

3/3/05

UNIVERSITY
RESEARCH

HFIN

FILE

Research and Development (R&D) at the University of Alaska

**Basics of R&D at UA
Evolution of our Program
Role in and for the State**

**Craig Dorman
Vice President
Academic Affairs and Research
University of Alaska Statewide System**

What drives the R&D Agenda?

Curiosity: Interests of the investigators
Reward structure of the R&D enterprise

Concern: Problems and interests of the sponsors (government, industry, philanthropy)

E.g., Federal:

President (OSTP/NSTC/OMB)

Congress (authorization and appropriation)

Departments and Agencies: Mission oriented (e.g., DOI,

DOT, NIH), and National Strength in key areas (NSF)

All with advice from NRC

Resources: Facilities, Partnerships, but most of all

Money: He who pays asks the question

Some Dynamics of R&D in Alaska

Nationally, Industry conducts 70% of R&D,

Universities conduct 14%

In Alaska, UA conducts 55% of R&D and Industries 10%

Average State R&D Intensity = 2.5% GSP

Alaska R&D/GSP ~1%

No major federal R&D lab presence

**Our University researchers are here because they
are interested in the people, environment, and
resources of Alaska...**

BUT: They have to go Outside for funding

UA total research revenue FY04: \$138M

Good growth pattern:

- FY98: \$77M
- FY99: \$81M
- FY00: \$91M
- FY01: \$109M
- FY02: \$120M
- FY03: \$133M

Most \$ currently at UAF (90%)

Growing at all MAUs

Traditionally "academic"

Becoming more applied

University Research as an Enterprise: Total Economic Impact

• Jobs

- 2,310 Total
- 1,228 University—full and part time
- 1,082 Private

• Payroll

- \$80.3 Million--Total
- \$45.2 Million-- University
- \$35.0 Million-- Private

• Private Business Sales

- \$106.8 Million--Total
- \$42 Million—Direct Procurement
- \$64.8 Million—Indirect
- Economic Importance of University Research

UAF Funding Sources

(04 Research Expenditures - \$m)

Direct Federal		84.0
DOD	6.6	
NIH	6.7	
Interior	6.0	
Ag	5.4	
Commerce	7.9	
NASA	11.0	
NSF	22.9	
State Agencies		1.7
Direct	1.2	
From Federal	0.5	
Private (Univ, Corp, Found n)		17.2
Direct	7.9	
Federal Indirect	9.3	
General Fund		14.4

(UAA: 6.7, 1.1, 3.0, 2.4)

**Large sums from small pieces (FY04) :
Diversity**

**986 Active Research Grants and Contracts
totaling \$466 Million**

**335 New awards annually - 118% increase
over FY99**

Legislative Performance Measures:

188 Awards in Specified Areas

297 Graduate Students Funded

318 Active Applied Research Projects

BOR Strategic Plan

Areas of Statewide Leadership

ANCHORAGE

Social, Economic Policy
Health delivery
Logistics
Community Engagement
Complexity
Finance, Business

FAIRBANKS

Biomedical Science
Engineering
Fisheries, Marine Science
Geophysics
Remote Sensing
Climate
Natural Resources
Native Languages, Culture
Arctic Research
Wildlife Biology
Energy Technology
Computational Science
Cold Regions Infrastructure

SOUTHEAST

Government
Education
Marine Biology
Environmental Technology

How are we organized for R&D?

Independent Research Units:

Geophysical Institute

Institute of Arctic Biology

International Arctic Research Center

Arctic Region Supercomputing Center

UAF Museum

R&D Units Within Schools and Colleges (examples)

Business Enterprise Institute

Institute for Social and Economic Research

Environmental and Natural Resources Institute

Center for Supply Chain Integration

Institute for Circumpolar Health Studies

Institute of Northern Engineering

Institute of Marine Science

Arctic Energy Technology Development Lab

Alaska Native Language Center

Mineral Industries Research Lab/Petroleum Development Lab

Office of Electronic Miniaturization

Agriculture and Forestry Experiment Station

Program Evolution

SJR 44 (2nd Session, 22nd Legislature)

Draft State R&D Plan (2/03)

Lead Participants: UA, NPRB, ARC, IARPC, ASTF

Objectives:

- Expand and Diversify Alaska's Economy
- Protect Health of Alaskans and Alaska's Environment
- Strengthen State Research Institutions
- Identify ways for Federal and State Governments to work together

Conclusions and Recommendations:

- **UA R&D is a valuable enterprise for Alaska in its own right, as well as a strategic tool for economic development**
- Establish mechanism for planning and Agency accountability
- Maintain excellence and build competitive capacity
- Establish monitoring networks coupled to analytical capacity
- Improve flow of information to decision makers, public

Since then (a few examples) . . .

R&D as an Enterprise:

- ISER Study
- UA Performance Based Budgeting System, ACAS, organizational changes, EPSCoR program focus, WRRB, Zerhouni/Bement visits...

R&D as a Strategic Tool

- ASTF went away – both an opportunity and a responsibility for UA
- Tech Transfer reviews, Business Enterprise Institute, Experimental Economics program, UAF Vice Chancellor for Research and Economic Development position, closer interface with A/J/F economic development groups
- Focused Federal Initiatives (e.g., Office of Electronic Miniaturization, Center for Supply Chain Integration, wood utilization, berry and fish products...)
- Transformed NSF EPSCoR Committee into State Committee on Research (SCoR) to continue the work started by SJR-44
- Governor and Cabinet meetings at UAF
- FY06 Competitive Research Initiative request and President Hamilton's State of the University speech to the Legislature on February 3 2005

Some examples of what we're already doing:

At UAF:

- Hazard Management: AVO (Eichelberger), AEIC/State Seismologist (Hansen), TWEAK (Tsumamis), extreme weather/climate (Walsh), GIN and remote sensing (ASF; Sharpton)...
- Energy: Shallow Viscous Oil and Gas and Methane Hydrate Development (Patil); Tundra Pond Pumping for Ice Reads (Hinzman); Fuel Cell development and testing (Witmer); Galena Electric Power Analysis (Johnson/Weiss w UAA Colt); pipeline studies (Huang); petrochemical development (Metz)...
- Transportation: Transportation research center (Kane); Rail routing/Army access (Metz); Automotive R&D, Infrastructure thermal protection(Goering/Raad)...
- Health: Infectious disease (Marr/Happ/Winker); obesity and diabetes (Mohat/Boyer); SIDS ; Torpor (Barnes et al); behavioral health (Mohat et al)...
- Electronic Miniaturization (Dickinson/Karulkar w/FEDC, City and Borough, Nanook Tech Accelerator...)
- Not to mention agriculture; fisheries, wildlife, art, language, space weather, ecology, the museum, climate impacts, etc etc

At UAA: Tom Case, Dean, College of Business and Public Policy

At UAS: Karen Schmitt, Dean, School of Business, Public Administration and Information Systems; and Dean School of Career Education

Next: Competitive Research Initiative Request

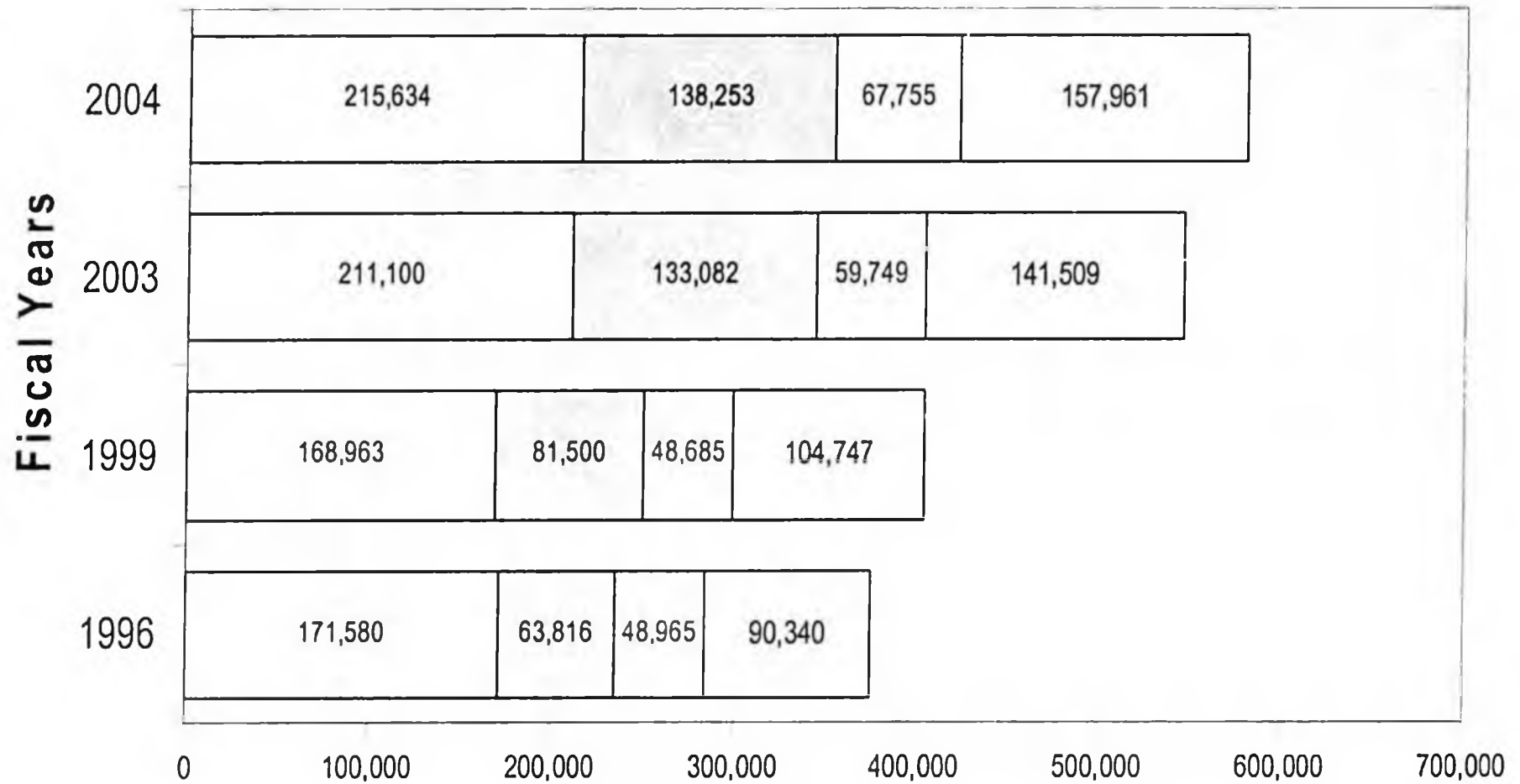
UA now invests ~8% of General Fund allocation in organized research, which we leverage at about 7-1

- Start-up, salaries, instrumentation, focused research, federal 'match'

Four ways you can help us do more for the State:

- Agency funding to address state specific mission-related issues – let state agencies 'buy the question'
- Turn to UA for advice and participation
- Support our infrastructure (capital budget) requests
- Direct augmentation of State GF for research directed to state needs
 - Cross-cutting projects and instrumentation, e.g. remote sensing and data management for resource assessment, hazard mitigation; addressing the impacts of climate change on infrastructure, ecosystems, and people; policy analysis
 - SCoR participation in prioritization as State R&D Plan evolves
 - Competitive opportunities to stimulate interest and participation
 - \$20M over 5 years – FY06 tranche \$2.5M

UA Revenue Structure by Different Sources



Thousands of Dollars

- State Appropriated Funds
- Externally Funded as a Result of Research
- Tuition
- Other

Karen Schmitt, Ph.D.

Dr. Karen Schmitt serves as the Dean for the School of Career Education and the School of Business, Public Administration & Information Systems at the University of Alaska Southeast. Dr. Schmitt has over fifteen years of experience directing education, research and outreach programs in academia and industry. In addition to her responsibilities at UAS, she is a member of several statewide UA workforce and distance education planning groups. In November 2004 Dr. Schmitt received the Leadership Award from the Alaska Association of Career and Technical Education.



COLLEGE of BUSINESS & PUBLIC POLICY



Thomas R. Case was born in 1946 in Baker, Oregon and graduated from the United States Air Force Academy in 1969 with a bachelor of science degree in geography. In 1976, he earned a master of science degree in systems management from the University of Southern California. He graduated from the National War College, Washington, D.C., in 1987 and served on the National War College faculty for two years as the Air Force Chief of Staff's Chair. In 1991, he completed Emory University's Advanced Management Program.

Gen Case completed a career of military service in July 2002 as the Deputy Commander-in-Chief and Chief of Staff, United States Pacific Command. As the second in command of a unified combatant command, he oversaw the combatant and peacetime activities of U.S. military forces of all services numbering more than 300,000 members in a geographic region covering 52 percent of the earth's surface. As Chief of Staff, he managed a staff of over 1,300 military and civilian members and a headquarters budget of \$234 million. In this capacity, he coordinated the activities of the military service components and provided direct oversight of the Asia Pacific Center for Security Studies. Gen Case had similar responsibilities while assigned to the United States Central Command, with experience in the Persian Gulf, North Africa and the Middle East.

During his prior assignment he was the senior military commander in Alaska and received the Eugene M. Zuckert Award honoring outstanding management achievements by an Air Force Manager, presented by the Secretary of the Air Force. Earlier in his career, Gen Case commanded the Third Wing at Elmendorf Air Force Base. During this period, Elmendorf won the Department of Defense Installation Excellence Award as the best managed installation of any service in the Department of Defense.

While serving at the Pentagon, Gen Case managed the Air Force's modeling, simulation, and analyses programs. He prepared and conducted the first-ever Air Force summit of senior leadership to redirect the modeling, simulation and analysis efforts Air Force-wide, leading to increased effectiveness in this vital mission area.

His flying career was primarily in fighter aircraft, logging over 4000 hours flying time in the Pacific, Europe, the Persian Gulf area, and Alaska.

Gen Case has been actively involved in community service through the Hawaii Business Roundtable, Commonwealth North, Rotary, and the Anchorage Chamber of Commerce. He has been a frequent presenter at national and international conferences and symposia.



what we do

The Marine Advisory Program provides information to Alaska's marine users on many topics such as seafood quality, business development, fisheries issues, and more through...

- Workshops and classes
- Publications and multi-media productions
- One-on-one technical assistance
- Applied research

Anchorage

2221 E. Northern Lights Blvd. #110
Anchorage, Alaska 99508-4140
Voice: 907-274-9691
Fax: 907-277-5242
E-mail: map@sfos.uaf.edu

Paula Cullenberg - anpic@uaa.alaska.edu
Ray RaLonde - afir@uaa.alaska.edu
Beverly Bradley - fnbjbl@uaf.edu
Julie Carpenter - anjsc@uaa.alaska.edu
Dohald Kramer - afdek@uaa.alaska.edu
Deborah Mercy - andam@uaa.alaska.edu
Nancy Mighells - annlm@uaa.alaska.edu
Rick Steiner - afrgs@uaa.alaska.edu

Bethel

UAF Kuskokwim Campus
P.O. Box 368
Bethel, Alaska 99559
Voice: 907-543-4541
Fax: 907-543-4527
Terry Reeve - fftar@uaf.edu

Cordova

P.O. Box 830
Cordova, Alaska 99574
Voice: 907-424-7542
Fax: 907-424-3673
Torie Baker - torie@sfos.uaf.edu

Dillingham

P.O. Box 1549
Dillingham, Alaska 99576
Voice: 907-842-1265
Fax: 907-842-3202
Liz Brown - brown@sfos.uaf.edu

Homer

4014 Lake Street #2018
Homer, Alaska 99603
Voice: 907-235-5643
Fax: 907-235-6048
Terry Johnson - rtj@uaf.edu

Ketchikan

2030 Sea Level Drive #2018
Ketchikan, Alaska 99901
Voice: 907-247-4978
Fax: 907-247-4976
Dolly Garza - ffdog@uaf.edu

Kodiak

118 Trident Way
Kodiak, Alaska 99615
Voice: 907-486-1500
Fax: 907-486-1540
Chuck Cropp - dfcoc@uaa.alaska.edu
Quentin Fong - qfong@sfos.uaf.edu
Kate Wynne - ffkmw@uaf.edu

Petersburg

P.O. Box 1329
Petersburg, Alaska 99833
Voice: 907-772-3381
Fax: 907-772-4431
Alison Rice - fnar@uaf.edu

Unalaska

P.O. Box 526
Unalaska, Alaska 99685
Voice: 907-581-4589
Fax: 907-581-2505
Reid Brewer - brewer@lms.uaf.edu



marine advisory program

map

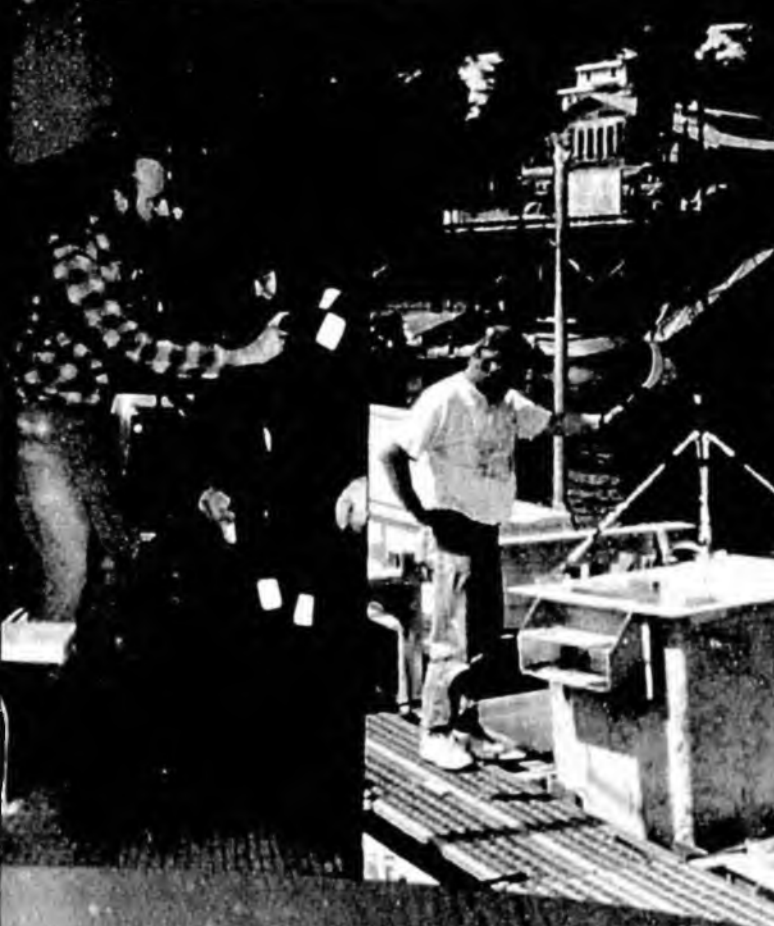


Alaska Sea Grant College Program
School of Fisheries and Ocean Sciences
University of Alaska Fairbanks

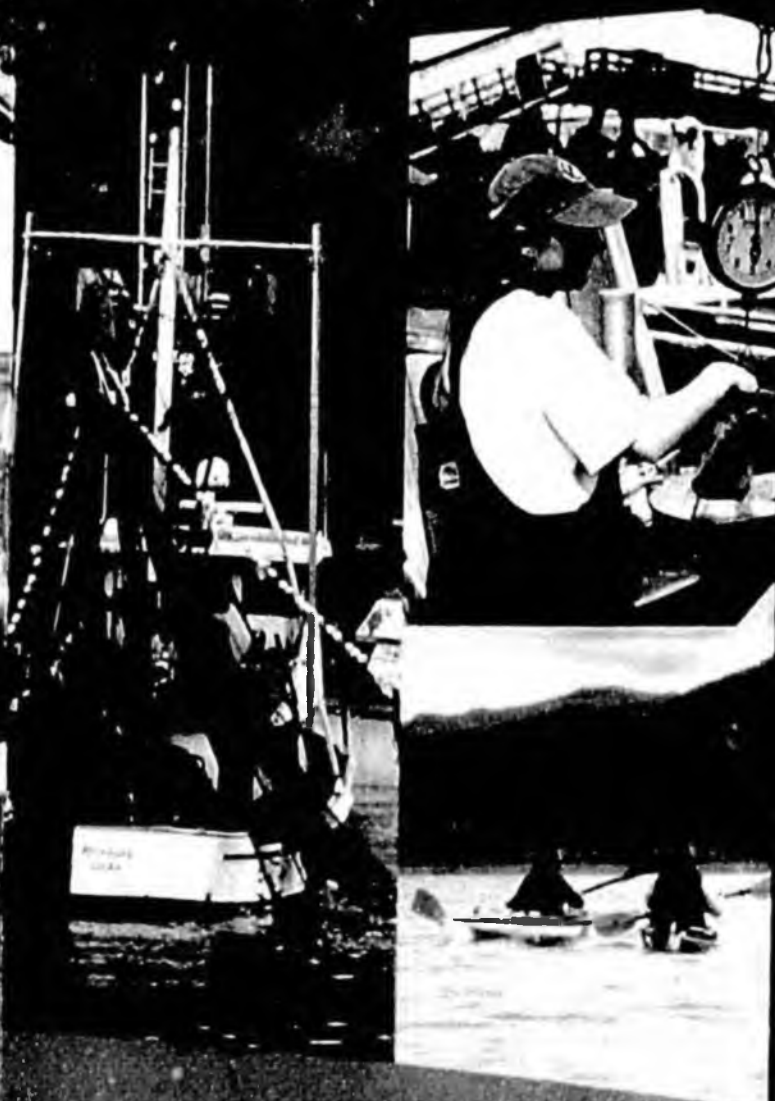
who we are

Alaska's abundant coastal and marine resources provide food, jobs, and recreation for people inside and outside the state. No matter where an Alaska resident lives—on the coast, along a river, or inland—everyone has a vested interest in the long-term health of the state's seas and coasts.

