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2005-0336-F

FOIA Number:
2005-0336-F

FOIA MARKER

**This is not a textual record. This is used as an
administrative marker by the George Bush Presidential
Library Staff.**

Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: Correspondence Files

OA/ID Number: 62020
Folder ID Number: 62020-005

Folder Title:
Executive Office of the President: White House Memoranda (1) [1 of 5] [1991]

Stack:

Row:

Section:

Shelf:

Position:

0

0

0

0

"Document Control"

TYPE: PRIORITY ACTION DOCUMENT NUMBER: 9125012
ORIGINATOR: 05 STATUS DIRECTORATE STATUS C

FROM: WHITE HOUSE

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 12/02/91

SUBJECT: CLEARENCE OF ENROLLED BILL S. 1563 -- NATIONAL SEA
GRANT COLLEGE PROGRAM AUTHORIZATION ACT OF 1991

DIRECTORATE STAFF
ASSIGNED: ASSIGNED: Nancy Maynard

ACTION STAFF
REQUIRED: ACTION: COMMENT TO CB ON 12/2

SENDER'S DUE DATE: 12/03/91
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 12/02/91

COPIES TO:

CLOSED

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: PER NANCY MAYNARD: "OSTP CONCURS"

OSTP RECEIVED:
FILE: P-EOP-WH MEMO

DEPT RECEIVED: 12/02/91

CENTRAL FILES:



9125012

WHITE HOUSE STAFFING MEMORANDUM

DATE: 12/2/91 ACTION/CONCURRENCE/COMMENT DUE BY: NOON. TUE., DEC 3, 1991

ENROLLED BILL S. 1563 -- NATIONAL SEA GRANT COLLEGE PROGRAM
AUTHORIZATION ACT OF 1991

SUBJECT: _____

	ACTION	FYI		ACTION	FYI
VICE PRESIDENT	☐	☒	HORNER	☐	☐
SUNUNU	☐	☐	MCCLURE	☒	☐
SCOWCROFT	☐	☐	PETERSMEYER	☐	☐
DARMAN	☐	☒	PORTER	☒	☐
BRADY	☐	☒	ROGICH	☐	☐
BROMLEY	☒	☐	SMITH	☐	☒
CARD	☐	☒	CLERK	☐	☐
DEMAREST	☒	☐		☐	☐
FITZWATER	☐	☒		☐	☐
GRAY	☒	☐		☐	☐
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please provide comments on the attached enrolled bill memo directly to this office NO LATER THAN NOON TUESDAY, DECEMBER 3. Thank you.

RESPONSE:

OSTP CONCURS

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702



EXECUTIVE OFFICE OF THE PRESIDENT

OFFICE OF MANAGEMENT AND BUDGET

WASHINGTON, D.C. 20503

THE DIRECTOR

November 29, 1991

91 NOV 29 P5:30

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Enrolled Bill S. 1563 - National Sea Grant College
Program Authorization Act of 1991
Sponsors - Sen. Kerry (D) Massachusetts and 13 others

Last Day for Action

December 5, 1991 - Thursday

Purpose

Extends through FY 1995 the appropriations authorizations for the National Sea Grant College Program and amends the program in certain respects.

Agency Recommendations

Office of Management and Budget	Approval
Department of Commerce	Approval
Department of State	No objection (Informally)
Department of Education	Defers to Commerce (Informally)
National Science Foundation	Defers to Commerce (Informally)

Discussion

The National Sea Grant College Program is administered by the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. The program authorizes grants, contracts, and fellowships for research and educational activities involving ocean, coastal, and Great Lakes resources. The authorization for appropriations for the program expired at the end of FY 1990.

S. 1563 would authorize appropriations for the program for FYs 1991-1995. For FY 1992, \$50 million would be authorized. (The enacted FY 1992 appropriation is \$45 million and the Administration's request was \$25 million.) The authorization levels would gradually increase to \$57 million in FY 1995.

The enrolled bill would also:

- Statutorily establish NOAA's existing National Sea Grant College Office, which administers the program.
- Clarify that funds from other Federal agencies may be used to add to previously awarded grants and contracts.
- Repeal authorities for two marine research grant programs that were authorized in 1987 but never funded.

Conclusion and Recommendations

The Department of Commerce strongly supports approval of S. 1563. We join the Department in recommending approval of the enrolled bill, which passed the Senate and House by voice vote.

A handwritten signature in dark ink, appearing to read "Richard Darman", with a stylized, flowing script.

Richard Darman
Director

Enclosures

"Document Control"

TYPE: PRIORITY ACTION DOCUMENT NUMBER: 9125010
ORIGINATOR: 05 STATUS DIRECTORATE STATUS C

FROM: WHITE HOUSE

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 12/02/91

SUBJECT: COMMENTS REQUESTED ON ENROLLED RESOLUTION S.J. RES.
187 -- CLEAN AIR ACT TECHNICAL CORRECTION

DIRECTORATE STAFF
ASSIGNED: ASSIGNED: Nancy Maynard

ACTION STAFF
REQUIRED: ACTION: RETURN FORM TO CB ON 12/2

SENDER'S DUE DATE: 12/03/91
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO:

CLOSED

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: PER NANCY MAYNARD: "OSTP CONCURS"

OSTP RECEIVED: DEPT RECEIVED: 12/02/91
FILE: P-EOP-WH MEMO

CENTRAL FILES:



9125010

WHITE HOUSE STAFFING MEMORANDUM

DATE: 12/2/91 ACTION/CONCURRENCE/COMMENT DUE BY: COB TUESDAY, DEC. 3

ENROLLED RESOLUTION S.J. RES. 187 -- CLEAN AIR ACT TECHNICAL
CORRECTION

SUBJECT: _____

	ACTION	FYI		ACTION	FYI
VICE PRESIDENT	☐	☒	HORNER	☐	☐
SUNUNU	☐	☐	MCCLURE	☒	☐
SCOWCROFT	☐	☐	PETERSMEYER	☐	☐
DARMAN	☐	☒	PORTER	☒	☐
BRADY	☐	☒	ROGICH	☐	☐
BROMLEY	☒	☐	SMITH	☐	☐
CARD	☐	☒	CLERK	☐	☒
DEMAREST	☒	☐	DELAND	☒	☐
FITZWATER	☐	☒	_____	☐	☐
GRAY	☒	☐	_____	☐	☐
HOLIDAY	☒	☐	_____	☐	☐

REMARKS:

Please provide comments on the attached enrolled bill memo directly to this office NO LATER THANK COB TUESDAY, DECEMBER 3. Thank you.

RESPONSE:

OSTP CONCURS

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

21 NOV 29 P5:30

THE DIRECTOR

November 29, 1991

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Enrolled Resolution S.J.Res. 187 - Clean Air Act
Technical Correction
Sponsor - Sen. Mitchell (D) Maine

Last Day for Action

December 9, 1991 - Monday

Purpose

Deletes hydrogen sulfide from a list of substances requiring stringent regulation under the Clean Air Act Amendments of 1990.

Agency Recommendations

Office of Management and Budget	Approval
Environmental Protection Agency	Approval
Department of Energy	No objection (Informally)
Department of Justice	Defers to EPA (Informally)
Department of Defense	No comment (Informally)

Discussion

Hydrogen sulfide is a gas commonly used in the petrochemical industry. During the conference on the Clean Air Act Amendments of 1990 (Public Law (P.L.) 101-549), it was agreed to delete hydrogen sulfide from a list of hazardous air pollutants requiring stringent regulation by the Environmental Protection Agency (EPA). Due to a clerical error, however, P.L. 101-549 included hydrogen sulfide on the list. S.J.Res. 187, which passed both Houses of Congress by voice vote, would correct this error.

We join EPA in recommending approval of S.J.Res. 187.

Richard Darman
Director

Enclosures

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123441
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: THE HONORABLE TOM LEWIS

TO: FRED MCCLURE

DATE OF
CORRESPONDENCE: 08/12/91

SUBJECT: REQUEST A VIDEOTAPED ADDRESS FOR THE OPENING OF THE
ANNUAL SCIENCE CONVENTION OF THE FLORIDA ASSOCIATION
OF SCIENCE TEACHERS, OCT (17-19) 91.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: INFORMATION COPY-NO ACTION ACTION:
NECESSARY

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON: SALLY KELLY
REMARKS: PHONE: EXT:

OSTP RECEIVED: 08/12/91 FILE: P-EOP-WHITE HOUSE MEMO
DEPT RECEIVED:

"CORRESPONDENCE TRACKING"

3441

RECEIVED

THE WHITE HOUSE OFFICE

91 AUG 12 P4:28
REFERRAL

OFFICE OF THE
DIRECTOR
AUGUST 12, 1991

TO: OFFICE OF SCIENCE AND TECHNOLOGY POLICY

ACTION REQUESTED:

INFORMATION COPY - NO ACTION NECESSARY

DESCRIPTION OF INCOMING:

ID: 257616

MEDIA: LETTER, DATED JULY 25, 1991

TO: FRED MCCLURE

FROM: THE HONORABLE TOM LEWIS
U.S. HOUSE OF REPRESENTATIVES

WASHINGTON DC 20515

SUBJECT: REQUESTS A VIDEOTAPED ADDRESS FOR THE OPENING
OF THE ANNUAL SCIENCE CONVENTION OF THE
FLORIDA ASSOCIATION OF SCIENCE TEACHERS,
OCT (17-19) 91

PROMPT ACTION IS ESSENTIAL -- IF REQUIRED ACTION HAS NOT BEEN
TAKEN WITHIN 9 WORKING DAYS OF RECEIPT, PLEASE TELEPHONE THE
UNDERSIGNED AT 456-7486.

RETURN CORRESPONDENCE, WORKSHEET AND COPY OF RESPONSE
(OR DRAFT) TO:

AGENCY LIAISON, ROOM 91, THE WHITE HOUSE, 20500

SALLY KELLEY
DIRECTOR OF AGENCY LIAISON
PRESIDENTIAL CORRESPONDENCE

5H

ID# 257616

THE WHITE HOUSE
CORRESPONDENCE TRACKING WORKSHEET

PP010

INCOMING

DATE RECEIVED: JULY 26, 1991

NAME OF CORRESPONDENT: THE HONORABLE TOM LEWIS

SUBJECT: REQUESTS A VIDEOTAPED ADDRESS FOR THE OPENING
OF THE ANNUAL SCIENCE CONVENTION OF THE
FLORIDA ASSOCIATION OF SCIENCE TEACHERS,
OCT (17-19) 91

ROUTE TO: OFFICE/AGENCY	(STAFF NAME)	ACTION ACT CODE	DATE YY/MM/DD	TYPE RESP	C D	COMPLETED YY/MM/DD
FREDERICK MCCLURE		ORG	91/07/26	FM A		91/07/29
AI Zanca	REFERRAL NOTE:	R	91/07/31			
99 OSTP	REFERRAL NOTE: And go ww	I	91/07/31			91/08/08
OSTP	REFERRAL NOTE:	DJ I	91/08/12			
	REFERRAL NOTE:					
	REFERRAL NOTE:					

COMMENTS:

ADDITIONAL CORRESPONDENTS: MEDIA: L INDIVIDUAL CODES: 1240
MAIL USER CODES: (A) (B) (C)

*ACTION CODES: *DISPOSITION *OUTGOING *
* * *CORRESPONDENCE: *
*A-APPROPRIATE ACTION *A-ANSWERED *TYPE RESP=INITIALS *
*C-COMMENT/RECOM *B-NON-SPEC-REFERRAL * OF SIGNER *
*D-DRAFT RESPONSE *C-COMPLETED * CODE = A *
*F-FURNISH FACT SHEET *S-SUSPENDED *COMPLETED = DATE OF *
I-INFO COPY/NO ACT NEC * OUTGOING *
*R-DIRECT REPLY W/COPY * * *
*S-FOR-SIGNATURE * * *
*X-INTERIM REPLY * * *

REFER QUESTIONS AND ROUTING UPDATES TO CENTRAL REFERENCE
(ROOM 75, OEOB) EXT-2590
KEEP THIS WORKSHEET ATTACHED TO THE ORIGINAL INCOMING
LETTER AT ALL TIMES AND SEND COMPLETED RECORD TO RECORDS
MANAGEMENT.

