Hello and Welcome!

I extend to you a warm welcome and a heart-felt "thank you" for your participation in the 4th Glacier Bay Science Symposium. The symposium is both recognition of and an opportunity for the exchange of an invaluable body of work resulting from the long and on-going tradition of science, research and resource management in this great national and cultural treasure, Glacier Bay National Park and Preserve. We will have the opportunity to learn much from each other and the material presented on a wide range of scientific topics over the course of the next two and a half days. It is also an opportunity to enjoy the fellowship with those who believe in the importance of science in the protection and management of the park and its natural and cultural resources. I sincerely hope that you will leave the symposium with a sense of accomplishment, a greater scientific knowledge and a renewed dedication to the protection of Glacier Bay National Park and Preserve for future generations.

Tomie Patrick Lee, Superintendent
Glacier Bay National Park and Preserve

Contents

PRE-SYMPOSIUM • Monday October 25th

Goldbelt – Tongass Rm.	8:00 am – 5:00 pm	Interpretive Research Course (pre-registration required)	
Goldbelt Hotel lobby	5:00 – 8:00 pm	Symposium registration	

Tuesday October 26th

Centennial Hall Lobby	7:00 am – 5:00 pm	Symposium registration	
Sheffield #3	OPENING SESSION		
	7:40 – 7:45 am	Introduction – Bob Winfree	
	7:45 – 8:15 am	Film – "Glacier Bay: Beneath the Reflections"	
	8:15 – 8:25 am	Introductory remarks – Sandy Milner & Scott Gende	
	8:25 – 8:35 am	Welcome – Regional Director Marcia Blaszak & Superintendent Tomie Lee	
	8:35 – 9:00 am	Huna welcome	
	9:00 – 9:45 am	**KEYNOTE: "Multiple Viewpoints Provide a Greater Understanding of Glacier Bay Ecosystems" – *Gary Davis***	
	9:45 – 10:20 am	**Break**	
Sheffield #3	SESSION 1	**Physical Systems I – Chair: Dave Brew**	
	10:20 – 10:40 am	Documenting a Century of Glacier Bay Landscape Evolution with Historical Photography	*Bruce Molnia*
	10:40 – 11:00 am	Animating Historical Repeat Glacier Photography: A Tool for Science and Education	*Ronald Karpilo*
	11:00 – 11:20 am	Early to mid-Holocene Glacier Fluctuations in Glacier Bay, Alaska	*Dan Lawson*
	11:20 – 11:40 am	Recent Thinning of Glaciers in Glacier Bay National Park	*Keith Echelmeyer*
	11:40 am – 12:00 pm	An Overview of Tectonic Elements and Plutonic Belts in the Glacier Bay National Park Region, Southeastern Alaska	*Dave Brew*
	12:00 – 12:20 pm	High Frequency Climate Signals in Fjord Sediments of Glacier Bay National Park, Alaska	*Ellen Cowan*
	12:20 – 1:30 pm	**Lunch**	
Sheffield #3	SESSION 2	**Marine Systems I – Chair: John Piatt**	
	1:30 – 1:50 pm	Glacial Fjords in Glacier Bay National Park: Nursery Areas for Tanner Crabs?	*Julie Nielsen*
	1:50 – 2:10 pm	Reproductive Cycle of Dungeness Crab Revisited: Variation at Higher Latitudes?	*Tom Shirley*
	2:10 – 2:30 pm	Increase in the Relative Abundance of Large Male Dungeness Crabs Following Closure of Commercial Fishing in Glacier Bay, Alaska	*Jim Taggart*

Tuesday October 26th (cont'd)

	2:30 – 2:50 pm	Ecdysteroid Levels in Tanner Crab in Glacier Bay: Evidence for a Terminal Molt	*Sherry Tamone*
	2:50 – 3:10 pm	Trapping Dinner: Causes of Injury in Dungeness Crabs and Survival Consequences for Released Males	*Julie Barber*
	3:10 – 3:40 pm	**Break**	
Sheffield #3	**SESSION 3**	**Freshwater/Marine Systems – Chair: Sandy Milner**	
	3:40 – 4:00 pm	Patterns of Early Lake Evolution in Glacier Bay National Park: A Comparison of Sediment Records with a Classic Chronosequence	*Dan Engstrom*
	4:00 – 4:20 pm	Ecological Development of the Wolf Point Creek Watershed from 1977 to 2001: a 25-year record	*Sandy Milner*
	4:20 – 4:40 pm	Simulating the Effects of Predation and Egg-Harvest at a Gull Colony	*Stephani Zador*
	4:40 – 5:00 pm	Behavioral Ecology of Kittlitz's Murrelets in Glacier Bay as Determined by Radio Telemetry	*Marc Romano*
Sheffield #2	6:30 – 8:00 pm	**Opening Reception**	
Sheffield #1	7:30 – 8:00 pm	Repeat showing Film – "Glacier Bay: Beneath the Reflections"	
Sheffield #1	8:00 – 9:30 pm	**Mount Fairweather Dancers**	

Wednesday October 27th

Centennial Hall lobby	open 7:00 am	Registration	
Sheffield #2	7:00 am – 5:00 pm	Poster set-up	
Sheffield #3	**PANEL**	**The Importance of Connectivity in Glacier Bay Research – Chair: Bill Brown**	
	8:00 – 8:15 am	Anecdotes from the History of Glacier Bay Science	*Bill Brown*
	8:15 – 8:30 am	A Landscape Reflected: Exploring Glacier Bay Through the Prism of Human Experience	*Wayne Howell*
	8:30 – 8:45 am	Geological Mapping of Glacier Bay and Adjacent Areas of Southeast Alaska	*Dave Brew*
	8:45 – 9:00 am	Connectivity in Glacier Bay Watersheds	*Sandy Milner*
	9:00 – 9:15 am	Peripheral Vision as an Adjunct to Rigor	*Greg Streveler*
	9:15 – 9:45 am	Panel Discussion	
	9:45 – 10:15 am	**Break**	

Wednesday October 27th (cont'd)

Sheffield #3	**SESSION 4**	**Physical Systems II – Chair: Keith Echelmeyer**	
	10:15 – 10:35 am	Active Tectonics of Southeast Alaska	*Jeff Freymueller*
	10:35 – 10:55 am	Post Little Ice Age Rebound in the Glacier Bay Region from GPS, Tide Gauge, and Raised Shoreline Measurements	*Roman Motyka*
	10:55 – 11:15 am	Landslide-induced Wave Hazard Assessment: Tidal Inlet, Glacier Bay National Park	*Gerald Wieczorek*
	11:15 – 11:35 am	A Transect of Glacier Bay Ocean Currents Measured by Acoustic Doppler Current Profiler (ADCP)	*Edward Cokelet*
	11:35 – 11:55 am	Glacier Bay Underwater Soundscape – Natural and Vessel-generated Sound in Lower Glacier Bay	*Blair Kipple*
	11:55 am – 1:10 pm	**Lunch**	
Sheffield #3	**SESSION 5**	**Management Issues – Chair: Susan Boudreau**	
	1:10 – 1:30 pm	Glacier Bay's Coastal Resources Inventory and Mapping Program: 900 Miles of Shoreline Resource Information:	*Lewis Sharman*
	1:30 – 1:50 pm	Distribution and Number of Backcountry Visitors in Glacier Bay National Park, 1996–2003	*Mary Kralovec*
	1:50 – 2:10 pm	Bear-Human Interactions at Glacier Bay National Park and Preserve: Conflict Risk Assessment	*Tom Smith*
	2:10 – 2:30 pm	Vessel Use and Activity in Glacier Bay National Park's Outer Waters	*Chad Soiseth*
	2:30 – 2:50 pm	Spruce Beetle and Forest Structure in Glacier Bay National Park: Results from Long Term Plots	*Mark Schultz*
	2:50 – 3:20 pm	**Break**	
Sheffield #3	**SESSION 6**	**Marine Systems II – Chair: Jim Bodkin**	
	3:20 – 3:40 pm	Oceanographic Patterns in a Glacially-fed Fjord Estuary: Implications for Biological Patterns and Productivity	*Lisa Etherington*
	3:40 – 4:00 pm	The Distribution and Relative Abundance of Pacific Halibut in a Recently Deglaciated Fjord: The Role of Glacial Inputs and Ecosystem Age	*Jennifer Mondragon*
	4:00 – 4:20 pm	Spatial Distribution of Nearshore and Pelagic Fishes in Relation to Physical Oceanography in a Glacial Fjord	*Mayumi Arimitsu*
	4:20 – 4:40 pm	Hotspots in a Glacial Landscape: Patchiness of Marine Fish, Birds and Mammals in Glacier Bay	*John Piatt*

Wednesday October 27th (cont'd)			
	4:40 – 5:00 pm	Marine Habitats and Their Effects on Marine Bird and Mammal Distributions in Glacier Bay National Park	*Gary Drew*
Sheffield #2	6:30 – 8:30 pm	**Poster Session & Reception**	
Sheffield #3	8:30 – 9:30 pm	**Tributes to Dr. Don Lawrence and William O. Field**	
Thursday October 28th			
Centennial Hall lobby	open 7:00 am	Registration	
Sheffield #2	8:00 am – 4:00 pm	Posters on display	
Sheffield #3	8:00 – 8:40 am	**KEYNOTE – "The Role of Glacier Bay Science in Understanding Long-term Ecological Processes" – *Terry Chapin***	
Sheffield #3	**SESSION 7**	**Social issues – Chair: Wayne Howell**	
	8:40 – 9:00 am	The Huna Tlingit People's Use of Gull Eggs and the Establishment of Glacier Bay National Park	*Eugene Hunn*
	9:00 – 9:20 am	Tlingit Traditional Knowledge and Clan Management of Sockeye Salmon in Dry Bay, Alaska	*Judith Ramos*
	9:20 – 9:40 am	Geologic Evidence Linking Neoglacial Ice Terminus Advance and Marine Incursion with Tlingit Ethnohistory and Archeology in Lower Glacier Bay	*Daniel Monteith*
	9:40 – 10:10 am	**Break**	
Sheffield #3	**SESSION 8**	**Marine Systems III – Chair: Scott Gende**	
	10:10 –10:30 am	Testing the Effectiveness of a High Latitude Marine Reserve Network: A Multi-Species Movement Study in Glacier Bay National Park	*Alexander Andrews*
	10:30 – 10:50 am	Killer Whale Feeding Ecology and Non-predatory Interactions with Other Marine Mammals	*Dena Matkin*
	10:50 – 11:10 am	Steller Sea Lion Population Trends, Diet, and Brand-resighting Observations in Glacier Bay	*Tom Gelatt*
	11:10 – 11:30 am	Age at First Calving of Female Humpback Whales in Southeastern Alaska	*Chris Gabriele*
	11:30 – 11:50 am	Perspectives from an Invading Predator: Sea Otters in Glacier Bay	*Jim Bodkin*
	11:50 am – 12:10 pm	Declines in Harbor Seal Numbers in Glacier Bay National Park, Alaska, 1992–2002	*Beth Matthews*
Sheffield #3	12:10 – 12:15 pm	Concluding remarks – Bob Winfree • Huna closing of meeting	

POST-SYMPOSIUM EVENTS • Thursday October 28th

Sheffield #3	1:00 – 5:00 pm	Science Integration Workshop (invited participants only)
Goldbelt – Tongass Rm.	1:00 – 5:00 pm	Interpretive Research Course (pre-registration required)
Sheffield #2	4:00 – 5:00 pm	Poster take-down

POST-SYMPOSIUM EVENTS • Friday October 29th

Goldbelt – Cedar Rm.	8:00 am – 5:00 pm	Science Integration Workshop (invited participants only)
Goldbelt – Tongass Rm.	8:00 am – 5:00 pm	Interpretive Research Course (pre-registration required)
UAS Egan Hall Rm. 112	7:00pm	Evening at Egan – "Overview of Glacier Bay Ecosystems"

A few points of interest regarding the structure of the program for this the 4th Glacier Bay Science Symposium. The overall goal of the symposium is to facilitate increased understanding of the Glacier Bay ecosystem by enhancing communication among researchers and identifying strategies for integrating research investigations. To achieve this goal there are four main objectives: (1) present papers summarizing the latest research investigations from Glacier Bay, (2) provide the opportunity for marine, watershed, ecosystem and social scientists to address topics that will support scientific integration in Glacier Bay, (3) convene a strategic workshop (to follow the technical sessions) to provide recommendations for the integration of research in Glacier Bay and (4) publish the individual presentations (oral and posters) from the meeting in short paper format in a proceedings to be published by the U.S. Geological Survey. Additionally some papers may be published as a group in a peer-reviewed journal, and it is planned to publish integrated papers from the symposium in a peer-reviewed book, which will summarize our present understanding of the Glacier Bay ecosystem.

We decided from the outset that concurrent sessions would not be part of the program, even if more abstracts for oral presentations were submitted than time permitted. This has always been the tradition with these symposia so that attendees can listen to a wide range of presentations relating to Glacier Bay. This symposium is about a place not a subject. There are 39 oral presentations in total, arranged into 8 sessions. Nine original oral submissions were switched to posters. This was a difficult decision, but the two main criteria used were firstly that the research be related directly to Glacier Bay and secondly that it not be preliminary findings or a pilot study. We have a vibrant poster session with 38 papers on Wednesday evening, and we hope you will all attend this important session.

While the program was structured to give a comprehensive coverage to all areas of research and investigation, three-and-a-half sessions of oral presentations and a large component of the posters are devoted to marine ecosystems and associated studies. This simply reflects a major focus of Glacier Bay research over the 11 years since the last symposium. We are fortunate to have two well-known keynote speakers to commence the presentations each day with Dr. Gary Davis on Tuesday morning discussing “Multiple Viewpoints Provide a Greater Understanding of Glacier Bay Ecosystems” and Professor Terry Chapin on the Thursday morning talking about “The Role of Glacier Bay Science in Understanding Long-term Ecological Processes.” On Wednesday morning, Bill Brown has assembled a panel discussion with five presenters that have a long association with Glacier Bay on the theme of “The Importance of Connectivity in Glacier Bay Research.”

– Sandy Milner (Program Chair)

Keynote Speakers

Tuesday, October 26 • 9:00 – 9:40 am
Multiple Viewpoints Provide a Greater Understanding of Glacier Bay Ecosystems
Gary E. Davis, Visiting Chief Scientist for Ocean Programs, National Park Service

Gary Davis is a marine ecologist and certified fisheries scientist from San Diego, California. He began his career in 1964 as a park ranger, and served as an Aquanaut on the1969 Tektite I Project in Virgin Islands National Park. As a research scientist in the 1970s, he explored how Dry Tortugas, Everglades, and Biscayne National Parks contributed to sustainable fisheries and to the integrity of ocean ecosystems in the Florida Keys. In the 1980s, Gary founded a prototype environmental 'vital signs' monitoring program at Channel Islands National Park, California. That program became a model for the National Park System, and led to the recent establishment of a pioneering network of marine reserves in the park. He has authored or edited more than 150 scientific articles, including the 1996 book *Science and Ecosystem Management in the National Parks*

Thursday, October 28 **• 8:00 – 8:40 am**
The Role of Glacier Bay Science in Understanding Long-term Ecological Processes
Terry Chapin, Professor of Ecology, Institute of Arctic Biology, University of Alaska Fairbanks

Terry Chapin has been a Professor in the Institute of Arctic Biology at the University of Alaska, Fairbanks, since 1996 when he returned to Alaska after teaching at the University of California, Berkeley. His general research interests focus on the consequences of plant traits for ecosystem and global processes and the interaction of ecological, cultural and economic processes to determine regional responses to global change. Terry is principal investigator of the Bonanza Creek Long Term Ecological Research (LTER) program, which conducts long-term ecological research in the boreal forest. His research within LTER relates to the impacts of climate, fire and other disturbances on energy exchange and feedbacks to regional climate. He has published extensively in terms of scientific papers and has co-authored numerous books.

Panel Presentation and Discussion

Wednesday, October 27 • 8:00 – 9:45 am
The Importance of Connectivity in Glacier Bay Research
Panel: Bill Brown, Wayne Howell, David Brew, Sandy Milner, Greg Streveler

This panel presentation and discussion focuses on the importance of the concept of connectivity when undertaking research in Glacier Bay. This connectivity can take many forms, across a wide range of spatial and temporal scales. Historical connectivity between early researchers and their findings to current research and new investigators is essential, as is the importance of long-term studies. We need to maintain connectivity and linkage between the cultural heritage of the region and Glacier Bay research. We need to understand the connectivity and important linkages between the different ecosystems as succession progresses to fully inform management decisions and approaches. We need to establish mechanisms to maintain connectivity between scientists working in different disciplines so that these linkages can be identified. Connectivity to our feelings for the landscape is also an important component to provide additional vision to our understanding of the Glacier Bay Ecosystem. Connectivity from the old horses (nags?) on the panel provides continuity between the three original locally-generated symposia (1983, 1988, and 1993) and this 2004 Regional Office-generated symposia, which may provide a more inclusive and wider perspective to sample the full span of science at Glacier Bay. Glacier Bay is not a blank slate. It is an ongoing scientific and esthetic adventure, a window onto the gestalt of how the world in its plethoric wonders functions.

Anecdotes from the History of Glacier Bay Science – *Bill Brown*

An overview of the connectivity of scientific activity in Glacier Bay, from initial observations, to inventory and monitoring, to integrated science plans and development of ecosystem models, including cultural factors.