The Marine Advisory Program (MAP) is a university-based, statewide, outreach and technical assistance program designed to help Alaskans wisely develop, use, conserve, and enjoy Alaska's marine and coastal resources. MAP faculty members and staff provide informal marine education, offer technical assistance to coastal communities related to economic development, conduct applied research and serve as a link between the University of Alaska and marine and freshwater resource users in many areas of the state not served by traditional faculty.



uaf.edu/map



how we can help

Seafood Technology

Advancing quality, safety, diversity and value of Alaska seafood products through training and publications.

Marine Safety

Working to reduce maritime injuries and fatalities in northern waters.

Business and Marketing

Offering business planning to marine businesses, fishermen and small tourism operators.

Fisheries

Supporting the understanding and development of Alaska's unique and vast resources for commercial and subsistence fisheries.

Coastal Community Development

Enhancing the economic development and stewardship of marine resources in Alaska's coastal communities.

Aquaculture

Developing shellfish production and marketing opportunities for Alaskans.

Marine Recreation

Promoting the development of the tourism and marine recreation industry in Alaska.

Marine Conservation

Increasing public awareness of marine conservation issues to enhance informed decision making.

Marine Mammals

Encourage understanding of marine mammal health and interactions through research, cooperative projects and training.

UAF is an AWEI employer and educational institution

In a state as big as Alaska that is so dependent on the health of marine resources, it's critical that people have quick and easy access to information and technical assistance. MAP agents and specialists live and work in the communities they serve. The integration of MAP personnel with local communities provides for the efficient flow of information between the University of Alaska and the people.



Anchorage
 2221 E. Northern Lights Blvd. #110
 Anchorage, Alaska 99508-4140
 Voice: 907-274-9691
 Fax: 907-277-5242
 E-mail: map@sfos.uaf.edu

Paula Cullenberg - anpj@uaa.alaska.edu
 Ray Rolande - afrl@uaa.alaska.edu
 Beverly Bradley - fbbl@uaf.edu
 Julie Carpenter - anjc@uaa.alaska.edu
 Donald Kramer - afdk@uaa.alaska.edu
 Deborah Mercy - andam@uaa.alaska.edu
 Nancy Nichols - annm@uaa.alaska.edu
 Rick Steiner - afrg@uaa.alaska.edu

Bethel
 UAF Kuskokwim Campus
 P.O. Box 368
 Bethel, Alaska 99559
 Voice: 907-543-4541
 Fax: 907-543-4527
 Terry Reeve - rtar@uaf.edu

Cordova
 P.O. Box 830
 Cordova, Alaska 99574
 Voice: 907-424-7542
 Fax: 907-424-3673
 Torie Baker - torie@sfos.uaf.edu

Dillingham
 P.O. Box 1549
 Dillingham, Alaska 99576
 Voice: 907-842-1265
 Fax: 907-842-3202
 Liz Brown - brown@sfos.uaf.edu

Homer
 4014 Lake Street #201B
 Homer, Alaska 99603
 Voice: 907-235-5643
 Fax: 907-235-4048
 Terry Johnson - rtj@uaf.edu

Ketchikan
 2030 Sea Level Drive #201B
 Ketchikan, Alaska 99901
 Voice: 907-247-4978
 Fax: 907-247-4976
 Dolly Gorza - ffdaz@uaf.edu

Kodiak
 118 Trident Way
 Kodiak, Alaska 99615
 Voice: 907-486-1500
 Fax: 907-486-1540
 Chuck Crope - dfcc@uaa.alaska.edu
 Quentn Fong - qfong@sfos.uaf.edu
 Kate Wynne - ffkmw@uaf.edu

Petersburg
 P.O. Box 1329
 Petersburg, Alaska 99833
 Voice: 907-772-3381
 Fax: 907-772-4431
 Allison Rice - rtar@uaf.edu

Unalaska
 P.O. Box 526
 Unalaska, Alaska 99685
 Voice: 907-581-4589
 Fax: 907-581-2505
 Reid Brewer - rbrewer@ms.uaf.edu

marine advisory program



what we do

The Marine Advisory Program provides information to Alaska's marine users on many topics such as seafood quality, business development, fisheries issues, and more through...

- Workshops and classes
- Publications and multi-media productions
- One-on-one technical assistance
- Applied research



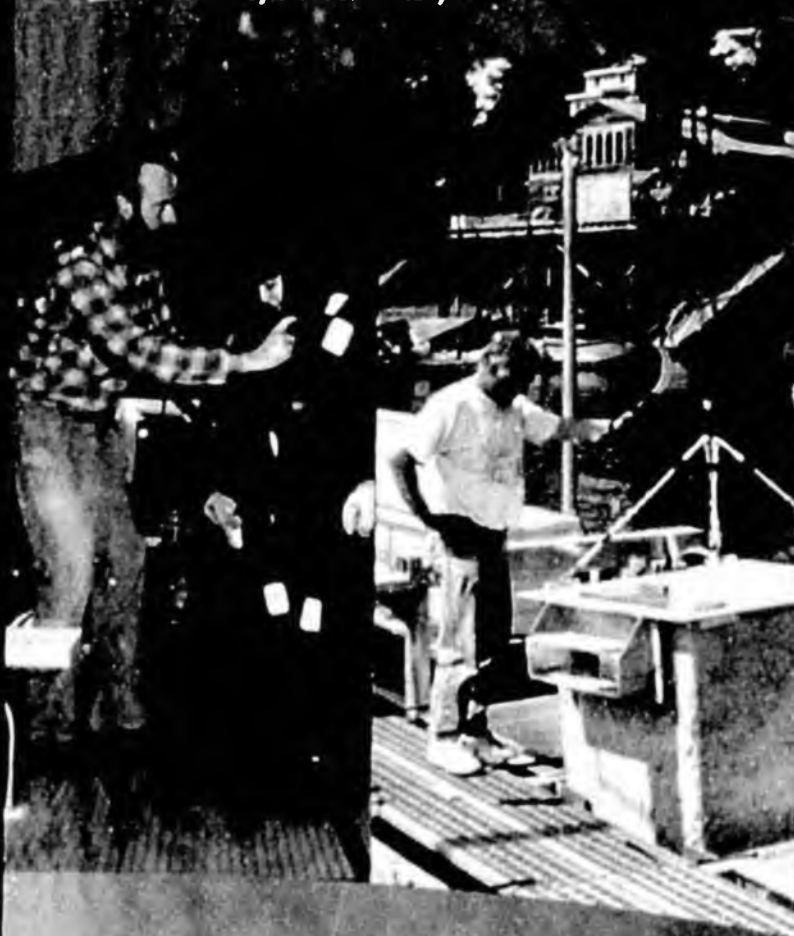
map

Alaska Sea Grant College Program
 School of Fisheries and Ocean Sciences
 University of Alaska Fairbanks

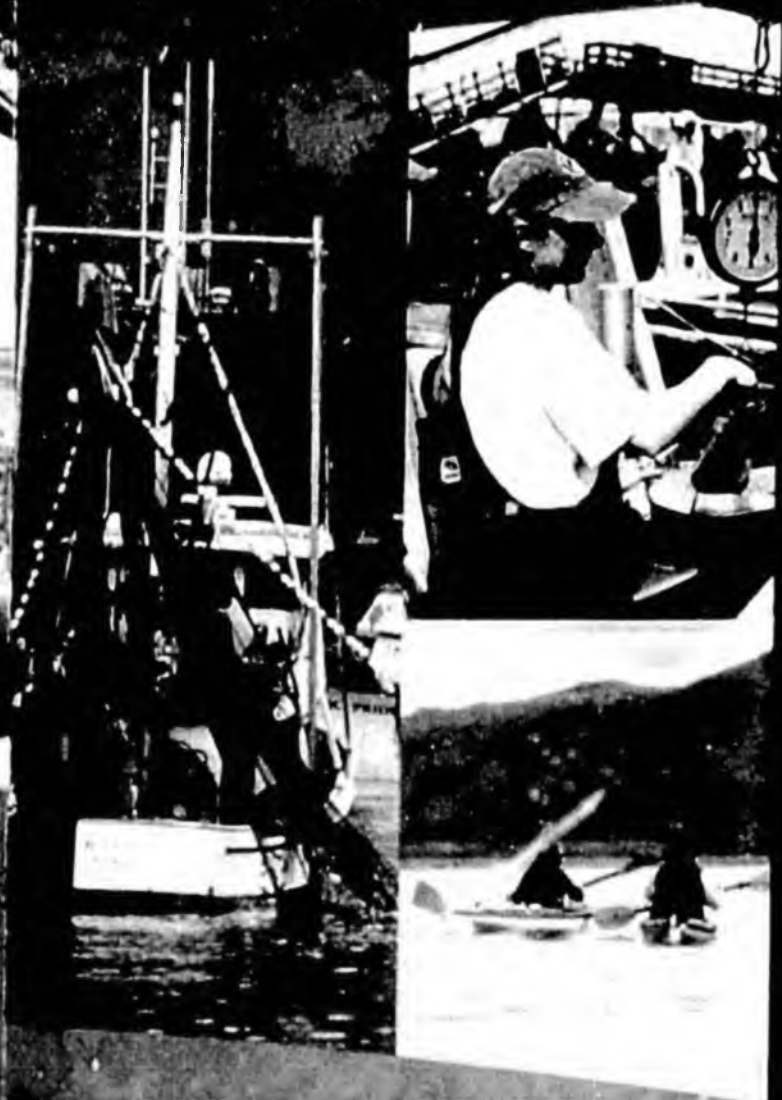
who we are

Alaska's abundant coastal and marine resources provide food, jobs, and recreation for people inside and outside the state. No matter where an Alaska resident lives—on the coast, along a river, or inland—everyone has a vested interest in the long-term health of the state's seas and coasts.

The Marine Advisory Program (MAP) is a university-based, statewide, outreach and technical assistance program designed to help Alaskans wisely develop, use, conserve, and enjoy Alaska's marine and coastal resources. MAP faculty members and staff provide informal marine education, offer technical assistance to coastal communities related to economic development, conduct applied research and serve as a link between the University of Alaska and marine and freshwater resource users in many areas of the state not served by traditional faculty.



uaf.edu/map



In a state as big as Alaska that is so dependent on the health of marine resources, it's critical that people have quick and easy access to information and technical assistance. MAP faculty and specialists live and work in the communities they serve. The integration of MAP personnel with local communities provides for the efficient flow of information between the University of Alaska and the people.

how we can help

Seafood Technology

Advancing quality, safety, diversity and value of Alaska seafood products through training and publications.

Marine Safety

Working to reduce maritime injuries and fatalities in northern waters.

Business and Marketing

Offering business planning to marine businesses, fishermen and small tourism operators.

Fisheries

Supporting the understanding and development of Alaska's unique and vast resources for commercial and subsistence fisheries.

Coastal Community Development

Enhancing the economic development and stewardship of marine resources in Alaska's coastal communities.

Aquaculture

Developing shellfish production and marketing opportunities for Alaskans.

Marine Recreation

Promoting the development of the tourism and marine recreation industry in Alaska.

Marine Conservation

Increasing public awareness of marine conservation issues to enhance informed decision making.

Marine Mammals

Encourage understanding of marine mammal health and interactions through research, cooperative projects and training.

UAF is an AAED employer and educational institution.

OFFICE OF ELECTRONIC MINIATURIZATION
UNIVERSITY OF ALASKA FAIRBANKS



WWW.SILICONTUNDRA.ORG

APPLICATION SPECIFIC ADVANCED PACKAGING

Contact us for microelectronic R&D and prototyping, for design, engineering, fabrication, testing and failure analysis of advanced electronic components and systems. Leverage our on-site, qualified Tessera µBGA™ Chip Scale Package (CSP) fabrication facility and UAF's diverse resources to find your electronic miniaturization solutions.



OFFICE OF ELECTRONIC
MINIATURIZATION

Office of Electronic Miniaturization
University of Alaska Fairbanks
www.silviantundra.org
sem@uaf.edu

OFFICE: 794 University Avenue, Suite 300 Fairbanks, AK 99709
ADDRESS: P.O. Box 758090 Fairbanks, AK 99775-8090
PHONE: (907) 455-2000 FAX: (907) 455-2020

APPLICATION SPECIFIC ADVANCED PACKAGING

Contact us for microelectronic R&D and prototyping, for design, engineering, fabrication, testing and failure analysis of advanced electronic components and systems. Leverage our on-site, qualified Tessera µBGA™ Chip Scale Package (CSP) fabrication facility and UAF's diverse resources to find your electronic miniaturization solutions.




OFFICE OF ELECTRONIC
MINIATURIZATION
UNIVERSITY OF ALASKA FAIRBANKS

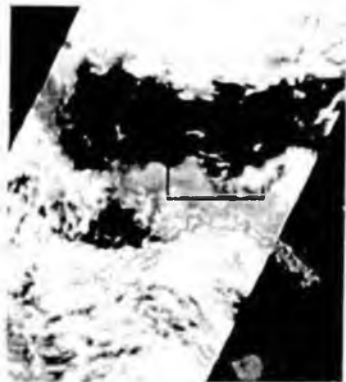
Office of Electronic Miniaturization
University of Alaska Fairbanks
www.siliconuaf.org
oem@uaf.edu

OFFICE 254 University Avenue, Suite 300 Fairbanks, AK 99709
ADDRESS P.O. Box 751090 Fairbanks, AK 99709
PHONE (907) 455-2000 FAX (907) 455-2000



Fairbanks

 GEOGRAPHIC INFORMATION NETWORK OF ALASKA
UNIVERSITY OF ALASKA



Alaska Wildfires

June 29, 2004

MODIS 250 meter resolution satellite composite

This image shows dozens of wildfires raging across Alaska's remote interior and filling the Tanana Valley with smoke. MODIS imagery is received and processed at the Geographic Information Network of Alaska (GINA). GINA works closely with the BLM Alaska Fire Service to help them detect and manage wildfires over Alaska's vast wilderness.

www.gina.alaska.edu

Place
Stamp
Here



GEOGRAPHIC INFORMATION NETWORK OF ALASKA

UNIVERSITY OF ALASKA

*Networking data to answer
scientific and societal questions
for Alaska and the Arctic.*



GEOGRAPHIC INFORMATION NETWORK OF ALASKA
UNIVERSITY OF ALASKA

Geophysical Institute, University of Alaska
P.O. Box 757320 Fairbanks, Alaska 99775-7320
www.gina.alaska.edu

GINA Partnerships:

Environmental Sciences, UAS - Carl Byers
(907-465-6616) jfcab@uas.alaska.edu

Geomatics Program, UAA - Cherie Northon
(907-786-6434) afcar@uaa.alaska.edu

Institute for Social and Economic Research, UAA
Steve Colt (907-786-1753) afsgc@uaa.alaska.edu

AK Natural Heritage Program, UAA - Keith
(907-257-2783) ankwb@uaa.alaska.edu

Water and Environmental Research Center, UAF
Matt Nolan (907-474-2467) matt.nolan@uaf.edu

Arctic Regional Supercomputer Facility, UAF
Greg Newby (907-474-7160) newby@arsc.edu

Cooperative Extension Service, UAF - Michelle Hebert
(907-474-2423) ffmah@uaf.edu

International Observatory of the North, UAF
Kevin Engle (907-474-5569) kengle@gina.alaska.edu

AMON Project, Institute of Marine Science, UAF
Dave Musgrave (907-474-7837) musgrave@ims.uaf.edu

AK Geobotany Center, Institute of Arctic Biology, UAF
Skip Walker (907-474-2460) slidaw@uaf.edu

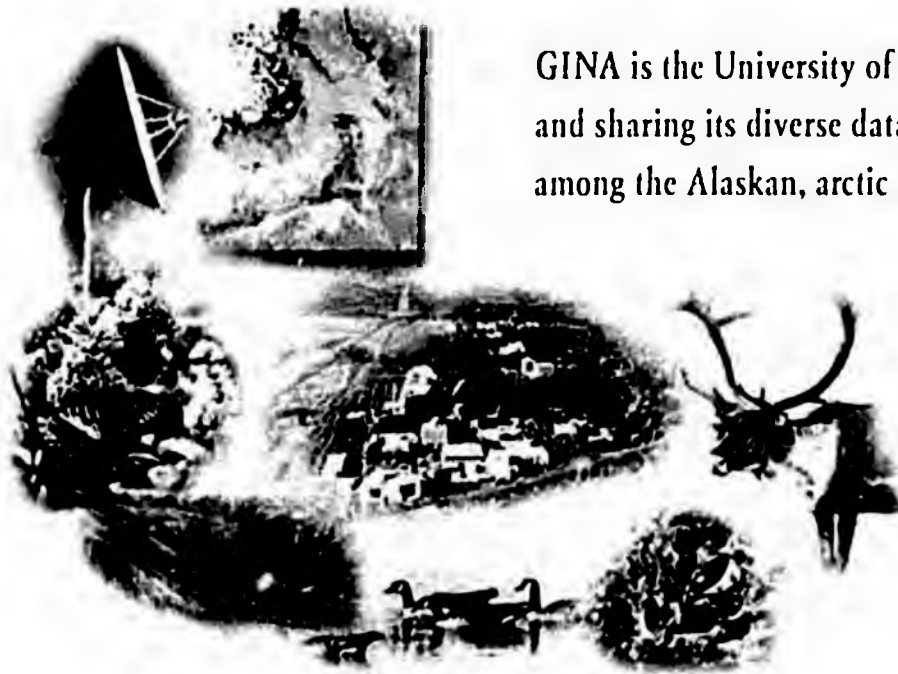


GEOGRAPHIC INFORMATION NETWORK OF ALASKA

UNIVERSITY OF ALASKA

GINA.....

- ... is a distributed data system for geospatial information.**
- ... maintains an enterprise-level geographic information system (GIS) with online archiving, internet mapping, and metadata services.**
- ... offers training and assistance in satellite image processing and GIS analysis and visualization.**
- ... provides custom processing, as well as server-side analysis and visualization tools.**
- ... unites and extends UA's GIS and remote sensing activities through the use of internationally adopted standards and a shared web portal.**



GINA is the University of Alaska's mechanism for organizing and sharing its diverse data and technological capabilities among the Alaskan, arctic and world communities.