July 29, 1991

Dear Congressman Lewis:

Thank you for your recent letter requesting that President Bush send a videotaped message to the Florida Association of Science Teachers' annual science convention to be held on October 17 - 19, 1991.

Your interest in recognizing the Florida Association of Science Teachers is certainly appreciated. I have forwarded your request to the appropriate White House officials for prompt consideration.

Thank you again for your interest in writing.

With best regards,

Sincerely,

Frederick D. McClure
Assistant to the President
for Legislative Affairs

The Honorable Tom Lewis
House of Representatives
Washington, D.C. 20515

FDM:JHH:

bcc: w/ copy of inc to Bruce Zanca, Office of Public Events and Initiatives - for
direct response

bcc: w/ copy of inc to Office of Science and Technology Policy - FYI

TC 'IS
12TH DISTRICT, FLORIDA

ROOM 1216
LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
TELEPHONE: (202) 225-5792

COMMITTEES:
COMMITTEE ON AGRICULTURE
COMMITTEE ON SCIENCE, SPACE,
AND TECHNOLOGY
SELECT COMMITTEE ON
NARCOTICS ABUSE AND CONTROL

NORTH ATLANTIC ASSEMBLY (NATO)



Congress of the United States
House of Representatives
Washington, DC 20515

257616
DISTRICT OFFICES:

PALM BEACH GARDENS
2700 PGA BOULEVARD
SUITE ONE
PALM BEACH GARDENS, FL 33410
(407) 627-6192

PORT ST. LUCIE
7601 SOUTH U.S. HIGHWAY ONE
SUITE 200
BARNETT BANK BLDG.
PORT ST. LUCIE, FL 34952
(407) 283-7989
(407) 465-3710

McClure
July 25, 1991

Mr. Fred McClure
Assistant to the President
For Legislative Affairs
The White House
Washington, D. C. 20500

Dear Fred:

I have been contacted by a constituent and good friend, Catherine Miller, of the Florida Association of Science Teachers, Inc. (F. A. S. T.), regarding their annual science convention. My district will host this year's convention, consisting of 3,000 science teachers from the state of Florida, on October 17 through October 19.

It is their hope that the President could provide an opening address to the convention via video tape. An opening address by the President would certainly enhance this year's program. It would be appreciated if you would contact Kathy Weekman in my office to discuss the details.

Your consideration of this matter is greatly appreciated.

Sincerely,

Tom Lewis

Tom Lewis
Member of Congress

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123406
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 08/08/91

SUBJECT: DEALER PROGRESS MAGAZINE -- A MESSAGE FROM THE
PRESIDENT

DIRECTORATE STAFF
ASSIGNED: ENVIRONMENT ASSIGNED:

ACTION STAFF
REQUIRED: COMMENTS TO DEB AMEND ACTION:
X 7150 BY 3:00PM 08/12

SENDER'S DUE DATE: 08/12/91
OSTP DUE DATE: 08/12/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
Damar Hawkins

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

CLOSED

OSTP RECEIVED: 08/09/91
DEPT RECEIVED:

FILE: ^{EOP} P-WHITE HOUSE MEMO

WHITE HOUSE STAFFING MEMORANDUM

DATE: 08/08/91ACTION/CONCURRENCE/COMMENT DUE BY: 3:00 p.m. Monday 08/12SUBJECT: DEALER PROGRESS MAGAZINE -- A MESSAGE FROM THE PRESIDENT

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☐	PETERSMEYER	☐	☐
SCOWCROFT	☐	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☒	☐
BROMLEY	☐	☐	UNTERMAYER	☐	☐
CARD	☐	☒	AMEND	☐	☐
DEMAREST	☒	☐	DELAND	☐	☒
FITZWATER	☐	☒	BROMLEY	☒	☐
GRAY	☒	☐		☒	☐
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please provide any comments directly to Deb Amend, x7150, Rm. 121, no later than 3:00 p.m. on Monday, 08/12, with a copy to this office. Thanks.

No comment called to DEB

AMEND

8/12/91

Diana Howken

RESPONSE:

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary

WHITE HOUSE STAFFING MEMORANDUM

DATE: 08/08/91ACTION/CONCURRENCE/COMMENT DUE BY: 08/12
3:00 p.m. MondaySUBJECT: DEALER PROGRESS MAGAZINE -- A MESSAGE FROM THE PRESIDENT

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☐	PETERSMEYER	☐	☐
SCOWCROFT	☐	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☒	☐
BROMLEY	☐	☐	UNTERMAYER	☐	☐
CARD	☐	☒	AMEND	☐	☒
DEMAREST	☒	☐	DELAND	☒	☐
FITZWATER	☐	☒	BROMLEY	☒	☐
GRAY	☒	☐		☐	☐
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please provide any comments directly to Deb Amend, x7150, Rm. 121, no later than 3:00 p.m. on Monday, 08/12, with a copy to this office. Thanks.

RESPONSE:

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

91 AUG -8 PM 4:47

A Message from the President

Thomas Jefferson once remarked that "cultivators of the earth are the most valuable citizens". Today, many of you farmers and farm supply retailers confirm Jefferson's conviction by balancing a profound sensitivity to the environment with a commitment to increased productivity. I applaud your responsible efforts to improve your yields with a deep respect for America's natural resources. It is important that those of you implementing environmental reforms in such a responsible manner be acknowledged. I would especially like to recognize the winners of the first annual Environmental Respect Awards. They are truly making a difference to protect America's resources. I hope that these agricultural chemical dealers will encourage other farm supply retailers to run their businesses in an environmentally-sound fashion.

Many of America's family-owned farms have passed from generation to generation. Farmers understand that to protect the land is to protect not only their livelihood but also their heritage. Farm supply retailers keep this in mind as new technology is developed. They must respond to new challenges every day. According to the National Agrichemical Retailers Association (NARA), the approximately 10,000 retailers are expected to spend \$1 billion dollars to make their agrichemical facilities

environmentally safe by the year 1997. Your commitment to the environment is already being backed by impressive financial support.

All of us are aware of how vital the containment of agrichemicals is in preventing contamination of our surface and ground water. Many farm supply retailers display a keen awareness of this fact as they undertake new measures to preserve the environment. Their funded research creates new technologies to apply safe pesticides as well as to clean up pesticide and fertilizer spills. New programs to recycle pesticide containers are being developed as well.

More and more, we see the important role high-tech is to play. The work done at farming cooperatives and plant and animal research centers explores new methods of farming while taking into account the need to protect our natural resources. Those of you in nutrient management continue to render our environment cleaner and healthier by putting into use high technology soil testing and precision application equipment.

An intensified commitment to the environment is paying off because more farm retail companies are being backed by the insurance industry. Thus, if environmental problems do arise, farming communities will be protected. This is certainly a step in the right direction. However, the efforts of farmers and farm supply retailers should not stop here.

My challenge to you is this: to recognize that productive agriculture and a sound environment can be compatible. And in doing so, that you work with your minds and your hands with the can-do attitude that has made American farming famous. You have your work cut out for you. As an important information source, farm supply retailers educate farmers about the latest farming technologies. Your influence in fostering new attitudes about the environment should never be underestimated.

Americans should be thankful for the efforts of all who contribute to the farming industry. After all, the United States of America enjoys the safest and most plentiful food supply in the world. Once again, I salute this year's winners and I look forward to an abundant and prosperous harvest for all. Thank you.

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123395
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE STAFFING MEMORANDUM

TO: DR. D.A. BROMLEY

AUG 8 1991

DATE OF
CORRESPONDENCE: 08/08/91

SUBJECT: PRESS RELEASE AND FACT SHEET: PRESIDENTIAL FACULTY
FELLOWS PROGRAM

DIRECTORATE STAFF
ASSIGNED: ALL ASSOCIATE DIRECTORS ASSIGNED:
FCCSET

ACTION STAFF
REQUIRED: PROVIDE COMMENTS DIRECTLY ACTION:
TO STEVE OLSON

SENDER'S DUE DATE: 08/12/91
OSTP DUE DATE: 08/12/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 8/12/91

COPIES TO: D. Allan Bromley
Steve Olson
Damar Hawkins

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: Please note that this is do by 12 noon 08/12/91.

Looks excellent. No suggested changes.
pod

CLOSED

OSTP RECEIVED: 08/09/91
DEPT RECEIVED:

FILE: EOP
P-WHITE HOUSE MEMO

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123395
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE STAFFING MEMORANDUM

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 08/08/91

SUBJECT: PRESS RELEASE AND FACT SHEET: PRESIDENTIAL FACULTY
FELLOWS PROGRAM

DIRECTORATE STAFF
ASSIGNED: ALL ASSOCIATE DIRECTORS ASSIGNED:
FCCSET

ACTION STAFF
REQUIRED: PROVIDE COMMENTS DIRECTLY ACTION:
TO STEVE OLSON

SENDER'S DUE DATE: 08/12/91
OSTP DUE DATE: 08/12/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 8/12/91

COPIES TO: D. Allan Bromley
Steve Olson
Damar Hawkins

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: Please note that this is do by 12 noon 08/12/91.

EW to see (but it looks OK to me) KAE 8/9/91
I recommend that we not say that it is successor
to the PYI program,

OSTP RECEIVED: 08/09/91 FILE: P-WHITE HOUSE MEMO
DEPT RECEIVED:

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123395
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE STAFFING MEMORANDUM

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 08/08/91

SUBJECT: PRESS RELEASE AND FACT SHEET: PRESIDENTIAL FACULTY
FELLOWS PROGRAM

DIRECTORATE STAFF
ASSIGNED: ALL ASSOCIATE DIRECTORS ASSIGNED:
FCCSET

ACTION STAFF
REQUIRED: PROVIDE COMMENTS DIRECTLY ACTION:
TO STEVE OLSON

SENDER'S DUE DATE: 08/12/91
OSTP DUE DATE: 08/12/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
Steve Olson
Damar Hawkins

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: Please note that this is do by 12 noon 08/12/91.

We did not get this before deadline.

Thickie

8/19/91

OSTP RECEIVED: 08/09/91
DEPT RECEIVED:

FILE: P-WHITE HOUSE MEMO

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123395
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE STAFFING MEMORANDUM

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 08/08/91

SUBJECT: PRESS RELEASE AND FACT SHEET: PRESIDENTIAL FACULTY
FELLOWS PROGRAM

DIRECTORATE
ASSIGNED: ALL ASSOCIATE DIRECTORS
FCCSET

STAFF
ASSIGNED:

ACTION
REQUIRED: PROVIDE COMMENTS DIRECTLY
TO STEVE OLSON

STAFF
ACTION:

SENDER'S DUE DATE: 08/12/91
OSTP DUE DATE: 08/12/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 8/12/91

COPIES TO: D. Allan Bromley
Steve Olson
Damar Hawkins

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: Please note that this is do by 12 noon 08/12/91.

OSTP RECEIVED: 08/09/91 FILE: P-WHITE HOUSE MEMO
DEPT RECEIVED:

STEVE
Minor editorial
change suggested.
It needs better as
two sentences,
E following.
JH.

3395

Document No. 261063

WHITE HOUSE STAFFING MEMORANDUM

RECEIVED

DATE: 08/08/91

NOON Monday 08/12

ACTION/CONCURRENCE/COMMENT DUE BY: _____

91 AUG 9 PT2: 07

SUBJECT: PRESS RELEASE AND FACT SHEET: PRESIDENTIAL FACULTY FELLOWS PROGRAM

OFFICE OF THE
DIRECTOR

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☐	☐
SUNUNU	☐	☒	PETERSMEYER	☐	☐
SCOWCROFT	☐	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☐	☒	UNTERMAYER	☐	☐
CARD	☒	☐	CLERK	☐	☒
DEMAREST	☒	☐	YALE, Ken	☐	☒
FITZWATER	☐	☒		☐	☐
GRAY	☒	☐		☐	☐
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please provide any comments directly to Ken Yale, x6272, Rm. 360, no later than Noon on Monday, 08/12, with a copy to this office. Thanks.