A Landscape Reflected: Exploring Glacier Bay Through the Prism of Human Experience – *Wayne Howell*

Blessed with a Native Culture that traces its origin to the Glacier Bay landscape, we are presented with a rare opportunity to explore the realm where physical and spiritual worlds connect. Long recognized as a part of the Glacier Bay story, our deepening understanding of Tlingit culture and their ties has opened up a new era of research, appreciation, and management approaches in the Park. At the same time, we must also recognize the invisible fabric that links the Tlingit peoples to their homelands, i.e. culture, is very fragile and is threatened with the passing of each Elder. How we confront this issue in the next few short years will determine if future generations will enjoy this special gift.

Geological Mapping of Glacier Bay and Adjacent Areas of Southeast Alaska – *Dave Brew*

This presentation will summarize nearly 40 years of field work and research in the Glacier Bay region, leading to new and revised geological mapping.

Connectivity in Glacier Bay watersheds – *Sandy Milner*

The importance of establishing linkages between ecosystems will be illustrated to understand the successional processes significant in stream development. Integrated research on the landscape is necessary to elucidate the connectivity that exists in watersheds as they develop in Glacier Bay. Understanding these linkages is important in determining appropriate management approaches.

Peripheral Vision as an Adjunct to Rigor – *Greg Streveler*

There has been an increasing emphasis on rigor in the selection and implementation of Glacier Bay research. Rigor requires focus and typically attention to instrumentation, data reduction and analysis. The result is diminished field time, and less attention to matters outside the strict limits of the research question. A further exacerbation is the need to select studies for which rigor is feasible; typically restricting investigations to what is quantifiable. Often, the most inconsequential is the most quantifiable. If rigorous studies are the entirety of the research program, this leaves a large proportion of the ecosystem outside our ken. In the final analysis, what we know about Glacier Bay may be less critical than what we feel. Love for the place may lead to self-restraint; by contrast, scientific endeavor has tended to abet the premise that ever more human activity can be shoehorned in and managed.

Biographies of Panel Speakers

Bill Brown *came to Alaska with the National Park Service task force in 1975. He has served as historian for the Alaska Region, and was later park historian at Gates of the Arctic and Denali National Parks. Bill makes his home in Gustavus.*

Wayne Howell*, an archeologist by training, now works for the Park Service to apply his expertise in cultural resources to foster new relationships with the Huna and Yakutat Tlingit Tribes and enhance our understanding of the Tlingit Homelands encompassed within the modern Park.*

Dave Brew *is a Research Geologist Emeritus with the U.S. Geological Service Research Center at Menlo Park, California. He has worked in southeast Alaska since the 1950's.*

Sandy Milner *first came to Glacier Bay in 1977, when leading an expedition from Chelsea College, London, and ended up staying in Alaska. Subsequently, he has conducted research into stream development in the Park every year, except one. He is now a faculty member at the University of Birmingham, UK and also at the Institute of Arctic Biology, University of Alaska, Fairbanks.*

Greg Streveler *first came to Alaska in 1962 in the midst of his education at the University of Wisconsin. He fell in love with Glacier Bay at first sight, and was fortunate to work there, initially as a ranger, and then as its first staff scientist from 1967-80. Greg lives in Gustavus, working as a consultant and teacher.*

Film: "Glacier Bay: Beneath the Reflections"

Tuesday, October 26 • 7:45 – 8:15 am • Centennial Hall, Sheffield #3
repeat showing • 7:30 – 8:00 pm • Sheffield Ballroom #1

Glacier Bay National Park & Preserve's new underwater film "Glacier Bay: Beneath the Reflections" explores the complex and dynamic marine ecosystem that inextricably links the marine and terrestrial environments, and the unexpectedly varied and abundant marine life under waters fed by melting glaciers. While thousands of visitors aboard cruise ships and tour boats travel to the park to see glaciers, few ever dive beneath the surface to experience the underwater world of Glacier Bay.

This 28-minute high-definition film has garnered a 2003 Telly Award for nonbroadcast media, a 2003 USGS Shoemaker Award for communication product excellence, a 2003 National Association of Interpretation Media Award, and 2004 International Wildlife Film Festival Awards. Kris Nemeth, Chief of Interpretation for Glacier Bay, received the 2002 Alaska Region Freeman Tilden Award for interpretive excellence for her role in producing the film. The film is a cooperative project with the National Park Service, Panasonic, Pace Technologies, USGS, USFWS, Alaska Natural History Association and the Challenge Cost Share Program.

Opening Reception

Tuesday, October 26 • 6:30 – 8:00 pm • Centennial Hall, Sheffield #2

Hors d'oeuvres, cash bar, and an opportunity to converse with symposium participants.

Mount Fairweather Dancers

Tuesday, October 26 • 8:00 – 9:30 pm • Centennial Hall, Sheffield #1

The Mount Fairweather Dancers have been in existence for over seven decades. Although the group includes members from all of the Clans of Hoonah, the group was initially organized as a way to preserve the songs, dances and stories of the Takdeintaan Clan who originate from Lituya Bay. The name was chosen for the group because Mount Fairweather (Tsalxhaan in Tlingit) towers over the traditional Takdeintaan territory from Cape Fairweather to Dundas Bay, and is the overarching heraldic crest for the entire clan. The group performs a variety of songs that relate to history and events within the Huna Tlingit homeland, in particular several spirit songs and dances that emanate from within Mount Fairweather itself. The group is led by a panel of elders who instruct the dancers, singers and drummers in the songs and dances that have been passed down over countless generations. The Mount Fairweather Dancers perform only at special events and have graciously agreed to share their deep tradition with attendees at the Glacier Bay Science Symposium.

Note: The Mount Fairweather Dancers have come to Juneau for the Glacier Bay Science Symposium largely at their own expense. As a way to defray costs the group will include a "Blanket Dance" as a part of their performance. During the course of the dance conference attendees will be invited to dance out to a blanket placed on the floor and leave a donation as a show of gratitude.

Poster Session & Reception

Wednesday, October 27 • 6:30 – 8:30 pm • Centennial Hall, Sheffield #1

An interactive session with poster authors and symposium attendees. Hors d'oeuvres and cash bar.

Tribute to Two Legends of Glacier Bay Research

Wednesday, October 27 • 8:30 – 9:30 pm • Centennial Hall, Sheffield #3

Tribute to Dr. Don Lawrence — Greg Streveler

Tribute to William O. Field — Suzanne Brown

Interpretive Research Training

Monday, October 25 • 8:00 am – 5:00 pm • Goldbelt Hotel, Tongass Room

Thursday, October 28 • 1:00 – 5:00 pm • Goldbelt Hotel, Tongass Room

Friday, October 29 • 8:00 am – 5:00 pm • Goldbelt Hotel, Tongass Room

This training introduces a framework for integrating scientific research with educational outreach products. The main components of the course focus on advanced resource-based research skills and guidance useful in working with resource managers and subject matter experts, advanced audience research skills, and appropriate techniques that connect multiple audiences to resource meanings and provoke them to care about the resources.

Science Integration Workshop

Thursday, October 28 • 1:00 – 5:00 pm • Centennial Hall, Sheffield #3

Friday, October 29 • 8:00 am – 5:00 pm • Goldbelt Hotel, Cedar Room

This is an invited participation science integration workshop designed to advance our understanding of Glacier Bay ecosystems through the careful development of a long-term integrated science plan that provides sounds science to help guide management decisions in the park. The workshop will consist of three panels of recognized experts representing the marine, freshwater, and terrestrial ecosystem components, and their interactions in Glacier Bay.

Evening at Egan: Overview of Glacier Bay Ecosystems

Friday, October 29 • 7:00 pm

University of Alaska Southeast, Egan Hall, Rm. 112

Symposium participants Jim Bodkin and Sandy Milner will be featured speakers at the Evening at Egan lecture series on the University of Alaska Southeast campus. Their presentations will provide an additional forum to share Glacier Bay science and research with the local community.

Session 1

Physical Systems I

Chair: David Brew, Research Geologist Emeritus, U.S. Geological Survey, Alaska Science Center, Menlo Park, California

Documenting a Century of Glacier Bay Landscape Evolution with Historical Photography

Bruce Molnia, Research Geologist, U.S. Geological Survey, Reston, Virginia
Ronald D. Karpilo, Jr., National Park Service, Geologic Resources Division, Denver, Colorado
Harold S. Pranger, National Park Service, Geologic Resources Division, Denver, Colorado

More than 750 pre-1962 photographs that show the Glacier Bay landscape and glacier termini have been identified by the author. The earliest of these predate 1890. In 2003, 50 photo-sites from which glacier termini had been photographed between 1899 and 1961 were revisited. Fourteen other photo-sites from which the author had photographed glacier termini in the late 1970s and early 1980s were also revisited. At each site, elevation and latitude and longitude were recorded using GPS technology. Then, bearings to photographic targets were determined with a geologic compass. Finally, using the historical photographs as a composition guide, new photographs were exposed using digital imaging and film cameras. In the laboratory, new images and photographs were compared with corresponding historical photographs to determine, and to better understand rates, timing, and mechanics of Glacier Bay landscape evolution, as well as to clarify the response of specific glaciers to changing climate and environment. The comparisons clearly document rapid vegetative succession throughout the bay; advance and retreat of larger glaciers; short-term fluctuations of smaller glaciers; transitions from tidewater termini to stagnant, debris-covered termini; fiord sedimentation and erosion; development of outwash and talus features; and many other dramatic changes. As might be expected, 100-year-plus photo comparisons show significant changes throughout the Glacier Bay landscape, especially at the southern ends of East and West Arms. Surprisingly, recent changes, occurring during the 23 years between 1980 and 2003 were equally dramatic, especially documenting the rapid thinning and retreat of glaciers in upper Muir Inlet.

Animating Historical Repeat Glacier Photography: A Tool for Science and Education

Ronald Karpilo, GIS/Web Specialist, National Park Service, Geologic Resource Division, Denver, Colorado
Bruce F. Molnia, Research Geologist, U.S. Geologic Survey, Reston, Virginia
Harold S. Pranger, Geomorphologist, National Park Service, Geologic Resources Division, Denver, Colorado

Repeat photography is widely used to document temporal environmental changes such as the dynamic landscape evolution associated with glacial retreat or advance.

Dramatic changes illustrated by static side-by-side before and after images are easy for the viewer to interpret, but more subtle changes may escape the viewer's attention if they are unfamiliar with the area or unwilling to study the images in detail. Introducing the dynamic element of digitally morphing the before-image into the after-image makes subtle changes perceptible and dramatic changes even more striking. The technique of photo-morphing was applied to several repeat photo pairs (1890's to 2003) of Glacier Bay National Park and Preserve glaciers. The animated images present over a century of landscape change in the matter of a few seconds. The ability of this technique to effectively communicate complex visual information to audiences ranging from scientific professionals to members of the general public makes it a useful tool for both educators and scientists.

Early to mid-Holocene Glacier Fluctuations in Glacier Bay, Alaska

Daniel Lawson, Research Physical Scientist, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

David Finnegan, Sarah Kopczynski, and Susan Bigl, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

The history of glacial activity in Glacier Bay during the Holocene is poorly constrained. Radiocarbon dating of trees overridden by glacial advance, coupled to sedimentological and geomorphological evidence, provide rates and positions of ice margins over the last 9500 years BP. Major periods of ice advance were initiated in both the East and West Arms prior to 9200 yrs BP and continued through at least 6200 yrs BP. This advance apparently reached as far south as Drake Island, but whether it extended beyond this point is not yet known. Ice receded to the upper reaches of both Arms prior to a second advance that began at about 4900 yrs BP and appears to have continued to expand without interruption through 3200 yrs BP to south of Willoughby Island. Data from more recent periods are not as well constrained, particularly in the West Arm, but data suggest that ice filled much of the lower bay during a subsequent re-advance, perhaps with the ice mass not fully melting from the West Arm after 3200 yrs BP. Two and possibly three periods of advance, each separated by a recession of unknown extent, took place after 3200 yrs BP, culminating in that of the Little Ice Age. Glacial expansion is commonly thought to occur during a period of colder climate; however, our data suggest that ice growth during the Early Holocene (9200 yrs BP) continued long after the Holocene thermal maximum began. Current investigations are evaluating signals in the tree ring record for possible causes, including external forcing such as El Nino, Pacific Decadal Oscillation and Arctic Oscillation.

Recent Thinning of Glaciers in Glacier Bay National Park

Keith Echelmeyer, Professor of Geophysics, Geophysical Institute, University of Alaska, Fairbanks, Alaska

We have measured volume changes of about 100 glaciers using an airborne GPS/laser altimetry system. Surface elevation profiles were flown in the mid-1990s and many were repeated in 2000-03 in order to calculate volume changes over this time interval. These measurements were also compared to topographic maps made in the 1950s to determine volume changes over this longer period. Using the data collected from all the profiled glaciers, we have extrapolated changes to all glaciers in Alaska, NW Canada and Washington. The extrapolated volume loss from the Alaskan glaciers comprises the second largest contribution to sea level rise, next to oceanic thermal expansion over both time periods. The wastage of these glaciers indicates a recent increase in temperature and/or a decrease in precipitation in Alaska and western Canada. In particular, glaciers in Glacier Bay National Park have retreated up to 100 km since 1794. We have profiled seven glaciers in the Park. Five of them have thinned by up to 0.3 m/yr during the 1950-1990s time period: Brady, Grand Pacific, Muir, Melbern and McBride. However, two of glaciers, Reid and Lamplugh, actually thickened by about 0.2 m/yr over this time period. All of the measured glaciers in the Park have thinned by an increased rate of 0.3 to 1 m/yr during the 1990s to 2001 period. Glaciers in areas surrounding Glacier Bay National Park show some these same trends.

An Overview of Tectonic Elements and Plutonic Belts in the Glacier Bay National Park Region, Southeastern Alaska

David Brew, Research Geologist Emeritus, USGS Alaska Science Center, Menlo Park, California

The non-plutonic (aka non-intrusive igneous) rocks in Glacier Bay National Park and Preserve (GBNPP) are assigned to field-mappable units. These units are in turn assigned to lithotectonic terranes. The terranes are in turn grouped into tectonic subregions. All subregions are cut by one or more of three major regional belts of plutonic rocks. Some of the belts are in only one subregion or terrane, others in more than one. GBNPP contains parts of three of the five major tectonic subdivisions of southeastern Alaska. From W to E, these are the (1) Coastal Island subregion, (2) Border Ranges fault zone, and (3) Central Alexander Archipelago subregion. Subdivision (1) includes the Yakutat and Chugach terranes; (2) includes mainly Wrangellia terrane and some Chugach terrane rocks, and (3) includes Alexander and Wrangellia terrane rocks. The plutonic rocks in the Glacier Bay region are in three main plutonic belts related to Cretaceous and Tertiary subduction. Altogether the plutonic rocks have been classified into fifteen different combination age-composition units that range in age from Jurassic (ca. 162 Ma) through middle Cretaceous (ca.123-110 Ma), to Tertiary (59 -28 Ma); and in composition from gabbro to granite and syenite. In general the Late Jurassic and middle Cretaceous plutons intrude rocks of the Alexander and Wrangellia terranes, the mid-Tertiary plutons intrude rocks of the Chugach, Alexander, and Wrangellia terranes, and those of Neogene age are found in the Alexander terrane. The pluton age-composition distribution patterns are roughly belt-like and some belts of different ages overlap.

High Frequency Climate Signals in Fjord Sediments of Glacier Bay National Park, Alaska

Ellen A. Cowan, Professor, Department of Geology, Appalachian State University, Boone, North Carolina

Ross D. Powell, Professor, Department of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, Illinois

Seafloor sediment in the glacial fjords of Glacier Bay National Park records processes operating in the water column on timescales ranging from hours to a year. Data from the water column, including CTD casts, sediment traps and suspended sediment samples provide a link to the climate forcing variables and to spatial and temporal patterns of fjord sedimentation. For example, biological productivity and ice rafting produce characteristic marker layers only during winter/spring when the glacial meltwater system is inactive, thus producing an annual signal with seasonal significance. These layers are identified in sediment cores by distinctive black layers produced from chemically-altered diatom blooms or gravelly-mud beds deposited by ice rafting. In addition, the duration and intensity of seasonal glacial meltwater is recorded in tidal rhythmite deposits by the thickness and particle size variation of silty-mud. These sediment packages deposited during summer can be used as an indicator or proxy of discharge from tidewater glaciers. Thus, these fjord sediment records store an archive of past climate variability for the region. To better constrain possible rates of future global change, such proxies of environmentally sensitive parameters are needed to establish what the natural baseline conditions were prior to human action and to evaluate rates and magnitudes of likely anthropogenically-forced changes. To this end, this Glacier Bay data set can help constrain PDO history in southern Alaska, and in association with data from other on-going high-latitude studies, we aim to evaluate high-frequency global changes over broader regions.

Session 2

Marine Systems I

Chair: John Piatt, Research Biologist, U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska

Glacial Fjords in Glacier Bay National Park: Nursery Areas for Tanner Crabs?