Our goal is to promote collaboration and wide participation in discovering and sharing data and analysis capabilities.

GINA Contacts:

Dr. Buck Sharpton - GINA Director
907-474-6663
buck.sharpton@gina.alaska.edu

Tom Heinrichs
GINA Technical Services Manager
907-474-6897
tom.heinrichs@gina.alaska.edu



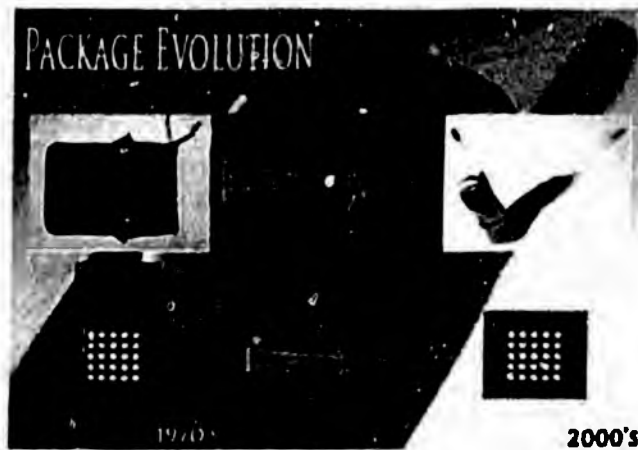
www.gina.alaska.edu

OEM's capabilities consist of designing and building systems and system components with reduced size & weight with electronic package miniaturization technologies, known as Chip Scale Packaging (CSP). This increases reliability and product life in most applications. OEM uses licensed technologies for packaging used in a broad range of electronic products such as wireless, computing, gaming, entertainment, medical and security applications.

OEM's current market niche is prototyping and small runs. Its capabilities are in the following CSP technologies:

μ BGA

The lead bonded μ BGA package features short signal paths for reduced parasitics, providing good electrical performance, thus resolving the reliability issues associated with the thermal expansion mismatch between the silicon die and the printed circuit board (PCB). This enables a smaller format with a highly reliable fine pitch ball grid array.



μ BGA-W

Like the lead-bonded version, the wire-bonded μ BGA incorporates compliance within the structure to ensure reliability. The wire-bonded technology offers design flexibility and can be used in Dynamic Random Access Memory (DRAM) applications as well as computer gaming and computational products.



μ BGA-F

The Face up μ BGA-F is oriented so that its contacts face away from and are wire bonded to the package substrate to electrically connect the chip to the packages solder connections. This technology is suitable for applications such as memory and Application Specific Integrated Circuits and can be used in products such as cell phones, PDAs and PCs.



μ Z-MCPs

A multi die packaging technology developed to address the trend towards miniaturization, increased functionality and reliability. Flexibility in solutions incorporate folding and/or stacking of die.



Image courtesy of Tysco, Inc



OFFICE OF ELECTRONIC
MINIATURIZATION
www.silicontundra.org

UAF Office of Electronic Miniaturization
PO Box 758090
Fairbanks AK 99775-8090

oom@uaf.edu
Phone: (907) 455-2000 • Fax (907) 455-2019

Pramod Karulkar—Director
P.Karulkar@uaf.edu
John Dickinson—Chief Financial Officer
John.Dickinson@alaska.edu

OFFICE OF ELECTRONIC
MINIATURIZATION
www.silicontundra.org



Working on the
last frontier...

... and on the Silicon Tundra

ABOUT OEM

UAF has restructured its Center for Nanosensor Technology, creating an Office of Electronics Miniaturization (OEM) to help differentiate between the faculty-focused research and the design and production capabilities that have been developed over the past four years with \$18.05 million in cooperative agreements with the Department of Defense's (DoD) Defense MicroElectronics Activity (DMEA). DMEA is supporting the development of a similar capability at North Dakota State University in Fargo.

The DMEA cooperative agreements have also allowed for the development of intellectual capability through its funding for research faculty and the acquisition/transfer of intellectual property in microelectronics processes.



CLEAN ROOM

The certified clean room houses state-of-the-art microelectronics packaging equipment and is located in UAF's Natural Sciences Facility.

CHIP SCALE PACKAGING

(CSP)

Developed in the early 1990s, Chip-scale packaging resulted in the significant reduction in size and weight and an increased reliability in cell phones and other consumer electronics primarily through the reduction or elimination of the horizontal and/or vertical space between chips. Through licensing agreements with Tessera, most major electronics manufacturers and resellers employ this technology, in the consumer electronics industry. Due to the length of DoD development cycles (typically 7-10 years), there is a lag before new technologies appear in fielded systems. DMEA sees the need for retrofits of low volume CSP into fielded system upgrades.

The Office of Electronic Miniaturization will provide the platform and core technologies for R&D and pilot production for:

- Leverage and enhance UAF's research, education, and training programs in advanced electronics,
 - Provide customers unique miniaturization services,
 - Lead to new intellectual property,
 - Create high value, knowledge based jobs in Alaska
 - Create spin-off companies, and
 - Provide new regional economic development opportunities
-

UAF believes that the ongoing development of this capability will allow it to support this niche market and advance the CSP process through technological innovation. As part of a diversification and risk-reduction strategy, UAF is also exploring industry partnerships with Crane Aerospace, Tessera, Inc and other potential partners.



OEM will provide the platform and core technologies for basic and applied research, deliver quality prototypes, create new intellectual property and job opportunities as well as provide new regional and statewide economic development.

FACULTY RESEARCH

During the past year several of the new hires within UAF's Center for Nanosensor Technology have branched out into various sensor system areas of study where DMEA sees a particular need. These young UAF faculty members have already begun winning independent funding from NIH, NSF and other sources.

MICROELECTRONICS IN ALASKA

The Office of Electronic Miniaturization is creating a Silicon Tundra mentality in Alaska. As microelectronics is beginning to have wings in Fairbanks— it will fly to new heights of innovation, inspiring the creation of new jobs and opportunities for Alaskans in the high-tech industry.



OEM is creating a Silicon Tundra mentality in Alaska. It is inspiring the creation of new jobs and projects in Fairbanks in the field of microelectronics.

Goals

The overall goals of CANHR are to increase the research capacities of the University of Alaska and local communities to address current Alaska Native health disparities. To meet these goals, it is essential that the University increase the breadth of its health and biomedical researchers. CANHR has hired researchers, data analysts, and staff to design and conduct community-based Alaska Native health studies. Studies at CANHR aim to understand disease distribution and health risks, and identify effective approaches to prevention and treatment of obesity, diabetes, and cardiovascular disease. To build the University's biomedical research infrastructure, CANHR has established five research support Cores: Administrative, Epidemiology and Bioinformatics, Genetics, Cultural-Behavioral, and Knowledge Application and Dissemination.

In addition to building expertise at the University level, an equally important goal of CANHR is to increase the health research capacity of the Yukon-Kuskokwim region. CANHR has worked with the Yukon-Kuskokwim Health Corporation (YKHC) to hire a research partner to coordinate information gathering and to assist with the on-going collaboration between CANHR, YKHC, and the regional communities. CANHR has also hired local Field Research Assistants in each participating village to help gather, utilize, and disseminate health information. The participatory research model used by CANHR, in partnership with YKHC and Alaska Native communities, will enhance the region's capacity to conduct important health research.

Center for Alaska Native Health Research
Institute of Arctic Biology
311 Irving I
Box 757000
University of Alaska Fairbanks
Fairbanks, AK 99775-7000
(907) 474-5528
FAX: (907) 474-5700
Email: ty@canhr.uaf.edu
Web Site: <http://www.alaska.edu/canhr>

Center for Alaska Native Health Research
Institute of Arctic Biology
311 Irving I
Box 757000
University of Alaska Fairbanks
Fairbanks, Alaska 99775-7000

CENTER for ALASKA NATIVE HEALTH RESEARCH



*A Program of the
University of Alaska*

Principal Investigator
Gerald V. Mohatt, EdD

Co-Principal Investigator
Bert Boyer, PhD

University of Alaska Fairbanks

*Supported by
NIH's National Center for Research Resources,
under the Centers of Biomedical Research
Excellence Program.*

UAF UNIVERSITY OF ALASKA
FAIRBANKS

UAF is an affirmative action/equal opportunity
employer and educational institution.

CANHR Mission

To build and increase research capacity to contribute to knowledge that will improve the health of Alaska Natives.



About CANHR

The National Institutes of Health, National Center for Research Resources, has awarded a five-year grant to the University of Alaska Fairbanks to establish the Center for Alaska Native Health Research (CANHR) to investigate weight, nutrition, and health in Alaska Natives. CANHR approaches this thematic focus from a genetic, dietary, and cultural-behavioral perspective. The funding comes through a program for Centers of Biomedical Research Excellence (COBRE). CANHR has been and is being developed in partnership with the Yukon-Kuskokwim Health Corporation (YKHC), and has offices at the University of Alaska Fairbanks (UAF) and the University of Alaska Anchorage (UAA).

Research Projects

CANHR currently supports three research projects focusing on obesity and its relationship to diabetes and cardiovascular disease. The project leaders are developing these projects jointly and in partnership with the Yukon-Kuskokwim Health Corporation.

1. Genetics of Obesity and Diabetes

Bert Boyer, PhD, Project Principal Investigator
Gabriela Antunez-de-Mayolo, PhD
Anna Goropashnaya, PhD
Erik Harrington, BS

This research will identify genetic and environmental risk factors that contribute to the development of obesity. In collaboration with other research scientists associated with the CANHR, interactions between genetic risk factors, diet, and behavior (lifestyles) will be examined to determine the conditions within a family or community that contribute to obesity. Current health status will be evaluated and family histories will be reviewed for information that may facilitate our understanding of genetic risk factors that lead to obesity, and how these risk factors may influence the prevalence of obesity in future generations. In addition, researchers will evaluate the role of body weight in the development of other health concerns in the community, such as heart disease or diabetes. This information will ultimately be used to develop health intervention programs designed to keep individuals at a healthy weight and to reduce their risk of other related diseases.

2. Diet and Nutrition Knowledge

Bret Luick, PhD, Project Principal Investigator
Andrea Bersamin, BS (UC Davis)

To understand nutritional factors that contribute to an individual's weight and overall health, it is necessary to know what a person eats. The

amounts and types of traditional and store-bought foods consumed and how individuals choose those foods are keys to understanding the benefits of a traditional diet. Nutritional information gathered from this project will assess characteristics important in the prevention or risk of obesity. In addition to studying energy intakes, researchers are also interested in energy expenditures. Physical activity levels will be monitored by asking participants to wear pedometers or activity meters. This project will also include the collection of basic physical measures such as height, weight, and percent body fat.

3. Cultural Understandings of Health

Cécile Lardon, PhD, Project Principal Investigator
Christopher Wolsko, PhD
Scarlett Hutchison, MA, RN

Before there were Western ways of understanding health and treatment, Yup'ik people had their own knowledge about what helped people to be healthy. This research project has worked with Yup'ik elders, health care providers, and other people to bring together knowledge of how culture and health are related. This knowledge has been used to develop a survey that can be used by researchers and health providers interested in learning about health from a cultural perspective. The project will also use this knowledge to develop health promotion programs in Yukon-Kuskokwim villages that are based on Yup'ik values and knowledge.





BOB HELLER

Looking to the Future

We have done a lot, but the work is never finished. Among other projects, over the next several years we will study what happens to Steller sea lions when their pollock prey is depleted. We will study how climate change affects salmon, to get information that fishery managers can use to predict salmon returns and determine how many salmon should be left to reproduce. We will also conduct research on new refrigerated seawater systems aboard fishing vessels, to improve the quality of salmon and other fish harvests that go to the processor.

Come to our Web site for a complete list of current research, scientific and educational books and videos, and much more information about Alaska's marine resources.

www.uaf.alaska/seagrant

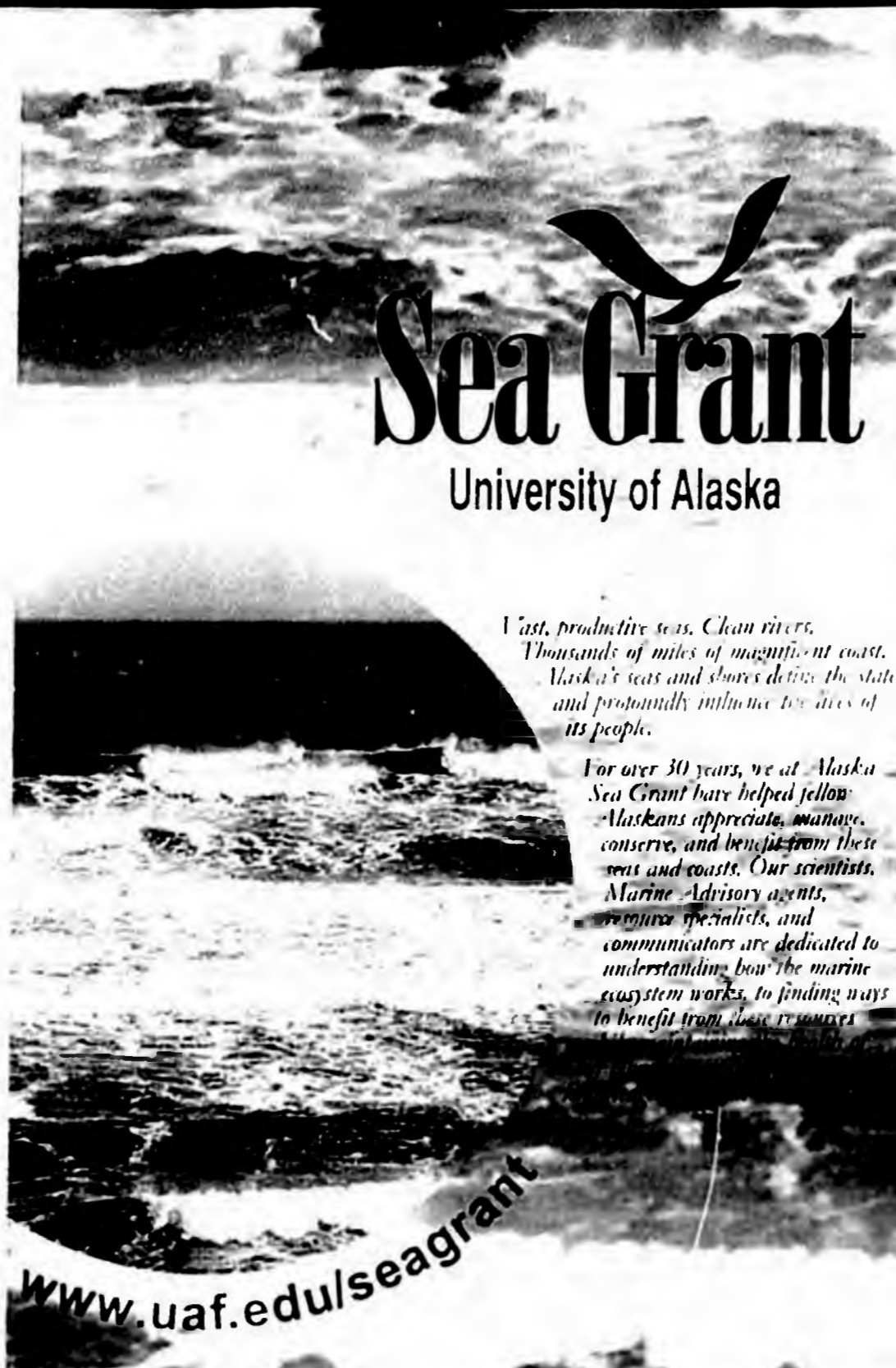


Alaska Sea Grant College Program
University of Alaska Fairbanks
P.O. Box 755040
Fairbanks, AK 99775-5040

Helping manage and conserve marine resources

Alaska Sea Grant scientists study the ecosystems critical to maintaining robust populations of living marine resources. To help fishery managers make good decisions, our researchers develop innovative fish surveys that improve fish counting and abundance predictions. Our research also develops new ways to evaluate differences in salmon from different locations, delves into the life cycles of little-understood fish and shellfish, and goes back in history to shed light on what fisheries were like under different environmental conditions.

Our Powell-Wakefield Fisheries symposia provide a forum for scientists to give valuable information to policy makers, educators, resource managers, and the news and seafood trade media.



Sea Grant

University of Alaska

*Vast, productive seas. Clean rivers.
Thousands of miles of magnificent coast.
Alaska's seas and shores define the state
and profoundly influence the lives of
its people.*

*For over 30 years, we at Alaska
Sea Grant have helped fellow
Alaskans appreciate, manage,
conserve, and benefit from these
seas and coasts. Our scientists,
Marine Advisory agents,
resource specialists, and
communicators are dedicated to
understanding how the marine
ecosystem works, to finding ways
to benefit from these resources.*

www.uaf.edu/seagrant



MARK FENNINGTON

Research for tomorrow's needs

Alaska's marine and coastal resources fuel much of the state's economy. Our nearshore and offshore waters produce about a half of the nation's seafood harvest—that's \$2 billion dollars every year for the state and national economy. Finding ways to wisely use and conserve the state's fishery resources is Alaska Sea Grant's number-one priority.

Grooming the next generation of scientists

Through our last 30 years, we've helped more than 140 graduate students earn degrees and go on to careers in marine science, resource management, the seafood industry, tourism, and other fields.

Our international scientific conferences give our new scientists a chance to mingle with veteran researchers and share techniques, findings, and new ideas.



Diversifying the seafood economy

Alaska will produce 14 million of salmon, pollock, crabs, halibut, and more than 50 other commercially important species. Alaska Sea Grant helps the seafood industry increase the value of its harvest by reducing waste and helping processors create new products, from restaurant entrees to snack foods. New products and processing techniques also create new jobs and businesses.

Oyster and clam aquaculture diversify the state's marine scene. Alaska Sea Grant is in the thick of helping build this fledgling industry. Thanks to technologies brought to Alaska by the Sea Grant Marine Advisory Program, farmers can grow oysters 40% faster than before, and now they can grow oysters right here in Alaska. These breakthroughs finally make oyster culture a viable enterprise in Alaska, and entrepreneurs are pumping money into the business.



Informing the public

Reliable information makes for good decision making by policy makers, resource managers, and resource users. Delivering useful information to Alaskans and other people of all ages, in all walks of life, is central to Alaska Sea Grant's mission.

Alaska Sea Grant's award-winning information program—which includes a Web site, publications, videos, weekly radio show, and media outreach— informs policy makers and private citizens, visitors, and others around the world about Alaska's coastal and marine resources.

Teachers and the students who will be the decision makers of tomorrow are a special audience for Alaska Sea Grant. Our field guides, curriculum guides, classroom activity material, Web site, and classroom visits help educators convey knowledge and stewardship concepts. This helps young people become well-informed citizens who can make good decisions on how to best use and conserve Alaska's marine and coastal resources.

Following the money

Alaska Sea Grant economists study the impact of fishery management decisions, the economic value of industries such as sport fishing, and the costs and benefits of industry programs such as the state's salmon hatchery system. These studies are crucial to helping lawmakers, policy makers, regulators, and resource managers make decisions.