Steve Olson

RESPONSE: _____

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

50

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RECEIVED

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20508

91 AUG-8 PM 3:13

August 8, 1991

MEMORANDUM FOR PHIL BRADY
STAFF SECRETARY

FROM: KEN YALE *Ky*
SUBJECT: Presidential Faculty Fellows Program

Attached for White House circulation is a draft statement and fact sheet on the Presidential Faculty Fellows Program.

This program is a successor to the former Presidential Young Investigator's Award (PYIA). The National Science Board recently renamed the PYIA as the National Science Foundation Young Investigator's Award and created the Faculty Fellows program, which will have higher stature than the PYIA.

Earlier drafts of the attached materials have been provided by the National Science Foundation to Cabinet Affairs, Office of Management and Budget and White House Counsel.

DRAFT

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release

August TK, 1991

The President today announced a new award program to recognize and support the scholarly activities of some of the nation's most promising young scientists and engineers.

The program will provide awardees with \$100,000 each year for five years. Known as the Presidential Faculty Fellows (PFF) Program, it will represent the Federal government's most prestigious award for young U.S. science and engineering faculty.

"By establishing this new program, I hope to encourage outstanding young scientists and engineers who demonstrate exceptional promise in research, teaching, and academic leadership," the President said. "These awards recognize one of this nation's most precious resources -- our young scientists and engineers at the leading edge of their fields -- and they demonstrate the vital interdependence of teaching and research in achieving excellence in science and engineering."

Up to 30 PFF awards are planned each year, with nominees to be judged on the basis of their competence and leadership in research and teaching. Nominees may work in any discipline of science or engineering normally supported by the National Science Foundation, and recipients may use their awards for both research and teaching purposes.

The National Science Foundation will manage the program, administer the evaluation process, and fund the awards, with final award decisions being made by the White House. The first awards will be made in Fiscal Year 1992.

#

DRAFT

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release

August TK, 1991

ESTABLISHMENT OF PRESIDENTIAL FACULTY FELLOWS PROGRAM

FACT SHEET

The President today announced a new award program that will recognize, honor, and support outstanding young scientists and engineers in America's colleges and universities. Known as the Presidential Faculty Fellows (PFF) Program, it will provide awardees with \$100,000 each year for five years.

By supporting young faculty members in science and engineering, the program will foster innovative and far-reaching developments in science and technology, increase the attractiveness of careers in science and engineering, recognize the interdependence of teaching and research in achieving excellence, and highlight the importance of science and technology to the nation's future.

The program has the following characteristics:

- Nominees will be judged on the basis of their competence and leadership in research, as demonstrated by their research accomplishments, publications, recognition by the community, and other noteworthy achievements, and on the basis of their competence and leadership in teaching, as evidenced by the design of new courses and curricula, published books and articles, service to the community, and other important educational contributions.

- Up to 30 PFF awards are planned each year, to be divided equally between engineering and science disciplines. Nominees may work in any discipline of science or engineering normally supported by the National Science Foundation, and recipients may use their awards for both research and teaching purposes.

- The President or Chief Academic Officer of any U.S. university or college offering a baccalaureate or graduate degree in science or engineering may nominate up to two young faculty members who have received their first faculty position within the

last four years.

- The National Science Foundation will manage the program, administer the evaluation process, and fund the awards, with final award decisions being made by the White House. The first awards will be made in Fiscal Year 1992.

- ~~• The Presidential Young Investigator Program will be renamed the NSF Young Investigator Program. Current or former Presidential Young Investigators who meet all eligibility requirements are eligible for PFF awards.~~

#

"Document Control"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123876
ORIGINATOR: 04 STATUS C DIRECTORATE STATUS C

FROM: BRADY, Phillip: The White House

TO: Dr. Bromley

DATE OF
CORRESPONDENCE: 08/07/91

SUBJECT: PROPOSED STATEMENT BY THE PRESS SECRETARY RE
REDUCTION OF POLLUTION AFFECTING THE GRAND CANYON

DIRECTORATE STAFF
ASSIGNED: ASSIGNED: Nancy Maynard

ACTION STAFF
REQUIRED: ACTION: COMMENTS TO BOB GRADY

SENDER'S DUE DATE: 08/07/91
OSTP DUE DATE: 08/07/91 STAFF DUE DATE
DATE COMPLETED: 08/07/91 DATE COMPLETED/DEPT: 07/08/91

COPIES TO:

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: COMMENTS\EDITS TO BE PROVIDED DIRECTLY TO BOB GRADY WITH COPY TO
BRADY BY COB 4:00 8/7/91

CLOSED

OSTP RECEIVED:
FILE: P-EOP-WH MEMO

DEPT RECEIVED: 07/08/91

CENTRAL FILES:

Admin copy

"Document Control"

TYPE: PRIORITY ACTION DOCUMENT NUMBER: 9123876
ORIGINATOR: 05 STATUS DIRECTORATE STATUS C

FROM: BRADY, Phillip: The White House

TO: Dr. Bromley

DATE OF
CORRESPONDENCE: 08/07/91

SUBJECT: PROPOSED STATEMENT BY THE PRESS SECRETARY RE
REDUCTION OF POLLUTION AFFECTING THE GRAND CANYON

DIRECTORATE STAFF
ASSIGNED: *environment* ASSIGNED: Nancy Maynard

ACTION STAFF
REQUIRED: ACTION: COMMENTS TO BOB GRADY

SENDER'S DUE DATE: 08/07/91
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 07/08/91

COPIES TO:

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: COMMENTS\EDITS TO BE PROVIDED DIRECTLY TO BOB GRADY WITH COPY TO
BRADY BY COB 4:00 8/7/91

OSTP RECEIVED:
FILE: P-ENV-EOP-WH MEMO

DEPT RECEIVED: 07/08/91

CENTRAL FILES:



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9/23876
Document No.

WHITE HOUSE
ACTION MEMORANDUM

DATE: 8/7/91

ACTION/CONCURRENCE/COMMENT DUE BY:

4:00 pm
TODAY, WED., AUG. 7

SUBJECT: PROPOSED STATEMENT BY THE PRESS SECRETARY RE REDUCTION OF POLLUTION AFFECTING THE GRAND CANYON

ACTION FYI			ACTION FYI		
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☒	PETERSMEYER	☐	☐
SCOWCROFT	☐	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☒	☐	UNTERMAYER	☐	☐
CARD	☒	☐	DELAND	☒	☐
DEMAREST	☒	☐	ANDERSON	☒	☐
FITZWATER	☒	☐	HUBBARD (VP STAFF)	☒	☐
GRAY	☒	☐	GRADY	☐	☒
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please provide comments/edits on the attached directly to Bob Grady, Rm. 260, x4844, with a copy to this office NO LATER THAN 4:00PM, TODAY, WEDNESDAY, AUGUST 7. Thank you.

to Nancy Maynard (Vickie's letter)

RESPONSE:

Nancy - this is generally considered a "win" for the Pres. to agree and support.
The science
Vickie supports this too!

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

91 AUG -7 AM 8:37

August 6, 1991

MEMORANDUM FOR THE STAFF SECRETARY

FROM: Robert E. Grady
Associate Director
Natural Resources, Energy, and Science

RE: Grand Canyon

Attached for White House circulation is a potential statement by the Press Secretary in reaction to an agreement that EPA has helped to negotiate to reduce pollution affecting the Grand Canyon.

As you know, the President may be visiting this area in September, potentially to participate in an announcement concerning this issue.

An earlier draft of this has been provided to Governor Sununu, Roger Porter, Ede Holiday, Al Hubbard and the EPA.

As the date on the attached draft implies, the parties to the negotiated agreement are planning to announce their agreement on Thursday, August 8th.

DRAFT

Office of the Press Secretary
The White House

For Immediate Release

August 8, 1991

Statement by the Press Secretary

The President today commended Governor Fife Symington of Arizona, the owners of the Navajo Generating Station, and representatives of the environmental community on the announcement of an agreement to place environmental controls on the Navajo plant in order to reduce emissions of sulfur dioxide (SO₂) and other pollutants and thereby improve visibility at the Grand Canyon.

"This agreement represents an outstanding example of the public and private sector working together to develop creative, cost-effective solutions to our Nation's environmental problems," the President said. "This represents a milestone in our implementation of the Clean Air Act, and in our efforts to protect one of America's crown jewel national parks," he added.

Under the announced agreement, annual SO₂ emissions from the plant would be reduced by 90% by 1999. The controls will be put in place in three phases, with the first phase operational by 1997. Earlier this year, the U.S. Environmental Protection Agency (EPA) had issued a Notice of Proposed Rulemaking (NPRM), which would have required a 70% reduction in emissions by 1999. It was estimated that compliance with that proposal would have cost the owners of the plant \$510 million. EPA estimates that the achievement of the reductions outlined in the agreement will cost only \$430 million, because of greater regulatory flexibility and the phase-in schedule.

According to the EPA, the announced agreement will achieve significantly greater visibility improvement than the earlier proposed rulemaking, because the aggregate emissions reductions achieved will be greater. The Navajo plant is only fifteen miles from the Grand Canyon.

The plant is owned by Arizona Public Service, the Salt River Project, Tucson Electric, the Los Angeles Department of Water and Power, Nevada Power, and the U.S. Bureau of Reclamation. In addition to the owners, the State of Arizona, the EPA, and the Grand Canyon Trust were participants in the negotiations.

The President has asked the EPA to conduct an expedited review of the agreement and to promulgate a final regulation as soon as possible.

#

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9122849
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: PORTER, Richard W.: DOMESTIC POLICY COUNCIL

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 07/26/91

SUBJECT: REQUEST FOR REVIEW/VOTES ON THE ATTACHED OPTIONS
PAPER ON WETLANDS AS WELL AS PROVIDING A BRIEF
STATEMENT OF ADVANTAGES & DISADVANTAGES THAT YOU
WOULD LIKE INCORPORATED IN THE DECISION MEMO FOR THE
PRESIDENT.

DIRECTORATE STAFF
ASSIGNED: ENVIRONMENT ASSIGNED:

ACTION STAFF
REQUIRED: REVIEW/COMMENT ACTION:

SENDER'S DUE DATE: 07/30/91
OSTP DUE DATE: 07/30/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
Damar Hawkins
Ken Yale

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

CLOSED

OSTP RECEIVED: 07/26/91
DEPT RECEIVED:

FILE: P-~~WHITE HOUSE MEMO~~
~~EOP-WH Correspondence~~
White House Memo

JULY 30, 1991

MEMORANDUM FOR D. ALLAN BROMLEY

FROM: VICKIE V. SUTTON

SUBJECT: WETLANDS OPTION PAPER

I met with Richard Porter today before noon, and discussed the options paper on wetlands. Option 3 is clearly the leading choice at this point.

We discussed one of the objectives in the "positive nonregulatory" category to "promoting excellence in research on wetlands", which will be part of any option selected. Richard suggested that we volunteer to coordinate the wetlands research through FCCSET as part of the positive approach.

Do you want to propose this, and have the Environmental Biology Subcommittee of CLSH take on this responsibility? Or do you think it should be an issue taken up by a Subcommittee of CEES? There is no current subcommittee within CEES that is appropriate to take on this issue.

The downside would be the potential for getting pulled in on the question of the development of criteria for the Wetlands Delineation Manual, where policy and science becomes inextricably entwined. The upside is that research coordination on wetlands could be one of the highlights of the entire wetlands issue for the President who has made the commitment for "no net loss". If the decision on wetlands actually does rise to the level of a Presidential decision, there is absolutely no doubt that you would be looked to for advice on the science questions which are being dominated in the debate by EPA at this point.

Let me know if you would like to become more involved.