Julie Nielsen, Graduate Student, Juneau Center, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska

S. James Taggart, USGS Alaska Science Center, Juneau, Alaska

Thomas C. Shirley, Juneau Center, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska

Jennifer Mondragon and Alexander G. Andrews, USGS Alaska Science Center, Juneau, Alaska

Tanner crabs (*Chionoecetes bairdi)* were sampled in a comprehensive systematic survey of Glacier Bay, Alaska, in 2002. Although adults were distributed widely throughout Glacier Bay, the distribution of juvenile crabs was more aggregated. Half of the

juveniles were caught in 4% of the stations sampled. Most of the high catches of juveniles occurred in two areas, both narrow glacial fjords, where adults were rare and temperatures were colder. We hypothesize that these two high-density juvenile areas, Wachusett Inlet and Scidmore-Charpentier Inlet, are nursery areas for Tanner crabs. Two broad components comprise a nursery area: 1) habitat attributes (physical and biological) that result in increased density, survival, or growth of juveniles, and 2) movement of juveniles from nursery to adult populations. Since densities of juveniles in the two narrow glacial fjords were much greater than in other areas where juveniles occurred (e.g., the central portion of the bay), it is possible that glacial processes create habitat attributes that allow increased larval supply or post-settlement survival of juvenile Tanner crabs. We compare habitat attributes (temperature, depth, substrate grain size and organic carbon content, distance from glaciers, and density of adults) between areas where juveniles occurred in high and low densities and areas where adults predominated. We also infer whether or not movement from hypothesized nursery areas occurs by determining change in size frequency over time in juvenile areas and analyzing spatial gradients in size class and shell condition.

Reproductive Cycle of Dungeness Crab Revisited: Variation at higher latitudes?

Thomas Shirley, Professor of Invertebrate Biology, Juneau Center, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska

Karen Scheding, Kathy Swiney and Deborah Hart, Juneau Center, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska

S. James Taggart and Jennifer Mondragon, USGS Alaska Science Center, Juneau, Alaska

The Dungeness crab has an extensive latitudinal range, from southern California to the northern Gulf of Alaska. In an ongoing, long-term study in Glacier Bay (MADS, Multi-Agency Dungeness Study) and a series of laboratory experiments, we have found a number of reproductive attributes of Dungeness females that differ substantially from the pervasive life history dogma in the southern part of their range. Female Dungeness crabs in Alaska are ovigerous at larger sizes than reported for crabs in the southern areas of their range; the larger ovigerous females are substantially more fecund than smaller females from lower latitudes. Our tagging and lab experiments demonstrate that most large Alaskan Dungeness females in Glacier Bay reproduce on alternate years or less often, and do not molt annually. Ovigerous females in Glacier Bay form dense aggregations in sandy sediments, are more sedentary and eat less than females without eggs, and brood their developing embryos for 7 to 9 months (September - June), in sharp contrast to the 3-4 month incubation period of lower latitudes. The long, sedentary, brooding period does not permit sufficient energy intake for ovarian development to occur; perhaps coupled with colder water temperatures, an alternate year reproductive cycle ensues. The cessation of commercial fishing for Dungeness crabs in Glacier Bay in 1999 resulted in dramatic increases in average size and abundance of male Dungeness crabs. As females can only mate with males at least one molt larger than themselves, the effects on size of ovigerous females and their fecundity may be substantial.

Increase in the Relative Abundance of Large Male Dungeness Crabs Following Closure of Commercial Fishing in Glacier Bay, Alaska

S. James Taggart, Research Fishery Biologist, USGS Alaska Science Center, Juneau, Alaska
Thomas C. Shirley, Juneau Center, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Juneau, Alaska
Charles E. O'Clair, National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska
Jennifer Mondragon, USGS Alaska Science Center, Juneau, Alaska

In 1999, the U.S. Congress closed commercial fishing in parts of Glacier Bay National Park, Alaska and effectively created one of America's largest temperate marine reserve networks. The size structure of the Dungeness crab, *Cancer magister*, population was studied at six sites in or near Glacier Bay, Alaska, before and after the closure of commercial fishing. Seven years of pre-closure and four years of post-closure data are presented. After the closure of Glacier Bay to commercial fishing, the number and size of legal-sized male Dungeness crabs increased dramatically at the experimental sites. Female and sub-legal sized male crabs, the portions of the population not directly targeted by commercial fishing, did not increase in size or abundance following the closure. There was not a large shift in the size abundance distribution of male crabs at the control site that is still open to commercial fishing. Marine protected areas are being widely promoted as effective tools for managing fisheries while simultaneously meeting marine conservation goals and maintaining marine biodiversity. Our data demonstrate that the size of male Dungeness crabs can markedly increase in a marine reserve, which supports the concept that marine reserves could help maintain genetic diversity in Dungeness crabs and other crab species subjected to size limit fisheries and possibly increase the fertility of females.

Ecdysteroid Levels in Tanner Crab in Glacier Bay: Evidence for a Terminal Molt

Sherry Tamone, Assistant Professor of Biology, University of Alaska Southeast, Juneau, Alaska
Alex Andrews, Jennifer Mondragon, and Spencer J. Taggart, USGS Alaska Science Center, Juneau, Alaska

Tanner crab, *Chionoecetes bairdi*, are a commercially important crab fished in southeastern Alaska. Since 1999 the fishery has been closed in Glacier Bay creating a network of five reserves. These reserves provide the opportunity to examine the size distributions of unexploited population. Crabs increase in size by molting, shedding their hard exoskeleton. Female Tanner crabs are known to undergo a terminal molt, which coincides with sexual maturity. Males on the other hand molt more times than females and can thus attain larger carapace widths than females. Males undergo a morphometric change in chelae size that is not linked to reproductive maturity. This change, however, has been hypothesized to occur during the male's terminal molt. Male Tanner crabs with morphometrically large chelae occur over a broad size range (55-200 mm). Ecdysteroid hormones regulate molt-

ing and circulating ecdysteroid concentrations could serve as an indicator for molting probability of crabs. We collected Tanner crabs from Glacier Bay and recorded the carapace width, chelae height and shell condition. Males sampled in this study ranged in carapace width from 37 to 174 mm. Blood samples (1.0 ml) were collected and assayed for ecdysteroids in the laboratory using an enzyme linked immunoassay (ELISA). Crabs with low ecdysteroid levels were assumed to be terminally molted which allowed us to estimate the proportion of the population that was terminally molted and the relationship between terminal molt and male crabs with large chelae.

Trapping Dinner: Causes of Injury in Dungeness Crabs and Survival Consequences for Released Males

Julie S. Barber, Marine Ecologist, Massachusetts Division of Marine Fisheries, North Falmouth, Massachusetts

I conducted a field study to examine the effects of trap soak time and crab density or trap soak time and size ratios on injury rates in male Dungeness crabs, *Cancer magister*. Results indicate that as soak time increased, injury rates increased regardless of crab density; and increased with respect to certain size ratios in addition to soak time. Consequences of injury to the overall fitness of individuals are especially important when considering sublegal-sized crustaceans, which will be released upon retrieval of the trap. A laboratory study determined that injured crabs were equally capable of competing for food against healthy crabs. Research on other crab species, however, demonstrates that multiple factors may be impacted by injury, including reduced growth rate, delayed reproduction, decreased mating success and higher mortality. This study suggests a need to monitor and regulate trap soak time in an effort to decrease injuries sustained by sublegal males.

Session 3

Freshwater/Marine Systems

Chair: Alexander Milner, Senior Lecturer, School of Geology, University of Birmingham, Birmingham, United Kingdom

Patterns of Early Lake Evolution in Glacier Bay National Park: A Comparison of Sediment Records with a Classic Chronosequence

Daniel Engstrom, Director, St. Croix Watershed Research Station, Science Museum of Minnesota, Marine on St. Croix, Minnesota

Sherilyn C. Fritz, Department of Geosciences and School of Biological Sciences, University of Nebraska, Lincoln, Nebraska

Stephen Juggins, School of Geography, Politics, and Sociology, University of Newcastle, Newcastle upon Tyne, United Kingdom

We use a chronosequence of lakes at Glacier Bay, Alaska, to explore the biogeochemical evolution of aquatic systems resulting from primary succession on recently deglaciated landscapes. The chronosequence suggests that long-term soil development and related hydrological change produce a loss of alkalinity and base cations, a decrease in pH, an increase in DOC, and a transient rise in lakewater nitrogen over time. We compare this model of lake evolution with patterns of change reconstructed from diatom assemblages in sediment cores from 10 of the Glacier Bay lakes. The majority of cores show a decline pH over time, but the pattern, rate, and magnitude of pH decline varies considerably among sites, apparently related to hydrologic differences. Inferred trends in nitrogen concentration over time are more variable and appear to be caused by local differences in vegetation history, specifically the development of alder thickets in the catchment. Thus, limnological development is tightly coupled to changes in vegetation and hydrology, although lakes do not follow a single successional pathway in terms of nutrient concentrations. This study demonstrates the power of the sedimentary record and diatoms in particular in tracking long-term environmental change and as an efficient tool for biomonitoring of aquatic systems.

Ecological Development of the Wolf Creek Watershed from 1977 to 2001: A 25-year Record

Alexander Milner, Senior Lecturer, School of Geology, University of Birmingham, Birmingham, United Kingdom

Anne Robertson, School of Life Sciences, University of Surrey, London, United Kingdom

Elizabeth Flory, Juneau, Alaska

Amanda Veal and Kieran Monaghan, School of Geography and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom

Wolf Point Creek is a short 3 km stream flowing from Lawrence Lake in Muir Inlet. We have studied the ecological development of this watershed since 1977. Initially the floodplain was barren of vegetation but due to the presence of the lake to buffer flow and sediment regimes, willows and alders have now developed to heights exceeding 4 m. Water temperature was initially 2 degrees C but has increased to 16 degrees C in 2001 as the remnant ice has melted from the upper watershed and the lake increased in size. Of the macroinvertebrates, chironomids (non-biting midges) were the first colonizers and were found in high densities > 15,000 m^2. Later colonizers included mayflies, stoneflies and caddisflies. A number of caddisfly and chironomid taxa were only found associated with the roots of riparian alder or willow catkins that had entered the stream. The first non-insect was oligochaete worms which colonized in 1992 followed by water mites, snails and the freshwater shrimp. The first salmonid colonizer was Dolly Varden charr in 1987 followed by 20 pink salmon in 1989. Pink salmon in 2001 were close to 10,000 spawners. Despite this large number of spawners, stable isotope analysis indicated that no marine derived N had become incorporated into the macroinvertebrate community. Although pools are now beginning to form, there is negligible large woody debris and nutrient retention of this system is low.

Simulating the Effects of Predation and Egg-Harvest at a Gull Colony

Stephani Zador, PhD Candidate, University of Washington, Seattle, Washington
John Piatt, Research Scientist, USGS Alaska Science Center, Anchorage, Alaska

We developed an individual-based simulation model to explore the effects of harvesting eggs from a glaucous-winged gull (*Larus glaucescens*) colony that also experiences egg loss from avian predators. The model has direct application to Glacier Bay National Park, where resource managers are concerned about potential effects of traditional harvesting of gull eggs at colonies within the park. This model simulates the sequence of egg laying, relaying, and incubation to hatching for individual nests and calculates hatching success, incubation length, and total eggs laid in all nests during the simulation. Stochasticity is incorporated in the distribution of nest lay dates and in which nests are attacked during predation and harvest events. We used maximum likelihood to estimate parameters by fitting the model to data collected at South Marble Island in 1999 and 2000. We then simulated harvests and analyzed model predictions. Model outputs suggest that (1) harvest strategies are largely ineffectual when background predation rates are high, and, (2) harvesting early, at one time, and from no more than 20% of the colony provides a constant harvest with the least impact to gulls when background predation rates are low to moderate (and within the natural range observed in the field).

Behavioral Ecology of Kittlitz's Murrelets in Glacier Bay as Determined by Radio Telemetry

Marc Romano, Wildlife Biologist, USGS Alaska Science Center, Anchorage, Alaska
John F. Piatt and Harry Carter, USGS Alaska Science Center, Anchorage, Alaska

Little is known about the behavior and ecology of the Kittlitz's Murrelet (*Brachyramphus brevirostris*) which spends most of its life at sea and tends to forage in glacially influenced marine waters during the breeding season. In summer, 2004, we affixed radios to 15 Kittlitz's Murrelets in Glacier Bay National Park. From these birds, we are able to examine a variety of variables that characterize their life history, including foraging behaviors (dive duration, dive-pause ratios, habitat use), foraging time budgets, incubation exchange schedules, fidelity to foraging areas, movement around the bay within and among days, and seasonally. We are also able to characterize non-foraging behaviors, such as response to moving vessels, resting time and time spent on social activities. Based on movements and locations of the birds, we are also able to characterize aspects of the habitats used by Kittlitz's Murrelets for foraging, resting and social interaction. The purpose of this pilot project was to determine whether Kittlitz's Murrelets could, in fact, be captured and tagged with radios, and whether this would yield information useful for managing the species. Overall findings and implications of the study will be discussed, as well as plans for future work.

Session 4

Physical Systems II

Chair: Keith Echelmeyer, Professor of Geophysics, Geophysical Institute, University of Alaska, Fairbanks, Alaska

Active Tectonics of Southeast Alaska

Jeff Freymueller, Associate Professor, Geophysical Institute, University of Alaska, Fairbanks, Alaska

Hilary J. Fletcher, Institute of Geological and Nuclear Sciences, New Zealand

Christopher F. Larsen, Roman J. Motyka, Keith A. Echelmeyer, Geophysical Institute, University of Alaska, Fairbanks, Alaska

The Yakutat terrane, the piece of crust west of the Fairweather fault in southeast Alaska, is moving rapidly relative to both the North American crust to the east of it and the Pacific ocean crust to the west of it. The Yakutat terrane has been displaced about 600 km northward over the last 65 million years along the Queen Charlotte-Fairweather fault system. Its collision with North America has contributed to the building of the Fairweather, Chugach, and St. Elias Ranges. The Yakutat terrane is presently bounded on the northeast by the strike-slip Fairweather fault, and on the north by a system of thrust and strike-slip faults in the Chugach and St. Elias mountains. It is bounded on its southwest (oceanic) side by a structure known as the Transition Zone. We have studied the motion of the Yakutat terrane and other slivers of mobile crust in southeast Alaska for several years using precise Global Positioning System (GPS) measurements, so we directly measure the steady motions of the crust. We can relate these measurements to the slip on active faults, resulting in a model for the active tectonics of the region. The slip rate on the Fairweather fault is more than 30% higher than for California's San Andreas fault, and the present shortening rate in the St. Elias range is 2-3 time faster than the shortening across the Himalaya, making this part of Alaska one of the mot dynamic places on earth.

Post Little Ice Age Rebound in the Glacier Bay Region from GPS, Tide Gauge, and Raised Shoreline Measurements

Roman Motyka, Research Associate Professor, Geophysical Institute, University of Alaska, Fairbanks, Alaska

Christopher F. Larsen, Jeffrey T. Freymueller, and Keith A. Echelmeyer, Geophysical Institute, University of Alaska, Fairbanks, Alaska

Extreme uplift and sea level changes in southeast Alaska have been documented by 1) a regional GPS deformation array consisting of 74 sites; 2) 18 tide gauge measurements of sea-level changes; and 3) 27 raised shoreline measurements of total uplift. The GPS data show peak uplift rates of 30 mm/yr in Glacier Bay, and also delineated a second center of rapid uplift east of Yakutat with peak rates of 32 mm/yr. The recent magnitude and distribution of regional sea level rates based on decadal averages of tide gauge measurements in the Glacier Bay area (up to 25 mm/yr) are similar to those found in an earlier study of tide gauge measurements.

A combination of dendrochronology and geomorphology was employed to identify and date raised shorelines throughout the region. These studies documented rapid and continuous total sea level changes of up to 5.5 m, and constrained the age of the ongoing uplift to less than 250 yrs. The raised shorelines show a pattern of higher uplift surrounding the region of peak GPS uplift rates in Glacier Bay, while the dating of these shorelines shows that they began uplifting at the same time the massive Glacier Bay Icefield began its retreat. This is a direct observation of glacial isostatic rebound processes acting on timescales of only a few hundred years in southern Alaska.

Landslide-induced Wave Hazard Assessment: Tidal Inlet, Glacier Bay National Park

Gerald Wieczorek, Research Civil Engineer, U.S. Geological Survey, Reston, Virginia
Eric Geist, USGS, Menlo Park, California
Matthias Jakob, BGC Engineering Inc., Vancouver, British Columbia
Sandy Zirnheld, Geophysical Institute, University of Alaska, Fairbanks, Alaska
Roman Motyka, Geophysical Institute, University of Alaska, Juneau, Alaska
Patricia Craw, Alaska Division of Geological and Geophysical Surveys, Fairbanks, Alaska

A landslide perched above the northern shore of Tidal Inlet moved sometime between 1892 and 1919 after retreat of Little Ice Age glaciers. GPS monitoring of one monument on the landslide showed 3.1 cm (± 1 cm) of movement in the downslope direction from July 2002 to August 2003, indicating the continuing instability. Using an estimated maximum landslide volume of 10 million m3 entering the water with an impact velocity of 63 m/s, empirical methods indicate a maximum wave height of 77 m in the center of Tidal inlet, with wave propagation speeds of 45-50 m/s, and wave runup on the southern shore up to 200 m. A numerical hydrodynamic simulation was performed using detailed bathymetry in the region in order to assess the potential risk to cruise ships and other boat traffic beyond Tidal Inlet into the western arm of Glacier Bay, and a floating National Park ranger station in Blue Mouse Cove. Near the mouth of Tidal Inlet, the amplitude of waves would be greatest within approximately 40 minutes of the slide entering the water. Numerical simulations indicate that significant wave activity would continue in the western arm of Glacier Bay for more than several hours and waves of significant amplitude (>10m) would occur in shallow regions, near the mouth of Tidal Inlet. In the deeper waterways of Glacier Bay, wave amplitudes would decrease. The severity of impact to vessels in the region depends on which part of the wave train the ships would encounter.

