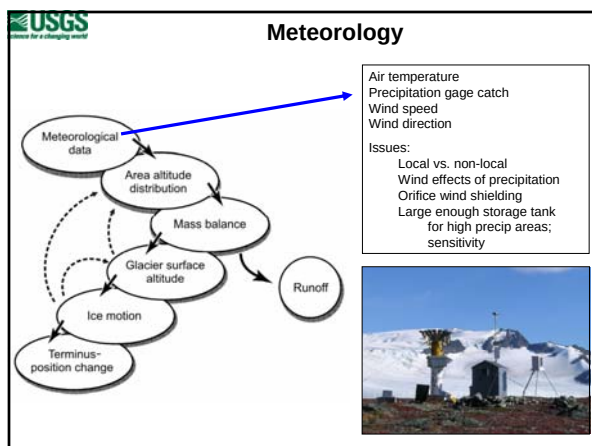
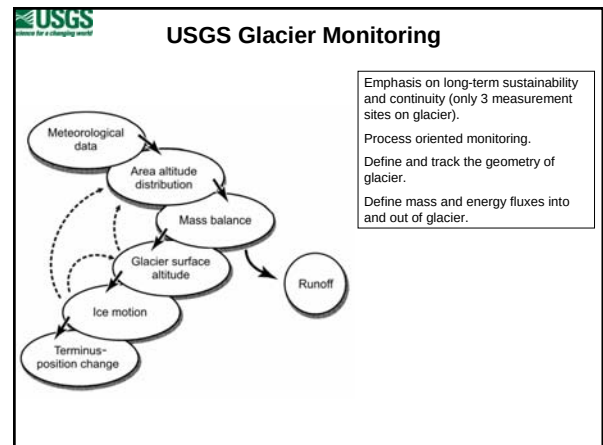
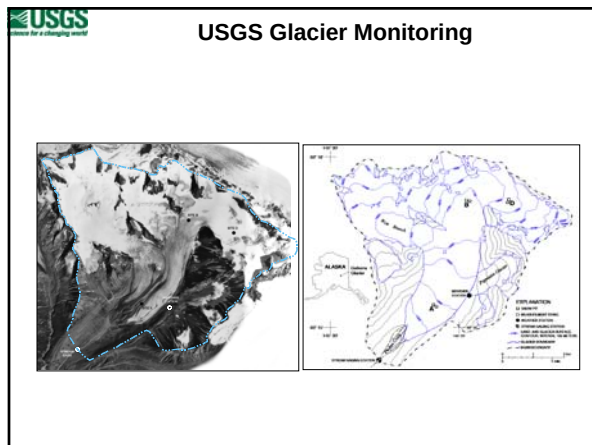
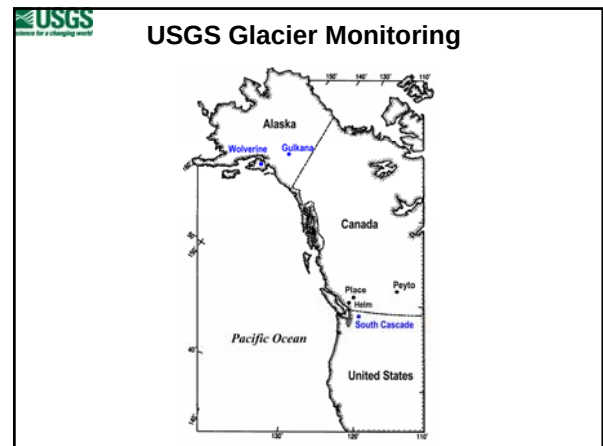
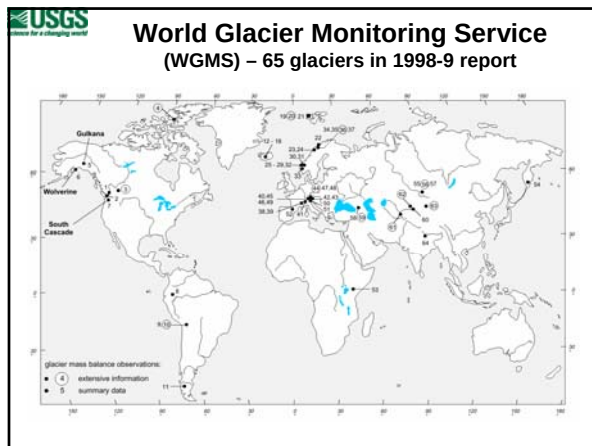
Other ice divides