RECEIVED
JUL 26 2 5:10

**THE WHITE HOUSE OFFICE OF CABINET AFFAIRS
STAFFING MEMORANDUM**

Date: July 26, 1991Due by: OFFICE OF THE
DIRECTORSubject: Attached Options Paper on Wetlands

Richard W. Porter, Executive Secretary

From: Domestic Policy Council

	Action	FYI		Action	FYI
ALL CABINET MEMBERS	☐	☐			
Vice President	☒	☐	CIA	☐	☐
Agriculture	☒	☐	CEA	☒	☐
Commerce	☒	☐	CEQ	☒	☐
Defense	☒	☐	EPA	☒	☐
Education	☐	☒	GSA	☐	☐
Energy	☒	☐	NASA	☐	☐
HHS	☐	☒	National Science Foundation	☐	☐
HUD	☒	☐	ONDCP	☐	☐
Interior	☒	☐	OPM	☐	☐
Justice	☒	☐	OSTP	☒	☐
Labor	☐	☐	SBA	☐	☐
OMB	☒	☐	UN	☐	☐
State	☐	☐	BRADY (For WH Staffing)	☒	☐
Transportation	☒	☐		☐	☐
Treasury	☐	☒		☐	☐
USTR	☐	☐		☐	☐
Veterans	☐	☒		☐	☐

COMMENTS: The attached paper on wetlands is submitted for your review and vote. In addition to notifying me of which option you would prefer, you may provide me with a brief statement of advantages and disadvantages that you would like to have incorporated in the decision memo for the President.

The timetable for deciding this issue is tight, so please return your comments and votes to me by noon, Tuesday, July 30.

Prefer option III.
DRP

CLOSE HOLD

THE WHITE HOUSE
WASHINGTON

July 26, 1991

MEMORANDUM FOR THE DOMESTIC POLICY COUNCIL

FROM: RICHARD W. PORTER *RWP*
Executive Secretary

SUBJECT: Final Review and Vote on Wetlands

The final options paper on wetlands policy reforms is attached for your review, comment and vote. To meet the expedited timetable for deciding this issue, your comments and votes should be returned to me by noon, Tuesday, July 30.

This paper builds on the discussion held at the DPC meeting on July 2, 1991. Two options were presented for discussion at that meeting, and the Council agreed that the presentation reflected the range of opinion about wetlands regulatory reform. The style of presentation used at the meeting is repeated in this paper to facilitate your review.

Following the July 2 meeting, Roger Porter, Assistant to the President for Domestic and Economic Policy, was asked to consult with others to develop a third option bridging the difference between the two options. Accordingly, the paper has been revised to include this third option.

In addition to notifying me of which option you prefer, you may provide me with a brief statement of advantages or disadvantages that you would like to have incorporated in the decision memo for the President.

Attachment

CLOSE HOLD

CLOSE HOLD

WETLANDS OPTIONS PAPER

Three important actions are proposed to address the no net loss goal and the existing controversy over wetlands regulation: (1) issuing a revised delineation Manual that will simplify and clarify the definition of wetlands; (2) strengthening nonregulatory efforts to protect wetlands; and (3) achieving a balanced program of wetlands regulation that respects private property rights and the need to maintain a healthy economy, while preserving this important natural resource.

I. Revised Delineation Manual

On January 10, 1989, the Environmental Protection Agency (EPA), the Army Corps of Engineers (Corps), the Fish and Wildlife Service (FWS), and the Soil Conservation Service (SCS) issued a joint Federal Manual for the Identification and Delineation of Wetlands to address inconsistencies in practice among the agencies. The Manual establishes the technical criteria and procedures used to define a wetland.

During the past two years, the Administration received numerous complaints that the revised Manual significantly expanded the coverage of the regulatory program. In response to these comments and field hearings, the four agencies are recommending changes designed to simplify and clarify the Manual. These changes are now going through interagency review and will be submitted for public comment before they are made final.

II. Positive Nonregulatory Measures to Protect Wetlands

Nonregulatory programs to protect wetlands play a significant role in the country's efforts to conserve this natural resource. At least one-quarter of the wetlands in the lower 48 states are found on Federal lands. The Administration proposed a 48 percent increase in funding for wetlands protection programs in the FY 1992 budget. This includes the purchase of 600,000 acres of wetlands in the Wetlands Reserve Program, enacted as part of the 1990 Farm Bill. In addition to major acquisition programs at the Interior Department, Army Corps of Engineers, and the Agriculture Department, we also restore and enhance existing wetlands, and conduct valuable research and monitoring on the quality and functions of remaining wetlands.

To ensure further progress towards the no net loss goal, we recommend several new initiatives to enhance wetlands protection on federal and private lands. These include:

CLOSE HOLD

CLOSE HOLD

-2-

- Fully funding the Wetlands Reserve Program in the 1990 Farm Bill. The 1990 Farm bill authorized the purchase of up to 1 million acres of wetlands. The FY 1992 budget submitted by the President requested funding for 600,000 acres.
- Initiating an Administration-wide wetlands restoration and creation program on Federal lands. Many agencies, including Interior, EPA, Defense, NOAA, and Energy, have restoration and creation programs. These activities could be coordinated through a standing interagency group. Such a group would develop an overall program for the most effective use of new and existing Federal resources.
- Promoting excellence in research on wetlands. Several agencies conduct their own research on wetlands. This initiative would coordinate, consolidate and establish priorities for wetlands research.
- Continuing to make wetlands a priority in the allocation of Land and Water Conservation Funds. Assure level funding or increases to this program. Target a portion of state LWCF funds to wetlands.
- Continuing and expanding the existing satellite monitoring program to periodically assess national wetland trends. Satellite imagery provides up to date information on the status and trends of wetlands, and can be effective in conducting periodic change analysis of high value wetland areas. Further accelerate and improve our national inventory of wetlands, with more geographically targeted reporting, and monitoring of the ecological health of our wetlands.
- Focusing existing public outreach and education programs on informing the regulated community about federal wetlands regulations.

III. Balance in Wetlands Regulation

A third objective is to balance progress toward important environmental goals, such as the no net loss of wetlands, with the need to maintain a healthy and growing economy. In the area of wetlands protection, it means reducing unnecessary bureaucratic delays in issuing permits and respecting private property rights.

CLOSE HOLD

CLOSE HOLD

-3-

Wetlands are regulated under section 404 program of the Clean Water Act. A landowner must receive an individual permit from the Corps of Engineers before adding dredged or fill material to a wetland. Smaller-scale actions which individually or in aggregate have less than a minimal impact are usually subject to the Corps' general permit program.

To receive an individual permit, the landowner must take "all appropriate and practicable steps" to minimize adverse impacts on the aquatic ecosystem. The landowner must show to the extent practicable that he has avoided, minimized, and compensated wetlands destruction -- a process known as sequencing.

Under the first step, a landowner bears the burden of showing that the site and the development program proposed are the least environmentally damaging practicable alternatives. The landowner must evaluate other potential sites and demonstrate why they are not practicable (from a technical or cost standpoint). After the landowner demonstrates that he has avoided damage where possible, he must demonstrate that the damage has been minimized through reasonable and practicable project modifications. Finally, any remaining environmental damage must then be compensated or "mitigated" to the extent practicable by restoring or creating wetlands of equivalent function and value.

The Army Corps of Engineers issues the permit, but EPA, FWS, SCS, and the National Marine Fisheries Service can consult on the terms of the permit. If any one of the agencies disagrees with the Corps, they can appeal a district office decision up the management chain to the Assistant Secretary level in Washington.

Finally, under section 404(c) of the Clean Water Act, the Administrator of EPA can veto a Corps decision to issue a permit if he determines that it will have an unacceptable adverse effect on the environment. EPA has vetoed eleven projects in the twenty-year history of the program.

Because of the controversy over wetlands protection, legislation amending the 404 program has been introduced in the House (160 cosponsors) and the Senate (24 cosponsors). The bill would narrow the definition of wetlands and would eliminate the consulting role of other agencies and EPA's authority to veto a permit. The legislation would also establish wetlands categories by function and value and replace the sequencing requirements with different regulatory requirements based on the category.

CLOSE HOLD

CLOSE HOLD

-4-

In response to the concerns raised by the regulated community and others, three major options were developed to: (1) streamline the regulatory process; (2) categorize wetlands; (3) encourage mitigation banking; (4) modify sequencing requirements; (5) increase the role of the states; and (6) modify the coverage of the program. These options reflect differing views on the amount of reform needed.

The First Option would leave the current 404 program largely intact, but would propose incremental reforms intended to make it work better. The advocates of this option take a cautious view of the current success rates for wetlands restoration and creation, and the science of wetlands classification. They prefer to move more incrementally, and to field test new regulatory programs (such as mandatory classifications and wetlands trading) before significantly changing the 404 program. In the interim, they advocate measures to help streamline the process to avoid unnecessary bureaucratic delays and enhance the States' role in the program. The agencies supporting this option endorse the development of mitigation banks, but disagree over the constraints that should be placed on the geographic scope and type of mitigation that should be allowed (creation versus restoration).

The Second Option would require significant changes to the 404 program to allow a more market-based approach to wetlands protection and to minimize the subjective nature of the current permitting decisions. Under this approach, the federal government would issue criteria for states to develop wetland categories and presumptive compensation requirements for each category. To reduce regulatory uncertainty, proponents of this approach would replace the current sequencing requirements with mitigation requirements for each wetland category. The Corps would be required to issue permits once an applicant has met the compensation requirements of the applicable wetland category. The development of mitigation banks and a market for the sale and banking of mitigation credits would be key to the success of this approach.

A Third Option seeks to find a middle ground. It incorporates elements of the Second Option (market-based) for moderate and low-value wetlands, but preserves elements of the First Option (incremental reform) for the highest value wetlands. This includes the "sequencing" requirements of avoidance, minimization, and mitigation, and the preference for on-site mitigation.

CLOSE HOLD

OPTION 1

OPTION 2

OPTION 3

Add new deadlines to accelerate interagency appeals.

Deem permit approved within 6 months if agency does not extend for good cause.

Expand use of general permits.

Streamlining

Limit consulting agency appeals on permit decisions to periodic review of generic policy issues.

Deem permit approved within 6 months if agency does not extend for good cause.

Expand use of general permits.

Require site-specific data when commenting on individual permits.

Categorizing Wetlands

Require the Corps to develop general criteria to use on a case-by-case basis.

Test use of categories in selected states.

Establish interagency technical committee to develop in one year wetland categories based on function, value, and scarcity/abundance.

Establish interagency technical committee to develop in one year wetland categories based on function, value, and scarcity/abundance.

Implement pilot projects to test feasibility of market for mitigation credits.

Restrict mitigation to geographical area.

Phase-in use of created wetlands for mitigation.

Mitigation Banking

Create a national market for mitigation credits.

Eliminate preference for on-site mitigation.

Presume satisfaction of mitigation if from same or higher category.

Create a national market for mitigation credits.

Eliminate preference for on-site mitigation.

Presume satisfaction of mitigation if from same or higher category.

CLOSE HOLD

OPTION 1

OPTION 2

OPTION 3

Sequencing and Presumptive Mitigation Requirements

Continue current exceptions from sequencing when losses are insignificant or when advanced planning has been accomplished.

Replace sequencing with mitigation requirements established for each category.

Replace sequencing in all but the highest wetland category with mitigation requirements established for each category.

Establish general permits for low-value wetlands.

Establish general permits for low-value wetlands.

Reduce mitigation requirements if project serves public interest.

Allow States with low historic rates of wetland development to satisfy permit requirements through minimization.

Increasing State Role

Amend the Act to allow performance based approach to State plan approval under 404.

Amend Act to allow States to develop own wetland categories and mitigation requirements based on Federal criteria.

Amend Act to allow States to develop plans which achieve equivalent levels of environmental protection to the 404 program. Further, allow States to tailor wetland categories based on federal criteria.

Allow permitting of wetlands near navigable waters.

Allow permitting of wetlands near navigable waters.

Allow permitting of wetlands near navigable waters.