A Transect of Glacier Bay Ocean Currents Measured by Acoustic Doppler Current Profiler (ADCP)

Edward D. Cokelet, PhD, Oceanographer, NOAA - Pacific Marine Environmental Laboratory, Seattle, Washington
Antonio J. Jenkins, Research Scientist, NOAA/PMEL and University of Washington/JISAO, Seattle, Washington

In recent years, Hooge and Hooge (2002) have conducted detailed studies of the water properties and density stratification in Glacier Bay, Alaska. However owing to a lack of resources and to the technical challenges of making ocean current measurements, we know little about current speeds in the fjord. Fortunately, at the end of a 23-day fisheries oceanography research cruise in the Gulf of Alaska, NOAA Ship Miller Freeman had 15 hours of ship time to spare as she passed the bay's entrance. Anticipating this we sought permission to enter Glacier Bay on 8 August 2003 and make underway observations. We measured currents with a 150 kHz acoustic Doppler current profiler (ADCP) down to about 400 m. We also measured temperature, salinity, nitrate concentration and chlorophyll fluorescence from water sampled from the ship's sea chest at 5 m depth. Miller Freeman entered the bay on one flood tide and left on the next one. During the incoming transect over the shallow entrance sill to West Arm the ADCP vectors show strong inflow with the largest observed current of ~160 cm/s just south of Bartlett Cove. The tidal flow accelerates over the shallow entrance sill and then slows to a few cm/s in the deeper basin beyond. According to the predicted tidal heights, the tide should have ebbed over the remaining up-bay transect, and the observed, weak outflowing currents confirm that. Cool near-surface temperatures of ~8°C were observed over the entrance sill with warming to ~12°C in the deeper bay beyond. Near-surface salinity was ~32 psu in Icy Strait and Sitakaday Narrows but freshened to ~20 psu in patches along West Arm owing to glacial meltwater. Nitrate was enriched (~19 mM) in the mixed water over the sill but then depleted (0-2 mM) in the West Arm, presumably due to phytoplankton production. Chlorophyll concentrations were relatively low (1-2 mg/L) throughout the Cross Sound-Glacier Bay-Icy Strait system. High (8-9 mg/L) inferred chlorophyll levels were measured in Tarr Inlet, but these measurements may be affected by rock flour in the water. We were pleased to make some of the first ADCP measurements in Glacier Bay.

Glacier Bay Underwater Soundscape: Natural and Vessel-generated Sound in Lower Glacier Bay

Blair Kipple, Engineer, Naval Surface Warfare Center, Bremerton, Washington
Christine Gabriele, Wildlife Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska

Underwater sound is an important aspect of the Glacier Bay ecosystem. This paper presents the underwater sound levels from natural processes and marine vessels in Glacier Bay, to address two important questions: What is the typical sound level in the bay, and how is it affected by human activity? For a 20-month period in 2000 through 2002, 10,000 underwater sound samples of 30 seconds duration were collected in lower Glacier Bay. In a collaborative effort between Navy and National Park Service scientists, these data were analyzed to characterize the Glacier Bay underwater soundscape. The results were used to determine the natural underwater sound character of the lower bay in the absence of human contributions. Wind and rain were the primary natural noise sources. In addition, this paper addresses the prevalence of marine vessel noise by vessel type, and the seasonal variation of manmade and biological related noises. Data also show the effect of the 10-knot 'whale waters' speed limit on underwater sound levels. Once marine mammal audiometrics are sufficiently understood, these results can be used to predict the effects of manmade sounds on marine mammals that frequent Glacier Bay.

Session 5

Management Issues

Chair: Susan Boudreau, Chief of Resources, Glacier Bay National Park and Preserve, Gustavus, Alaska

Glacier Bay's Coastal Resources Inventory and Mapping Program: 900 Miles of Shoreline Resource Information

Lewis Sharman, Resource Management Division, Glacier Bay National Park and Preserve, Gustavus, Alaska

Bill Eichenlaub, Phoebe Vanselow and Jenni Burr, Glacier Bay National Park and Preserve, Gustavus, Alaska

Coastal resource managers at Glacier Bay have developed detailed field and data processing protocols to describe a variety of coastal resource attributes and make them easily available in an information-rich, GIS-linked database. The system is designed to describe sinuous, relatively protected, physically and biologically complex marine shorelines typical of temperate North Pacific inside waters. The focus is on resources associated with the intertidal zone and the immediately adjacent nearshore marine and upland terrestrial environments. Attributes include beach substrate type, slope, relative exposure, intertidal community characteristics, and the presence of tidepools, offshore kelp beds, interstadial wood, key habitat types, and certain wildlife aggregations such as seabird colonies and pinniped haulouts. During seven field seasons nearly 1,000 miles of coastline were mapped; this translates to 6,000+ discrete shoreline segments, 21,000+ ground photos, and 300+ highly resolved/georeferenced aerial photos. The final tool is a quick and easy-to-use interactive GIS-linked database with a map locator function allowing the resource decision-maker to click on any shoreline location to immediately access all the resource information associated with the selected beach segment (see also the poster session abstract by Vanselow). Resource attributes were selected and described to make the information maximally useful to variety of end users including park managers, scientific researchers, oil spill responders, educators, and the general public. Future plans include making the project available on the internet in a similar interactive map-based format, and completion of the park's more remote and exposed outer coast shores using an aerial videography approach.

Distribution and Number of Backcountry Visitors in Glacier Bay National Park, 1996-2003

Mary Kralovec, Chief of Resources, Organ Pipe Cactus National Monument, Ajo, Arizona
Allison Banks, Recreation Planner, Glacier Bay National Park and Preserve, Gustavus, Alaska
Hank Lentfer, Gustavus, Alaska

Glacier Bay National Park includes some of the premier wilderness lands in the National Park Service and National Wilderness Preservation System. With its tidewater glaciers, temperate rainforest, and diversity of wildlife and plants the park has quickly become a favorite destination for backcountry visitors. Due to the park's topography, visitor use both on the water and off is often concentrated in the upper inlets where most visitors travel to view tidewater glaciers. Due to concerns about growing use in the park's backcountry, a backcountry visitor distribution study was initiated in 1996. In 1997, the study was expanded to include private vessel operators and administrative employees. This talk will present the results of 8 years of survey data on backcountry visitor campsites and hiking trails and backcountry vessel routes and anchorages. Information on group size, entry and exit dates and length of stay are also presented. Additionally, a backcountry permit system was started and backcountry limits were imposed in 1997. Results from these administrative actions will also be presented.

Bear-Human Interactions at Glacier Bay National Park and Preserve: Conflict Risk Assessment

Tom S. Smith, Research Ecologist, USGS Alaska Science Center, Anchorage, Alaska
Terry D. deBruyn, National Park Service, Alaska Support Office, Anchorage, Alaska
Tania Lewis and Rusty Yerxa, Glacier Bay National Park and Preserve, Gustavus, Alaska
Steve Partridge, USGS Alaska Biological Science Center, Anchorage, Alaska

Sea kayaking is the predominant recreational activity within the extensive marine backcountry of Glacier Bay National Park and Preserve, Alaska. Kayakers frequently stay several nights, camping by the ocean at the base of steep-walled fjords. Both brown and black bears inhabit and seasonally occupy these same areas. Consequently, the potential for bear-human interaction at Glacier Bay's campsites is much higher than for other areas of the backcountry. We initially constructed an accurate history of bear and human activity and conflict at the park drawing upon National Park Service records that included 300 instances of bear-human conflict (1960-2003), >3700 bear sightings (1932-2003), and >9000 records of backcountry campsite use (1996-2003). We used geographic information system (GIS) software to create a temporal-spatial profile of bear and human activity and conflict in the backcountry. We visited 162 of the highest-use campsites and assessed them for their bear habitat quality, bear encounter and bear displacement potentials, building upon previous work by Herrero et al. (1986) and MacHutchon and Wellwood (2002). This paper presents findings from this research and provides managers with guidance for minimizing bear-human conflict and disturbance of bear activity within the backcountry.

Vessel Use and Activity in Glacier Bay National Park's Outer Waters

Chad Soiseth, Fisheries Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska
Jesse Kroese, St. Paul, Minnesota
Rob Liebermann, Glacier Bay National Park and Preserve, Gustavus, Alaska
Susan Bookless, Gustavus, Alaska

The National Park Service has managed recreational vessel traffic in Glacier Bay proper since the mid 1970s. Daily entries and seasonal use by vessel class in the Bay have been documented during the visitor use season (June 1 - August 31) since 1976. Vessel traffic, activity and potential resource impacts outside the Bay are poorly known and relatively undocumented. Our objective was to better understand patterns of vessel use, abundance, distribution, activity, fishing effort and potential impacts to the park's outside waters. We used aerial surveys to estimate vessel activity over three summers beginning in 2001. We employed a two-stage stratified sampling design to select survey dates and times, and recorded vessel location, class and activity during 1.5-hour aerial surveys. Conventional and digital photographic methods and GPS were used to document and identify individual vessel locations and activity. We identified high use areas and extrapolated sample results to estimate seasonal vessel abundance, distribution, and activity for 19 vessel classes ranging in size from kayaks to cruise ships. Commercial salmon trollers, followed by cabin cruisers and charter vessels were the most commonly observed vessels. We are currently developing fishing effort estimates for appropriate vessel classes. Tugs and barges, with the capacity for large volumes of fuel and other potentially hazardous materials, were occasionally documented. Barges may pose the greatest potential risk to park resources in the event of a grounding or sinking and accidental fuel discharge.

Spruce Beetle and Forest Structure in Glacier Bay National Park: Results from Long Term Plots

Mark Schultz, Forest Pathologist, USDA Forest Service, Juneau, Alaska

Mature spruce forests are often attacked by spruce beetle in Alaska. Blow-down was extensive throughout many spruce stands in southeast Alaska in the late 1970s resulting in even higher numbers of spruce beetle and a large number of attacked and killed trees in the early 1980s. Spruce beetle mortality was already present on Young Island before 1979. However, this outbreak accelerated the conversion of infested stands toward stands that have the old-growth characteristics of canopy gaps and vertical structure. Nutrient poor soil and building populations of spruce beetle were important factors of mortality. Spruce beetle has been associated with most of the dying spruce, but it is not the only contributing mortality agent. Evidence of spruce beetles in the long-dead standing spruce at the time of examination in 1998 had disappeared.

Session 6

Marine Systems II

Chair: James Bodkin, Research Wildlife Biologist, USGS Alaska Science Center, Anchorage, Alaska

Oceanographic Patterns in a Glacially-fed Fjord Estuary: Implications for Biological Patterns and Productivity

Lisa Etherington, Marine Ecologist, USGS Alaska Science Center, Gustavus, Alaska
Philip Hooge, Denali National Park and Preserve, Denali Park, Alaska
Elizabeth Hooge, Denali Park, Alaska

Oceanographic conditions within high latitude glacially-fed estuaries are often complex, due to high rates of freshwater input, dramatic bathymetry, and high sedimentation rates. Through a long term monitoring program, we have conducted physical and biological oceanographic sampling at 24 stations within Glacier Bay, Alaska, from 1993-2002. Seasonal patterns of salinity, temperature, stratification, turbidity and euphotic depth are related to seasonal patterns of modeled freshwater input. High rates of freshwater input create strong and persistent stratification of surface waters from spring through fall. Spatial patterns of phytoplankton abundance vary throughout the season and are influenced by stratification levels and euphotic depth. Highest levels of phytoplankton abundance exist at regions of physical and bathymetric discontinuities, where shallower mixed zones are juxtaposed with deep stratified basins. Results of this study highlight the strong competing forces influencing water column stability: high levels of freshwater discharge from glacial melt and rainfall promote stratification, while strong tidal currents over shallow sills enhance vertical mixing. Where these two processes meet in the central deep basins there are optimal conditions of intermediate stratification, higher light levels, and potential nutrient renewal. These conditions may explain the high and sustained chlorophyll-a levels observed in these regions of the Bay and provide a framework for understanding abundance patterns of higher trophic levels within this estuarine system. These findings further our understanding of physical-biological coupling within fjord estuaries and provide information necessary for making management decisions and understanding the ecosystem properties of high latitude marine reserves, such as Glacier Bay National Park.

The Distribution and Relative Abundance of Pacific Halibut in a Recently Deglaciated Fjord: The Role of Glacial Inputs and Ecosystem Age

Jennifer Mondragon, Marine Ecologist, USGS Alaska Science Center, Juneau, Alaska
Lisa Etherington, USGS Alaska Science Center, Gustavus, Alaska
S. James Taggart, USGS Alaska Science Center, Juneau, Alaska
Philip N. Hooge, Denali National Park and Preserve, Denali Park, Alaska

Glacier Bay, Alaska, is a recently deglaciated fjord estuarine system with strong salinity, temperature and turbidity gradients. Since at least 1900, Glacier Bay and the outer waters of the Park supported a substantial commercial fishery for Pacific halibut *(Hippoglossus stenolepis).* We hypothesized that abundance of Pacific halibut would be correlated with distance from glaciers and our study correlated halibut population parameters (CPUE, size frequency distribution) with time since deglaciation and fjord oceanographic parameters. Forty standardized longline sets were placed approximately every four nautical miles starting outside the terminal glacial sill at the mouth of Glacier Bay and continuing up to the end of both the East and West Arms of Glacier Bay. Captured halibut were measured and all other fish species were identified and measured. We observed decreases in halibut abundance in the upper reaches of the fjord, but contrary to our expectations the abundance was not strictly related to time since deglaciation. Some areas glaciated as recently as 20 years ago had abundances similar to areas with much longer histories of deglaciation.

Spatial Distribution of Nearshore and Pelagic Fishes in Relation to Physical Oceanography in a Glacial Fjord

Mayumi Arimitsu, Fishery Biologist, USGS Alaska Science Center, Juneau, Alaska

Glacier Bay National Park is marked by complex oceanographic processes that influence the distribution and abundance of nearshore and pelagic fishes. We sampled marine waters in the park between 1999 and 2002 in order to characterize marine predator and forage fish resources and to census marine and estuarine fishes. At least 45 species of nearshore fishes were collected with 289 beach seine sets at 66 sites. We also sampled 43 pelagic fish species with 135 modified herring trawl sets and 37 Isaac's-Kidd midwater trawl sets. Nearshore and pelagic habitats are analyzed using LANDSAT and AVHRR satellite imagery as well as existing NPS and USGS data that detail the coastal habitat resources and oceanographic regimes within the park. The distribution and abundance of select nearshore and pelagic fish species relative to marine habitat parameters such as sediment type, salinity, temperature, turbidity and depth are examined.

Hotspots in a Glacial Landscape: Patchiness of Marine Fish, Birds and Mammals in Glacier Bay

John Piatt, Research Biologist, USGS Alaska Science Center, Anchorage, Alaska
Gary Drew and Mayumi Arimitsu, USGS Alaska Science Center, Anchorage, Alaska

Glacier Bay National Park hosts a diverse community of marine birds and mammals, and these predators are supported in turn by an abundance of forage species, including euphausiids, capelin, herring, sand lance and juvenile walleye pollock. The distribution of these taxa is influenced strongly by local environmental conditions and their dispersion in Glacier Bay is neither random nor homogeneous. Less than 1% of the bay contains significant forage concentrations, and only a fraction of those are dense enough to support larger predators. Most prey biomass is found in surface layers (<50 m) and more than 50% of biomass occurs where bottom depths < 35 m. Similarly, the vast majority of fish-eating marine birds and mammals are concentrated in relatively shallow waters near shore. Other factors strongly influence local productivity. Waters adjacent to tide-water glaciers in the upper arms support high levels of phyto- and zoo-plankton, forage fish (including mesopelagic lanternfishes), and selected pagophilic predators such as kittiwakes, Kittlitz's murrelets and harbor seals. Underwater glacial sills create local hotspots, e.g., at the entrance to Glacier Bay and Muir Inlet. Shallow shelves with inlets and islands (e.g., the Beardslees) create rich, protected habitats for fish and predators alike. Turbulent, mixed waters, such as those found at Sitakaday Narrows appear to disperse prey. Headlands with shallow banks and strong tidal currents (e.g., Pt. Adolphus, Pt. Carolus) appear to actively concentrate prey schools, or at least attract them, and their associated predators. The importance of hotspots in structuring communities will be discussed.

Marine Habitats and their Effects on Marine Bird and Mammal Distributions in Glacier Bay National Park

Gary Drew, Research Biologist, USGS Alaska Science Center, Anchorage, Alaska
John Piatt, Research Biologist, USGS Alaska Science Center, Anchorage, Alaska

Unlike terrestrial environments, marine habitats are rarely classified. In part, this is due to the more ephemeral nature of marine environments; however, the logistical challenges of acquiring marine data are also substantial. Recognition of the potential for marine habitat classification to aid our understanding of these complex systems has spurred recent work in this area. We developed a marine habitat classification system for Glacier Bay National Park during the summer months. We classified areas based on bathymetry, sea surface temperature, distance to shore, distance to colony or haul-out, glacial effects, and productivity. Using this classification model, we examined the distribution of selected marine birds and mammals counted on surveys in Glacier Bay 1999-2003. The classification model suggests that Glacier Bay provides a wide variety of habitats. We were able to identify associations between a number of species and the classified habitats. The construction of a habitat-based time-series will be necessary to validate the final model.