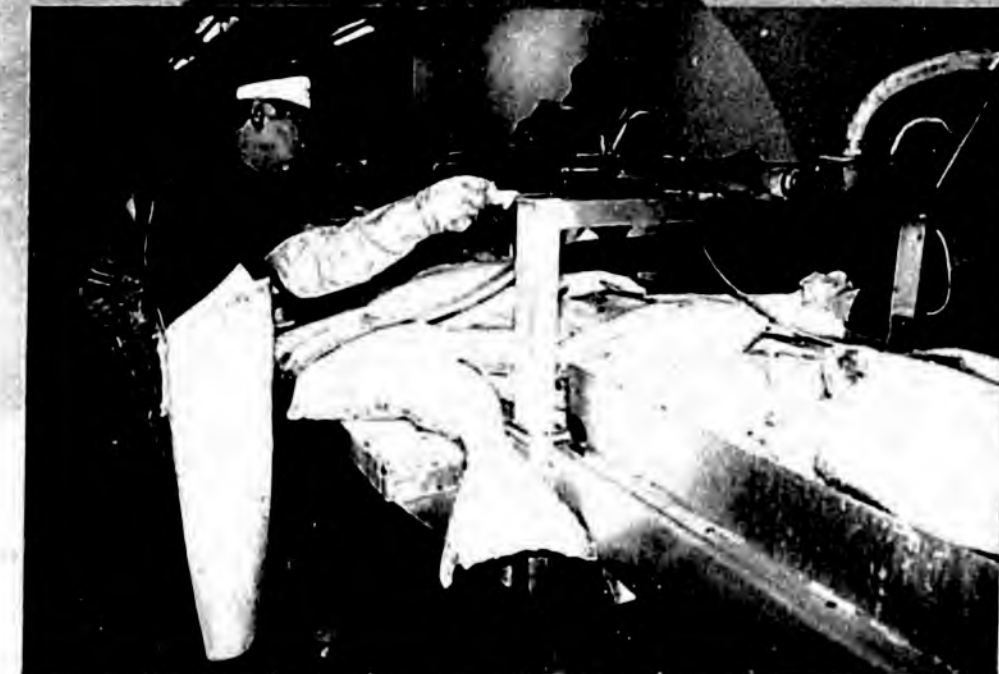
Protecting public health

Alaska Sea Grant scientists unraveled the genetic and molecular causes of paralytic shellfish poisoning (PSP), caused by a toxin that sickens and sometimes kills people who eat tainted crabs, clams, and other shellfish.

Testing shellfish and other invertebrates for PSP costs harvesters thousands of dollars and retards development of the dive harvest industry. Alaska Sea Grant personnel collaborate in studies to find quick and inexpensive new methods to detect PSP in shellfish. And through publications and our Web site, we distribute potentially life-saving information about PSP.

Tsunamis are a constant public safety threat in Alaska, the nation's most seismically active state. Our research and Web site provide information to help people prepare for and respond to tsunamis and earthquakes.

Alaska's climate can be harsh and unforgiving. Marine Advisory agents produce publications and videos on marine and outdoor safety and survival, and instruct safety trainers how to teach marine emergency prevention and survival.



A helping hand in your hometown

Assistance from Alaska Sea Grant is never far away. Our cadre of Marine Advisory agents and specialists live among the people they serve. For example, while one specialist is giving a teacher workshop on salmon habitat inventory, another agent is showing fishermen how to reduce contacts with marine mammals. At the same time, other agents are helping communities prevent oil spills, training seafood processors to meet federal food safety requirements, showing fishermen how to maintain the highest seafood quality on their vessels, teaching fishermen to survive accidents at sea, and helping charterboat operators understand changes in regulations.

To locate the agent or specialist nearest you, visit www.ut.edu/seagrant where.html or call (907) 274-9691.



© Staff Photo

P.O. Box 755000
Fairbanks, AK 99775

907-450-8019 (Voice)
907-450-8002 (Fax)
craig.dorman@alaska.edu

Craig Dorman

Vice President for Research

Dr. Craig E. Dorman joined the University of Alaska as Vice President for Research in March 2002. Prior to joining the University of Alaska, Dr. Dorman was a senior scientist at the Applied Research Laboratory of Pennsylvania State University. From Penn State, he was detailed on an Intergovernmental Personnel Act assignment to the Office of Naval Research, where he served first as Chief Scientist and Technical Director of the International Field Office, headquartered in London, and then as Special Assistant and Chief Scientist at ONR Headquarters in Arlington, Virginia. Dr. Dorman is also a director of Maritrans, Inc., Tampa, Florida; and a board member of several non-profit educational and research institutions.

Dr. Dorman attended Dartmouth College on a Naval ROTC scholarship, receiving his BA in Geography (summa cum laude; Senior Fellow) and commission as Ensign, USN, in 1962. His naval career comprised service with the Underwater Demolition and SEAL Teams, and as a Program Manager. While in the Navy, he received his MS and Ph.D. in Oceanography, respectively at the Naval Postgraduate School (1969) and the Massachusetts Institute of Technology-Woods Hole Oceanographic Institution (MIT/WHOI) joint program (1972). He retired from the Navy in the rank of Rear Admiral in February 1989, to accept the position of Director of Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Following his tour as director, Dr. Dorman spent two years as deputy director for Laboratory Management, Defense Research and Engineering, before joining Penn State.

THE ECONOMICS OF UNIVERSITY RESEARCH

Scott Goldsmith and Pam Cravez

Prepared for
Understanding Alaska Program
at
Institute of Social and Economic Research
University of Alaska Anchorage

June 1, 2004

Understanding Alaska is a series of special economic studies, funded by the
University of Alaska Foundation



1. RESEARCH ACTIVITY IN THE UNITED STATES AND ALASKA

United States

Research and Development (R&D) is a \$284 billion business in the United States, accounting for 2.5 percent of the Gross Product.¹ The output of this spending is new knowledge—advances in basic understanding of the world and technological and other improvements in the way we produce goods and services. The increases in productivity that come from research account for a large share of the overall growth in the economy. Capital investment and increases in the quantity and quality of the work force account for the rest.

California leads the nation in research spending with \$48 billion followed by Michigan, New York, Texas, and Massachusetts (Table 1). However R&D accounts for a larger share of the economy in several smaller states, as measured by the ratio of spending to Gross Product, including New Mexico, Rhode Island, and Maryland.

Table 1. Top Research and Development States in 1999

	Share Amount (Billion \$)		Share of GSP (Percent)
1 California	\$48.0	New Mexico	6.4
2 Michigan	\$18.8	Michigan	6.1
3 New York	\$14.1	Rhode Is	5.1
4 Texas	\$12.4	Mass	4.6
5 Mass	\$12.2	Maryland	4.6

Source: National Science Foundation, *Science Resource Statistics*, June 2002

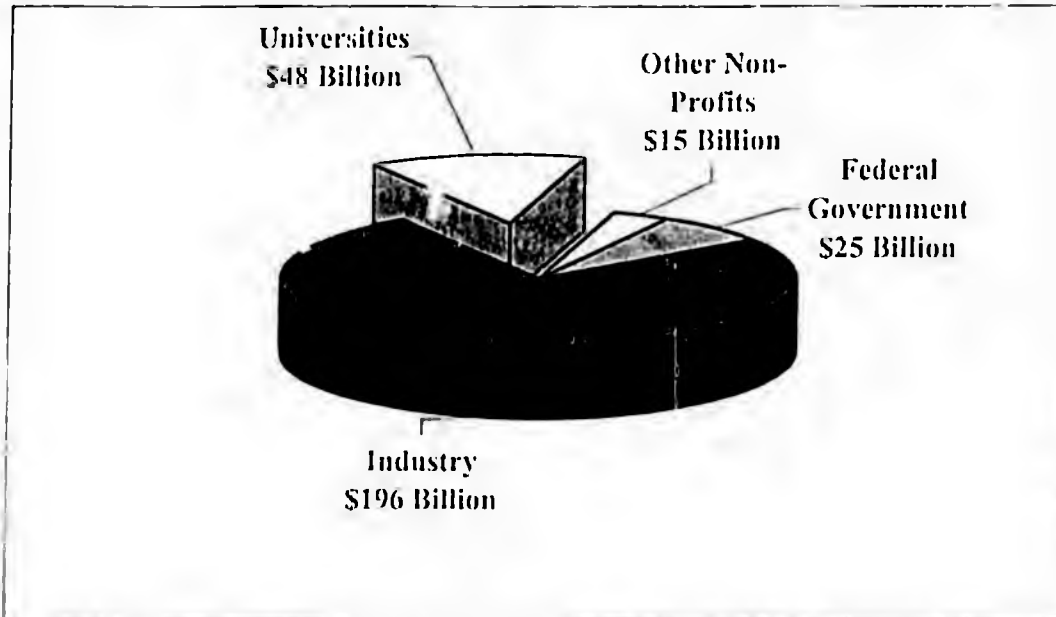
Most (69 percent as measured by dollars spent) research and development is done directly by private industry (Figure 1). About 14 percent takes place within the federal government and non-profits. Universities and Colleges account for the remaining 17 percent—about \$48 billion in 2003 (including Federally Funded Research Development Centers administered by Universities).

While Industry is also the source of most funding for research and development, the federal government provided 30 percent (Figure 2). Universities contributed only 4 percent and other non-profits the remaining 3 percent.

Basic research accounted for 19 percent of total spending, but 55 percent was conducted by universities with 61 percent of the funds provided by the federal government. In contrast most applied research, which accounted for 24 percent of the total was performed by private industry. Development expenditures, 57 percent of the total, were primarily spent by private industry.

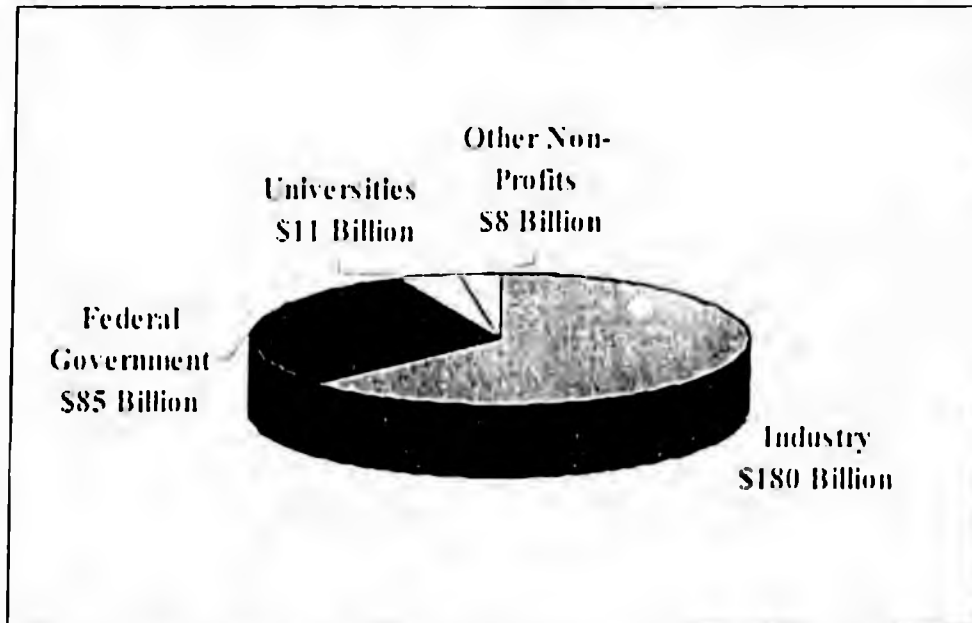
¹ Data for 2003 from National Science Foundation, *Science Resources Statistics*

Figure 1. National Expenditures for Research and Development, 2003



Source: National Science Foundation, National Patterns of Research and Development Resources, 2003

Figure 2. Sources for Research and Development Funding, 2003



Source: National Science Foundation, National Patterns of Research and Development Resources, 2003

Alaska

Alaska ranks near the bottom among the states in the total amount of R&D activity. Most research in Alaska is conducted by the University of Alaska and directly by the federal government, and very little is done by industry. Alaska ranks 47th among the states in total research, 50th in industry research, and 42nd in University research (Table 2).

Alaska's performance is better in per capita terms, but spending on R&D per person is only half the U.S. average. Only federal R&D is above the per capita U.S. average. In terms of the "intensity" of R&D spending (R&D/Gross Product), Alaska is ranked number 41. About 1 percent of Alaska Gross State Product is devoted to R&D spending.

The small amount of private industry spending on R&D in Alaska is due to several factors. The first is the absence of manufacturing industry within the state, except for seafood processing. Second is the dominance of the public sector within the economy both in terms of jobs and resource ownership. Third is the absence of Alaska based resource businesses large enough to financially support investments in R&D. Finally Alaska has not been an attractive location for private research facilities due to cost and distance from clients and customers.

Table 2. Alaska Research and Development Profile

Indicator	Rank	Amt	% U.S. Average	Date
Total R&D (mill \$)	47	\$196		2000
Industry R&D (mill \$)	50	\$9		2000
Academic R&D (mill \$)	42	\$116		2001
Population (% US)	48	0.22%		2002
Total R&D (\$ per capita)	32	\$467	49%	2001
R&D Intensity (R&D/GSP)	41	1.04%	38%	2001
Federal R&D (\$ per capita)	13	\$335	116%	2001
Fed R&D / Total Fed \$	22	3.30%	72%	2001
SBIR Awards	51	9		97 to 01
Patents	51	50		2001

Source: National Science Foundation, Science and Engineering State Profiles, 2000-2001

Note: SBIR is the Small Business Innovation Research Program of the Small Business Administration.

2. UNIVERSITY RESEARCH IN THE UNITED STATES AND ALASKA

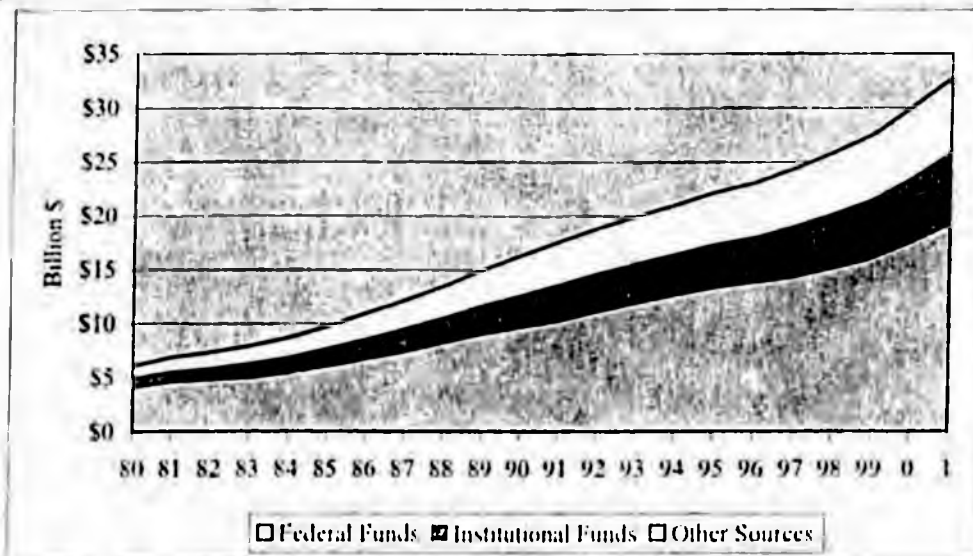
United States

University R&D is a growth industry. Since 1980 University R&D spending has increased at an average rate of 7.6 percent a year, compared to a 6.3 percent growth rate for the economy in total. Furthermore, University R & D spending has increased in every year while the overall economy has gone through two recessions during that period (Figure 3).

The federal government supplies the majority of funding for University R & D (59 percent in 2001). This funding source continues to grow, but its share of the total is falling as other sources grow in importance. Institutional funds supplied directly by the Universities account for 20 percent of total funding and industry, state and local government, and non-profit providers account for the remainder.

Institutional support for University R&D has been increasing as a share. In the early 1980s Universities spent 16 cents of their own money for every \$1 of research funding attracted from outside academia (from federal, private, and non-profit sources). By 2000 institutions committed on average 25 cents for every \$1 attracted from outside.

Figure 3. University Research and Development by Funding Source



Source: National Science Foundation

The majority of University research (75 percent) is basic rather than applied.

The largest research University in the nation, Johns Hopkins, spent \$1 billion on R&D in 2002 (Table 3). The next largest research Universities—each with more than half a billion in research spending—were public institutions: UCLA, University of Wisconsin,

University of Michigan, and University of Washington. The University of Alaska at Fairbanks was ranked 95th with spending of \$110 million.

Table 3. University R&D Spending: 2002

Rank	Institution	Budget (Million \$)
1	Johns Hopkins	\$999
2	UCLA	\$693
3	U of Wisconsin	\$604
4	U of Michigan	\$601
5	U of Washington	\$590
95	U of Alaska Fairbanks	\$110

Source: National Science Foundation, Science Resources Statistics

Alaska

Total R&D revenue generated at the University of Alaska in 2003 was \$133 million, primarily at Fairbanks and its associated campuses (Table 4).² However Anchorage and Juneau were also sites of research activity. The research budget not only funded the activities directly associated with research (\$121.6 million), but also contributed \$11.5 million to the general support of the University budget through payments to other departments within the University (redistributed indirect cost recovery (ICR)).

Table 4. University of Alaska Research Revenue in 2003

	(Thousand \$)
UA Anchorage	\$11,529
UA Fairbanks	\$108,948
UA Southeast	\$1,110
UA Total	\$121,587
Plus: Redistributed Indirect Cost Recovery	\$11,496
TOTAL	\$133,083

Source: University of Alaska, Statewide Budget and Institutional Research

Growth in University R&D in Alaska has been strong and consistent. It has increased from \$77 million in FY98 to \$133 million in FY03 — an increase of 73 percent in 5 years (Table 5). This growth has consistently exceeded the national average.

² The University defines research to include program evaluation and training, both of which contribute to productivity growth in organizational structure and the labor force.

Table 5. Growth in University of Alaska Research Revenue

(In Thousands of Dollars) Growth Rate

FY98	\$77,204	
FY99	\$81,458	5.5%
FY00	\$90,664	11.3%
FY01	\$109,407	20.7%
FY02	\$119,753	9.5%
FY03	\$133,083	11.1%

Source: University of Alaska Statewide Budget and Institutional Research

A small share of funds for research comes from the state General Fund as part of the University of Alaska appropriation, but the majority comes from other sources (Table 6). In 2003 there was \$8 of total research spending for each \$1 of State General Fund support for research (Total R&D / General Fund). This "General Fund Multiplier" has been growing over time from a level of 5.1 in 1998.

Table 6. University of Alaska Research Revenue: Sources of Funds

(in Thousands of Dollars)

	State General Fund	All Other	Total	General Fund Multiplier (Ratio: Total / General Fund)
FY98	\$15,058	\$62,146	\$77,204	5.1
FY99	\$12,956	\$68,502	\$81,458	6.3
FY00	\$15,392	\$75,272	\$90,664	5.9
FY01	\$16,313	\$92,890	\$109,407	6.7
FY02	\$16,322	\$103,431	\$119,753	7.3
FY03	\$16,618	\$116,465	\$133,083	8.0

Source: University of Alaska Statewide Budget and Institutional Research

Most outside funding for University research comes from the federal government (Table 7). In 2003 University research expenditures totaled \$109.9 million. \$98.8 million came from the federal government--\$80.6 million directly and \$18.1 million indirectly through state agencies and other sources, mostly private. Private sources directly accounted for \$9.2 million (plus \$15.7 million that originated with the federal government but was channeled through private sources). The state accounted directly for \$2 million, plus \$2.4 million of federal funding channeled through government.

¹ Accounting definitional differences result in total expenditures being slightly less than revenues.

Table 7. University of Alaska Research Expenditures by Funding Source for FY2003
(In Thousands of Dollars)

FUNDING SOURCE	Direct			Federal Indirect Through		TOTAL
	Federal Agency	State Agency	Other Sources	State Agency	Private, Local, Other	
GRAND TOTAL	\$80,650.0	\$2,011.2	\$9,200.2	\$2,423.6	\$15,685.7	\$109,970.7
FEDERAL	\$80,650.0			\$2,423.6	\$15,685.7	\$98,759.3
STATE		\$2,011.2				\$2,011.2
PRIVATE, LOCAL, OTHER			\$9,200.2			\$9,200.2

Note: These numbers represent research expenditures (including ICR) and not the awarded amount. Excludes state General Fund support. Keep in mind that many grants are multi-year awards and so are the expenditures associated with them.

Source: University of Alaska, Statewide Budget and Institutional Research.

Among federal agencies the largest contributors to University research in 2003 were the National Science Foundation, NASA, the Department of Defense, and NOAA (Table 8).