CLOSE HOLD

OPTION 1

OPTION 2

OPTION 3

Modifying Coverage of Program

Expand coverage of program through administrative rule.

Amend the Act to expand coverage of program if significant reform is included.

Amend the Act to expand coverage of program if significant reform is included.

Exempt certain man-made wetlands.

Exempt certain man-made wetlands.

Use of EPA Veto

Maintain veto as is.

Eliminate the veto or narrow its use.

Maintain EPA's veto, but limit EPA review to adverse environmental harm as stated in the Clean Water Act.

Revise Executive Order

Revise E.O. to include a greater emphasis on stewardship on federal lands and acquisition of valuable wetlands. Further revise E.O. to include a general commitment to the no net loss goal.

No specific provision.

Revise E.O. to include a greater emphasis on stewardship on federal lands and acquisition of valuable wetlands. Further revise E.O. to include a general commitment to the no net loss goal.

CLOSE HOLD

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123653
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: BRADY, Phillip D.: Assistant to the President and Staff
Secretary

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 07/08/91

SUBJECT: ACTICLE FOR THE WASHINGTON STATE ENERGY OFFICE PUGET
SOUND TELECOMMUTING DEMONSTRATION NEWSLETTER.

DIRECTORATE STAFF
ASSIGNED: D. Allan Bromley ASSIGNED:

ACTION STAFF
REQUIRED: REVIEW/COMMENT ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 07/08/91 STAFF DUE DATE
DATE COMPLETED: 07/08/91 DATE COMPLETED/DEPT:

COPIES TO:

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 07/08/91
DEPT RECEIVED:

FILE: P-EOP-WHITE HOUSE MEMO

WHITE HOUSE STAFFING MEMORANDUM

DATE: 7/8/91 ACTION/CONCURRENCE/COMMENT DUE BY: ---

ARTICLE FOR THE WASHINGTON STATE ENERGY OFFICE PUGET SOUND
SUBJECT: TELECOMMUTING DEMONSTRATION NEWSLETTER

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☐	☒
SUNUNU	☐	☐	PETERSMEYER	☐	☐
SCOWCROFT	☐	☐	PORTER	☐	☒
DARMAN	☐	☒	ROGICH	☐	☒
BRADY	☐	☒	SMITH	☐	☒
BROMLEY	☐	☒	UNTERMAYER	☐	☐
CARD	☐	☒	ROGERS	☐	☒
DEMAREST	☐	☒	AMEND	☐	☒
FITZWATER	☐	☒	_____	☐	☐
GRAY	☐	☒	_____	☐	☐
HOLIDAY	☐	☒	_____	☐	☐

REMARKS:

The attached has been forwarded to the President.

*DAB has seen
file
dec
7/8/91*

RESPONSE:

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

THE WHITE HOUSE

WASHINGTON

June 28, 1991

91 JUN 31 PM 1:13

MEMORANDUM FOR THE PRESIDENT

THROUGH:

DORRANCE SMITH *DS*
DEB AMEND *DA*

FROM:

PAUL MCNEILL *PM*
Assistant Director
Office of Media Relations

SUBJECT:

ARTICLE FOR THE WASHINGTON STATE ENERGY OFFICE
PUGET SOUND TELECOMMUTING DEMONSTRATION NEWSLETTER

I. SUMMARY

Attached for your review is a byline article on the benefits of telecommuting. This will be printed in the Washington State Energy Office's "Puget Sound Telecommuting Demonstration" newsletter.

II. DISCUSSION

You support the idea of telecommuting and provided for its research and development and for the development of related technology in your **National Energy Strategy**. It is also cited as an "opportunity to transform transportation" in DOT's **Statement of National Transportation Policy Strategies for Action** -- issued March 8, 1990.

You talked about telecommuting in two speeches -- the California Chamber of Commerce Centennial Dinner (March 1, 1990) and the National Transportation Policy Meeting (March 8, 1990).

III. PURPOSE

This article rewards the Washington State Energy Office for their efforts to rely less on the Federal government to solve their traffic congestion and other problems remedied by telecommuting. It is consistent with your policy to promote states' innovation - you paraphrased this idea as "States as Laboratories" in your State of the Union address.

While the audience of this publication is relatively small (1500), they are not the typical news consumer. It is read all over our country by policy makers and state officials who are looking for innovative ways to improve life in their states.

Draft Three
McNeill
June 18, 1991

PRESIDENTIAL ARTICLE FOR WSEO PUGET SOUND TELECOMMUTING
DEMONSTRATION. NEWSLETTER

I know the advantages of working at home. It saves time. It gives people the flexibility to work efficiently and productively. Telecommunications help millions of people enjoy the benefits of challenging work in a comfortable environment. By "telecommuting," many of our citizens are more productive and better able to balance the demands of working and maintaining a modern family.

Let's face it, our definition of "work" changes as technology marches forward. The information industry has become a major source of innovation and economic growth throughout the world. Computers with modems and facsimile machines have replaced many of the drafting tables and dictaphones of yesteryear. They improve productivity -- slashing the time it takes to transform a flash of inspiration into a product.

Many organizations in the private and public sectors have implemented telecommuting programs. And they offer powerful testimony as to the benefits that come from it.

Those who telecommute don't have to commute. Studies show that telecommuting at least one day per week yields enormous savings.

It's obvious -- each day of work at home eliminates one day's worth of pollution and gasoline consumption.

Telecommuting creates valuable family time for many households where both parents hold jobs. By being home with the child during the typical workday, parents can avoid juggling schedules to allow for mid-day health care appointments and feeding. Parents can balance better the demands of home and work. Most importantly, these families spend more time together.

Telecommuting is not feasible for everyone, but for some businesses and organizations, it can save money, increase productivity, and boost worker morale.

I applaud the Washington State Energy Office Puget Sound Telecommuting Demonstration for their efforts to promote telecommuting, and I urge every organization or individual who uses electronic data to consider providing this "alternate route to work."

GEORGE BUSH

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE MEMO DOCUMENT NUMBER: 9123651
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: BRADY, Phillip D.: ASSISTANT TO THE PRESIDENT & STAFF SECRETARY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 07/08/91

SUBJECT: PRESIDENTIAL REMARKS: AMERICAN DEFENSE PREPAREDNESS
ASSOCIATION

DIRECTORATE STAFF
ASSIGNED: D. Allan Bromley ASSIGNED:

ACTION STAFF
REQUIRED: AS NECESSARY ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 07/08/91 STAFF DUE DATE
DATE COMPLETED: 07/08/91 DATE COMPLETED/DEPT:

COPIES TO: NATIONAL SECURITY

WHITE HOUSE TRACKING #: 251832 CONTACT PERSON:
PHONE: EXT:
REMARKS:

OSTP RECEIVED: 07/08/91 FILE: P-EOP-WHITE HOUSE MEMO
DEPT RECEIVED:

WHITE HOUSE STAFFING MEMORANDUM 3651DATE: 07/08/91 ACTION/CONCURRENCE/COMMENT DUE BY: ----SUBJECT: PRESIDENTIAL REMARKS: AMERICAN DEFENSE PREPAREDNESS ASSOCIATION
(Draft three 07/08)

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☐	☒
SUNUNU	☐	☐	PETERSMEYER	☐	☐
SCOWCROFT	☐	☒	PORTER	☐	☒
DARMAN	☐	☒	ROGICH	☐	☒
BRADY	☐	☒	SMITH	☐	☒
BROMLEY	☐	☒	UNTERMAYER	☐	☐
CARD	☐	☒	ROGERS	☐	☒
DEMAREST	☐	☒	SNOW	☐	☒
FITZWATER	☐	☒		☐	☐
GRAY	☐	☒		☐	☐
HOLIDAY	☐	☒		☐	☐

REMARKS:

The attached has been forwarded to the President.

RESPONSE:

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

THE WHITE HOUSE

WASHINGTON

91 JUL -8 PM 6:09

July 8, 1991

MEMORANDUM FOR THE PRESIDENT

FROM: TONY SNOW *TS*
SUBJECT: DEFENSE ADDRESS

I. SUMMARY

On Tuesday, July 9, at 10:15 a.m., you will address the American Defense Preparedness Association at the J.W. Marriott Hotel. The audience will consist of about 700 defense contractors.

II. DISCUSSION

The speech (12 minutes, on teleprompter) closely follows your address at the Air Force Academy. The speech is designed to influence the Senate's work on the defense bill this week by strongly defending the Administration's plan -- including full funding for the B-2 and G-PALS, and cuts in the Reserves and National Guard.

91 JUL -8 PM 7:50

Snow/Simon
DEFENSE.TS
Draft Three
July 8, 1991

PRESIDENTIAL ADDRESS: AMERICAN DEFENSE PREPAREDNESS ASSOCIATION
J.W. MARIOTT HOTEL
JULY 9, 1991
10:15 A.M.

Thank you, General Skibbie, for that wonderful introduction.
And thanks also to your chairman, Mac Cramer.

[[I've seen some incredible things in the last week: Mt.
Rushmore at its dedication; Americans celebrating their nation
and their fighting forces. And here in Washington, we enjoyed an
incredible fireworks display last Thursday -- a spectacle
surpassed only by the red glare of Patriot missiles over Israel
and Saudi Arabia. //]]

[[You may not realize it, but today is the anniversary of
Zachary Taylor's death. I know the poor man has suffered his
share of indignities recently. But before we leave him alone
entirely, I do want to set the historic record straight. I am
told that his last words were not, "Please pass the broccoli," //
but instead, "I have endeavored to do my duty."]] //

Well, I've come here to talk about our shared duty to
maintain an effective national defense. The Senate has started
looking at our defense budget, and its deliberations could have a
profound impact on our future national security.

Recognizing the changing international environment and
taking into account domestic fiscal constraints, our

Administration has proposed a tough, lean defense budget -- a proposal that consumes a smaller proportion of our gross national product than any defense budget since the Great Depression. Now, you don't have to have an accounting degree or a chest full of medals to understand that, under present circumstances, every penny we spend on unnecessary defense items will come at the expense of defense muscle.

I know that budget cuts will hurt some of you. I also know that some of you build or support systems that our Administration does not consider absolutely vital. But as President, I have a duty to serve the national interest -- and our national interest demands a defense budget that guarantees our security at the lowest feasible cost.

Last August I announced plans to restructure our armed forces in light of the Cold War's end and the emergence of a new kind of world. That proposal recognized some fundamental facts:

One: We don't have a blank check for defense -- never have. We must live within our means.

Two: Instabilities around the globe still threaten us. Many nations have acquired weapons of mass destruction. When despots such as Saddam Hussein combine modern weapons and ancient ambitions, they threaten us all. Meanwhile, the Soviet Union remains a military superpower, with an increasingly sophisticated war machine.

Three: we need the right kind of military. Our forces must have the strength here and abroad to discourage aggression, the

mobility to meet unexpected challenges, and the flexibility to deal with everything from ICBMs to regional conflicts to hostage crises.

These principles lie at the heart of our Administration's defense proposals. Any defense bill that fails to incorporate them will get my personal veto. //

With that in mind, let me talk about a few items I consider crucial, beginning with the B-2 Stealth bomber.

I have asked for 75 B-2 bombers, the most revolutionary military aircraft in our nation's history. When you hear members' complaints about the B-2's cost, remember that a single B-2 does the job of literally dozens of aircraft: tankers, escorts, suppression and surveillance craft, and other bombers.

When people play cute by arguing that we only need a few B-2s because they're so technologically advanced, ask yourselves: Should we risk our security, the lives of our sons and daughters, and our national credibility just because some members of Congress don't want to come to grips with a revolution in warfare? Should we enter the 21st Century reliant upon a bomber designed in the Forties and built in the Fifties?