Session 7

Social Issues

Chair: Wayne Howell, Management Assistant, Glacier Bay National Park and Preserve, Gustavus, Alaska

The Huna Tlingit People's Use of Gull Eggs and the Establishment of Glacier Bay National Park

Eugene S. Hunn, Professor of Anthropology, University of Washington, Seattle, Washington
Darryll R. Johnson, National Park Service, PNW Region Cooperative Ecosystem Studies Unit, University of Washington, Seattle, Washington
Thomas S. Thornton, Trinity College, Department of Anthropology, Hartford, Connecticut
Priscilla N. Russell

The objectives of this ethnographic study focused on Huna Tlingit harvests of birds' eggs with an emphasis on Glaucous-winged Gulls in the geographic area of Glacier Bay National Park and Preserve (GBNPP). Forty-two bird egg harvesting sites were identified in traditional Huna territory, 33 of which lie within GBNPP boundaries. North and South Marble Islands were particularly popular for gull egg harvesting. However, gull-egg harvest sites within Glacier Bay necessarily changed over the long term because natural succession of vegetation converted open nesting areas to forests unsuitable for nesting. Multiple factors limited the number of gull eggs taken during traditional Huna egg harvests. Most notably, the majority of traditional gull-egg harvest strategies were designed to enhance the quantity and quality of eggs harvested while attempting to minimize impacts on gull nesting success. The Huna people value gull-egg harvests not only for their nutritional contribution but also for their capacity to sustain ties to ancestral lands, which are essential components of Huna identity. Virtually all Huna consultants objected to the prohibition of their gull-egg harvests and voiced strong interest in resuming legal egg harvests within GBNPP.

Tlingit Traditional Knowledge and Clan Management of Sockeye Salmon in Dry Bay, Alaska

Judith Ramos, Tribal Planner, Yakutat Tlingit Tribe, Yakutat, Alaska

This study was a collaborative effort between the Yakutat Tlingit Tribe (YTT) and the National Park Service. This TEK was also coordinated with YTT's other TEK - Mapping the Traditional Clan Territories and Subsistence Use areas funded by the USDA Forest Service. The objective of this study was to document traditional Tlingit knowledge of salmon management and utilization strategies, particularly in the lower Alsek River watershed (Dry Bay). This paper will focus on: 1) Tlingit use and beliefs about the Dry Bay area, 2) the settlement and traditional use of the Dry Bay area, 3) how the Tlingit worldview and knowledge affected Tlingit treatment and management of salmon, and 4) traditional "clan" territorial rights and "clan leaders" responsibilities.

Geologic Evidence Linking Neoglacial Ice Terminus Advance and Marine Incursion with Tlingit Ethnohistory and Archeology in Lower Glacier Bay

Daniel Monteith, Assistant Professor of Anthropology, University of Alaska Southeast, Juneau, Alaska

Cathy Connor, Associate Professor of Geology, University of Alaska Southeast, Juneau, Alaska

We have been collecting data to identify the interconnections between geological, archeological, and ethnohistorical evidence that chronicle the history of the Huna people in the dynamic environment of lower Glacier Bay. Archeological investigations in Ground Hog Bay have yielded some of the oldest dates of human occupation in the Icy Straits region at 10,180 +/- 800 years BP. In lower Glacier Bay, radiocarbon dates on emergent Late Holocene tree stumps north of Berg Bay and at Halibut Cove at the entrance to Bartlett Cove have yielded ages ranging from ~3,000 years BP to ~240 years B.P. respectively, marking the advance of Neoglacial ice advancing down the bay. In the ethnohistorically rich areas of Bartlett Cove, the Beardslee Islands and Berg Bay the Huna people have names for places and narratives from Glacier Bay that describe pre-Little Ice Age landscapes, including L'awsha Shakee Aan or "town on top of the glacial sand dunes", accounts of villages overrun by surging glaciers, and a name for the bay Sit' eeti Geeyi that translates as "Bay in place of the glacier". Deposits of fluvial, glacial and marine sediments record geomorphic dynamism created by advancing ice, the establishment of forested outwash plains and their subsequent burial, the existence of proglacial lakes, and their submergence under transgressing seas. These sediments provide a geochronological framework for landscapes available to and the possible timing of occupancy by the first human residents in the lower Glacier Bay region.

Session 8

Marine Systems III

Chair: Scott M. Gende, Ecologist, National Park Service, Glacier Bay Field Station, Juneau, Alaska

Testing the Effectiveness of a High Latitude Marine Reserve Network: A Multi-species Movement Study in Glacier Bay National Park

Alexander Andrews, Fishery Biologist, USGS Alaska Science Center, Juneau, Alaska
S. James Taggart and Jennifer Mondragon, USGS Alaska Science Center, Juneau, Alaska
Julie K. Nielsen, University of Alaska Fairbanks/USGS Alaska Science Center, Juneau, Alaska

In 1999, the U.S. Congress closed commercial fishing in parts of Glacier Bay National Park, Alaska and effectively created one of America's largest temperate marine reserve networks. In order to be effective, a marine reserve must be large enough to protect a sufficient proportion of the population for positive effects such as increased size, density, or fecundity to be realized. The retention of breeding adults in marine reserves is quantified in simulation models as transfer rate; these models demonstrate that transfer rate is central to reserve effectiveness. Although the effectiveness of marine reserves at protecting breeding adults has been demonstrated in tropical areas, data on the effectiveness of marine reserves in temperate ecosystems are limited. In 2002 we initiated a study to measure the exchange rate between the East Arm reserve and the area remaining open to commercial fishing. We tagged 31 male Tanner crab (*Chionoecetes bairdi*) and 19 male and female red king crab (*Paralithoides camtschaticus*) with ultra-sonic tags. We deployed an ultrasonic gate along the boundary of the reserve and performed periodic searches to relocate tagged animals. Tanner crabs demonstrate wide variation in movement patterns between individuals, with some individuals moving large distances. A total of 9 Tanner crabs have crossed the East Arm reserve boundary. In contrast, red king crab have shown coordinated movements on an annual cycle and, except for one individual, have not been found outside of the East Arm reserve.

Killer Whale Feeding Ecology and Non-predatory Interactions with Other Marine Mammals

Dena Matkin, Marine Biologist, North Gulf Oceanic Society, Gustavus, Alaska
Jan Straley, Professor of Marine Biology, University of Alaska Southeast, Sitka, Alaska
Christine Gabriele, Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska

The populations of killer whales that utilize the waters of southeastern Alaska overlap with populations inhabiting Prince William Sound, Alaska and British Columbia, Canada where other long-term studies of their diet have been conducted. This paper synthesizes the results of an 18-year study in which individuals were photo-identified and predation events documented primarily in Glacier Bay and Icy Strait, Alaska. Foraging strategies of killer whales on their prey were compared to behavior documented in similar studies in adjacent areas. Ninety-seven of the Resident form of killer whales, 139 of the West Coast Transients and 13 of the Gulf of Alaska Transients were photo-identified in the study area, as well as 14 of the Offshore form. Prey was identified by direct observation and genetic analysis of sampled prey remains. Residents preyed on silver and king salmon and Pacific halibut. Residents rarely harassed seabirds, harbor porpoises and humpback whales. This study mainly focused on Transient feeding habits, and is based on 43 predation events (kills). The primary prey of Transients were harbor seals (40%), followed by harbor porpoises (23%), Dall's porpoises (5%), Steller sea lions (15%), seabirds (14%) and a minke whale (2%). A lack of predatory behavior by both Residents and Transients near sea otters was noted. Unidentified killer whales cooperated to kill a swimming moose. Transients rarely harassed humpback whales, and on several occasions humpbacks closely approached killer whale groups that were attacking other marine mammal species. Non-predatory interactions also occurred between killer whales and Steller sea lions.

Steller Sea Lion Population Trends, Diet, and Brand-resighting Observations in Glacier Bay

Tom Gelatt, Leader, Alaska Ecosystems Program, National Marine Fisheries Service, Marine Mammal Lab, Seattle, Washington
Andrew Trites, Marine Mammal Research Unit, University of British Columbia, Vancouver, British Columbia
Ken Pitcher, Kelly Hastings and Lauri Jemison, Alaska Department of Fish and Game, Anchorage, Alaska

Steller sea lions (SSL) are listed as endangered west of Cape Suckling, Alaska and as threatened throughout Southeast Alaska (SEA) including Glacier Bay National Park (GBNP). The two populations are genetically distinct and show diverging population trends with the western stock continuing to decrease. We are using animal sampling, brand resighting, and scat analyses to compare the populations in hopes of finding measurable factors that could explain population differences. SSLs frequent at least five terrestrial sites in GBNP, most notably South Marble and a recently established rookery on Graves Rocks. These animals include a mix

of animals from rookeries as distant as southern SEA and Kodiak Island. Because of its location as the northern-most rookery in SEA, Graves Rocks occupies a unique role in the continuum of breeding sites for SSLs in Alaska. Breeding season counts in GBNP increased at ~6%/yr between 1989-2002, a rate nearly double that of SEA overall. Brand resighting throughout SEA during 2003 revealed 524 unique brands, 19 from the western stock. Fourteen of these 19 animals were seen within GBNP. Ninety percent of pups branded at GBNP were seen and photographed within 14 months after branding. Preliminary analyses suggest a minimum monthly survival rate of 0.95 between branding and 15 months of age. Sandlance and pollock were top prey items at Graves Rock and South Marble. Capelin was also dominant at South Marble whereas arrowtooth flounder was important at Graves Rock. Continued monitoring of SSLs in GBNP is vital to understanding SSL ecology in Alaska.

Age at First Calving of Female Humpback Whales in Southeastern Alaska

Christine Gabriele, Wildlife Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska
Jan Straley, University of Alaska Southeast, Sitka, Alaska
Janet Doherty, Glacier Bay National Park and Preserve, Gustavus, Alaska

Female humpback whales in southeastern Alaska have never been observed with their first calf at age 4-5 years, the documented mean age at first reproduction in humpback whale populations in the Gulf of Maine and Western Australia. Long term sighting histories of 11 individually identified females of known age in southeastern Alaska were used to investigate this disparity. Whales in our study population were individually identified by the pigmentation and morphology of their ventral tail flukes. The age of a whale is known if it was photographed as a calf. Whales were determined to be female either by genetic analysis of skin samples or by sightings in close, consistent affiliation with a calf. Three known-aged females with complete sighting histories were sighted with their first calf at ages 8, 9 and 12. An additional female with a complete sighting history has reached age 11 without producing a calf. Seven other females with incomplete sighting histories were first sighted with a calf at ages between 8 and 16. For these whales, their minimum age at first calving was defined as the earliest age they were not sighted but were older than age 5, because they may have produced a calf in that year. The average age at first calving appears to be 8-11 years in southeastern Alaska, in contrast to the 4-5 years documented in a similar longitudinal study in the Gulf of Maine population. The distributions of the minimum and observed ages at first calving in southeastern Alaska are both significantly different than the age distribution observed in the Gulf of Maine. These differences may indicate that female humpbacks in southeastern Alaska mature later or experience a higher rate of calf mortality. The limitations and potential biases inherent in these results will be discussed. Knowledge of the reproductive parameters of endangered populations is essential for predicting population dynamics and recovery.

Perspectives from an Invading Predator: Sea Otters in Glacier Bay

James Bodkin, Research Wildlife Biologist, USGS Alaska Science Center, Anchorage, Alaska
Brenda Ballachey, George Esslinger, Kimberly Kloecker, Daniel Monson and Heather Coletti, USGS Alaska Science Center, Anchorage, Alaska

The sea otter population in Glacier Bay may be the only increasing population in Alaska. Since 1995, the number of sea otters in Glacier Bay proper has increased from around 5 to approximately 1,800 in 2003. Population growth is a result of both reproduction of residents and immigration of individuals from areas elsewhere in SE Alaska. Large portions of the Bay remain unoccupied by sea otters, but recolonization is occurring rapidly. Abundant prey populations of benthic invertebrates, including species of clams, mussels, crabs and urchins likely provide the energy resources fueling this rapid growth. Contrasts of marine communities with and without sea otters elsewhere suggest profound and long-lasting ecological consequences of sea otter foraging. In 1993 we designed and implemented a large-scale experiment to determine the causes and consequences of change that result from sea otter colonization in Glacier Bay that consists of three elements. First, we describe the abundance and distribution of sea otters over time; second, we describe the diet of sea otters; and third, we describe the species composition, abundance, and sizes of a suite of conspicuous benthic marine invertebrates in the Bay that will be affected by sea otters.

Declines in Harbor Seal Numbers in Glacier Bay National Park, 1992-2002

Elizabeth Mathews, Assistant Professor, University of Alaska Southeast, Juneau, Alaska
Grey W. Pendleton, Biometrician, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, Alaska

Glacier Bay had one of the largest breeding colonies of harbor seals in Alaska, and it is the only place in Alaska where regulations prohibit subsistence hunting of harbor seals and where vessels are restricted from seal breeding areas. Since 1992, we have counted up to 6,200 seals on icebergs in a glacial fjord and at terrestrial sites annually from shore and using aerial photography (glacial and terrestrial sites, respectively). We estimated population trends using models that controlled for environmental and observer-related factors. Numbers of non-pup seals declined in the glacial fjord in June (-39%/8 yrs, -6.8%/yr, 1992-1999) and August (-64%/11 yrs, -9.6%/yr, 1992-2002) and at terrestrial sites (-75%/10 yrs, -14.5%/yr, 1992-2001). The number of pups remained steady in the glacial fjord from 1994 to 1999, and they made up an increasing proportion of seals counted (5.4%/yr). The proportion of pups born in glacial fjords (34-36%) is high relative to terrestrial breeding sites of harbor seals. Seals in GB do not appear to be spending more time in the water. Human disturbance may explain some of the differences in trends within Glacier Bay, but disturbance is not considered a major cause of the declines. Increased mortality, possibly due to predation, is the hypothesized cause of the declines with the most lines of supportive evidence, although further tests of this hypothesis are needed and redistribution of seals out of Glacier Bay and changes in prey also need to be examined as possible causes.

#1 An Opportunistic Amphibian Inventory of Alaska's National Parks, 2001-03

Blain Anderson, Biological Science Technician, National Park Service, Anchorage, Alaska

The National Park Service identified amphibians as a taxonomic group of concern for the southeast Alaska National Parks in April 2000. Because distribution and abundance of most amphibian species are poorly understood in Alaska, the Inventory & Monitoring Program developed an opportunistic amphibian inventory to gather baseline information in all of its parks. Between 2001 and 2003, 40 observers recorded 79 observations, and approximately 1600 individual amphibians were reported at 65 distinct sites, in ten of the sixteen parks in Alaska. Species found included the western toad *Bufo boreas* (40 observations), wood frog *Rana sylvatica* (24), Columbia spotted frog *Rana luteiventris* (2), rough-skinned newt *Taricha granulosa* (1), and northwestern salamander *Ambystoma gracile* (1). The known scientific ranges of all these species were extended by this project, and most were observed in Glacier Bay NP&P, followed closely by Klondike Goldrush NHP. A search of the University of Alaska Museum located 58 amphibian specimens that have been previously collected in the National Parks. These collections represent a significant, though small, historic amphibian collection for additional research. Long-term residents of Gustavus and Skagway gave anecdotal reports of once abundant western toad populations in the areas, and noted a significant decline in numbers from the 1970s to today. The cause of these declines remains unknown and warrants additional investigation. This project was a valuable first step towards comprehension of the presence and spatial distribution of amphibian species in Alaska's National Parks. Far more monitoring will be needed to establish abundance, conservation status, and to estimate population trends of these enigmatic and important species.

#2 Monitoring Western Toad Populations in Glacier Bay National Park

Bob Christiansen, President, Southeast Alaska Wilderness Exploration, Analysis and Discovery (SEAWEAD)

Glacier Bay National Park is one of the pilot areas in southeast Alaska where western toads *(Bufo boreas)* are being inventoried and monitored using survey protocols developed by the USGS Amphibian Research and Monitoring Initiative (ARMI). The Glacier Bay survey is part of a larger project to monitor western toad populations in southeast Alaska. The objectives of the project are to: 1) develop and refine methodology for monitoring toad distribution, 2) establish quantitative baselines of toad distribution, 3) describe breeding-pond habitat and possible sources of decline, and 4) provide a monitoring and conservation action plan.