Table 8. Largest Federal Funding Sources for University of Alaska R&D in 2003

	(Thousand \$)
National Science Foundation	\$24,685.3
NASA	\$15,595.4
Dept of Defense	\$11,528.2
NOAA, Dept of Commerce	\$9,893.5
National Institutes of Health, Dept HSS	\$5,842.0
US Geological Survey, Dept of Interior	\$4,119.6
Cooperative State Research Service, Dept of Agriculture	\$3,726.4
Subtotal	\$75,390.5
All Other Federal	\$23,368.8
TOTAL	\$98,759.3

Source: University of Alaska Statewide Budget and Institutional Research

Private, local and other sources directly contributed \$9.2 million as well as \$15.7 million through federal agencies

Corporations and other universities are the largest non-government sources of funding, although a majority of the funds they provide originate with the federal government (Table 9).

Table 9. Largest Non-Government Funding Sources for R&D in 2003

	(Thousand \$)
Other Corporations	\$7,659.5
Other Universities	\$5,666.5
University Foundations	\$2,343.2
Other Nonprofit Organizations	\$1,664.8
International Corporations	\$40.9
Native Corporations	\$2.4
Other	\$7,508.5
TOTAL	\$24,885.8

Source: University of Alaska Statewide Budget and Institutional Research

The state contributed \$4.4 million for specific studies over and above the General Fund appropriation. The largest state agency contributors to University research were the Departments of Health and Social Services and Fish and Game. Some of this funding also originated with the federal government.

About 2/3 of University research takes place through the organized institutes and centers. Faculty and staff within the different schools and departments account for the remainder (Table 10). Most research funding is obtained through the competitive process, although some is earmarked for specific purposes, and thus obtained non-competitively.

Table 10. New Research Awards to University of Alaska in 2003 by Type

	Organized Research		Other Sponsored Activities		Total FY New Awards	
	# of Grants	Grant Amt (\$ 000)	# of Grants	Grant Amt (\$ 000)	# of Grants	Grant Amt (\$ 000)
Total 2003	322	\$66,935.0	323	\$39,956.4	645	\$106,891.4
Competitive	212	\$53,096.8	174	\$22,299.2	386	\$75,396.0
Non-Competitive	88	\$11,279.1	104	\$11,170.2	192	\$22,449.3
Other	22	\$2,559.0	45	\$6,487.0	67	\$9,046.1

Source: University of Alaska Statewide Budget and Institutional Research

University of Alaska research is concentrated in several areas, as can be seen by its national rank for expenditures by discipline. The University of Alaska Fairbanks is 12th in the nation in the field of Mathematics and Computer Science, largely due to the Arctic Region Supercomputing Center (Table 11). It also ranks high in spending for research in the field of Atmospheric, Earth, and Oceanography Science. In contrast it ranks low in Life Science research.

Table 11. University of Alaska Fairbanks R & D Profile for 2001

Indicator	Rank	Amount (Million \$)
Total R&D	95	\$110.0
Math and Computer Science	12	\$16.3
Atmospheric, Earth, Oceanography	16	\$30.5
Physical	54	\$13.6
Life Science	150	\$16.6
Federal Funding	105	\$55.3
Total R&D --All UA Campuses	68	\$115.0

Source: National Science Foundation

In 2003 new awards totaling \$106.9 million were concentrated in Science, Mathematics & Technology and in Education (Table 12).

Table 12. Number and Value of New Research Awards in 2003
(in Thousands of Dollars)

Total	Organized Research		Other Sponsored Activities		Total	
	#	Value	#	Value	#	Value
Total	322	\$66,935.0	323	\$39,956.4	645	\$106,891.4
Science, Math & Technology	191	\$55,503.1	35	\$2,238.0	226	\$57,741.1
Education	7	\$380.1	87	\$14,563.6	94	\$14,943.7
Social Sciences	38	\$3,401.0	46	\$6,423.2	84	\$9,824.3
Other	17	\$1,822.0	49	\$6,645.2	66	\$8,467.2
Health & Medicine	22	\$2,781.6	22	\$2,725.9	44	\$5,507.5
Cooperative Extension	3	\$74.9	22	\$2,181.2	25	\$2,256.1
Business, Management & Commerce	5	\$263.6	21	\$1,854.7	26	\$2,118.3
Agriculture & Food Sciences	7	\$260.4	5	\$1,441.5	12	\$1,701.9
Inter-Disciplinary	10	\$768.0	13	\$726.2	23	\$1,494.2
EPSCoR Research Focus Area	8	\$1,293.1			8	\$1,293.1
Engineering	9	\$188.8	3	\$555.8	12	\$744.7
Arts and Humanities	2	\$132.7	20	\$601.2	22	\$734.0
Energy	3	\$65.4			3	\$65.4

Source: University of Alaska Statewide Budget and Institutional Research

Research spending is concentrated in a handful of institutes on the campus at Fairbanks, with lesser amounts broadly distributed across many organizations on all campuses of the University (Table 13).

Table 13. Research Revenue by Campus and Program in 2003
(in Thousands of Dollars)

TOTAL	\$133,082.6
UA Fairbanks	\$108,948.0
Geophysical Institute	\$32,013.4
School of Fisheries and Ocean Sciences	\$20,602.3
Institute of Arctic Biology	\$13,469.4
Arctic Region Super Computer	\$9,500.7
International Arctic Research Center	\$9,397.7
School of Natural Resources and Agric Sciences	\$7,113.5
Institute of Northern Engineering	\$4,538.8
College of Science, Engineering, and Mathematics	\$4,298.1
Mineral Industries Research Laboratory	\$1,494.8
Museum	\$845.5
Petroleum Development Lab	\$813.3
Alaska Native Language Center	\$165.0
School of Management	\$73.3
Center for Cross Cultural Studies	\$0.4
College of Rural Alaska	
Other	\$4,621.8
UA Anchorage	\$11,529.0
Institute of Social & Economic Research	\$3,835.2
Environment and Natural Resources Institute	\$1,620.5
Institute for Circumpolar Health	\$1,469.7
Psychology	\$785.8
School of Engineering	\$630.4
Alaska Natural Heritage	\$624.2
Justice Center	\$532.6
Center for Alcohol and Addiction Studies	\$312.2
Community & Technical College	\$136.4
Biomedical Program	\$74.2
Other	\$1,507.9
UA Southeast	\$1,109.5
UA Total	\$121,586.5
Plus: Reallocated Indirect Cost Recovery	\$11,496.0

Source: University of Alaska Statewide Budget and Institutional Research

3. UNIVERSITY RESEARCH AS AN ECONOMIC ENTERPRISE

Economic Impact

The overwhelming majority of money funding University research in Alaska comes from sources outside the state. For this reason University research can be viewed as an economic enterprise similar to the metal mining industry, the seafood industry, the timber industry, or the oil and gas industry. Each sells its output to customers outside the state and each brings new dollars into the state in the process.

These new dollars lead to expansion of the economy of Alaska. They pay the salaries of Alaska workers and support sales to Alaska businesses. Their economic impact extends beyond the direct effect of paying for the cost of research. Through the mechanism of the economic multiplier, employment, payroll, and sales are generated in the private economy throughout the state.

Over half of the University research budget in 2003⁴ was paid out in wages and benefits to 1,228 full and part time University employees (Table 14). The next largest budget item was contracted services, comprising a diverse array of services from computer and aircraft maintenance, to facilities rental, to freight services. Capital equipment purchase was largely computer related and miscellaneous research equipment, but also included less esoteric items such as safety and transportation equipment. Commodity purchases included things like field camp supplies, food for animals, and fuel for planes and boats. Travel included both instate and out-of-state travel. Small amounts were budgeted for student aid and miscellaneous expenses.

Table 14. UNIVERSITY RESEARCH AS AN
ECONOMIC ENTERPRISE

DIRECT ECONOMIC IMPACT IN 2003 (Million \$)

TOTAL UA RESEARCH	\$121.6
Wages	45.2
Benefits	17.5
Contracted Services	33.6
Capital Equipment	8.4
Commodities	8.1
Travel	5.7
Student Aid	2.0
Miscellaneous	1.0

Source: University of Alaska Statewide Budget and Institutional Research

⁴ This excludes the \$11.5 million of indirect cost recovery that provided general University support

Although some of these purchases, like computer and other research equipment, were made outside the state and had little impact on the Alaska economy, most of the research budget does result in either wages to Alaska workers or purchases from Alaska businesses. Because of this, the total impact on Alaska's economy is large relative to the total amount spent on University research.

Adding to the direct impact of University research on the economy is the spending associated with visiting scholars who travel to Alaska to conduct their own research activities funded through their home academic institutions in other states.⁵ The economic impact of these visitors is exactly analogous to that of tourists visiting Alaska from other parts of the world, bringing outside money into the state and spending it to the benefit of the Alaska economy.

The total economic impact of University Research can be measured in jobs created, payroll produced, and total business sales generated within the state (Table 15). More than 2,300 jobs can be traced back to University research spending. About 1,200 are within the University—faculty, staff, student assistants, and others—and nearly 1,100 are in a large variety of businesses in the private economy scattered throughout the state— from construction, to transportation and trade, to services.

The total payroll associated with these jobs is more than \$80 million, with a little over half going to University employees and the rest to workers in the private economy.

We estimate direct in-state procurement of \$42 million associated with the University research budget. As indicated, this includes purchases of a wide array of services, and commodities as well as some construction and transportation services. Employees spending their paychecks and companies (who do business with the University) making local purchases from other businesses generated an estimated \$65 million more in business sales within Alaska.

⁵ For example Toolik Field Station every year hosts large numbers of non-resident researchers during the summer field season.

⁶ University and other research facilities in Alaska also attract other visitors to the state, and help to enhance the quality of the experience of visitors. Examples include the Sealife Center in Seward and the Museum at the University in Fairbanks.

**Table 15. UNIVERSITY RESEARCH AS AN
ECONOMIC ENTERPRISE
TOTAL ECONOMIC IMPACT IN 2003**

JOBS	
Total	2,310
University	1,228
Private	1,082
PAYROLL (Million \$)	
Total	\$80.3
University	\$45.2
Private	\$35.0
PRIVATE BUSINESS SALES (Million \$)	
Total	\$106.8
Direct Procurement	\$42
Other Sales	\$64.8

Source: ISER Calculations.

Industry Characteristics

Viewed as an economic enterprise, University research has a number of attractive features including:

- **Labor Intensive**—Over 1/3 of the revenues from this industry (37 percent) went directly into payroll.
- **High Wage**—Although faculty make up only a portion of jobs in this industry, the average wage is higher than the economy-wide average.
- **Quality Jobs**—Most jobs in the industry come with a full benefits package that adds considerable value over and above the wage.
- **Year Round Employment**—Although some jobs are seasonal, most are not, and tend to offset the summer seasonal decline in teaching activity at the University.
- **Diverse Job Mix**—The variety of research activities generates a diverse job mix in the private economy dependent on research spending.
- **High Resident Job Share**—Residents hold most of the jobs in University research.
- **Stable**—The level of spending on University research nationally has increased each year for at least the last 20 years.

- **Growing**—Growth in spending on University research has outpaced growth in the overall US economy.
- **Footloose**—Most research can be conducted wherever there is a decent laboratory with support for the scientists. It need not be located in proximity to resource deposits, as is the case for our natural resource industries, or close to markets, as is the case for most services.
- **Environmentally Benign**—University research is a clean industry with minimal impacts on the quality of the environment.
- **Low Burden on Government**—Government regulation and oversight of the industry is not required.
- **Non-Competitive with Other Industry**—Unlike oil and gas, mining and our other natural resource industries, University research does not generate conflicts over appropriate and conflicting uses of the environment and natural resources.
- **Stable Potential Tax Base**—Although it does not directly create a product that is taxable, the large payroll and in-state procurement per dollar of spending on research create potential tax bases of personal and business income.
- **Backward Linkages**—Unlike some industries (like oil and gas and rural tourism) that are “enclaves” physically located in Alaska but not linked to the rest of the economy through purchases of local inputs, the large procurement budget and urban location for most research activities result in strong backward linkages that foster economic activity in support industries.
- **Forward Linkages**—There are no direct forward linkages in the form of sales to other sectors of the economy, but this is a characteristic of most of our resource industries as well.
- **Value Added “Spin-offs”**—The objective of private businesses is profit and they create spin-offs that benefit other industries only indirectly or by chance. In contrast, the objective of University research is new knowledge that can be applied to increase productivity in business and government. New knowledge can also be applied to the non-profit sector to improve economic and social well-being. These value added spin-offs are the most unique feature of University research, an added bonus that other industries do not provide.

Benefit to Cost Comparison

The State General Fund appropriation to the University for general support of research in 2003 was \$16.6 million, about 8 percent of the total University general fund budget of

\$211 million. Total University research expenditures in that year were \$121.6 million, producing 2,310 jobs and \$80.3 million in payroll.⁷

If we think of the State General Fund appropriation for research as "seed money", then we can calculate the return to the economy from that expenditure as the jobs and income created. Specifically the "Bang Per Buck" for each \$1 million of General Fund appropriation for research was 139 jobs and \$4.8 million in payroll within the state.

There are indirect benefits to the University from research activities as well. World-class research⁸ adds prestige to the University which in turn leads to a greater demand from students and an increased ability to attract quality faculty.

The General Fund appropriation to University research also generates value added "spillovers" that we will address in more detail below.

Comparisons to Other Selected Alaska Private Sector Basic Industries

Each Alaska basic sector industry has different features and characteristics. In this section we review some features of selected industries simply to provide some comparisons with University Research as an economic enterprise.

Each of these industries receives support from state government, just as does University Research, through a variety of mechanisms. These include operating expenditures for management, tax expenditures, capital expenditures, and loans. We have not attempted to quantify the support provided each industry to make any comparisons with our "Bang per Buck" calculation for University Research as such data is not readily available for most industries.

Metal Mining. The value of metal minerals production in Alaska, primarily zinc, gold, and silver, was \$823 million in 2002, generating a payroll of \$77 million in the industry, and annual average employment of 1,153 in the mining sector. Mining is very capital intensive (as reflected in the low ratio of payroll to value of production), high wage, resource dependent (and subject to market price fluctuations and location dependent), and environmentally sensitive. It produced \$2.5 million in revenues to the state in 2002 as well as additional revenues to local governments and resident resource owners.⁹

⁷ Not counting the impact of the \$11.5 million of reallocated indirect cost recovery.

⁸ For example the research of Brian Barnes of the Institute of Arctic Biology has been highlighted on the cover of Science magazine. The first Rasmuson Chair in Economics was held by Dr. Vernon Smith, a Nobel Prize Laureate.

⁹ Alaska's Mineral Industry 2002, Division of Geological and Geophysical Surveys, and Alaska Department of Labor.

A legislative research study done in the 1990's calculated that the revenues to the state generated by mining at that time (\$4 million) were exceeded by the direct government cost to manage the resource (\$8 million).¹⁰

Tourism. Non-resident vacationers spent \$811 million in Alaska in 1998, directly generating 12,835 wage and salary jobs and 3,584 proprietor jobs for a total of 16,419 jobs. Wages were \$249 million and proprietor income was an additional \$65 million.¹¹ These jobs were concentrated in the lodging, restaurant, retail, and transportation services sectors of the economy. Tourism related employment tends to be highly seasonal with a large non-resident share. Tourism is a rapidly expanding industry and the growth potential is significant for Alaska.

There has not been a comprehensive analysis of either the public expenditures or public revenues associated with the tourism industry in Alaska. However, continued expansion of this industry will require substantial public investments in infrastructure, marketing, and other services.

Seafood. The annual value of the Alaska seafood harvest exceeds \$1 billion and after processing it has a wholesale value in excess of \$2 billion. During 2000 45,550 people were engaged in commercial fishing and processing in Alaska, including the adjacent federally managed waters. This was equivalent to 27,877 full time jobs, of which Alaskans held 36 percent. Total personal income was \$437 million.¹² Taxes from fishing activity averaged \$47 million in the 1990s, with about half going to local communities.¹³

A 1996 analysis calculated state revenues of \$67 million from commercial fishing and \$21 million from sport fishing, compared to \$102 million in fisheries-related state expenditures.¹⁴

International Air Cargo. Employment associated with international air cargo operations at Ted Stevens International Airport in 2000 has been estimated to be 3,058 with a payroll of \$126 million.¹⁵ The operation is labor intensive and is part of a rapidly expanding industry. It is somewhat sensitive to environmental issues and the business cycle, as well as technological developments that could impact the relative attractiveness of Anchorage as a location for air cargo services.

Air cargo operations produce revenues for the airport, but the amount of revenue generated for the state general fund has not been calculated. State expenditures in

¹⁰ State of Alaska Natural Resource Revenues and Expenditures in FY 95, Legislative Research Series, June 1996.

¹¹ Alaska Visitor Industry Economic Impact Study, 1999 Update, McDowell Group, 1999.

¹² Alaska Economic Performance Report 2002, Alaska Department of Community and Economic Development, 2003.

¹³ Ibid.

¹⁴ State of Alaska Natural Resource Revenues and Expenditures in FY 95, Legislative Research Series, June 1996.

¹⁵ Ted Stevens Anchorage International Airport - Economic Significance 2000, ISER, 2001.

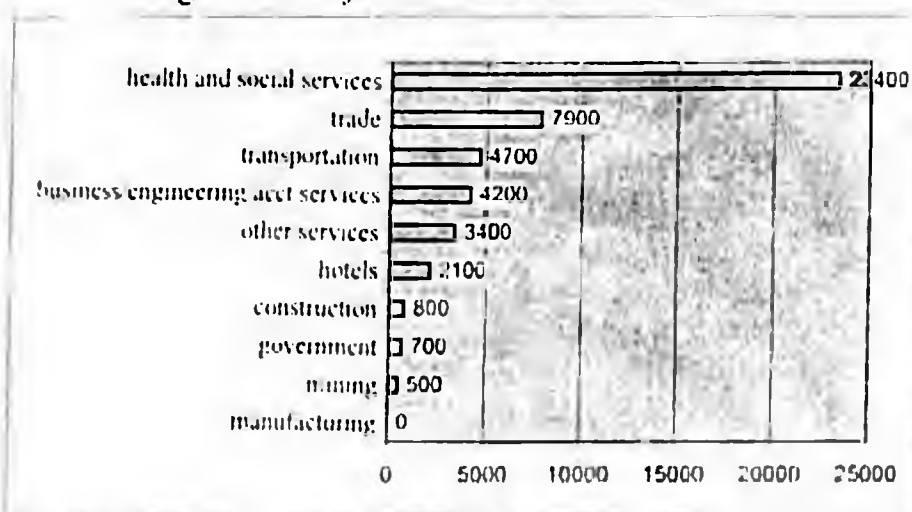
support of the industry have also not been specifically studied, but are probably modest, although the industry does enjoy a tax advantage on fuel sales.

4. FUTURE GROWTH OPPORTUNITIES FOR ALASKA UNIVERSITY RESEARCH

Jobs and income have been growing in Alaska, but much of the growth is tied to federal spending which has increased rapidly in the last 5 years and cannot be counted on to continue expanding or even to stay at its current high level. Strength in the tourism, international air cargo, and mining sectors has also contributed to the strong economy, but timber, seafood, and oil and gas have been struggling because of global competition and other challenges.

Looking ahead, the Alaska Department of Labor projects employment to increase by 48 thousand (1.6 percent growth per year) between 2000 and 2010. Compared to the 40 thousand jobs added in the previous decade this would be a solid performance. However, the Department expects that 97.5 percent of new jobs will be in service producing industries and only 2.5 percent in the goods producing industries of mining (including oil and gas), construction, and manufacturing (including seafood processing and timber) (Figure 4).¹⁶ Most new jobs will be in health and social services (49 percent) and trade (17 percent). These new jobs will have a lower wage than the current average, consequently pulling down the economy-wide average as time passes.

Figure 4. Projected Job Growth 2000-2010



Source: Alaska Department of Labor, May 2002

Because of its attractive characteristics, expansion of university research as an enterprise can contribute to strengthening of the economy in the future. It can contribute to diversity of the economic base, growth in high wage employment, and stability in the

¹⁶ Alaska Economic Trends, May 2002. This projection includes construction of a gas pipeline by 2010.

work force without adverse impact on the environment, little conflict with other industries, and minimal government administrative cost.