Think about the costs; think about military operations; think about our long-range national security needs, and you'll conclude that we do indeed need two full wings of the B-2. //

Some also seem reluctant to spend money protecting Americans from accidental -- or intentional -- ballistic missile attacks. We have asked Congress to support the G-PALS system -- that's

Global Protection Against Limited Strikes. Anyone who thinks we will face threats no more severe than the SCUD missile lives in a dream world. If we want to protect ourselves and deter aggression, we have a responsibility to develop defense technologies, such as brilliant pebbles, that lie within our reach. This includes G-PALS. //

As we prepare for the future, we also must ask what kind of military force structure we need. Our Gulf experience reinforced the valuable role reserves can play. It also showed that we don't need the kind of reserve component the House insists we keep. The House defense bills would spend nearly 12 billion dollars over the next five years on unneeded reserve positions and operations. This money would come at the expense of programs that all our forces -- active and reserve -- will need.

We learned many things in the Gulf -- a number of which were anticipated in the defense speech I gave last August 2nd -- ironically, the day Saddam invaded Kuwait.

We learned that nations of the world can and will act collectively to deal with aggression. They will try diplomacy first, and use military action only as a last resort.

We learned that the United States alone can mobilize the international community and lead it through such crises.

We learned that high-tech weapons are not pricey "toys," as critics have claimed for years. They minimize civilian casualties, maximize damage to military targets, shorten wars and save lives -- American lives, coalition lives, and even enemy

lives. We must never forget any life unnecessarily lost is a tragedy -- especially in times of war.

It would be a shame if, so soon after the war, we disregarded these lessons. // And it would be a travesty to waste money on defenses that would not have helped us in the Gulf, and won't help us win the next war we face. //

As the Senate begins its deliberations, I urge it to pass a budget that defends people, not pork; // that enables us to fight the next war, not the last one; // that promotes national security, period. //

Our Administration has tried to restore proportion to federal government and use the office of the presidency to make decisions that might seem too painful for representatives or senators. I've served in Congress and I know the pressure to advance the interests of the home district.

A president, charged with the national interest, can help. The Base Closure Commission provides a case example of a fair and impartial attempt to serve the national interest; to ensure that government lives within its means without abandoning its fundamental responsibilities.

Thirty years ago, in his valedictory address to the nation, Dwight Eisenhower emphasized several themes that remain important today. "A vital element in keeping the peace is our military establishment," he said. "Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction."

Yet, Ike also cautioned that our efforts must serve national interests and national needs -- not the narrow concerns of specific industries or interest groups.

A New World Order demands a new set of defense priorities. Together, we can put those priorities into action. // As attention turns toward the Senate, I ask your help in creating a military strong enough to protect our interests but lean enough to preserve public faith in government. //

Thank you for your continued efforts to keep America safe and strong. Thank you for letting me join you today -- and may God Bless the United States of America.

#

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE STAFFING MEMO DOCUMENT NUMBER: 9121865
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE

TO: DR. D.A. BROMLEY

JUN 25 1991

DATE OF
CORRESPONDENCE: 06/24/91

SUBJECT: NATIONAL SPACE POLICY DIRECTIVE 4

DIRECTORATE STAFF
ASSIGNED: NATIONAL SECURITY ASSIGNED:
INDUSTRIAL

ACTION STAFF
REQUIRED: REVIEW/COMMENT BY C.O.B. ACTION:

SENDER'S DUE DATE: 06/25/91
OSTP DUE DATE: 06/25/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 6/25/91

COPIES TO: Damar Hawkins
PHYSICAL SCIENCES

WHITE HOUSE TRACKING #: CONTACT PERSON: JIM BEALE
PHONE: EXT: X6175

REMARKS: "Look fine" - WDP 6/25. called in to ~~Damar~~ Jim Beale @ 2:30
+ sent copy of response sheet to Brady's office 6/25
af-

OSTP RECEIVED: 06/25/91
DEPT RECEIVED:

FILE: WHITE HOUSE STAFFING MEMO

Mary

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE STAFFING MEMO DOCUMENT NUMBER: 9121865
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: WHITE HOUSE

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 06/24/91

SUBJECT: NATIONAL SPACE POLICY DIRECTIVE 4

DIRECTORATE STAFF
ASSIGNED: NATIONAL SECURITY ASSIGNED:
INDUSTRIAL

ACTION STAFF
REQUIRED: REVIEW/COMMENT BY C.O.B. ACTION:

SENDER'S DUE DATE: 06/25/91
OSTP DUE DATE: 06/25/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:
JUN 25 1991 Natl Security

COPIES TO: Damar Hawkins
PHYSICAL SCIENCES

WHITE HOUSE TRACKING #: CONTACT PERSON: JIM BEALE
PHONE: EXT: X6175
REMARKS:

OSTP RECEIVED: 06/25/91
DEPT RECEIVED: JUN 25 1991

FILE: WHITE HOUSE STAFFING MEMO

WHITE HOUSE STAFFING MEMORANDUM

91 JUN 25 A 9:39
COB 06/25/91

DATE: 06/24/91

ACTION/CONCURRENCE/COMMENT DUE BY: _____

OFFICE OF THE
DIRECTORSUBJECT: NATIONAL SPACE POLICY DIRECTIVE 4

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☒	PETERSMEYER	☐	☐
SCOWCROFT	☒	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☒	☐	UNTERMAYER	☐	☐
CARD	☐	☒	<u>BOSKIN</u>	☒	☐
DEMAREST	☒	☐	<u>ALBRECHT</u>	☐	☒
FITZWATER	☐	☒	<u>BEALE</u>	☐	☒
GRAY	☒	☐	_____	☐	☐
HOLIDAY	☒	☐	_____	☐	☐

REMARKS: Please provide your comments directly to Jim Beale, x6175, Rm. 423, by close of business on Tuesday, 06/25, with a copy to this office. Thanks.

RESPONSE:

Concur.
- Mitchell Van Chave
for D. Allan Bromley

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

WHITE HOUSE STAFFING MEMORANDUM

RECEIVED

91 JUN 25 A 9:39
COB 06/25/91

DATE: 06/24/91

ACTION/CONCURRENCE/COMMENT DUE BY: _____

OFFICE OF THE
DIRECTOR

SUBJECT: NATIONAL SPACE POLICY DIRECTIVE 4

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☒	PETERSMEYER	☐	☐
SCOWCROFT	☒	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☒	☐	UNTERMAYER	☐	☐
CARD	☐	☒	<u>BOSKIN</u>	☒	☐
DEMAREST	☒	☐	<u>ALBRECHT</u>	☐	☒
FITZWATER	☐	☒	<u>BEALE</u>	☐	☒
GRAY	☒	☐	_____	☐	☐
HOLIDAY	☒	☐	_____	☐	☐

REMARKS: Please provide your comments directly to Jim Beale, x6175, Rm. 423, by close of business on Tuesday, 06/25, with a copy to this office. Thanks.

DR. WM. PHILLIPS CONCURS. (OSTP)

RESPONSE: 1

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

WHITE HOUSE STAFFING MEMORANDUM

91 JUN 25 A 9:39

COB 06/25/91

DATE: 06/24/91

ACTION/CONCURRENCE/COMMENT DUE BY: _____

OFFICE OF THE
DIRECTORSUBJECT: NATIONAL SPACE POLICY DIRECTIVE 4

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☒	MCCLURE	☒	☐
SUNUNU	☐	☒	PETERSMEYER	☐	☐
SCOWCROFT	☒	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☒	☐	UNTERMAYER	☐	☐
CARD	☐	☒	<u>BOSKIN</u>	☒	☐
DEMAREST	☒	☐	<u>ALBRECHT</u>	☐	☒
FITZWATER	☐	☒	<u>BEALE</u>	☐	☒
GRAY	☒	☐	_____	☐	☐
HOLIDAY	☒	☐	_____	☐	☐

REMARKS: Please provide your comments directly to Jim Beale, x6175, Rm.423; by close of business on Tuesday, 06/25, with a copy to this office. Thanks.

RESPONSE: _____

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

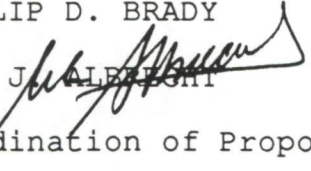
NATIONAL SPACE COUNCIL
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20500

June 24, 1991

91 JUN 24 PM 5:37

MEMORANDUM FOR PHILLIP D. BRADY

FROM:

MARK J. ALBERTSON 

SUBJECT:

Coordination of Proposed Space Policy Directive

The attached draft policy directive was prepared by a National Space Council interagency working group and has been reviewed by the Council. Following internal White House-staff coordination, the Vice President, as Chairman of the Council, plans to forward it to the President for consideration.

Please insure that appropriate White House offices have an opportunity to review the proposed policy. Comments may be provided directly to Jim Beale, who may be contacted at 6175.

1 Attachment

Tab A: Proposed Space Policy Directive

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01. Memorandum	To: Distribution List Re: National Space Policy Directive 4 (6 pp.)	6/24/91	(b)(1)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: Correspondence Files
WHORM Cat.:
File Location: Executive Office of the President: White House Memoranda (1) [1 of 5] [1991]

Date Closed:	2/24/2010	OA/ID Number:	62020-005
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P-6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Removed as a personal record misfile.

Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
(b)(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
(b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
(b)(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
(b)(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
(b)(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

"CORRESPONDENCE TRACKING"

TYPE: WHITE HOUSE STAFFING MEMO DOCUMENT NUMBER: 9121807
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: BRADY, Phillip D.: ASSISTANT TO THE PRESIDENT & STAFF SECRETARY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 06/19/91

SUBJECT: SECOND BIENNIAL REVISION TO THE U.S. ARTIC RESEARCH
PLAN (1991-1992)

DIRECTORATE STAFF
ASSIGNED: ENVIRONMENT ASSIGNED:

ACTION STAFF
REQUIRED: REVIEW/COMMENT ACTION:

SENDER'S DUE DATE: 06/25/91
OSTP DUE DATE: 06/25/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
Damar Hawkins
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: 2/26/91 CONTACT PERSON:
REMARKS: Damar called in no comments fine as is PHONE: EXT: X2702

OSTP RECEIVED: 06/20/91
DEPT RECEIVED:

FILE: WH CORRESPONDENCE-WH MEMO

9121802

Document No. 24797155

RECEIVED

WHITE HOUSE STAFFING MEMORANDUM

91 JUN 20 P12:53

DATE: June 19, 1991ACTION/CONCURRENCE/COMMENT DUE BY: COB 06/25OFFICE OF THE
DIRECTORSUBJECT: SECOND BIENNIAL REVISION TO THE U.S. ARCTIC RESEARCH
PLAN (1991 - 1992)

	ACTION FYI			ACTION FYI	
VICE PRESIDENT	☐	☐	MCCLURE	☐	☐
SUNUNU	☐	☐	PETERSMEYER	☐	☐
SCOWCROFT	☒	☐	PORTER	☒	☐
DARMAN	☒	☐	ROGICH	☐	☐
BRADY	☐	☒	SMITH	☐	☐
BROMLEY	☒	☐	UNTERMAYER	☐	☐
CARD	☐	☐	CLERK	☐	☒
DEMAREST	☐	☐		☐	☐
FITZWATER	☐	☐		☐	☐
GRAY	☐	☐		☐	☐
HOLIDAY	☒	☐		☐	☐

REMARKS:

Please forward your comments directly to this office by COB 06/25.
Thank you.

PLEASE RETURN REPORT

RESPONSE:

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

nsf

OFFICE OF THE
DIRECTOR

June 18, 1991

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

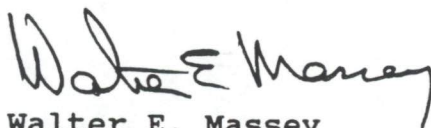
In response to the requirements of the Arctic Research and Policy Act of 1984, and on behalf of the Interagency Arctic Research Policy Committee (IARPC), I am pleased to transmit the second biennial revision to the United States Arctic Research Plan.

This revision contains accomplishments and updates to agencies' Arctic programs, and reflects current and ongoing U.S. activities and national concerns for Arctic research. It includes recommendations for several interagency programs and the initial results of an Arctic Social Science program. It describes the status of cross-cutting activities including logistics and data, which support and enhance U.S. capabilities for conducting an integrated national program of Arctic research. These revisions have been coordinated with and are responsive to guidance provided by the Presidentially-appointed Arctic Research Commission.