#3 Ground-nesting Marine Bird Distribution and Potential for Human Impacts in Glacier Bay National Park

Mayumi Arimitsu, Fishery Biologist, USGS Alaska Science Center, Juneau, Alaska
Marc Romano and John Piatt, USGS Alaska Science Center, Anchorage, Alaska

Except for a few large colonies, the distribution of ground-nesting marine birds in Glacier Bay National Park is largely unknown. There is growing concern about the potential for impact of human disturbance to breeding birds as visitor use increases in backcountry areas. During the first year of a three-year study, we surveyed areas known to be important to ground-nesting birds and areas with significant visitor use. We used land-based beach surveys and kayak-based shoreline surveys to determine the distribution of nesting birds. We located 395 nests at 94 different sites belonging to eight different bird species. In 2003 we focused our effort on determining the distribution of four species: black oystercatcher (*Haematopus bachmani*), Arctic tern (*Sterna paradisaea*), mew gull (*Larus canus*), and glaucous-winged gull (*Larus glaucescens*). We also recorded observations of other ground nesting bird nests we encountered such as parasitic jaeger (*Sterorarius parasiticus*), semipalmated plover (*Chardrius semipalmatus*), spotted sandpiper (*Actitis mucularia*) and pigeon guillemot (*Cepphus columba*). We will continue to survey beaches in Glacier Bay in 2004 and 2005 to provide a broad assessment of marine bird distribution and breeding sites in the park. This baseline information will be used to assess impacts of human disturbance and changes in bird populations over time.

#4 Investigating Harbor Seal Decline in Glacier Bay National Park

Gail Blundell, Principal Investigator, Harbor Seal Research Program, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, Alaska

Scott M. Gende and Jamie Womble, National Park Service, Glacier Bay Field Station, Juneau, Alaska

Elizabeth Mathews, University of Alaska Southeast, Juneau, Alaska

Glacier Bay National Park has historically supported one of the largest breeding populations of harbor seals (*Phoca vitulina richardsi*) in Alaska, but the number has declined by more than 70% since 1992, with a total decline of approximately 6,500 seals. The magnitude and rate of decline exceed all reported declines of harbor seals in Alaska and show no signs of reversal. The cause of decline may be specific to the park or nearby region: in contrast to the population trend in Glacier Bay, harbor seals in two other areas of southeastern Alaska (near Sitka and Ketchikan) are stable or increasing. A multi-year, multi-agency study was initiated in April 2004 intended to address potential causal factors contributing to the decline. Harbor seals were trapped in April 2004 (with further trapping efforts scheduled for September 2004, and April and September 2005) and fitted with either long-term (battery life = 5 years) implant transmitters, designed to quantify 'vital rates', including survival and reproductive success, or fitted with external 'headmount' VHF transmitters and time-depth recorders, intended to address fine-scale movements, habitat use, foraging ecology, and dive behavior. Biopsies, hair, and blood samples were also taken for genetic analysis, diet reconstruction (fatty acid profiles), and assess disease, nutritional state, and contaminant load. These data sets will be integrated to address a suite of questions including whether seals with certain parameters (e.g., a particular diet, forage in a particular area, low body fat, elevated liver enzymes, high contaminant loads, etc.) have lower survival or reproductive rates, or delayed maturation.

#5 A Geologic Approach to Ecosubsection Delineation in Glacier Bay National Park, Southeastern Alaska

David Brew, Research Geologist Emeritus, USGS Alaska Science Center, Geologic Office, Menlo Park, California

The concept of using landform and generalized-bedrock-lithologic units together for ecosystem subsection delineation has been applied to Glacier Bay National Park and Preserve (GBNPP) in northern southeastern Alaska. Some related U.S. Forest Service (USFS) studies in central and southern southeastern Alaska covered generally forest-covered shoreline to timberline areas with relatively subdued topography, extensive bedrock-lithologic map unit exposures, and no active glaciers. Those studies established that the combination of landform plus lithologic information was a good predictor of plant communities in undisturbed areas. The study of GBNPP covers some similar areas, but also includes a large proportion of very high (to 15,300 feet), glacier-clad alpine terrain and large active valley glacier systems. It thus includes the weather and microclimatic effects associated with both the high-altitude barrier that is the Fairweather Range part of the St. Elias Mountains and with the rapidly retreating glaciers. In this study (1) landforms were classified—using topographic maps and personal experience—into eight categories similar to those used by the USFS; and (2) the 90 bedrock units on the current Glacier Bay geologic map were classified into 13 generalized lithologic units corresponding exactly to those used by the USFS. Incomplete storm-track, storm-intensity, and limited climatic information have also been compiled.

#6 Monitoring of Vital Ecosystem Components in the Southeast Alaska Park Network

Chiska Derr, Ecologist, Glacier Bay National Park and Preserve, Gustavus, Alaska

An ecological vital signs monitoring program has been initiated for the Southeast Alaska Park Network (SEAN) (Glacier Bay National Park and Preserve, Klondike Gold Rush Historical Park, and Sitka Historical Park). The objective of vital sign monitoring is to better understand the natural range of variability within key ecosystem components, which can help managers detect potentially undesirable ecosystem change and modify park management if appropriate. A vital sign is any quantifiable biological or physical component or process that can provide insight into the condition of park ecosystems. Ecological inventories of vascular plants, marine and estuarine fishes, and amphibians in all three parks, and of breeding land birds in Klondike Gold Rush National Historical Park were completed in spring 2004, and provide a foundation for the monitoring program. A conceptual ecosystem model for the parks has been developed and portrays important components of the ecosystem and processes that influence them. This basic model can be used to help identify change from sources or processes external to the natural ecosystem. A technical committee of internal and other natural resource professionals has been formed to begin identification of potential vital signs to monitor. The SEAN I&M Program will complete its monitoring plan and associated monitoring protocols by 2008, at which time vital sign monitoring will be implemented. The information gathered through the monitoring program is a cornerstone of effective park management, providing park managers with the scientifically sound information needed to safeguard the ecosystems under their stewardship.

#7 A Conceptual Ecosystem Model of National Parks in Southeast Alaska: An Ecosystem Context for Selection of Vital Signs for Future Monitoring

Christopher L. Fastie, Biology Department, Middlebury College, Middlebury, Vermont
Chiska C. Derr, Glacier Bay National Park and Preserve, Gustavus, Alaska

As part of a nationwide effort, the National Park Service is developing an inventory and monitoring program for the National Parks in Southeast Alaska (Glacier Bay National Park and Preserve, Klondike Gold Rush National Historical Park, and Sitka National Historical Park). To guide the selection of vital signs to be monitored in each park, we are developing conceptual models of park environments and the global, regional, and local processes affecting those environments. Conceptual models of Southeast Alaska's terrestrial, freshwater, and marine ecosystem components incorporate physical and biological processes and include human influences. A common theme in the models is the environmental change (ecological succession) that occurs following natural or anthropogenic disturbance (e.g., glacial retreat, floods, timber harvest, global warming). The unique geography of the region is central to an understanding of these environments. Southeast Alaska is a network of islands, peninsulas, and mainland coast juxtaposed with diverse marine and freshwater habitats including open ocean, deep embayments, fjords, lakes, and streams. Interaction among environmental components within this naturally fragmented landscape is strongly dependent upon the size of islands or patches, the natural barriers between them, and the distance over which interactions operate.

#8 Humpback Whale Entanglement Rates in Fishing Gear in Southeastern Alaska

Janet Doherty, Biological Technician, Glacier Bay National Park & University of Alaska Fairbanks, Gustavus, Alaska
Christine Gabriele, Glacier Bay National Park and Preserve, Gustavus, Alaska
Janice Straley, Sitka, Alaska

Between 1997 and 2003, 47 humpback whales were reported entangled in fishing gear in Alaska, with the majority reported in southeastern Alaska (SEAK). In 2003, we began a two-year study to assess the rate of non-lethal entanglement for humpback whales in SEAK. This constitutes the first systematic effort to investigate humpback whale entanglement rates in Alaska. The insertion point of the tail flukes (caudal peduncle) is a body part commonly involved in entanglements, where wounds may persist as visible binding and wrapping scars for many years after the entanglement event. Using a technique developed in the North Atlantic, we are collecting photographs of whales' caudal peduncles as they dive and then coding the photographs based on the likelihood that the whale has been previously entangled. Whales are identified based on the pigmentation and morphology of the ventral surface of their tail flukes. Preliminary analysis of the 2003 sample (n=117) suggests that the entanglement rate in SEAK is lower than that reported in the Gulf of Maine (56%) but higher than that reported in Hawaii (14%) based on studies using the same methodology. After the 2004 field season, we will identify any particularly vulnerable segments of the study population by analyzing the scar data in conjunction with existing demographic data; calculate the reporting rate of entanglements in SEAK in 2003-04; and describe the location of fishing gear in the study area.

#9 Monitoring of Marine Predator Communities in Glacier Bay National Park 1991-2003

Gary Drew, Research Biologist, USGS Alaska Science Center, Anchorage, Alaska
John Piatt, USGS Alaska Science Center, Anchorage, Alaska

The monitoring of the marine bird and mammal communities is typically difficult. While the examination of a single species might be possible at a colony or haulout, the monitoring of the entire suite of marine birds and mammals requires a major commitment of resources. A highly heterogeneous environment characterizes the productive Glacier Bay marine system and provides wide varieties of marine habitats. Marine bird and mammal populations were surveyed in Glacier Bay, Alaska in June of 1991 and 1999-2003. Although the 1991 surveys were not as extensive as the 1999-2003 surveys they do provide a baseline estimate of marine bird and mammal populations. Intensive ship based surveys conducted annually in June 1999-2003 provide reliable population estimates that indicated a number of population changes over the last decade. Populations of most species showed little change over the last 13 years, however there were several notable exceptions. Kittlitz's and marbled murrelet populations are in decline within the Bay. Alternatively, increased populations were identified for sea otters, humpback whales. The cause of these population changes may vary by species; however, concurrent dramatic changes in Glacier Bay's marine habitats may play a part in determining species populations.

#10 Tlingit Place Name Map of Glacier Bay and Vicinity

Johanna K. Dybdahl, Tribal Administrator, Hoonah Indian Association, Hoonah, Alaska

The Hoonah Indian Association has collaborated with the Glacier Bay National Park and Preserve to produce a map of the Glacier Bay area that indicates the Tlingit names for many geographical and historical sites and features. There is an associated list that shows the English translation and where applicable the English name. There is also an associated electronic interactive version that has been developed as an educational tool for studying the Tlingit Place Names of Glacier Bay and Vicinity.

#11 Temporal and Spatial Patterns in Dungeness Crab Larval Abundance within Glacier Bay

Ginny Eckert, Assistant Professor, University of Alaska Southeast, Juneau, Alaska
Jeff Douglas, University of Alaska Southeast, Juneau, Alaska
Jim Taggart, USGS Glacier Bay Field Station, Juneau, Alaska
Jennifer Fisher, Benthic Ecology Research Group, Moss Landing Marine Laboratory, Moss Landing, California

The commercial fishery for Dungeness crabs, *Cancer magister*, was closed in Glacier Bay, Alaska in 1999, creating one of the largest high-latitude marine reserves. In order to assess the effectiveness of this marine reserve and to gather information about the early life stages of Dungeness crab in Alaska, we studied temporal and spatial patterns of larval abundance of Dungeness crab within Glacier Bay. From 2000 to 2003 we quantified late-stage (megalopae) larval abundance using light traps at Bartlett Cove. Larval abundance varied four- to five-fold inter-annually. Megalopae were abundant in Bartlett Cove over a two and a half month period from August to November, with peaks within one week before and after the new moon in September and October. In July and August 2002, spatial variation in Dungeness crab larval distribution was assessed using light traps at the surface and at 10 m depth in 114 locations throughout the bay. Large cohorts of larvae were not observed, which would be expected if larvae were developing in Glacier Bay. Of the few Dungeness crab larvae that were caught, many were observed in the upper reaches of Glacier Bay, where adult abundance is very low. In contrast, larvae of other Cancer species were observed in greater abundance throughout the bay. Future research should identify mechanisms that drive species-specific larval distributions and aim to develop an understanding of relationships between adults and larvae to determine if establishment of this marine reserve will replenish stocks either within or outside the reserve.

#12 Glacier Bay Seafloor Habitat Mapping and Classification: First Look at Linkages with Biological Patterns

Lisa Etherington, Research Marine Ecologist, USGS Alaska Science Center, Gustavus, Alaska
Guy Cochrane and Hank Chezar, USGS Pacific Science Center, Menlo Park, California
Jodi Harney, USGS Pacific Science Center, Santa Cruz, California
Jim Taggart, Jennifer Mondragon, and Alex Andrews, USGS Alaska Science Center, Juneau, Alaska
Jim de La Bruere, USGS Alaska Science Center, Gustavus, Alaska

Ocean floor bathymetry and sediment type are the base of marine communities, affecting the kinds of benthic organisms found in a particular environment and the oceanographic conditions that communities are subject to. Currently there is limited knowledge of the bathymetry, sediment types, and marine habitats in Glacier Bay, Alaska. Multibeam and side-scan sonar imaging have been conducted in the lower and central regions of Glacier Bay providing bathymetric and substrate reflectance data. To ground-truth the initial geological classification of substrate type, we conducted video surveys along 52 transects covering various

bottom types. In conjunction with the collection of geological data of primary and secondary substrate, slope, and rugosity, we collected biological data of animal presence, relative abundance and biomass. This paper will examine the relationship between habitat type and benthic communities across varied substrate types and depths within Glacier Bay. Preliminary assessment of substrate types reveal sharp contrasts in habitat type within small spatial scales that appear to be strongly associated with benthic community distribution patterns. In addition, differences in substrate type over broad spatial scales are associated with depth and distance from glacial sources of sediment and are characterized by differing benthic communities. These data will provide insight into the distribution of various species of commercial and ecological importance, including Tanner, Dungeness, and red king crabs, halibut, horse mussels and scallops. Information on animal-habitat relationships, particularly within a marine reserve framework, will be valuable to agencies making decisions about critical habitats, marine reserve design, and fishery management.

#13 Assessing Contemporary and Holocene Glacial and Glacial-Marine Environments

David Finnegan, Research Physical Scientist, Cold Regions Research and Engineering Lab, Hanover, New Hampshire

Daniel E. Lawson and Sarah E. Kopczynski, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Understanding tidewater and terrestrial glacial and glacial-marine environments is critical to determining the long term impacts that contemporary climate changes and anthropogenic activities may have on terrestrial and marine ecosystems in the Park. This understanding is acquired through long-term, repetitive and quantitative analyses of regional and global factors including climate, hydrology, oceanography and geophysical processes and their role in the physical processes of glacial and glacial-marine environments. We conduct repetitive hydrologic and oceanographic measurements in glaciers and fjords that reveal seasonal, annual and longer-term trends, as well as define rates of erosion, sedimentation and sediment flux. Climatic investigations include analyzing modern meteorological trends at 26 locations across Glacier Bay and measuring the isotopic composition (Oxygen and Hydrogen) of precipitation, surface water and glacier ice to assess regional hydrologic trends and localized weather patterns. Concurrently, the park's longer-term Holocene glacial history and paleoclimate are being investigated using dendrochronological and radiocarbon dating of in-situ stumps, logs and soils. Radiocarbon dating by Accelerated Mass Spectrometry (AMS) has provided a preliminary estimate of ice-marginal positions and probable rates of tidewater glacier advance during the mid to late Holocene. We are also attempting to develop a tree-ring chronology of the last 9,000 years that, if successful, would be a unique paleoclimatic record of a subarctic zone of the North Pacific region.

#14 Distribution, Abundance, and Timing of Brachyuran Larvae in a High-latitude Fjord

Jennifer Fisher, Graduate Student, Moss Landing Marine Laboratories, Moss Landing, California

The persistence of a marine benthic population is regulated by a multitude of factors. These factors are often referred to by, or affect, life-stages. Pivotal to understanding the distribution and abundance of species is the ability to understand and integrate information on all life-stages as well as the factors affecting them. In 1999, Glacier Bay was closed to commercial fishing, creating one of the largest marine reserves in the United States (1,255 km^2). Prior to the fishing closure, Glacier Bay once supported a highly productive fishery for commercial crab species. While many published studies and ongoing research have been conducted on the adult distributions of commercial crab species in Glacier Bay (O'Clair et al. 1990 and 1993, Leder and Shirley 1993, Taggart et al. 2003), there has been little to no research on the dispersal phase of crabs. It has been well documented that the temporal occurrence of brachyuran larvae generally varies with latitude (Jamieson and Phillips 1988 and Lough 1974). While there is a growing body of literature on *Cancer magister* larvae from California to Vancouver, British Columbia, the larval distribution and abundance of this species and others in high latitude regions are largely unknown. This poster describes the distribution, abundance, and timing of brachyuran larvae from five families in Glacier Bay. These data represent the first intensive study of brachyuran larval abundance and timing of all larval stages in Glacier Bay and can be used as a baseline for future studies.

#15 The Diffusion of Fishing Technique and Conservation Ideology in a Charter Boat Fishery: Guide-client Power Relationships in Gustavus, Alaska

Jason Gasper, Research Assistant, University of Washington, Seattle, Washington

Marc L Miller, University of Washington School of Marine Affairs, Seattle, Washington

Vincent F Gallucci, University of Washington School of Aquatic and Fisheries Sciences, Seattle, Washington

Chad Soiseth, Glacier Bay National Park and Preserve, Gustavus, Alaska

Jane Swanson and Darryll R. Johnson, National Park Service, PNW Region Cooperative Ecosystem Studies Unit, University of Washington, Seattle, Washington

Charter sport fisheries present a situation where management information is not directly disseminated to an angler from agencies. Information and regulations are disseminated from management agencies to charter guides who are expected to pass it on to their clients. Communication between management and charter anglers is dependent on a guide's ability to communicate accurate management information. This paper explores educative interactions that took place between guides and their clients in a charter boat fishery in Gustavus, Alaska. Guide-client interactions were framed in the context of power relationship using a framework outlined by Michele Foucault. The power framework described by Foucault suggests that tour guides control what clients see on a trip and the nature of disseminated information, while clients on a tour retain the power to reject or accept a tour guide's activities. This interaction was observed between charter guides and clients in the context of a conservation ideology. Charter guides encouraged their clients to release halibut larger than 100 lbs and encouraged them to reduce the pounds of halibut harvested. Moreover, guides utilized a client's willingness to learn and their position of power when diffusing their conservation viewpoints, which suggests that charter boat guides have significant control over their clients' behavior, the nature of disseminated information (i.e. regulations), and that charter-client interactions follow a Foucauldian framework.