The growth potential for University research as an enterprise comes from several factors. First, University R&D spending nationally has been increasing faster than growth in the total economy for two decades. Second, Alaska University research is under-represented in several important and high growth areas, in particular, the life sciences. Third, a considerable share of research about Alaska-specific questions is currently being conducted by Universities in other parts of the country. The University of Alaska could be capturing a larger share of that research—and be benefiting to a much larger degree than it currently is by simply hosting visiting scholars who come for a short time and return to their homes outside Alaska with information collected here. Fourth, the University of Alaska could capture a larger share of research on the Arctic currently done outside Alaska.¹⁷ Finally, there is research that Alaska governments, businesses, and non-profits fund. Some of this research is done at the University of Alaska, but much of it is exported to Universities in other states. This represents another growth opportunity for expansion of Alaska University research.¹⁸

A large share of University research funding comes from the federal government, either directly, or through other agencies, as is the case in other Universities in other states. Some federally funded research at the University of Alaska is the result of earmarks—research money allocated to the University non-competitively. It is University policy to use these earmarks to build research capacity within the state in order to compete more effectively for research funds in the future.

Not all funds earmarked for Alaska research is conducted in Alaska or by the University of Alaska. Some earmarked funding for Alaska research goes to support research conducted directly by agencies of the federal government like the National Marine Fisheries Service and the Department of Defense. Also some of the research funded through those agencies is placed with organizations outside of Alaska. Because a share of Alaska research earmarks is spent outside the state, the risk to the Alaska economy from a reduction in earmarked research is less than it might otherwise appear to be.

5. VALUE ADDED SPILLOVERS FROM UNIVERSITY RESEARCH: WHAT CAN WE "TAKE TO THE BANK" FROM APPLIED RESEARCH?

Much University research is "basic" meaning it has no immediate practical application, but rather increases our understanding of the world we live in. But such research may lead to important and exciting breakthroughs in unanticipated ways. For example,

¹⁷ A Web site listing of National Science Foundation grants for Arctic Natural Sciences Research accessed March 3, 2004 identified \$3.6 million out of a total of \$46.2 million going to researchers affiliated with the University of Alaska.

¹⁸ Capturing some of this exported research would be equivalent to "import substitution" as characterized in the economic development literature.

research on hibernation in small mammals, conducted at the University of Alaska Fairbanks, could provide insights into treatments for stroke patients or applications in the military.

However a considerable share of the research at the University provides a more direct benefit to Alaska over and above its value as an economic enterprise. There are several ways that University research, unlike other economic enterprises within the state, produces value added in the form of knowledge that can be applied to problems. For many of these applications a monetary value might be calculated, although this is rarely done in practice. Below we discuss some of the links between the University and economic development from applied research and give examples of each. This discussion is illustrative rather than exhaustive because of the multitude of projects underway at any time within the University research community.

- **COMMERCIAL SPINOFFS**—Sometimes a new invention discovered at the University, a new way of doing something, or a new application of knowledge results in the creation of a new business startup.¹⁹ To many people this is the essence of the link between University research and economic development—epitomized by the experience of places like Silicon Valley. While important, this is only one of many aspects of the link between University research and economic growth and development. In Alaska this is a small, but potentially growing, part of that link.
 - ABR Inc., an environmental research and services firm was founded in Fairbanks in 1976 by University of Alaska Fairbanks graduate Bob Ritchie. ABR Inc. is an example how expertise gained doing university research translates to private sector growth and the export of specialized services. ABR Inc. now has 40 employees serving the federal and state government, Native organizations, engineering firms, oil and gas industry, timber, utility, and other for-profit organizations, universities, and non profit groups, primarily those managing or using natural resources. Twelve of the 15 senior scientists have higher degrees from UAF. Degrees include wildlife management, natural resource management, marine biology, ecology and botany. Most of the other technical staff also have degrees from UAF. Each higher degree graduate is currently involved in research similar to, or related to, the theme of their thesis. Ritchie has continued to do wildlife surveys, primarily of raptors, which he'd done while a student at UAF. ABR Inc. scientists have used their specialized knowledge to develop an expertise using radar to monitor avian use around transmission lines and other facilities. They've exported this expertise outside of Alaska, adding an Oregon office in 1995. That office's revenues and research programs are still very dependent on radar investigations and the client base has expanded to include the military. ABR Inc. has developed a solid niche in Alaska and their services are often selected over 'outside' competitors.

¹⁹ A new business startup could either add to the export base of the economy, or generate economic growth through import substitution

- RFID is an example of movement of research outside traditional natural resource applications. Radio frequency identification has application in national defense, home electronics, medicine, and other fields where it can be used to more efficiently track inventory and cargo. University researchers are working with private industry on installation of RFID systems and developing computer programs to link information to a secured Web-based system. In addition to research that helps businesses use RFID technology, UAF's Center for Nanosensor Technology, in partnership with private industry and North Dakota State University, is building a sterile lab for research and development of high-end, custom RFID tags.
- **BUSINESS INNOVATION**—A lot of applied University research involves investigating specific problems encountered in Alaska natural resource industries. Solutions to these problems reduce the cost of doing business, increase the opportunities for business expansion, and can lead to the development of new products and ways of doing business.
 - **Fisheries**—A commercial geoduck harvest in southeast Alaska has historically supported the export of about 400,000 pounds of processed geoducks annually to the Pacific rim. University researchers helped develop a PSP (Paralytic Shellfish Poisoning) monitoring system that has allowed harvesters to ship their product to market live rather than processed. Since the market price for live geoducks is potentially \$5 to \$10 per pound compared to \$.80 for processed products, this change is having a dramatic effect on the profitability of this industry. Furthermore it opens up the opportunity for an entirely new enterprise—geoduck farming—that is beginning to develop at sites in southeast Alaska. When fully developed the industry could be shipping 1 million pounds or more of live geoducks annually.²⁰
 - **Mining**—The manager of the Fort Knox gold mine near Fairbanks moved there specifically to work with the Mineral Industry Research Lab at the University and he is currently working towards his PhD at UAF. His work involves modeling that assists in making production more cost effective. University research contributed to a \$6.7 million expansion on the Fort Knox plant that has increased recovery by 2 percent—\$3.8 million dollars.²¹ Other employees at the Fort Knox Mine are working on degrees at MIREL and using classes to explore problems they encounter at work.
- **PUBLIC INFRASTRUCTURE EFFICIENCY**—University research is involved in many areas looking at ways to reduce the costs of providing public services in Alaska. Innovations reduce the cost of government and ultimately the cost of doing business in the state.
 - **Engineering Roads**—Alaska roads from Glenallen and all points north are subject to the settling heaves of thawing permafrost. Permafrost

²⁰ Julie Decker, Southeast Alaska Dive Fisheries Association, personal communication

²¹ John Holloway, mill manager, personal communication

typically takes 50 years to thaw completely making maintenance expensive. A new embankment material developed by Prof. Doug Goering at the Institute of Northern Engineering at UAF is designed to keep permafrost under roads frozen and to prevent the settling heaves. The material, which can cost up to 10 percent more than current embankment material, is being used in new road construction in Fairbanks. The Alaska Department of Transportation plans to use the material on other new road construction where it will save money over the life of the road, even though initial installation is more expensive than traditional methods.

- **Telemedicine**—Delivery of medical services to rural Alaska is expensive and time consuming—often requiring patients and health care workers to travel great distances to see each other. University research developed a method for transporting images over existing telephones lines. This technology is being used by health aides in rural Alaska who take pictures of patients and send them to doctors hundreds of miles away at considerable savings to all involved. Telemedicine is used by the Alaska Federal Health Care Access Network. (AFHCAN), which has 235 sites throughout the state and coordinates between public health nurses, the Coast Guard, Veterans Administration, military and Native community. University researchers presented a report on Alaska's telemedicine project to the eight-nation Arctic Council so that this technology could benefit other countries where great distances make it difficult to deliver health services. There are plans to expand into telepsychology, teleradiology, and teledermatology.²²

- **PUBLIC ASSET MANAGEMENT**--University research helps to sustain and enhance the value and productivity of Alaska's natural resources.
 - **Seafood**-- The UAF Fishery Industrial Technology Center (FITC) in Kodiak is working to increase the value of Alaska's fishing industry and marine resources through research, technological development, education and service. FITC two main programs are Sustainable Harvesting and Seafood Processing.
 - **Energy for Alaska Communities**--Scientists at the Arctic Energy Technology Development Laboratory at UAF are working closely with the power generation, coal, oil and natural gas industries to design and fund research projects that will make a difference for Alaska. They are particularly emphasizing proposals that involve UAF and industry collaborations.
 - **Coal**-- A Coalbed Methane Project is underway to find coal seams in remote villages where importing energy is very expensive. A Coalbed Methane Project in Fort Yukon is being undertaken with support from the Department of Natural Resources.
 - **Oil and Gas**-- the unbiased nature of University research often makes it desirable to private industry. This is true of a project undertaken by

²² Prof. Carl Hild, Associate Director, College of Health and Social Welfare, personal communication

UAF's Institute of Northern Engineering to study the environmental impact of draining tundra ponds to create ice roads on the North Slope. BP is interested in the project because it not only provides valuable information on roads the company is using to conduct business, but it also provides "unbiased" research the company can use to respond to environmentalists' concerns. The project has funding from the Department of Energy and BP is providing a cost share.

- Methane Hydrates—the University is conducting research on energy sources that can be used when fossil energy supplies are depleted, 50-80 years from now. This forward-looking research—which BP is supporting with money and expertise—is concentrated on extracting methane from frozen methane hydrates. Methane is a pure chemical compound from which natural gas is produced. There is as much methane in methane hydrates as in all known natural gas reserves.
 - Membrane Separation Technology—University researchers will be junior partners in research that is planned by BP and its stakeholders to find a cheaper method to separate CO₂ from natural gas. Before natural gas may be shipped through a pipeline CO₂ must be separated out. Costs for building a gas separation plant are currently estimated at \$2.5 billion. This project would develop a process that could save \$500 million from the total cost.
 - Prospects for future research—Alaska is becoming less and less attractive to large oil companies that can extract oil other places more cheaply. This will mean smaller oil companies coming to Alaska. These smaller companies will have less in-house research capability (unlike BP that has its own geology department) and will be more likely to turn to University research to support their work.
- **INFORMATION FOR BETTER BUSINESS DECISIONMAKING--**The University provides nonproprietary information available to all for use in aiding business and government decision making.
 - GINA, the Geographic Information Network of Alaska, that makes digital data associated with geographic coordinates, available to scientists, policy makers and the Alaskan public.
 - Alaska Sea Ice Atlas, a website of ice information used for logistical and engineering-type decisions in ice covered water.
 - ISER economic projections produced by the Institute for Social and Economic Research are used by government, individuals and businesses to make investment and planning decisions.
 - **EXPERTISE--**Expertise gained doing University research provides a source of experts on issues of importance to industry and to the public process.
 - Seafood Markets—Prof. Gunnar Knapp has spent many years researching Alaska fisheries issues and specifically Alaska's salmon industry for the Institute of Social and Economic Research. His expertise has been used by the Alaska Seafood Marketing Institute. Alaska salmon

processors have also relied upon Prof. Knapp's expertise, most recently in a class action antitrust case brought against them in 2003. Salmon processors relied upon Prof. Knapp as an unbiased expert since he testified based on research conducted for the University and received no pay for his testimony. Prof. Knapp's testimony helped the jury understand the downturn in the salmon markets, resulting ultimately, in the processors prevailing in court. The jury's decision preserved thousands of processing jobs and saved Alaska processors millions of dollars.²³

- Grant Assistance--University faculty are experienced in developing grant proposals and use this expertise to help teach community members how to apply for grants. The Institute for Circumpolar Health Studies assisted the Aleutian Pribilof Island Association in getting a grant to study contaminants in subsistence foods. The Association was the first tribal body to obtain, independently, a competitive grant from the National Institute for Health Sciences Environmental Research.²⁴ They in turn contracted with the University to evaluate the program and other services. By providing expert advice—and evaluation services—University researchers enabled community members to conduct research of benefit to themselves.
- TRAINING--Researchers trained in Alaska do a better job than those imported from outside Alaska. Many private and public offices have close ties to University departments graduating students in their field. These students not only bring innovative ideas, up-to-date knowledge, and sensitivity to Alaska issues and problems, but they are also more likely to stay on the job thereby reducing the costs of turnover to employers.
 - Lead Removal from Contaminated Soils—Brice Environmental, a Fairbanks range maintenance and remediation firm, hired staff trained at UAF's Mineral Industry Research Lab (MIRL) when it made the transition 15 years ago from construction work to soil remediation. University expertise helped Brice to blend its "dirt moving" capabilities with technical lead remediation to provide clients with environmental services. The firm continues its association with MIRL—consulting with faculty, benefiting from research papers and staff taking courses. Now, ninety percent of Brice's work is done outside of Alaska. They've completed projects at the Twin Cities Army Ammunition Plant, Fort Polk Louisiana, Massachusetts Military reservation, and Fort Dix New Jersey among others. They've also done work at Fort Greeley.²⁵
- TOURISM ENHANCEMENT--University research facilities such as the Alaska SeaLife Center, Poker Flat Research Range, and UAF Museum contribute to the

²³ Letters in support of Prof. Gunnar Knapp's testimony and research sent to University of Alaska President Mark Hamilton June 2003 from Don Giles, President & CEO Icelde Seafoods, Inc, Alec Brindle, Chairman Wards Cove Packing Company; and Charles H. Bundrant, President & CEO Trident Seafoods Corporation.

²⁴ Prof. Carl Hild, College of Health and Social Welfare, personal communication.

²⁵ Tom Benjamin, Brice Environmental, personal communication.

attractions that bring tourists to Alaska. Ongoing research provides interesting displays and current information making these institutions vital and interesting to tourists looking for uniquely Alaskan experiences.

- **INVENTIONS AND LICENSING**—the Intellectual Property and Technology Transfer Office is encouraging the licensing, patent and copyright of products of University research and is working with government and industry to find support for University research. It is encouraging inventions and helping with marketing. In addition to Prof. Doug Goering's road embankment material that prevents permafrost thaw, other licenses have recently been issued for musk ox feed rations; a genetic switch in bacterial form; three nanoscale sensors; a method for softening both saline and freshwater ice with biodegradable materials that will have application in the frozen food industry; and an acoustical tree/log imager to find flaws in standing timber. Joint inventor projects include a new design for a flow field that may have use in the medical industry as well as reverse osmosis industry that may have application in the fuel cell industry. Although Prof. Goering's embankment material is being used, as is the musk ox feed, other inventions and procedures licensed may take longer to find their niche in the market and to bring financial returns.
- **NATIONAL SPILLOVERS**--Research that has a "spillover effect" providing benefits to the rest of the nation and the world, enhances the University's reputation. University of Alaska research is internationally recognized in a large number of fields within engineering, space physics, climate change and policy research. Much of this research is conducted at the Big Institutes on the UAF campus: the Geophysical Institute, International Arctic Research Center, Institute of Arctic Biology, School of Fisheries and Ocean Sciences, School of Natural Resources and Agricultural Sciences, and the Arctic Region Supercomputing Center.

6. THE BIG 6 INSTITUTES

- **GEOPHYSICAL INSTITUTE**--The Geophysical Institute conducts research from the center of the earth to the center of the sun. The largest institute on the UAF campus—with seven research groups and ten research centers—GI has a world class reputation in marine and terrestrial geophysics and receives a total of nearly \$30 million in research funds from NASA, the National Science Foundation, the Department of Energy, USGS in addition to other public agencies and private industry. The products of research at the Geophysical Institute—which includes Space Physics; Atmospheric Science; Snow, Ice and Permafrost; Seismology; Volcanology; Tectonics and Sedimentation; and Remote Sensing—is exported throughout the world. Examples include:
 - **SAR**-- One of the major projects at GI is the Alaska SAR (Synthetic Aperture Radar) Facility. NASA uses SARs data to study changes in the

earth's surface, including a recent project mapping the destruction of the Amazon rainforest.

- **Sedimentary Research**—Private industry is interested in GI research such as basic sedimentary research in the Brooks Range which is being conducted with funding from the oil industry.
 - **Poker Flat Research Range**—The Geophysical Institute is home to the Poker Flat Research Range—the largest land-based rocket range in the country and only University-based rocket range.
-
- **INTERNATIONAL ARCTIC RESEARCH CENTER (IARC)**--Jointly established by the Japanese and United States governments the International Arctic Research Center conducts research vital to understanding climate change, global warming and Arctic phenomena. While the economic benefits of this research may not be realized for a long time, the work of IARC in determining the balance of natural and human factors contributing to global warming will be of great interest to industry as well as governments. The results may very well determine how industry conducts business in the future. Examples of activities include:
 - **CO2 Protocols**—IARC research helps countries develop CO2 protocols to address global warming.
 - **International Research**—The Center integrates the work of more than 90 international researchers.
-
- **INSTITUTE OF ARCTIC BIOLOGY**--The Institute of Arctic Biology has six major programs that include research in neuroscience, infrastructure research, Native health research, an Experimental Program to Stimulate Competitive Research (EPSCoR), ecological research programs; and a Resilience and Adaptation Graduate Program. These programs bring in research money from NIH, NSF, the National Center for Research Resources, among others. Program examples include:
 - **Arctic Ground Squirrel Hibernation**--University research on the hibernation of Arctic ground squirrels has been featured in national magazines such as *Nature* and created a great deal of interest. Understanding how the squirrels can nearly stop their hearts during hibernation could lead to methods for preventing tissue damage in humans during strokes, as well as many other possibilities.
 - **Toolik Field Station**--The Toolik Field Station on the north slope of the Brooks Range attracts researchers from around the world interested in high latitude ecological and global change research.
 - **Experimental Program to Stimulate Competitive Research**—EPSCoR, a University-state partnership, is intended to build Alaska-based research to support training of students for 21st century technologically based economy.

- **SCHOOL OF FISHERIES AND OCEAN SCIENCES**—Alaska's oceans supply over half the seafood for the nation and the School of Fisheries and Ocean Sciences (SFOS) has seven units and five research programs that conduct vast amounts of research to support the ocean harvest. The research done in this school is of great benefit to Alaska's seafood industry—which is the largest private employer in the state. SFOS not only provides help in the management of the resource it also contributes to expanding the resource with innovations in product and machinery. Examples of activities include:
 - **Fisheries Management**--Studies on the Steller sea lion and fishing gear impacts on endangered seabirds help with management of the fisheries—allowing fishermen to make a living and also preserving the environment.
 - **Expanding the Resource**--A new state law opened up 100 leases to shellfish aquaculture that includes clams and mussels. University research is providing information on the best way to grow shellfish and also providing information on different species that might thrive in Alaskan waters.
 - **New technology**--Research at the Fishery Industrial Technology Center in Kodiak is focused on finding innovations in product and machinery for the fishing industry.

- **SCHOOL OF NATURAL RESOURCES AND AGRICULTURAL SCIENCES**—The School of Natural Resources and Agricultural Sciences continues to focus research on problems related to sustainable agriculture and forestry in relation to economic, social and cultural needs. This research helps Alaskans develop crops, livestock and feed in our challenging environment.
 - Turfgrass performance for golf courses in Southeast Alaska and the development of a new feed mix for musk ox are recent research projects conducted in the School of Natural Resources and Agricultural Sciences.

- **ARCTIC REGION SUPERCOMPUTING CENTER**—ARSC provides computational resources to hundreds of scientists and researchers in Alaska and across the nation. These researchers tackle enormous computational problems for some of the Arctic's greatest challenges including global climate change, bioinformatics, permafrost, ocean circulation and sea ice. Completely funded by the Department of Defense, ARSC also brings in significant research dollars from outside Alaska. In the future ARSC may be used by private businesses, which would bring additional revenue to the University.