The Act, through the Interagency Committee and Commission activities, has stimulated increased awareness that the U.S. is an Arctic nation. Implementation of the Plan can ensure that adequate resources are maintained to address important related issues including ocean research, which serves our Nation's economic vitality and security interests. The Plan seeks to coordinate a number of agency programs. As a major step in addressing this challenge, the IARPC is undertaking an interagency initiative concerned with the Western Arctic.

On behalf of the IARPC, I hope that this second biennial revision to the Arctic Research Plan will provide a sound information basis to assist the Administration and the Congress in the evaluation and implementation of our Nation's commitment to and support for Arctic research.

Sincerely,



Walter E. Massey
Director

Enclosure: Biennial Revision to United States Arctic Research Plan

- D R A F T -

TO THE CONGRESS OF THE UNITED STATES:

Pursuant to the provisions of the Arctic Research and Policy Act of 1984 (Public Law 98-373, sec. 109(a); 15 U.S.C. 4108(a)), I hereby transmit the second biennial revision (1991-92) to the United States Arctic Research Plan.

THE WHITE HOUSE,

- D R A F T -

The incoming material from the National Science Foundation did not include a draft transmittal of the message to the Congress. This draft was prepared by the Executive Clerk's Office.

TO THE CONGRESS OF THE UNITED STATES:

Pursuant to the provisions of the Arctic Research and Policy Act of 1984 (Public Law 98-373, sec. 109(a); 15 U.S.C. 4108(a)), I hereby transmit the first biennial revision (1990-91) to the U.S. Arctic Research Plan.

Cy Bush

THE WHITE HOUSE,

August 2, 1989.

COPY OF LAST TRANSMITTAL

UNITED STATES ARCTIC RESEARCH PLAN

SECOND BIENNIAL REVISION

1992-1993

**Interagency Arctic Research Policy Committee
Washington, D.C.**

**UNITED STATES ARCTIC RESEARCH PLAN
SECOND BIENNIAL REVISION
1992-1993**

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INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE

Chairman

National Science Foundation

Walter E. Massey

Members

Department of Agriculture

Eldon W. Ross

Department of Commerce

Ned A. Ostenso

Department of Defense

Raymond F. Siewert

Department of Energy

James F. Decker

Department of Health and Human Services

W. Craig Vanderwagen

Department of Interior

John Sayre

Department of State

Curtis Bohlen

Department of Transportation

Wally Burnett

Environmental Protection Agency

Erich W. Bretthauer

National Aeronautics and Space Administration

Lennard A. Fisk

Office of Science and Technology Policy

Nancy G. Maynard

Observers

Office of Management and Budget

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NATIONAL SCIENCE FOUNDATION
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nsf

June 18, 1991

OFFICE OF THE
DIRECTOR

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

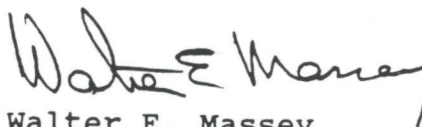
In response to the requirements of the Arctic Research and Policy Act of 1984, and on behalf of the Interagency Arctic Research Policy Committee (IARPC), I am pleased to transmit the second biennial revision to the United States Arctic Research Plan.

This revision contains accomplishments and updates to agencies' Arctic programs, and reflects current and ongoing U.S. activities and national concerns for Arctic research. It includes recommendations for several interagency programs and the initial results of an Arctic Social Science program. It describes the status of cross-cutting activities including logistics and data, which support and enhance U.S. capabilities for conducting an integrated national program of Arctic research. These revisions have been coordinated with and are responsive to guidance provided by the Presidentially-appointed Arctic Research Commission.

The Act, through the Interagency Committee and Commission activities, has stimulated increased awareness that the U.S. is an Arctic nation. Implementation of the Plan can ensure that adequate resources are maintained to address important related issues including ocean research, which serves our Nation's economic vitality and security interests. The Plan seeks to coordinate a number of agency programs. As a major step in addressing this challenge, the IARPC is undertaking an interagency initiative concerned with the Western Arctic.

On behalf of the IARPC, I hope that this second biennial revision to the Arctic Research Plan will provide a sound information basis to assist the Administration and the Congress in the evaluation and implementation of our Nation's commitment to and support for Arctic research.

Sincerely,



Walter E. Massey
Director

Enclosure: Biennial Revision to United States Arctic Research Plan

Executive Summary

1. Background

As required by the Arctic Research and Policy Act of 1984 (Public Law 98-373),* a comprehensive Arctic research plan was prepared by the Interagency Arctic Research Policy Committee (IARPC 1987) and submitted to the President, who transmitted it to Congress in July 1987. Section 109(a) of the Act requires a biennial revision to the Plan. The first revision was submitted on August 1, 1989. This document, the second biennial revision to the Arctic Research Plan, updates the previous two documents and elaborates on requirements of Section 109(a).

United States research in the Arctic and for this biennial revision is governed by the goals and objectives agreed upon by the Interagency Committee on February 3, 1986, and by the guidance provided by the Arctic Research Commission (ARC 1991a). These include supporting research to implement national policy for protecting national security interests, promoting rational development while minimizing adverse effects, contributing to the knowledge of the environment best studied in the Arctic, and contributing to mutually beneficial international cooperation.

The Act did not provide separate additional funding for Arctic research. Agencies are expected to request and justify funds as part of their normal budgetary processes. It was anticipated in the 1987 Plan that agencies would provide levels of funding consistent with the Plan's recommendations and existing programs during the intervening period. FY 1992 expenditures for Arctic research in the twelve Federal agencies is estimated at \$146 million.

The Arctic Research and Policy Act requires cooperation among agencies of the U.S. Government that have missions and programs relevant to the Arctic. The Interagency Committee is providing the mechanism for developing and coordinating overall U.S. Arctic research activities. This biennial revision to the U.S. Arctic Research Plan serves as guidance for planning by individual agencies and for coordinating and implementing mutually beneficial national and international research programs. The document includes two major sections: the Strategy for Integrated U.S. Arctic Research Programs; and revisions to Research Mission Components. The Strategy is new to the Plan and provides another step in implementing

the intent of the Arctic Research and Policy Act of 1984. It represents Federal agencies' efforts to plan and implement research involving a number of agencies and to cooperate in the international scientific arena on research related to the U.S. Arctic. The Research Mission Components consist of six major topics important to Arctic research and conducted as part of individual missions of twelve Federal agencies.

Over the past two years there has been an increasing amount of international activities, both on the governmental and nongovernmental levels. An intergovernmental agreement on protection of the Arctic environment was agreed to in June 1991 in Finland. The nongovernmental International Arctic Science Committee was agreed upon in 1990 and has begun its work on an international agenda related to global change.

2. Strategy for Integrated Research Programs

The Interagency Committee, at its meeting on June 28, 1990, agreed upon the following policy:

"The IARPC agrees that a more comprehensive approach to funding of research and baseline programs is required to ensure a long-term, viable research and development presence in the Arctic. This presence will ensure support of the national needs, which include renewable and nonrenewable resource development, environmental protection, and partnerships with the private sector and residents of the Arctic. It will complement other national and international scientific programs, such as Global Change. To this end the IARPC agencies, in concert with OMB policy, agree to develop, starting in 1992, an integrated interagency program sufficient for meeting national needs."

Subsequently the IARPC agencies examined Arctic research from an interagency perspective and concluded that the following four programs were ready for immediate attention as multiagency focused efforts:

- *Western Arctic Ocean Circulation and Productivity*

Goal: Understand the processes controlling physical and biogeochemical variability and productivity of the marine western Arctic.

- *Geodynamics of the Arctic Basin and its Margins*

* Amended on November 16, 1990 (Public Law 101-609).

Goal: Determine the climatic, paleo-oceanographic and tectonic evolution of the Arctic and their effects on global change.

- *Arctic Monitoring*

Goal: Establish baseline values and monitor trends in key environmental variables across a national and international network of sites.

- *Bering Land Bridge*

Goal: Determine human responses and adaptations to changing climate and environment.

The FY 1991 funding for these four programs across eleven agencies is estimated at \$51.3 million. The FY 1992 budget is proposed at a level of \$57.3 million.

Another area of cooperation already underway involves data and information. Interagency activities have been initiated to develop an Arctic Environmental Data Directory and to automate, integrate and exchange Arctic bibliographic references. An interagency effort is underway to facilitate the exchange of Arctic data and published literature, not only within the U.S. but on an international basis. The initial products are the Arctic Environmental Data Directory and several CD-ROMs, including prototypes of the Arctic Data Interactive and bibliographic citations.

3. Research Mission

Components

Under this section of the Plan, recent accomplishments and ongoing and planned activities of Federal agencies (1992–1993) are briefly described under the following subjects and scopes. To focus attention on recent accomplishments and plans within each agency, a Federal Arctic Research Workshop was held in Alaska in March 1991. All Federal agencies involved in the following activities participated or were represented.

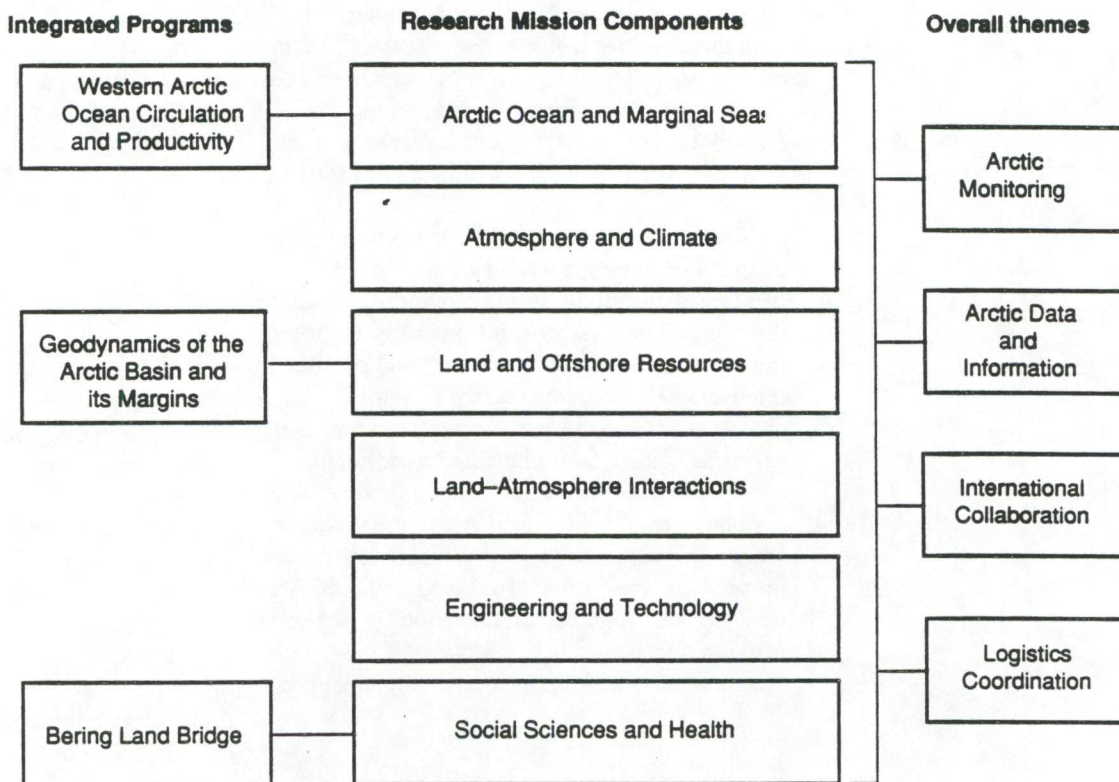
Arctic Ocean and Marginal Seas

Ice Dynamics and Oceanography

Research in this area is important to advance our understanding of Arctic Ocean dynamics and air–sea heat and gas exchange. A systematic program of oceanographic measurements is urgently needed to support the objectives of interagency and individual agency programs.