#16 The Decline of Steller Sea Lion and the Ecosystem of the Gulf of Alaska: Insights from Ecosystem Modelling

Sylvie GuÈnette, Research Associate, University of British Columbia, Fisheries Centre, Marine Mammal Unit, Vancouver, British Columbia

Sheila J. Heymans, Villy Christensen, and Andrew W. Trites, University of British Columbia, Fisheries Centre, Vancouver, British Columbia

Steller sea lions have declined in the western Gulf of Alaska since the late 1970s, while the populations in Southeast Alaska and British Columbia have increased during the same period. Various hypotheses have been formulated to explain the decline, including the "junk food" hypothesis, which postulates that the food consumed by young sea lions in the western GOA, dominated by walleye pollock or Atka mackerel, do not contain enough energy to sustain the population. Another hypothesis is that there is more predation by transient orcas in the western Gulf of Alaska than further east. A third hypothesis is that the carrying capacity for sea lions is lower due to a decrease in primary production in the western Gulf of Alaska. Another possibility is that the large-scale fisheries in the Gulf of Alaska have modified the ecosystem structure and function to the detriment of the sea lions. We tested these hypotheses using 'Ecopath with Ecosim' models of the Aleutian Islands, the central Gulf of Alaska and the Southeast Alaska (which includes Glacier Bay National Park). The models were calibrated using time series data on abundance and catches of commercial and other species. Results provide insights into the probable roles that predation, fishing, and change in productivity may have played in the decline. For example, it is unlikely that orcas caused the decline of sea lions given their original abundance. Results show that orcas would have had to be present in the Aleutians in higher numbers and feed mainly on sea lions to reproduce the trends in abundance of otters, small marine mammals and sea lions. Similar modeling could be done for the Glacier Bay National Park to address other issues such as the decline of harbour seals.

#17 Geologic Characteristics of Benthic Habitats in Glacier Bay Derived from Geophysical Data, Videography, and Sediment Sampling

Jodi Harney, Research Geologist, USGS Pacific Science Center, Santa Cruz, California

Guy Cochrane and Hank Chezar, USGS Pacific Science Center, Santa Cruz, California

Lisa Etherington and Jim de la Bruere, USGS Alaska Science Center, Gustavus, Alaska

Jennifer Mondragon, Alex Andrews, and Jim Taggart, USGS Alaska Science Center, Juneau, Alaska

In April 2004, more than 40 hours of georeferenced submarine digital video were collected in water depths of 15-370 m in Glacier Bay to: (1) ground-truth geophysical data (bathymetry and acoustic reflectance) collected in the lower and central bay; (2) examine and record geologic characteristics of the seafloor; (3) investigate the relationships between substrate types and benthic communities; and (4) develop a model of habitat distribution in Glacier Bay. During video collection, real-time observations of seafloor characteristics (including primary and secondary substrate type, slope, rugosity, and benthic biomass) were digitally recorded at 30-second intervals, as were the presence of benthic organisms and demersal fish. These observations are being used in a supervised statistical classification of acoustic reflectance data to construct a habitat-distribution model that will be applied to other areas in Glacier Bay where geophysical data exist but video ground-truthing observations are lacking. This poster will present geologic observations from 52 submarine video transects collected in the lower and central bay, the Beardslee and Marble Islands, Tlingit Point, and portions of the east and west arms. Common substrates observed include unsorted rubble, rippled sands and large sand waves, bioturbated muds, and extensive beds of live Modiolus and scallops. In collaboration with ecologists from the Alaska Science Center, observations of benthic fauna are being used to investigate the relationships between geological features of the seafloor and the biological communities that inhabit them. This poster will also present results of sedimentological analyses of grab samples, sediment cores, and digital seafloor photography.

#18 SEAMONSTER: Application of Distributed Array of Sensors to Southeast Alaska Science

Matt Heavner, Assistant Professor of Physics, University of Alaska Southeast, Juneau, Alaska
Rob Fatland, Research Scientist, Vexcel Corporation, Boulder, Colorado

SEAMONSTER, the SouthEast Alaska MOnitoring Network for Scientific, Telecommunication and Research, is a network being developed to provide infrastructure to benefit research through Southeast Alaska. The array will be composed of 'bricks,' which are small Linux-based computers with digitizers and wireless network communication capabilities. The first use of this network is for bioacoustic monitoring of bats in Southeast Alaska for species identification and measurement of population dynamics. Additional projects during summer 2004 include experiments for range link budget estimation and measurement to study network requirements. We hope to conduct several other trial scientific measurements during summer 2004 which will include geophysical measurements of the Mendenhall Glacier and also the use of network components ('bricks') for real-time acquisition of signals from remotely located hydrophones. The presentation will highlight the results of development and testing during 2004 with an emphasis on uses of the network which can enable and enhance current and future research projects in Glacier Bay. The capabilities and possibilities of the 'bricks' will be described.

#19 Effects of Moose Foraging on Soil Nutrient Dynamics in the Gustavus Forelands, Alaska

Eran Hood, Assistant Professor, University of Alaska Southeast, Juneau, Alaska
Amy Miller, National Park Service, Anchorage, Alaska
Kevin White, Alaska Department of Fish and Game, Division of Wildlife Conservation

We are studying how selective foraging by moose is affecting soil nutrient dynamics in the Gustavus forelands. Following an extended period of natural colonization beginning in the late-1950ís, the moose population on the Gustavus forelands has rapidly increased in recent years and current over-winter density (ca. 6.2/km^2) is among the highest recorded in Alaska. This sharp increase in moose density, and associated levels of herbivory, has altered plant community structure in preferred foraging habitats (i.e. Salix thickets). The extent to which this activity has affected soil microbial communities and soil nutrient stocks is not known. Thus, in order to investigate the effects of selective foraging by moose on nutrient cycling dynamics, we collected soil samples from two sets of paired exclosure-control plots located in willow thicket habitats both within and adjacent to the Gustavus airport. The fence surrounding the airport has functioned as a moose exclosure since 1998, thus samples collected inside the airport were treated as unbrowsed controls. All soil samples were analyzed for inorganic N pools, microbial biomass N, and soil C:N ratios. In addition, soil cores in buried bags were installed in all plots to measure in situ net mineralization rates. Results from this study will provide preliminary insight into the extent to which the moose population on the Gustavus forelands may be altering soil nutrient dynamics. Because of concerns about the comparability of willow communities inside and outside of the airport, we are also establishing three 12 m x 12 m moose exclosures in other areas of the forelands that span a gradient of soil moisture regimes. These additional exclosures will allow a more comprehensive evaluation of the impact of moose herbivory on local plant community structure and soil nutrient dynamics.

#20 How Loud are those Cruise Ships Anyway? Underwater Noise — Skiffs to Ships

Blair Kipple, Engineer, Naval Surface Warfare Center, Bremerton, Washington
Chris Gabriele, Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska

What are the underwater sound levels of vessels and what is their potential for adversely affecting marine life? The first part of this longstanding question has been addressed in a joint effort between U.S. Navy scientists and staff scientists at Glacier Bay National Park. Their study focused on determining the actual underwater acoustic levels of marine vessels that frequent Glacier Bay. The underwater acoustic signatures of 35 small, medium, and large vessels were measured directly under controlled conditions. Vessel types included small craft powered by outboard engines, 100 to 200 foot tour vessels, and cruise ships up to 850 feet in length. This poster will present and compare the sound levels and sound spectrum characteristics of these vessels, discuss their 'loudness', and open dialogue about the possible effects of such noise on marine mammals common to Glacier Bay.

#21 Humpback Whale and Vessel Use Patterns and Interactions at Point Adolphus

Nikki Koehler, Graduate Student, University of Alaska Fairbanks, Fairbanks, Alaska
Christine Gabriele, Wildlife Biologist, Glacier Bay National Park and Preserve, Gustavus, Alaska
Mia Grifalconi, Cetacean Researcher, North Fork, California

Point Adolphus in Icy Strait is unique within southeastern Alaska due to continually high summer concentrations of humpback whales, levels of vessel activity and proximity to fjord processes within Glacier Bay National Park. In 1999-2001, the National Park Service and NOAA Fisheries funded research on changes in humpback whale distribution, abundance and behavior in relation to vessel activity. Shore-based visual scans were used to determine whale and vessel distribution. Humpback whale dive times, swim speeds and respiration rates were tracked during focal behavioral observation sessions as behavioral parameters. Whale locations and behavior were recorded with a Sokkia DT500 theodolite in conjunction with a laptop computer running a time-synchronized data-collection program developed for shore-based whale studies. Highest densities of humpback whale and vessel observations occurred within 1 mile of shore at Point Adolphus. 55% of whale surfacings occurred with at least one vessel within 500 meters. 72% of observed cruise ships changed course or speed at Point Adolphus. Whale respiration rates, dive durations and swimming patterns were correlated to vessel distance, speed and course. Further investigation is necessary to adequately describe the relationship between whale feeding patterns and oceanographic processes.

#22 Post-glacial Colonization of Pink and Sockeye Salmon in Glacier Bay

Christine Kondzela, Fishery Research Biologist, NOAA Fisheries, Auke Bay Laboratory, Juneau, Alaska
Anthony J. Gharrett, Professor, University of Alaska Fairbanks, Juneau Center School of Fisheries and Ocean Sciences, Juneau, Alaska

Numerous watersheds in Glacier Bay now provide spawning and rearing habitat for several species of Pacific salmon, however virtually nothing is known about these recently colonized populations. Glacier Bay National Park and Preserve provides a rare opportunity to indirectly study gene flow, the successful result of straying, in salmonids in their natural environment under minimal human influence. Our study evaluates colonization mechanisms among variable aged streams within and adjacent to Park waters through analysis of genetic variation among and within pink and sockeye salmon populations. Genetic variation was assessed using protein electrophoresis of allozyme loci, restriction site analysis of mitochondrial DNA, and genotyping of nuclear microsatellite loci. With this information we address the questions of whether colonization is a one-time event or a lengthy event with re-current straying, and whether the initial colonization events involved large numbers of fish or experienced founder effects.

#23 Bald Eagle Productivity and Nest Distribution and Characteristics in Glacier Bay National Park, 1994-2002

Mary Kralovec, Chief of Resources, Organ Pipe Cactus National Monument, Ajo, Arizona

Surveys for bald eagles and their nests in Glacier Bay began in the early 70's with most of the work conducted opportunistically. However, from 1994-2002, systematic surveys of bald eagle productivity were conducted using established protocols. Also, in 1994, characteristics on bald eagle nest trees were collected to determine if bald eagles were building their nests in smaller trees and lower to the ground than elsewhere in North America. Results from this study indicated that the Glacier Bay bald eagle productivity rate is close to the average found for eagle populations in other areas in Alaska. Also, bald eagles nesting in Glacier Bay showed a strong propensity to nest in cottonwoods close to the intertidal zone, with over 70% of the located nests found in them. Mean tree and nest height appeared to be lower than for nests in other parts of North America. This suggests that bald eagles in Glacier Bay tend to nest in smaller trees and place their nests closer to the ground.

#24 Glacial Isostatic Rebound Models of Rapid Uplift in Southeast Alaska

Christopher Larsen, Research Associate, University of Alaska Geophysical Institute, Fairbanks, Alaska

Roman J. Motyka, Jeffrey T. Freymueller, and Keith A. Echelmeyer, University of Alaska Geophysical Institute, Fairbanks, Alaska

Erik Ivins, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California

Five years of GPS observations at 74 sites indicate uplift rates of 10 - 32 mm/yr over a large area of southeast Alaska. Studies of raised shorelines at 27 sites throughout the region show rapid sea level changes, consistent with the distribution and magnitude of the GPS determined uplift rates. Both the raised shoreline data and the GPS data indicate greatest uplift surrounding areas of post-Little Ice Age (LIA) deglaciation. Using a combination of geomorphic indicators and historical observations of the ice extent in Glacier Bay, we have built a model of LIA glacial expansion and retreat of the Glacier Bay Icefield. Total ice volume lost in Glacier Bay since 1750 AD is on the order of 2500 km^3, with ice thickness changes up to 1.5 km. Additionally, present day rates of glacier thinning across southeast Alaska have been measured with airborne laser altimetry. Using these observations of past and ongoing glacial load changes combined with the unloading specific to Glacier Bay, we have developed a series of viscoelastic rebound models constrained by our uplift observations. Rebound models that invoke an Earth structure of a 50 km thick elastic crust over a 100 km thick asthenospheric layer with viscosity of 1×10^{19} Pa s can completely account for the rapid uplift of southern Alaska as due to post-LIA ice loss. Tectonic forces are a minor contributor to the rapid uplift in southeast Alaska.

#25 Some Preliminary Results of Tree Ring Analyses of Interstadial Wood in Glacier Bay

Daniel Lawson, Research Physical Scientist, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Laura Conkey, Department of Geography, Dartmouth College, Hanover, New Hampshire

David Finnegan, Sarah Kopczynski, and Susan Bigl, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire

Interstadial wood is common throughout the Glacier Bay region. In many instances this wood is in remarkably good condition when first exposed from beneath sediments and ice. We have been acquiring samples from across the interior of Glacier Bay with the primary objective to develop a dendrochronology representing the periods of time the trees were alive. Such interstadial periods are identified by radiocarbon dating of the wood; these data suggest that forests existed throughout much of the last 10000 years, but were destroyed by several periods of ice advance that culminated in the Little Ice Age. We are currently examining sections and cores of modern (living) trees to determine if they contain signals of climate in tree ring width variability that may be related to changes in temperature and precipitation. Our climate data from stations across the Park will allow us to determine if local changes may strongly alter this signal. We are also assessing the feasibility of cross-dating the samples to form a continuous long-term chronology of ring widths that may cover a period as long as the last 9000 years. In addition preliminary analyses of sections suggest that periodic changes resulting from external forcing, such as El Nino, may exist in sections of ancient wood, revealing further paleoclimatic information with relevance to understanding longer term, regional and global changes in climate.

#26 Wilderness Camping in Glacier Bay: Assessing Human Impacts to Shoreline Habitat

Tania Lewis, Biological Technician, Glacier Bay National Park and Preserve, Gustavus, Alaska

Allison Banks and Nat Drumheller, Glacier Bay National Park and Preserve, Gustavus, Alaska

The vast majority of backcountry use in Glacier Bay National Park occurs along the shoreline of Glacier Bay. Kayakers, boaters, and hikers camp, cook, and travel in the narrow beach fringes and intertidal zones and most evidence of human activity occurs there. This was the first attempt to systematically record the condition of known campsites. We measured the type and amount of human caused damage at 257 identified shoreline campsites. We attempted to use a standard campsite impact measurement protocol however it proved difficult to apply in our shoreline sites due to affects of isostatic rebound, rapid plant succession, substrate types, and winter storm events. We are developing a modified protocol to suite our unique conditions. Impacts were classified as long-lived, short-lived, and ecological. Almost half the sites received a rating of low impact, 14% showed no sign of use, and 4% received a high impact rating. The most commonly observed impacts were rock rings used to anchor tents, occurring at 74% of sites. Trash was seen at 22% of sites while 5% or less showed intertidal fire pits, human waste, structures or firewood piles.

#27 Trophic Differences in Harbor Seals from a Glacial Fjord and a Terrestrial Haulout in Glacier Bay Inferred from Stable Carbon and Nitrogen Isotopes from Molted Hair

Elizabeth A. Mathews, Assistant Professor, University of Alaska Southeast, Juneau, Alaska

In Glacier Bay, approximately 5,000 harbor seals breed in two distinct habitats: tidewater glacial fjords where they rest on drifting icebergs and terrestrial sites including small islands and reefs. The two largest of these habitats are 70 km apart. It is not known whether there is exchange of breeding animals between these areas nor if these seals have a common feeding area. I hypothesized that seals from glacial fjords would have stable-nitrogen and -carbon isotope signatures distinct from those of seals at terrestrial sites if they were faithful to their resting sites and if they fed in different areas. Molted hair samples were collected from icebergs in Johns Hopkins Inlet (n=101) and from a large terrestrial site in Glacier Bay (n=32). Hair samples were analyzed for isotope ratios. The mean d15N value for seals from the glacial site (15.9‰, SD = 0.826) was significantly higher than that from terrestrial sites (15.4‰, SD = 0.762), indicating that seals in the glacial fjord feed at a slightly higher trophic level. d13C of samples from glacial ice (-15.8, SD = 0.824) was significantly lower than from terrestrial sites (-14.7, SD = 0.793), a difference that may be due to glacial inputs. Although there was within habitat variation, there was almost no overlap from the glacial fjord compared to terrestrial sites when both isotopes were considered, supporting the hypotheses that there is very little exchange between seals at glacial and terrestrial resting sites, and that seals from these two habitats do not feed in the same locations during hair growth.