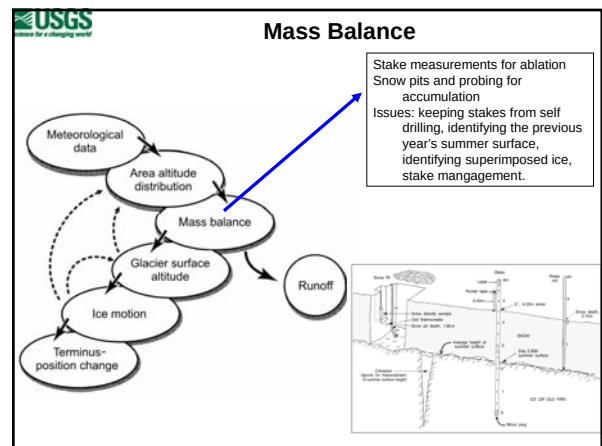
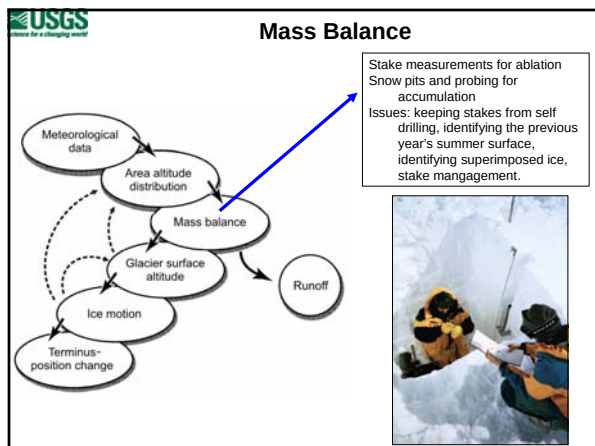
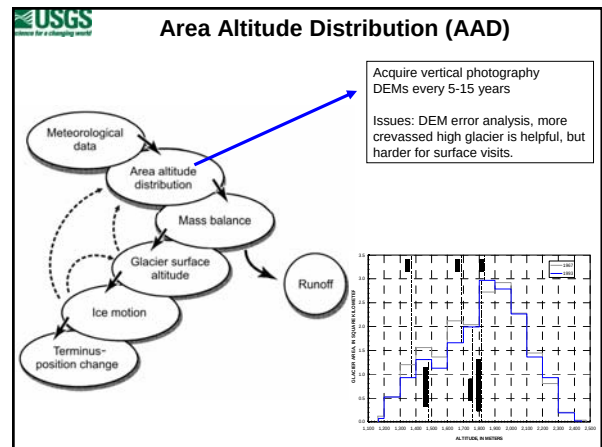
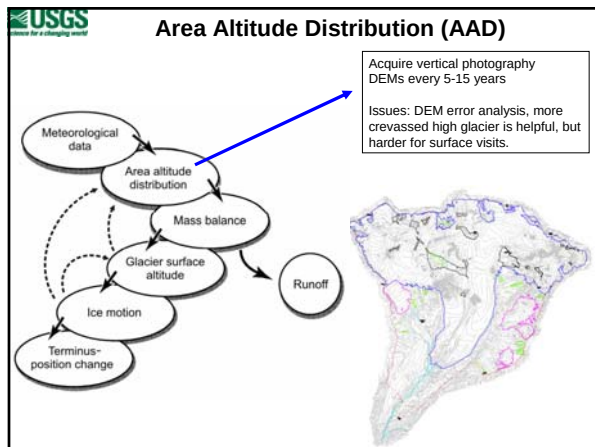
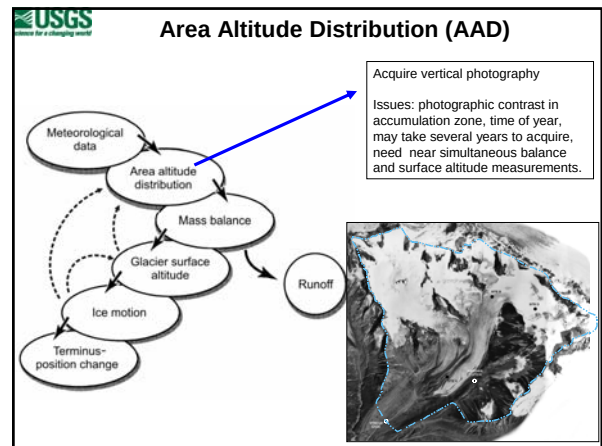
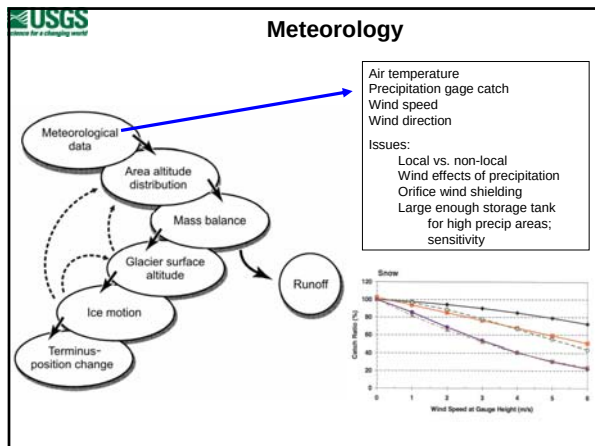