Water & Environmental Research Center

University of Alaska Fairbanks

North Slope Watershed Investigations

WERC-Fact Sheet-03-01

Project Partners

- ◆ GW Scientific
- ◆ BP Exploration
- ◆ ConocoPhillips Alaska
- ◆ Alaska Department of Natural Resources
- ◆ Alaska Department of Fish and Game
- ◆ U.S. Bureau of Land Management

Introduction

For many years, the oil industry and support services have built ice roads and pads for increased access to remote sites with decreased maintenance costs. This technique is quite important to the oil industry in that it allows oil field development or maintenance while avoiding the environmental disturbance associated with construction of gravel roads and pads. Construction on ice-roads and pads begins in December or January when the tundra mat is adequately frozen to support construction traffic and continues through April (depending upon weather). Recently numerous questions have been raised regarding the potential environmental consequences of such pumping. Possible effects of pumping include impacts to the water balance, impacts to aquatic organisms (including fish and invertebrates), and impacts to the lake water chemistry.

Physical, Biological and Chemical Implications of Mid-Winter Pumping of Tundra Lakes

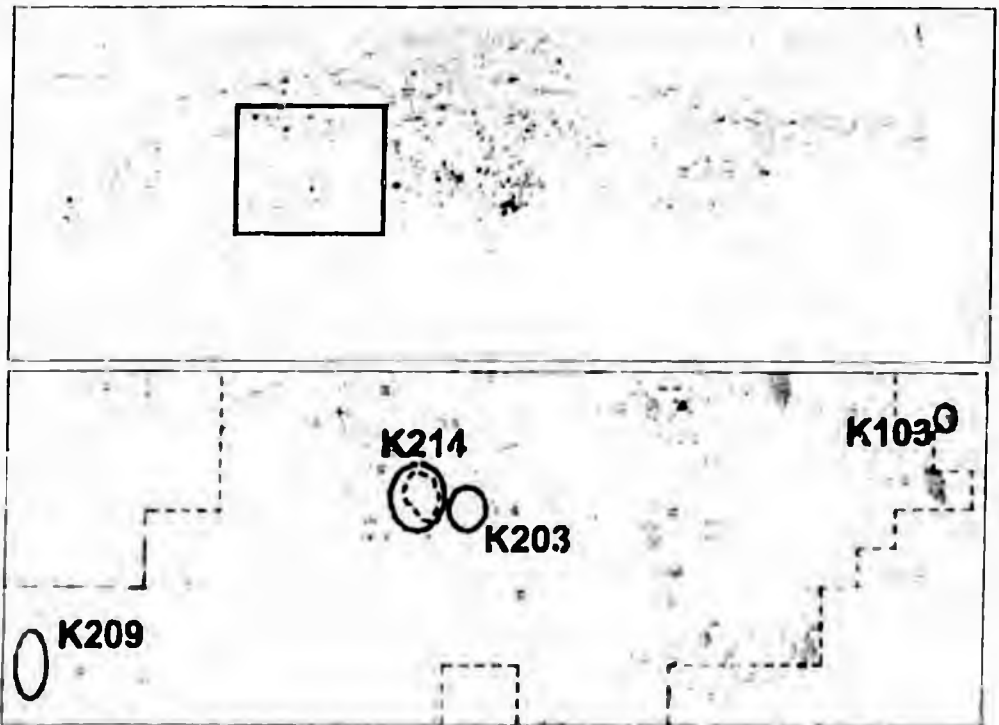


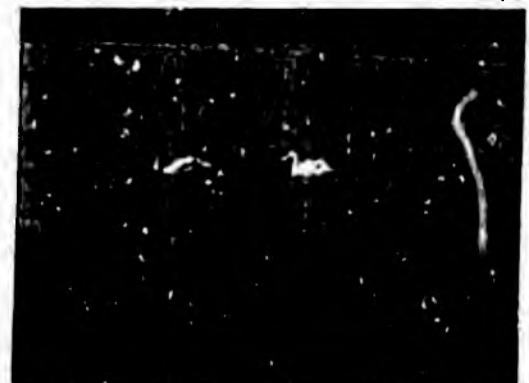
Figure 1. North Slope map indicating current study area (top) and map indicating the four existing monitored lakes (image courtesy BP Exploration).

Project Information

In the Fall of 2002, the University of Alaska Fairbanks Water and Environmental Research Center, together with other project cooperators, initiated a study to obtain baseline information about the physical, biological, and chemical characteristics of North Slope tundra lakes in order to help assess some of the major questions related to winter pumping of lakes. Data from the project is available to the public on the web site. Automated data collection stations on lakes provide 15-minute data which is updated on the dominate at hourly intervals. This project is funded in part by the U.S. Department of Energy through a grant provided by the University of Alaska Fairbanks

Arctic Energy Technology Development Laboratory (AEDTL). Additional funding is provided by project cooperators in the form of financial and in-kind match.

Figure 2. Many North Slope lakes are breeding areas for Tundra Swans (photo - D. Karo).



Project Goals

- ◆ *Collect baseline environmental data on pumped and non-pumped tundra lakes*
- ◆ *Define recharge areas to the lakes*
- ◆ *Initiate distributed modeling analyses of broad area tundra pond water balance*
- ◆ *Determine the implications of pumping the lakes*
- ◆ *Provide data and project reporting to project website*

Parameters Monitored

- ◆ *Continuous lake water levels and temperature*
- ◆ *Continuous specific conductance and dissolved oxygen*
- ◆ *Individual measurements of pH, alkalinity, specific conductance, turbidity, ice thickness*
- ◆ *Individual measurements of water chemistry parameters: Calcium, Magnesium, Nitrate, Potassium, Sodium*

Figure 5. Researchers collect water quality and water chemistry data on a lake during the winter.

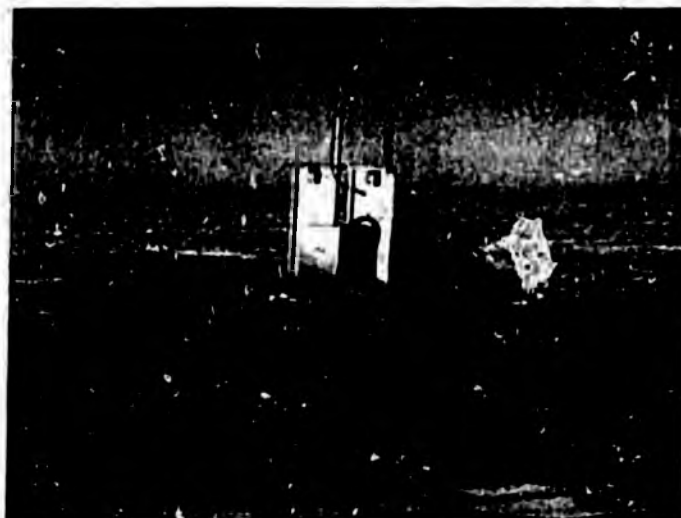


Figure 3. Transporting the hydrologic data collection station to the lake. Stations are designed to float on the lake during the summer months. They are solar powered and data is transmitted to a base station and uploaded to the internet for near real time reporting.

Figure 4: Ice road construction begins when the active layer is satisfactorily frozen. Snow is packed and then pumped water is sprayed onto the snow surface until a sufficient road thickness is attained (photo — W. Morris).



For More Information:

If you would like to find out more about this project, visit the following website.

http://www.uaf.edu/water/projects/northslopelake_recharge/index.html

Or contact:

Larry Hinzman (UAF) 907-474-7331, lhinz@uaf.edu

Douglas Kano (UAF) 907-474-7808, dkano@uaf.edu

Michael Lilly (GWS) 907-479-8891, mlilly@gws.cornell.edu

Galena Electric Power – a Situational Analysis



Robert E. Chaney, SAIC Corporation
Stephen G. Colt, University of Alaska Anchorage
Ronald A. Johnson, University of Alaska Fairbanks
Richard W. Wies, University of Alaska Fairbanks
Gregory J. White, Idaho National Engineering & Environmental Laboratory

DRAFT Final Report
December 15, 2004

Prepared for the U.S. Department of Energy
National Energy Technology Laboratory
Arctic Energy Office Contract
DE-AM26-99FT40575

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

EXECUTIVE SUMMARY

Purpose

The purpose of the investigation is to compare the economics of various electrical power generation options for the City of Galena. Options were assessed over a 30-year project period, beginning in 2010, and the final results were compared on the basis of residential customer electric rates (\$/kWh).

Galena's electric utility currently generates power using internal combustion diesel engines and generator sets. Nearby, there is an exposed coal seam, which might provide fuel for a power plant. Contributions to the energy mix might come from solar, municipal solid waste, or wood. The City has also been approached by Toshiba, Inc., as a demonstration site for a small (Model 4S) nuclear reactor power plant.¹ The Yukon River is possibly a site for in-river turbines for hydroelectric power. This report summarizes the comparative economics of various energy supply options.

This report covers:

- thermal and electric load profiles for Galena
- technologies and resources available to meet or exceed those loads
- uses for any extra power produced by these options
- environmental and permitting issues and then
- the overall economics of each of the primary energy options.

Loads

Currently, the city buildings, school, swimming pool, and health clinic space heating needs are met by capturing the heat rejected by the diesel electric generators (DEGs) and transferring the hot water to the buildings (all close to the power plant). We have assumed an existing average cogeneration load of 400 K Btu/hr for 8 months per year plus a 300 K Btu/hr [commercial/residential boiler load] for other buildings in town for eight months. This gives a total yearly cogeneration thermal load [CTLoad] projected for the future of about 4 B Btu. (Northern Resource Group, 2004). We have distributed these over a year using Fairbanks heating degree days [HDD] data. Analysis shows that allowing for expansion and additional customers for heat (the Air Station), the heat delivered annually could be about 8 B Btu in the future.

In Figure ES.1, we see the monthly electric energy generated. This results in an annual load slightly under 10 M kWh. The average monthly load was around 800 kW in July and over 1 MW in January.

¹ Subsequent to release of this report in draft form, Toshiba has offered clarifications to their proposal. First, due to current US regulations and fuel availability, the fuel would probably be manufactured and the reactor charged in a US nuclear facility (i.e. Argonne National Laboratory). Toshiba's assumption is that the reactor would be returned to that location for decommissioning. Second, the capital cost would be borne by a third party (to be determined) that would become the plant owner and responsible for decommissioning. Changes to the text have been made to reflect these assumptions.

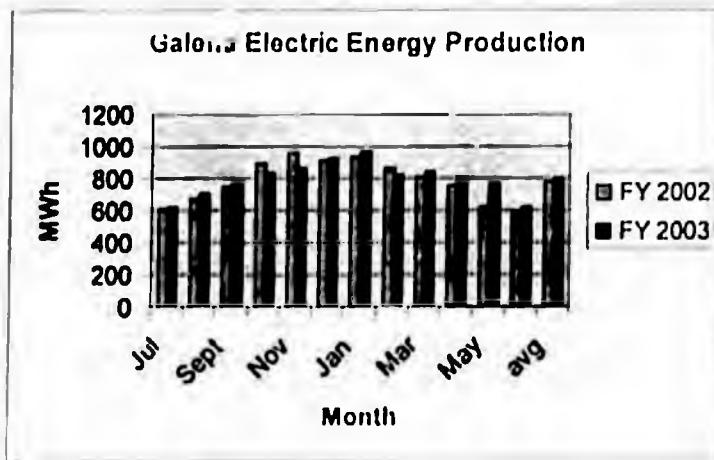


Figure ES.1. Monthly electric generation for Galena

Taking the equivalent projected heating loads and adding the electric loads over the year yields the load requirements displayed in Figure ES.2. for the year 2010.

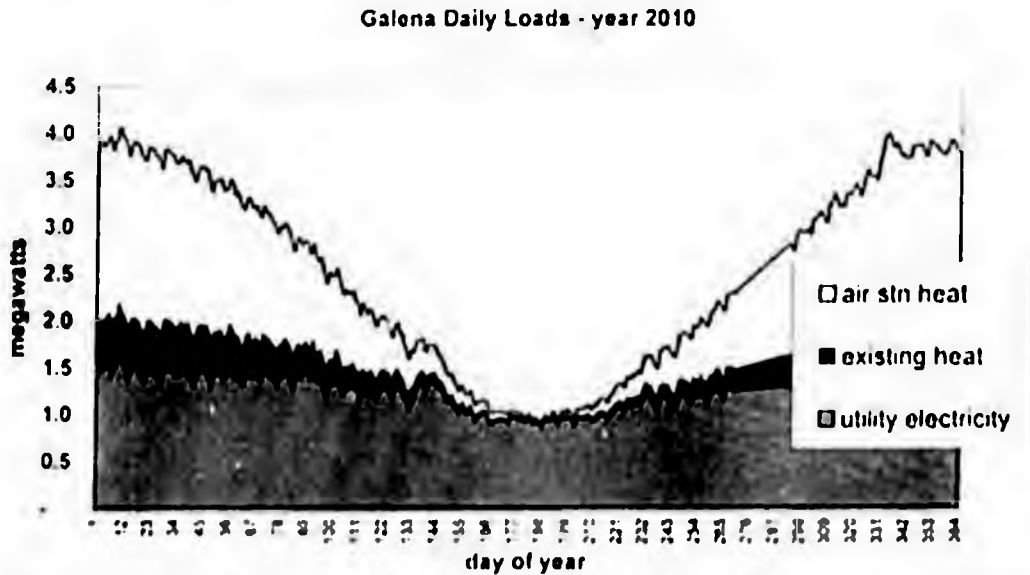


Figure ES.2. Combined heating and electrical loads based on current use in Galena

The various generation options available have different output capacities. For example, the Toshiba 4S system has a generation capacity of 10 MW. Thus, extra power would be available. If the rates were sufficiently low, residential space heating might be an option, as would commercial activities including greenhouses and aquaculture. Figure ES.3. illustrates a possible profile using the base loads from Figure ES.2 with the addition of some of these options for the year 2039. The power requirements are about 8 MW. This would still leave extra power for other uses.

Galena Daily Loads - year 2039

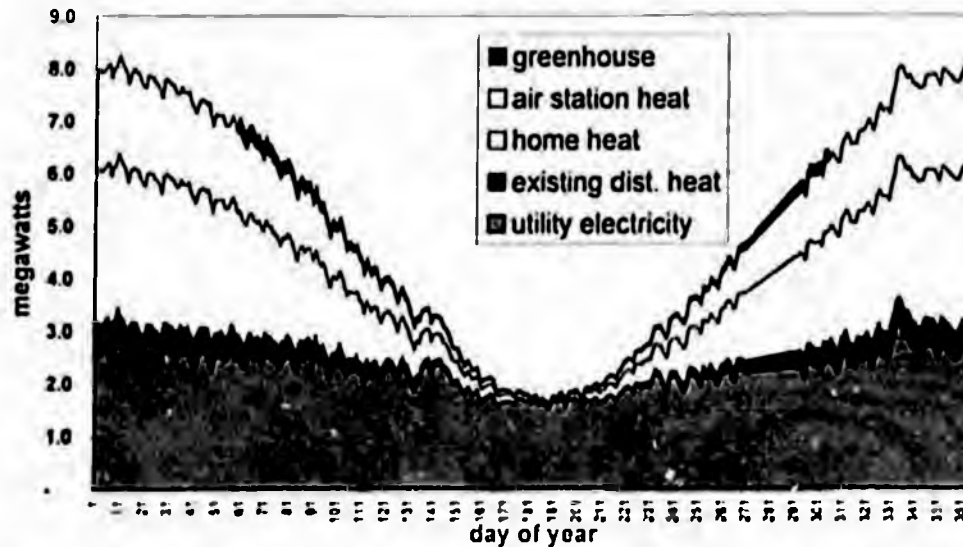


Figure ES.3. Projected combined loads for 2039 with residential space heating and one 2000 ft² greenhouse.

Power Generation Options

The three systems assessed in depth were enhanced diesel, coal (mine and power plant), and the Toshiba 4S nuclear reactor. In the later two cases, backup diesel generators were retained to provide power during any time the primary system was down for repairs or maintenance. All economic analyses included the cost of the backup diesel system.

Enhanced Diesel. According to the Rural Alaska Energy Plan (MAFAa, 2002), the most efficient village sized DEGs available today are capable of achieving peak efficiencies in the 15.8 kWh/gal range. With a fuel oil having a heating value of 135 K Btu/gal, this is equivalent to converting 40% of the energy in the fuel to electric power. For the past two years, the Galena average monthly electrical generation efficiency varied from about 13.2 to 14.8 kWh/gal and averaged 13.76 kWh/gal. For this analysis, we assumed that the units currently in use will continue to perform at 14 kWh/gal and any upgraded or new units will operate at 15 kWh/gal.

Coal (Mine & Power Plant). Exposed coal seams are about 18 road miles upriver from Galena near the Loudon town site. This deposit is not well-understood. Before much further analysis is attempted, the deposit must be explored to determine its size and very importantly its depth below the surface. Samples have been analyzed and have shown an estimated heating value averaging 9.4 K Btu/lb (18.6 M Btu/ton), sulfur content less than 0.5%, ash averaging 9% [range 2 – 16%], and moisture content averaging 19% [14 to 28%]. One exposed seam is about 9 feet high and 2,000 feet across. [Phillips and Denton, 1990]. If a 1-MW coal-fired plant were to operate with an efficiency of 25%, it would require about 0.68 tons/hr of coal or about 12,000 ft³/month. If a 100-foot width were taken from this 9-foot-high coal seam, 13 ft³/month or 166 feet/yr

Pre-Publication Draft – Subject to Change

would have to be excavated. This coal might be delivered to Galena for an estimated \$100 to \$128/ton.

Atmospheric fluidized-bed combustion (AFBC) boilers are now well-established as a mature power generation technology with more than 620 AFBC units in operation worldwide in the size range 20 to 300 MW. Current operating experience shows that AFBC boilers meet high environmental standards and are commercially viable and economically attractive. For more information on AFBCs see <http://www.epri.com/journal/details.asp?id=627&doctype=features>

These plants burn a range of fuels, including bituminous and subbituminous coal, coal waste, lignite, petroleum coke, biomass, and a variety of waste fuels. In many instances, units are designed to fire several fuels (including biomass fuels), which emphasizes one of the technology's major advantages: its inherent fuel flexibility.

While no AFBC coal power plants in the small size range required at Galena have been built and operated at this time, small AFBC boilers have been used to provide heat for industrial processes. Adaptation to power production requires the addition of a steam turbine and ancillary equipment.

The U.S. Department of Energy (DOE) initiated a study in 1998 (Northern Economics, 2001) to investigate the capital and operating costs of small coal-fired power plants (300 kW to 2 MW). The installed capital costs were estimated at from \$3.0K to \$4.3K/kW and an electricity cost of \$0.22 to \$0.77/kWh.

A 2003 feasibility study on a barge-mounted 5-MW AFBC power plant (Bonk, 2004) estimated capital costs from \$20M to \$25M and electricity costs of \$0.20/kWh minus a credit for heat delivered using Galena coal.

J.S. Strandberg (1997) did a feasibility analysis of an 800 kW AFBC coal plant in McGrath plus a 125 kW DEG. The analysis estimated a total project budget of about \$14 million, which included the power plant, coal mine development, haul road, and an expanded district heating system. The estimated electricity cost was \$0.176/kWh, which included a \$0.077/kWh credit for heat delivered. Over half the total cost was for coal and limestone. A major issue was the high parasitic power required (over 155 kW), and the estimate for it was increased as the study was completed.

Phillips and Denton (1900) calculated costs for a 483 kW coal-fired model cogeneration facility producing 6.8 M Btu/hr of heat. The costs of electricity ranged from \$0.11 to \$0.22/kWh for a base load plant to as much as \$0.80/kWh for a lightly loaded plant. Of the 21 M Btu/hr fuel input, 46% went to the production of electricity. Of the total capital cost of \$7.5 M, \$2.0 M was allocated to electrical and +\$5.5 M to heat. For a plant in Galena using Loudon coal, the electricity costs were estimated to range from \$0.26 to \$0.36/kWh.

A coal-fired plant should be a base-load plant sized to run near its capacity all of the time except for planned shutdowns for maintenance and repair.