#28 Spatial Distribution and Relative Abundance of Tanner and Red King Crab Inside and Outside of Marine Reserves in Glacier Bay, Alaska

Jennifer Mondragon, Marine Ecologist, USGS Alaska Science Center, Juneau, Alaska
S. James Taggart, Alexander G. Andrews, and Julie K. Nielsen, USGS Alaska Science Center, Juneau, Alaska

Recent closures of commercial fishing for Tanner crab (*Chionoecetes bairdi*) and red king crab (*Paralithodes camtschaticus*) in parts of Glacier Bay National Park created a network of five protected areas that vary in shape and range in size from 40 to 280 km^2. Unique opportunities now exist in Glacier Bay for testing the value of marine reserves for managing crab populations for several reasons: 1) the Bay exhibits high spatial variability in oceanographic, sedimentary, and successional processes and thus represents a range of environmental conditions found elsewhere in Southeast Alaska; 2) Tanner crab distribution is typically patchy, suggesting a strong relationship between crabs and some habitat characteristic; 3) the closures have created open and closed fishing areas that provide opportunities to test the ecosystem-wide effects of the commercial Tanner crab fishery. Using a 1.5 km grid, we systematically sampled for Tanner and red king crab throughout Glacier Bay and estimated the relative density and relative abundance of the crabs inside and outside of the newly created reserves. These data demonstrate that reserves in close proximity to each other are very different in the abundance of Tanner and king crab; the majority of the Tanner crab were in two reserves and most (73%) of the king crab were in a small part of a single reserve. This study demonstrates the value of systematic sampling for marine reserve design and location.

#29 The Distribution of Bitter Crab Disease in Tanner Crabs from Glacier Bay, Alaska

Kyle Moselle, Undergraduate Student, University of Alaska Southeast, Juneau, Alaska
Sherry Tamone, University of Alaska Southeast, Juneau, Alaska
S. James Taggart and Jennifer Mondragon, USGS Alaska Science Center, Juneau, Alaska

In this experiment, we establish the distribution of Bitter Crab Disease (BCD) in Glacier Bay, Alaska, and calculate percent of incidence in areas with infected crabs. BCD was first described in Alaskan Tanner crabs, *Chionocetes bairdi*, in 1974; in 1987 the cause of the disease in southeastern Alaskan crab populations was determined to be a dinoflagellate (*Hematodinium* sp.). Crabs infected with BCD exude a bitter taste, suffer from poor meat quality, and are unmarketable; therefore the disease represents an economically significant problem. The relative crab abundance was estimated throughout Glacier Bay by sampling 415 systematic stations (on 1.5 km grid) in July and August 2002. Sixteen pots were set daily and hemolymph samples were randomly collected from 10 male and 10 female Tanner crabs from each daily pot set. The hemolymph was smeared onto a glass slide, fixed, stained, and examined for the presence of the vegetative stages of *Hematodinium* sp. Hemolymph of Tanner crab was sampled for BCD in Glacier Bay in 1987 by ADF&G with no finding of the disease. During this study, however, positive hemolymph samples were identified in all sampled areas of Glacier Bay, except for the Beardslee Islands. Additionally, the percent of incidence of BCD was highest in Geikie Inlet. The distribution of BCD in Glacier Bay does not appear to be confined to a single region.

#30 Relationship between Abundance of Dungeness Crab Adults and Larvae: Regional Population Increase or Larval Export from an MPA?

Wongyu Park, Graduate Student, Juneau Center, School of Fisheries and Ocean Science, University of Alaska Fairbanks, Juneau, Alaska
Thomas Shirley, Juneau Center, School of Fisheries and Ocean Science, University of Alaska Fairbanks, Juneau, Alaska
S. James Taggart, USGS Alaska Science Center, Juneau, Alaska

The relationship between larval and adult abundance of Dungeness crabs, *Cancer magister*, was investigated in a multi-year investigation in Glacier Bay, and the adjacent Icy Strait. Male Dungeness crabs were sampled from 6 bays within Glacier

Bay with pot collections from 1996 to 2002. Dungeness crab larvae were collected monthly (May-September) from four stations in Icy Strait from 1996 to 2003 with double-oblique tows from a 0.6 m bongo net. Abundance of early zoeal stages increased dramatically from 1997 to 2003, except for 2002. CPUE for male crabs was significantly correlated to abundance of early zoeal stages ($f = 8.44$, $p = 0.01$). Possible explanations for the relationship include increased numbers or fecundity of females within Glacier Bay, or that the Glacier Bay population is an index for the regional metapopulation and a regional increase in reproduction has occurred.

#31 The Meiofauna of Glacier Bay Streams

Anne Robertson, Senior Lecturer, University of Surrey Roehampton, School of Life & Sports Sciences, London, United Kingdom

Alexander M. Milner, School of Geography, Earth and Environmental Science, University of Birmingham Edgbaston, Birmingham, United Kingdom

The meiofauna, defined as those aquatic benthic organisms passing through a 1000 micrometre sieve but retained on a 63 micrometre one, include a wide range of invertebrate phyla. They are relatively neglected in streams and rivers due to methodological problems and an assumption that they are of marginal importance in these habitats. Meiofauna, however, make a substantial contribution to lotic diversity, comprising between 58-82% total invertebrate species diversity in 7 European streams. Additionally, detailed gut analyses indicate that many stream invertebrates, and of course fish, feed on meiofauna. It is essential that meiofauna are studied alongside the other components of the lotic biota for comparative purposes. An example of this integrated approach is a study of invertebrate colonisation and succession in streams in Glacier Bay National Park. We have studied meiofaunal assemblages in a range of Glacier Bay streams of different ages since 1994. Even the youngest stream (Stonefly Creek) possesses meiofauna and in some streams there is an abundant and diverse meiofaunal assemblage (e.g. a minimum of 19 microcrustacean taxa in Berg Bay North stream). A major environmental predictor of meiofaunal abundance and diversity is stream stability. We have conducted field experiments on the role of leafy debris (scarce in the younger areas of Glacier Bay due to limited riparian zone development) in the composition and abundance of stream invertebrate assemblages. Our results suggest that meiofauna and macroinvertebrates exhibit different responses, emphasising the necessity of studying all elements of this community.

#32 Temporal and Spatial Variability in Distribution of Kittlitz's Murrelets in Glacier Bay

Marc Romano, Wildlife Biologist, USGS Alaska Science Center, Anchorage, Alaska

John F. Piatt, Gary S. Drew, and James Bodkin, USGS Alaska Science Center, Anchorage, Alaska

The Kittlitz's Murrelet (*Brachyramphus brevirostris*) is a rare seabird that nests in alpine terrain and generally forages in glacially influenced marine waters during the breeding season. Nest sites are inaccessible and therefore most of what we know about their ecology comes from observations at-sea. Population trends are also determined from counts of birds at sea. However, we are still fairly ignorant about the pelagic ecology of Kittlitz's Murrelets and are just beginning to understand factors that influence their distribution and abundance at sea. Surveys conducted annually in Glacier Bay (1999-2003), and at daily, weekly and seasonal time scales during 2003 provide some insight into the pelagic life of this enigmatic seabird. These datasets suggest that Kittlitz's are a highly mobile species, and only a few areas of Glacier Bay are occupied by murrelets on a continuous basis during summer or among years. Shifts in distribution over 10s and 100s of km may occur in response to changes in strength of tidal oscillations, seasonal succession of productivity up bay, changes in forage species abundance and distribution, and the presence or absence of potential competitors, such as the Marbled Murrelet (*B. marmoratus*). As others have found in Prince William Sound, the Kittlitz's Murrelet prefers to forage in the vicinity of tide-water glaciers, and where glacial rivers flow into the ocean, but murrelets in Glacier Bay are also drawn to other features, such as underwater sills, which appear to have little direct glacial influence.

#33 The Influence of Air Temperature, Water Inputs, and Transport on the Water Temperature Flux in Glacier Bay, a Recently Deglaciated Fjord

S. James Taggart, Research Ecologist, USGS Alaska Science Center, Juneau, Alaska
Daniel E. Lawson, David Finnegan, Sarah Kopczynski, and Susan Bigl, Cold Regions Research and Engineering Lab, Hanover, New Hampshire
Jennifer Mondragon, Alexander Andrews, and Julie K. Nielsen, USGS Alaska Science Center, Juneau, Alaska

Water temperature changes the growth rates and timing of life history events of most marine invertebrates and fishes. Northern southeast Alaska is at the northern boundary of the range of some marine species and temperature is thought to be especially critical to their distribution. Within Glacier Bay, many marine species are limited in occurrence to the lower portion of the Bay and water temperature variations have been hypothesized to be an important factor. To compare the seasonal changes in water temperature, we measured water temperature by mooring temperature loggers at 5 and 10 m depths at stations throughout Glacier Bay. Simultaneously, air temperature and precipitation were collected at an array of 26 weather stations across the Park so that we could measure the influence of both on water temperature. In the lower Bay, we found that the seasonal air temperature cycle was in phase with the seasonal water temperature cycle. In the upper Bay, however, the seasonal water temperature and air temperature cycles were out of phase by about 30 days; in the spring water temperature continued to decline even as air temperature rose. In this poster we present hypotheses about the factors that are causing the temperature variations throughout the Bay.

#34 The Cultural Ecology of Berries in Glacier Bay National Park

Thomas Thornton, Professor, Trinity College, Department of Anthropology, Hartford, Connecticut

A study of Tlingit berry picking in Glacier Bay suggests we need to rethink the relationship between hunting-gathering peoples and plants. Historically, like salmon streams and other key resource areas among the Tlingit, prime berry patches were named, owned, cultivated, conserved, and celebrated as places. Glacier Bay berries were internationally renowned, widely traded, and comprised an important nutritional component of the diet and symbolic and spiritual element in ceremonial gatherings. Maintaining the productivity of prized berry patches involved a variety of management techniques and strategies to control supply and demand and thus avoid shortages. Despite Park Service restrictions on hunting and fishing in Glacier Bay, berry picking remains an important communal subsistence activity in the Park – one relatively free from controversy and competition – that continues to bind contemporary Tlingit to their ancient homeland. (This poster will be supplemented by a short video, "A Time of Gathering.")

#35 John Muir, Glacier Bay and the Tlingit Indians

Michael Turek, Regional Supervisor, Alaska Department of Fish and Game, Subsistence Division, Juneau, Alaska

In the autumn of 1879, John Muir boarded a Tlingit canoe in Wrangell, Alaska for a journey to Glacier Bay. The Tlingits, hesitant to leave on a long and possibly treacherous trip, reluctantly agreed to lead the curious white man north. When they reached Icy Straits, they enlisted a Hoonah Tlingit seal hunter to lead them into Glacier Bay. Muir eventually published a description of his journey in a popular journal and became known as the man who discovered Glacier Bay. During his travels Muir grew to know and like the Tlingits. An experienced wilderness traveler, Muir respected the Tlingits' seamanship, their camp skills, and the beauty and performance of their canoes but he did not approve of their hunting. Muir not only refused to eat the "oily flesh" of the deer, seals, and ducks served by his Tlingit hosts, he interfered with their hunting, "when we want to shoot, Mr. Muir always shakes the canoe." Muir, although he could appreciate his host's sense of humor concerning his inappropriate behavior, "(the Indians were) making a good deal of sport of my pity for the deer and refusing to eat any of it and nick naming me . . . the deer and duck's Tillicum (friend)," refused to cease shaking the Tlingit's canoe. This poster will portray Muir's travels with his Tlingit companions, his attitudes towards Native hunting and how his philosophy has influenced the management of Glacier Bay National Park.

#36 Glacier Bay's Coastal Database: Providing Rapid and Easy Access to Coastal Resources Information

Phoebe Vanselow, Resource Management Division, Glacier Bay National Park and Preserve, Gustavus, Alaska

Bill Eichenlaub, Jenni Burr, and Lewis Sharman, Glacier Bay National Park and Preserve, *Gustavus, Alaska*

Glacier Bay's Coastal Resources Inventory and Mapping Program (see paper presentation by Sharman *et al.*) was designed primarily to collect and make available "base" information to be used in addressing a variety of current and future coastal resource management issues. However, we also wanted to ensure rapid and easy access by a variety of other users (scientific researchers, educators, park visitors, the general public) with a range of computer skill levels. A primary focus was creating a user-friendly "tool" that is a "one-stop shop" for all the information gathered by the program. The final map-based interactive database provides instant access to gigabytes of data with a few mouse clicks. Users needn't be versed in database manipulation or Geographic Information System (GIS) use; indeed, one needn't even know how to type! The database is intuitive and provides users with choices for accessing information ranging from highly technical analyses to colorful photographs of beaches and organisms. It includes an inviting format with multiple "help" avenues, along with links to explanatory background information and photos, all designed to provide easy access by non-technical as well as technical users. A popular component is an "ethnoecological encyclopedia" linked to all the marine intertidal species and species groups recorded as part of the inventory. The entire product (interactive database, actual Glacier Bay data, and protocols) fits on a single DVD, and a map server version is in development for distribution via the internet. This poster will include a computer demonstration of the database.

#37 Evaluation of Geochemical Signatures as Natural Fingerprints to Determine Tanner Crab Movement in Glacier Bay National Park, Alaska

Bronwen Wang, Aqueous Geochemist, U.S. Geological Survey, Anchorage, Alaska
Jim Crock, U.S. Geological Survey, Lakewood, Colorado
Robert Seal, U.S. Geological Survey, Reston, Virginia
Spencer Taggart, Jennifer Mondragon, Alex Andrews, and Julie Nielsen, U.S. Geological Survey, Juneau, Alaska

The movement of Tanner crabs (*Chionoecetes bairdi*) with ontogeny is poorly understood but could have important implications for fisheries management. High concentrations of juvenile Tanner crabs have been found in several areas within Glacier Bay; these areas could be nursery areas from which maturing crabs disperse. Geochemical signatures imparted to the carapace during the molt could serve as a natural fingerprint that could be used to identify the area where molting occurred. For this pilot study, recently molted Tanner crabs from Scidmore Bay, Charpentier Inlet, Hugh Miller Inlet, Wachusett Inlet, and Bartlett Cove were harvested. The carapace and leg meat were retained for elemental and stable isotopic (C, N, and S) analysis. If geochemical signatures differ between crabs from different sample sites, this technique could be used to determine movements of Tanner crabs from areas where molting occurs, such as hypothesized nursery areas. This poster will present the preliminary data and baseline information necessary to determine the feasibility of establishing a geochemical signature for use as a natural fingerprint.

#38 Effects of Food-limitation on an Irruptive, High-density Moose Population on the Gustavus Forelands, Alaska

Kevin White, Wildlife Research Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, Alaska

Neil Barten, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, Alaska

John Crouse, Alaska Department of Fish and Game, Moose Research Center, Soldotna, Alaska

Moose populations in southeastern Alaska have a relatively short history as a result of recent de-glaciation of regional landscapes. The colonization trajectories of such populations have typically been characterized by irruptive fluctuations. That is, following a period of initial establishment, populations have generally increased rapidly (possibly exceeding habitat carrying capacity) and subsequently declined precipitously. Unfortunately, due to temporal rarity of such occurrences, detailed studies of irruptive moose populations in southeastern Alaska have not been conducted. In this presentation, we describe preliminary findings from an ongoing study focused on detailing individual- and population-level responses to food-limitation in an irruptive, high-density (ca. 3.9 moose/km^2) moose population inhabiting the Gustavus forelands. We document high levels of forage utilization (54-62% biomass removal of preferred forages) over a 5-year period in which the population roughly doubled. In addition, we compare measures of moose body condition (adult female rump fat thickness) and population productivity (pregnancy and twinning rates) to other populations throughout Alaska. We also describe efforts to link changes in individual over-winter body condition to correlates of habitat quality. The conservation challenges associated with irruptive, high-density moose populations are discussed.

Notes

Acknowledgements

The Glacier Bay Science Symposium would not have been possible without the continued support of many individuals and organizations. Steering Committee members provided the ideas and energy to make this happen. They include (in alphabetical order): Susan Boudreau, Bill Brown, Jed Davis, Emily Dekker-Fiala, Joy Geiselman, Scott Gende, Wayne Howell, Tomie Lee, Alexander Milner, John Morris, Kris Nemeth, John Piatt, Tom Shirley, Sherry Tamone and Bob Winfree. Brendan Kelly and Eric Knudsen worked closely with the Steering Committee to develop the Symposium concept and format. Alex Andrews, Jim Bodkin, Chiska Derr, Chris Gabriele, Gail Irvine, Mary Kralovec, Jennifer Mondragon, Lewis Sharman, Barbara Sheinberg, and Jim Taggart helped design and implement the Science Integration Workshop. National Park Service (NPS) administrative support was provided by Sheri Barry, John Dennis, and Joy Kucinski. Jesse Arrington of the Alaska Public Lands Information Center, Fairbanks, provided the cover artwork for this program booklet. Fritz Koschmann designed the symposium poster.

Major sponsors include Glacier Bay National Park and Preserve, the USGS Alaska Science Center, the NPS Alaska Region Inventory and Monitoring Program, the Pacific Northwest Cooperative Ecosystem Studies Unit, and the NPS Alaska Regional Office. The George Wright Society provided conference planning and registration. Sheinberg Associates facilitated the Science Integration Workshop.

Centennial Hall Meeting Rooms