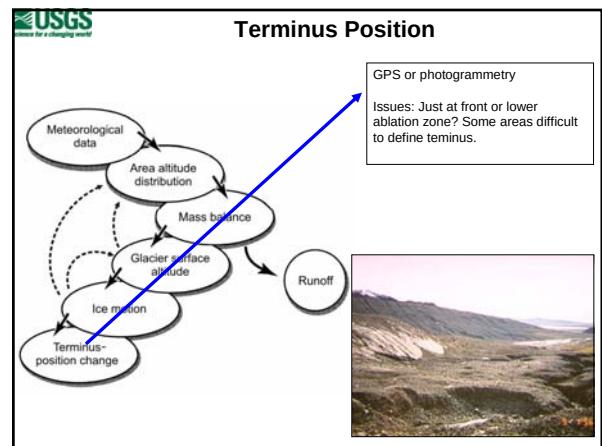
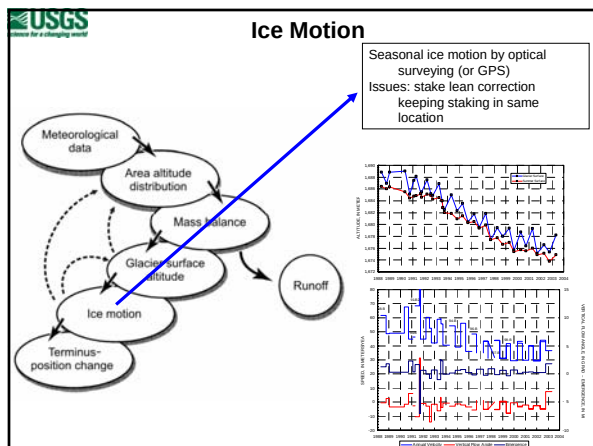
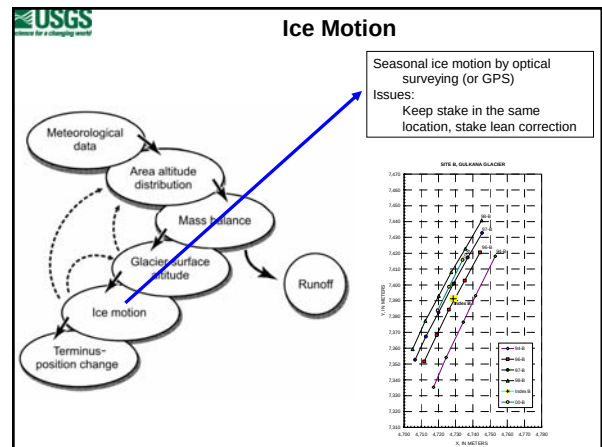
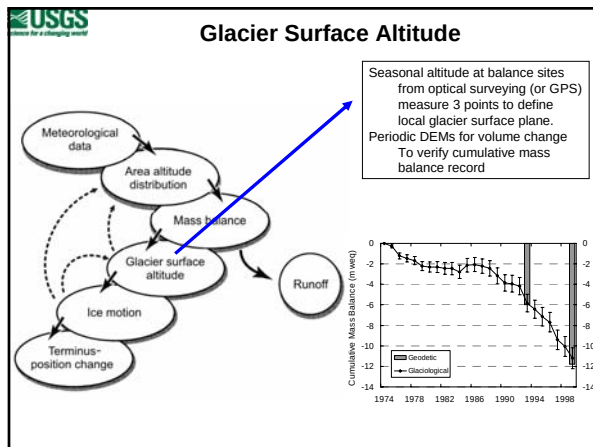
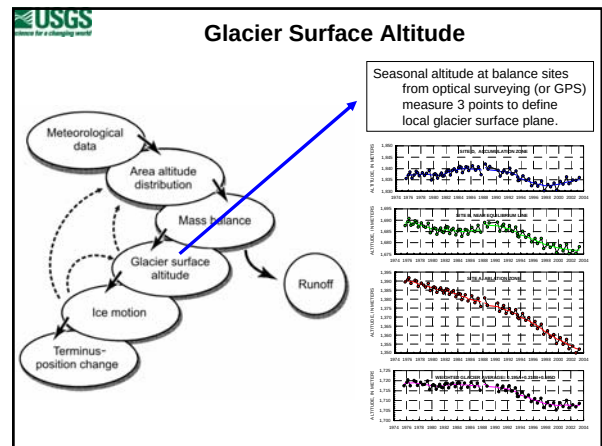
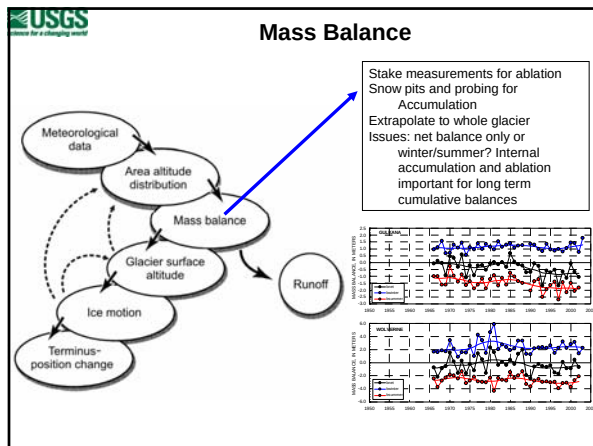