Toshiba 4S Nuclear Plant. The 4S Model power plant concept is based on a design for a Small Innovative Reactor (SIR), which is a sealed unit. Unlike conventional

Pre-Publication Draft – Subject to Change

reactors, the 4S concept is for the sealed reactor to be delivered at the site, installed with the generator system, operated for the prescribed design life, removed, and replaced with the sealed assembly intact. Thus, there would be no emissions (other than steam), no release of radioactivity, and minimum chance of radiation exposure when the reactor assembly is buried. Toshiba has approached the City with a proposal to provide the reactor and power plant so that the 4S can have a reference site and gain operational experience. The capital cost would be borne by a third party to be identified. Some expense may be incurred by the City for site preparation and installation.

The 4S has no mechanical systems internal to the sealed assembly. Electromagnetic pumps move the cooling fluid. The reflecting shield that controls the reaction is also moved electromagnetically. This greatly reduces the potential for mechanical and equipment problems. Cooling and heat transfer is accomplished using liquid sodium metal. Heat is transferred to a steam generation loop and the resulting steam drives the turbine to generate electricity with rejected heat in the condensed water available for district heating or other uses. For district heating, the steam can be used directly. Problems that have occurred in sodium-cooled plants design have been in sections of the plant other than the reactor.

In this concept, the nuclear reactor is planned to be installed up to 100 feet below grade and capped with reinforced concrete. This provides a nearly impenetrable barrier that cannot be lifted by any heavy equipment available in Galena. The 4S also uses a nonproliferation fuel that cannot be used to produce a nuclear weapon without first undergoing isotopic enrichment, an extremely costly and technologically challenging process.

The projected 4S capital cost is projected to be \$2,500/kW for the 50-MW model when developed. If these assumption scales for a 10 MW unit, the capital cost would be \$25 million.² If fully utilized, electric power from the 50-MW unit is estimated by the vendor to be \$0.065/kWh. Our economic analysis proved to be highly sensitive to the number of plant personnel required. A reasonable number of operations personnel are required for efficiency and safety, but it is not known how many security personnel may be required. A detailed safety and security risk assessment, required by the Nuclear Regulatory Commission licensing process, will determine the necessary staffing levels. The time required for the NRC licensing process is not known at this time. It may add a significant period before the plant can be started, but for purposes of this analysis, we assumed a start date in 2010. The experience gained from the Galena project will be used to refine capital and installation cost estimates for future installations.

Other Generation Modules

Although, other options for power were considered, they were not viable for large-scale deployment by the utility. These include solar, wind, in-river turbines, biomass, fuels cells, and coal bed methane.

In-river Turbines. Prototype turbines have been developed but have not been demonstrated in arctic settings. Calculations of the power output from candidate models

² Toshiba presented this estimate with slides describing the 50-MW plant. We have used the cost per kW figure and applied it to the smaller size. Due to economies of scale, this approach may underestimate the cost of the smaller, 10-MW plant. However, we are unaware of a direct cost estimate for the 10-MW size.

Pre-Publication Draft – Subject to Change

indicate the output would be relatively low at Galena (22.5 kW for a unit with two 3m diameter turbines). For these reasons, we did not pursue or recommend installation of in-river turbines at this time.

Solar. Much of interior Alaska has a good solar resource for as much as eight months of the year, including the springtime when there is a large need for both heat and electricity. A downside to using solar energy is the intermittent nature of the resource. Hence, as with any intermittent resource, storage can be a key issue. Solar technologies take two forms, solar-electric (photovoltaic) and solar thermal. Photovoltaic devices convert sunlight directly to electricity at efficiencies as high as 25%, although 10% is typical. Installation of a 100 kW module in a Galena setting could cost \$2M. Solar thermal technologies use the heat in sunlight to produce hot water, heat for buildings, or electric power. In Galena, solar technology would best serve individual home or business owners. Its impact on the utility was determined to be limited.

Biomass. Biomass can be wood from trees as well as plant residue, animal waste, and the paper portion of municipal solid waste (MSW). The dispersed nature of this resource makes the energy and time involved in harvesting an important issue. We determined the contribution from this source to be too small for a stand-alone unit. However, MSW could be burned in the AFBC of the coal power plant.

Wind. Galena is located in a low wind resource region – Class 1. For wind turbines to work efficiently and contribute significantly to a utility, they must operate in a Class 5, 6, or 7 region. Thus, wind was not considered.

Fuel Cells. This technology is under intense development but has not been commercialized. While some demonstrations are underway, fuel cells are not available for utility applications at this time.

Coal Bed Methane. Gas has been produced commercially from coal beds in the lower 48. Development of resources in other parts of Alaska is in a preliminary stage. Because information to develop CBM in arctic conditions is insufficient, CBM cannot be considered for Galena. If considered for development, extensive work is required to delineate local reserves before development could occur.

Conservation

Conserving energy can reduce loads for utilities and reduce consumer power bills. Utilities have a role in providing information on conservation to their customers. This report discusses measures that can be taken by end-users to conserve.

Uses of Extra Power

Some power plant options have optimum sizes that would provide power over and above current and projected electrical consumption. For those cases, possible uses studied included district heating, residential electric baseboard heating, transmission to nearby villages, production of hydrogen, and horticulture/aquaculture. Use of all energy produced by generation options is essential to realize the full economic potential of generation systems.

Pre-Publication Draft – Subject to Change

District Heating/Heat Sales. Currently, DEGs provide heat to City buildings, the school, and swimming pool. This is assumed to continue in all of the scenarios considered. Some expansion is assumed. Also considered is the sale of heat through a hot water pipeline to the Air Station. To provide space heating, the Air Station consumes about the same volume of fuel oil each year as the electric utility. The value of the heat supplied is equivalent to the value of the displaced fuel oil.

Electric Space Heating to Residences. If electric rates can be lowered sufficiently, residents will begin to use more electricity in their homes. With sufficiently low rates, many will convert to electric baseboard heating systems. The only reasonable option here is the 4S nuclear plant. If this situation were to be realized, retrofitting the homes and upgrading the distribution system would result in economies of scale, increased convenience, and enhancement of in-door air quality. In considering the economics of the 4S option, the costs of retrofitting and installation were included in the capital cost to the utility.

Hydrogen Production. Projected electric and heat loads over the 30-year life of this analysis indicate that extra power will still be available. In considering other potential uses, we assessed the production of hydrogen for fuel. Transportation of hydrogen for sale outside the City was determined to not be economical. However, under certain conditions, converting City vehicles, school district buses, and Air Station heavy equipment may be economically feasible. It might also provide the City the opportunity to be a test-bed for production and use of hydrogen in remote arctic settings. Hydrogen production may be feasible but not economically viable without subsidies. No credit was taken for the oxygen that is coproduced, but it could be captured and compressed for local use.

Transmission to other villages. An analysis of estimated construction costs of transmission lines to the villages nearest to Galena revealed that the capital costs were several million dollars greater than the revenue that could be collected over the 30-year period. This option is therefore not considered feasible from an economic standpoint.

Greenhouses and Aquaculture. The extra heat produced by new power plants may give rise to private entrepreneurial activities. We briefly looked at the potential of greenhouses and aquaculture. Many other activities may be viable. If the cost for the heat (in the form of heated water) were low enough, these ventures appear to have merit.

Environmental Issues and Permitting

Issues related to permitting were surveyed for the generation options considered viable. The critical considerations are

- Air pollution control
- Water pollution control
- Waste management
- Disturbance of lands/habitat

After considering all issues and potential emissions, the 4S option appears to be the least problematic (this depends on the Nuclear Regulatory Commission) from the

Pre-Publication Draft – Subject to Change

standpoint of ease of gaining new permits. Opening a coal mine and building a coal-fired power plant appears to be the most difficult.

Economic Analyses

Estimating the cost of power to the consumer is the primary objective of this project. We considered the three options: improved diesel, coal (mine & power plant), and the Toshiba 4S nuclear power plant. In all cases, the base case was taken as the continuation and improvement of the diesel-based system now in place. The most critical parameters for each option are shown below.

In the base case, two extremes were taken. First, the continuation of diesel generation with a fuel cost of \$1.50/gal at a flat rate (no escalation). The second case took the cost of fuel at \$2.15/gal and escalated it at 2%/year. These cases were used to compare all the others. For the coal option, the delivered cost of the fuel and the conversion efficiency of the plant were the variables on which the power cost most depends. For the 4S option, the staffing levels (the plant operation staff was held constant, but the number of security personnel was varied) required were the most important.

Table ES.1. Most critical parameters for each option considered.

	units	low value	high value
Diesel fuel price in 2010	\$/gallon	1.50	2.15
Diesel fuel price increase (over and above general inflation)	% per year	0.0%	2.0%
Coal price (delivered to Galena)	\$/ton	100	125
Coal plant average efficiency		30%	40%
Nuclear plant security staff	positions	4	34

Numerous scenarios were run showing the effect of various assumptions. The power plant sizes, optimized for the various technologies, were taken with the load and energy uses, and the total project cost, as well as the electricity cost to the consumer, was calculated. The figures below show the results for various scenarios beginning in 2010. The coal and nuclear systems assumed that DEGs would be employed as back-up for maintenance and emergency shutdowns. Therefore, the price of diesel fuel affects the economics of those systems.

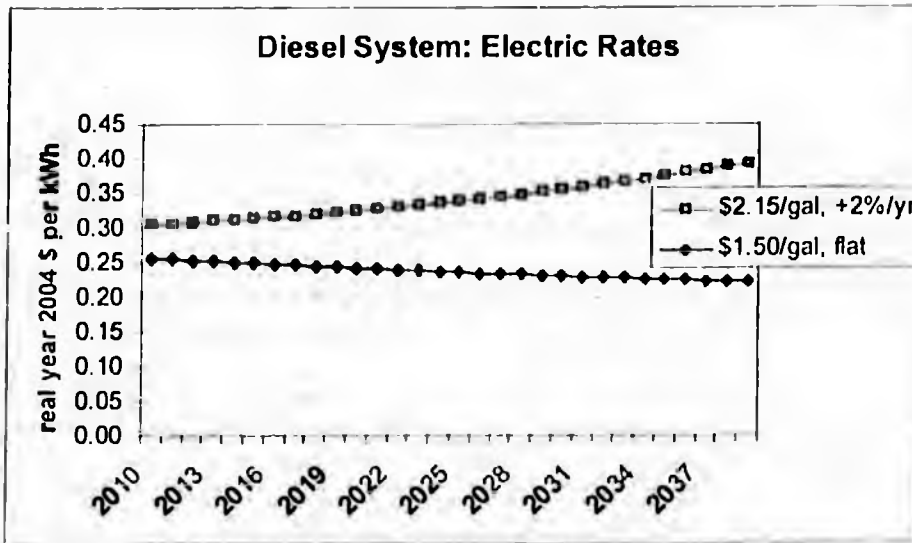


Figure ES.4. Projected future electric rates with a diesel system.

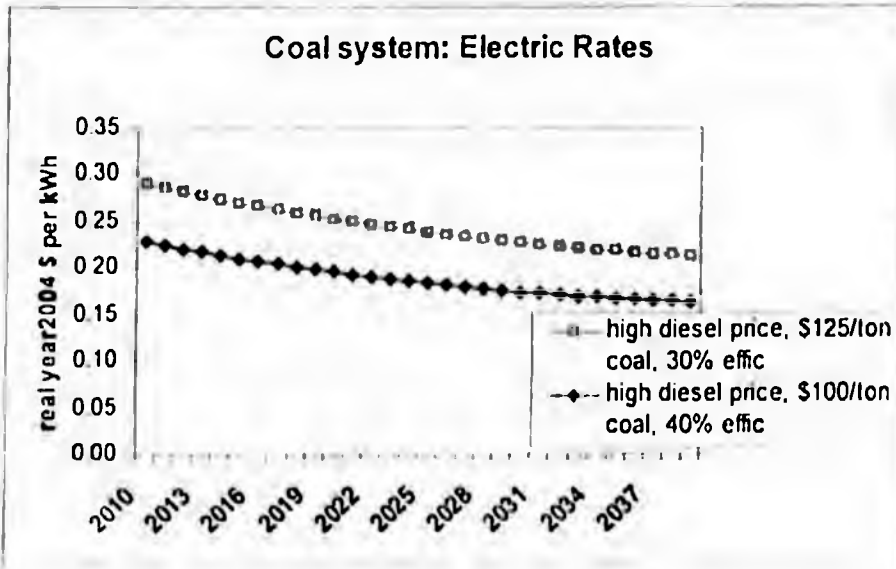


Figure ES.5. Projected future electric with rates with coal system.

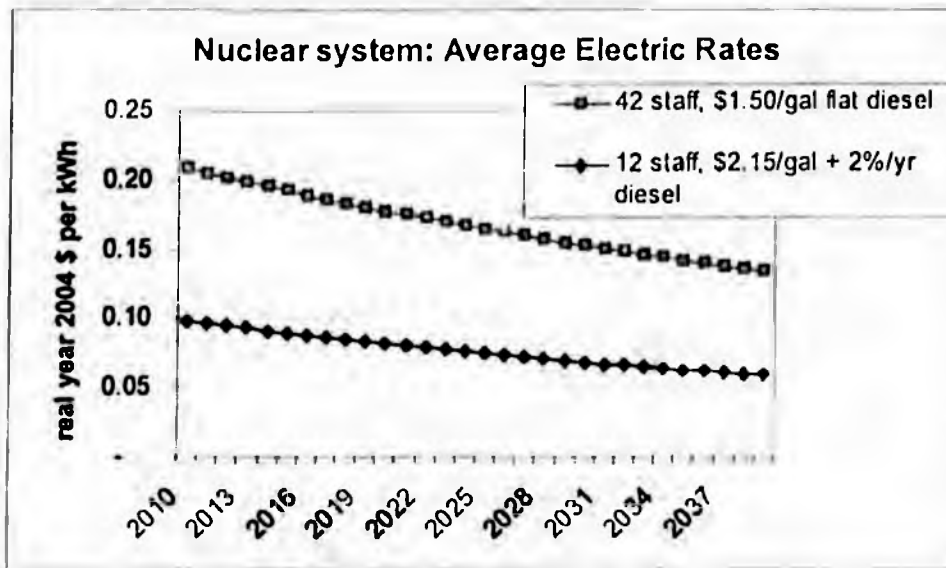


Figure ES.6. Projected future electric rates with nuclear system.

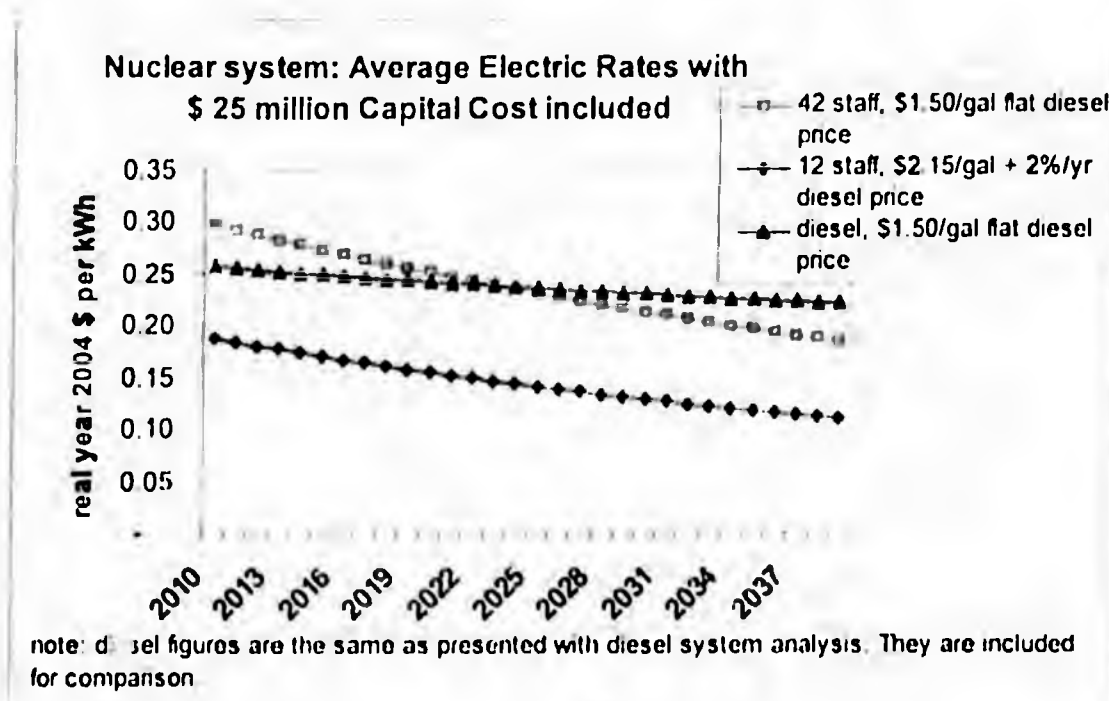


Figure ES.7. Projected future electric rates with nuclear capital costs included in rates.

ES.2. Summary of results of the economic evaluations

Pre-Publication Draft – Subject to Change

	Diesel	Nuclear	Coal
Loads served:			
utility electricity	X	X	X
existing district heat	X	X	X
residential electric space heat		X	
greenhouse		X	
air station district heat		X	[sometimes]
Life-cycle total cost (\$million)			
low value	38	(7)	23
high value	59	35	36
Net benefits compared to diesel (\$million)			
low value		3	3
high value		67	36
Average electric rate in 2010 (\$/kWh)			
low value	0.26	0.10	0.23
high value	0.30	0.21	0.29
Average electric rate in 2030 (\$/kWh)			
low value	0.23	0.07	0.17
high value	0.36	0.15	0.23

The economic evaluations included the costs of diesel backup generators for coal and nuclear.

In all cases, the nuclear system will provide the lowest cost power to the consumer. The coal option will beat the diesel option in some scenarios.

Conclusions and Recommendations

On the basis of environmental permitting, the nuclear plant appears to be a clear winner. Obtaining permits for the coal plant appears to be the most difficult. The validity of this conclusion depends on the process and length of time required to gain a license from the NRC. All assumptions regarding costs and timing require validation.

The economic analysis reveals that the 4S option will provide the lowest cost power if the assumptions hold. In the Galena case, the assumption is that capital cost will be borne by an outside party and that reasonable staffing levels will result from the licensing process. The coal option may be economic in some scenarios compared to enhanced diesel systems, so the coal option should not be entirely dismissed.

Even though installation of the 4S nuclear plant presents a potential long-term solution to Galena's critical energy issues from economic and environmental permitting standpoints, other aspects, such as safety analyses, remain to be performed as part of the licensing process. Ultimately, the selection of the best energy option must consider these analyses and other factors. Specifically, regarding the 4S nuclear plant option, safety relating to potential accidents involving the reactor core and the use of liquid sodium as a heat transfer medium must be adequately addressed. If this technology is successfully deployed in Galena, its economic viability in other Alaska villages and elsewhere depends on the actual life cycle costs yet to be quantified.

Pre-Publication Draft – Subject to Change

Benefits associated with adoption of one or more of the technologies discussed in this report go beyond their ability to meet Galena's thermal and electric energy loads.

We see the potential for Galena to serve as a training center for rural Alaskans interested in using similar technologies in their villages. We also see the potential for use of additional cogeneration leading to economic development such as the development of horticulture and aquaculture. Enhancement of local employment associated with these activities is another benefit. With today's uncertain energy situation, many communities are diversifying their energy options. This includes adding renewably based technologies to lessen dependence on fossil fuels. Adding a few tens of kW of PV arrays, for example, could help Galena insulate itself against fluctuations in the price and supply of diesel fuel.

Therefore, the recommendations are:

- ◆ Proceed with refining the 4S evaluation process in conjunction with the NRC
 - It may be advantageous for Galena to enlist an independent organization to estimate the time required for licensing and permitting
 - Toshiba and Galena should consider partnering with a U.S. organization or National Laboratory to assist in the process
- ◆ Retain the current diesel systems (with scheduled upgrades) until a decision is made regarding the installation of a replacement by about 2010.
- ◆ Retain the option of a coal mine and power plant until it is determined if the 4S system can be permitted and licensed. If the 4S cannot be realized, then the coal option appears feasible (with a favorable coal resource assessment result).