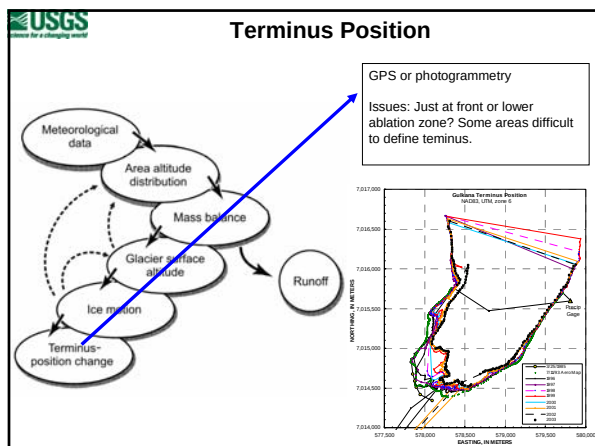
What is a "representative" glacier?

Discussion









1991 Glacier Research Workshop

February 5-7, 1991, Eagle River, Alaska

- **Sponsored by NPS, USGS, CRREL, UAF-GI**
- **70 participants from universities, federal and state agencies**
- **Goal was to promote cooperation and coordination among groups.**
- **Recommendations were made for a NPS glacier monitoring system.**
- **Recommendation for a permanent coordinating group be formed (NAGO) to:**
 1. Facilitate communications and information transfer among groups.
 2. Serve as a clearinghouse for coordinating glacier monitoring and research efforts.
 3. Recognize and ensure responses to special events such as surges, catastrophic calving, outburst floods, or other hazards.
 4. Coordinate a system for accessing archived glacier data.
 5. Improve interpretation and communication of glacier research results to the public.
- Don't intend to revisit recommendations or go to the same detail, but use it as a platform from which to shape NPS efforts.