Ocean and Coastal Ecosystems and Living Resources

Arctic marine ecosystems are dominated by sea ice, and coastal ecosystems are influenced by freshwater input and seasonal sediment loads. There is a need to quantify the influence of physical processes on the variability of marine living resources through long-term and well-designed in-



terdisciplinary research.

Marine Geology and Geophysics

The Arctic continental margin and deep ocean basin constitute one of the world's least understood geological regions. A better understanding of the tectonic history, geologic structure, sediment processes and distribution, and climatic and glacial history of the deeper basins will require extensive geophysical and geological research and the integration of newly collected data on an international scale.

Atmosphere and Climate

Upper Atmosphere and Near-Earth Space Physics

The goal of this research is to trace the flow of energy, momentum and mass from the sun to the Earth, and to understand their interaction. Arctic-based studies of this energy flow are necessary to help develop and verify theoretical models needed for future predictions.

Climate and Weather

The Arctic climate has global implications as well as local and regional importance. Research is needed to address Arctic weather problems occurring on a variety of spatial and temporal scales that range from microscale to global. There is a need to relate Arctic atmospheric circulation to midlatitude weather and to measure and understand phenomena that may be linked to global warming.

Tropospheric and Stratospheric Chemistry

The chemistry of the Arctic atmosphere is dynamic, changing in response to natural and man-induced disturbances. Ozone depletion is a bipolar process. Expected warming trends could have a significant influence on biosphere-atmosphere interactions, trace gas emissions and retention, and atmospheric photochemical processes.

Land and Offshore Resources

Energy and Minerals

The geologic framework of the Arctic is poorly known because of its complexity, its remoteness and its relative lack of exploration. Information is necessary for discovery, assessment and mapping of new and dependable sources of oil, gas, coal and strategic minerals.

Coastal and Shelf Processes

Erosion rates are extremely high along the Alaskan Arctic coast, where sea ice and permafrost degradation are dominant geomorphic agents.

Specific questions about where to locate causeways, man-made islands and other structures require studies of coastal erosion and sediment transport and an understanding of the long-term history of coastal areas.

Terrestrial and Freshwater Species and Habitats

The Arctic supports many unique species of birds, mammals, fish and plants that are important resources to the Nation, as well as to Alaskan Natives. To assure that biological resources are protected for future generations, management agencies must have adequate data and information on the biology and ecology of these species, as well as on environmental factors of importance to vital processes (e.g. feeding, breeding).

Forestry, Agriculture and Grazing

Increased knowledge of the current and potential productivity of Arctic and Subarctic forests and soils will lead to improved management practices for increased productivity of renewable resources.

Land-Atmosphere Interactions

Glaciology and Hydrology

Documentation of seasonal, interannual and long-term trends in the physical environment of the Arctic requires attention to the special features of seasonal and perennial snow and ice covers and glaciers, especially as they relate to and record climatic change. Reliable long-term information is needed on surface water quality and quantity.

Permafrost, Landscape and Paleoclimate

Geologic processes that are responsible for the present morphology and land surface are to a large degree a function of the underlying permafrost. Additional knowledge is needed about the temperature, distribution, thickness and depth of permafrost throughout all geomorphic provinces of the Arctic, including the continental shelf.

Ecosystem Structure, Function and Response

Global Circulation Models (GCMs) indicate that the Arctic will be sensitive to the effects of possible climatic changes resulting from greenhouse warming. Research is needed to improve understanding of the influence of climate on land and freshwater processes, including heat balance relationships and landscape alteration. This should include the identification of biological indicators of change, long-term trends in biological diversity, and management strategies for living resources.

Engineering and Technology

Further development of Alaskan resources economically and in an environmentally sound manner requires improved designs and new technologies. Research is required to improve methods and systems for protecting the environment, including oil spill prevention technology and innovative containment and cleanup operations for ice-infested waters and permafrost terrain. Research is also needed for improving human habitability, including waste disposal and air pollution control, power generation and energy storage, and transportation systems.

Social Sciences and Health

Cultural Resources and Historical Processes

Long records of cultural and environmental change, when combined with the proxy records of ethnography and history, make the study of Arctic cultures critical for modeling human responses to global climatic and environmental change. Additional research is needed on the prehistory and history of Arctic cultures, on their interactions with other Native and Western peoples, and on their relationships with past and present environments.

Social Change

Rapid economic, social and political changes have resulted in the emergence of human problems that, while not unique to the Arctic, are nevertheless accentuated by economic development in this environment. Most prominent among them are human-environmental relationships, community viability and social reorientation. Unprecedented op-

portunities exist for basic and applied social and behavioral science research in Arctic regions.

Health

The Arctic is a region where health research has broad implications and applications. Key concerns in health and health research include social and behavioral problems, disease trends and transmission, nutrition, bioaccumulation, and human adaptation to extreme environmental and occupational challenges. The health-culture-socioeconomic component is important in the attempt to address the complex issues being faced in the Arctic.

4. Operational Support

Since the passage of the Act, the Interagency Committee, the Arctic Research Commission, and the State of Alaska have addressed issues related to logistics support for Arctic research. In 1988 the Interagency Committee established a working group on Arctic logistics to deal with Arctic operational needs and to compile information on Federal Arctic logistics capabilities. This interagency effort produced an electronic directory of Federal Arctic logistics capabilities. In September 1989 a workshop was convened to address new technologies available to facilitate Arctic operations and logistics. The Interagency Committee continues to endorse the need for an icebreaker fleet, the acquisition of an ice-capable research vessel, and a more centralized approach for Federal logistics information and scheduling.

1. Introduction

As required by the Arctic Research and Policy Act of 1984 (Public Law 98-373),* a comprehensive Arctic Research Plan was prepared by the Interagency Arctic Research Policy Committee (IARPC 1987) and submitted to the President, who transmitted it to Congress in July 1987. Section 109(a) of the Act requires a biennial revision to the Plan. The first revision was submitted on August 1, 1989 (IARPC 1989). This document, the second biennial revision to the Arctic Research Plan, updates the previous two documents and elaborates on requirements of Section 109(a) (see Appendix F).

The Plan presented a detailed agenda for United States Arctic research and was the result of an extensive process of planning, consultation and revision. The biennial revisions build on the published Plan but are more restricted in scope, and they focus on what might be accomplished in the succeeding two-year periods (1990-91, 1992-93 etc.). In addition to the individual agency research activities (described in Section 3), this revision presents several integrated, interagency research programs (Section 2) as requested by the Interagency Committee at its June 1990 meeting. These cooperative efforts should be initiated in the 1992-93 period, and continue into 1994 and beyond. Each represents ongoing or planned programs of more than three Federal departments and has direct relation to economic, social and international developments in the Arctic and scientific questions related to regional and global processes.

This revision to the Plan was provided for review to all the groups identified in the Act (the Arctic Research Commission, the State of Alaska, residents of the Arctic, the private sector and public interest groups), as well as the participating Federal agencies, the Polar Research Board of the U.S. National Academy of Sciences, and individual scientists and engineers.

1.1 Goals and Objectives

United States research in the Arctic and this biennial revision are governed by national interests and Arctic research goals and objectives agreed upon by the Interagency Committee on February 3, 1986, and guidance provided by the Arctic Research Commission (ARC 1991a).

* Amended on November 16, 1990 (Public Law 101-609); see Appendix F.

U.S. Interests

It is in the national interest of the United States to support scientific and engineering research to implement its national policy of protecting essential security interests, promoting rational development of the Arctic region while minimizing adverse environmental effects, and contributing to the knowledge of the Arctic environment or to aspects of science that are most advantageously studied in the Arctic. Where appropriate this research should be coordinated with the efforts of state and local government and the private sector. The research should be carried out in a manner that benefits from and contributes to international cooperation. Arctic research policy is subject to periodic review and revision.

U.S. Goals and Objectives in Arctic Research

Arctic research shall be aimed at resolving scientific and technological problems concerning the physical and biological components of the Arctic and the interactive processes that govern the behavior of these components. The objectives include addressing the needs for increased knowledge in such issues as the Arctic as a natural laboratory, national defense, natural hazards, global climate and weather, energy and minerals, transportation, communications, renewable resources, pollution, environmental protection, health, adaptation and Native cultures.

More specific long-term goals have been developed by the Interagency Committee to further guide the revision of the Plan:

- Pursue integrated, interagency research programs;
- Continue to develop and maintain U.S. scientific and operational capabilities to perform research in the Arctic;
- Promote the improvement of environmental protection and mitigation technology and the enhancement of ecologically compatible resource exploitation technology;
- Develop an understanding of the role of the Arctic in predicting global environmental changes and perform research to reveal early signals and to determine the significance of global changes in the Arctic;
- Contribute to the understanding of the rela-

tionship between Arctic residents and subsistence use of wildlife and how this relationship might be affected by global climate change and transported contaminants;

- Include Arctic residents in planning and conducting the research and report results to the individuals and communities involved in the research;
- Continue to document and understand the role of permafrost in environmental activities;
- Advance knowledge of the Arctic geologic framework and paleoenvironments;
- Develop the scientific basis for responding to social changes and the health needs of Arctic people;
- Contribute to the understanding of upper atmospheric and outer space phenomena;
- Develop and maintain data bases and data and information networks;
- Promote mutually beneficial international research programs and cooperation; and
- Develop and maintain a strong technological base to support national security needs in the Arctic.

In addition to these goals and objectives for Arctic research developed by the Interagency Committee, the Arctic Research Commission has provided further guidance for U.S. Arctic research (ARC 1991a) and recommendations for improvements in logistics for support of Arctic research (ARC 1988b) and for focused research on the Bering Sea as an Arctic marine ecosystem (ARC 1988a), on data and information (ARC 1989) and on engineering (ARC 1990). This revision of the Plan is consistent with many of these Commission recommendations.

1.2 Budgetary Considerations

The Act did not provide separate additional funding for Arctic research. Agencies were expected to request and justify funds for these activities as part of their normal budgetary processes. It was anticipated in the 1987 Plan (p.17) that agencies would provide levels of funding consistent with the Plan's recommendations and existing programs. Table 1 presents a summary of each agency's funding for the period of the Act (1985-1991). The total interagency Arctic budget estimate for FY 1991 is \$122 million; for FY 1992 it is \$132 million.

The trends in Arctic funding are given in Table

Table 1. Arctic research budgets by individual Federal agencies (in thousands of dollars).*

Agency	FY 85-89 Average	FY 90 Actual	FY 91 Estimate	FY 92 Proposed
NSF	21,503	24,088	27,567	29,805
DOI	24,497	25,213	27,693	30,465
DOD	23,109	24,540	25,200	28,090
NASA	12,232	17,350	18,030	23,315
DOC	4,894	8,528	12,866	15,614
DHHS	1,311	8,001	9,268	9,561
DA	689	3,962	4,152	4,183
DOE	3,271	2,429	2,082	1,884
SI	568	630	705	705
EPA	225	500	500	1,250
DOT	472	305	305	735
DOS	10	20	60	60
Total	92,781	115,566	128,428	145,667

* Capital facilities are not included in these estimates.

Table 2. Arctic research by major categories (in millions of dollars).*

	1991 enacted	1992 proposed	Dollar change	Percent change
Resource development [†]	49	56	+7	+14
Arctic as laboratory ^{**}	48	50	+2	+4
National security ^{††}	25	28	+3	+12
Total	122	134	+12	+10

* As published in the President's FY 1992 budget. Discrepancies between sums in Tables 1 and 2 for 1991 and 1992 represent recent changes in agency budgets. Categories on resource development and the Arctic as a laboratory include activities directly related to environmental protection and monitoring. See Sections 2 and 3 of this document for details.

[†] Includes DOI, DOC, DA, DOE, DOT, DOS and EPA.

^{**} Includes DHHS, NASA, NSF and SI.

^{††} Includes DOD.

2, organized according to the three major policy objectives described above, and as reported for 1992 in the President's budget request (Appendix D). Early increases in the national security and resource development funding were in part due to modifications in reporting procedures within some agencies as the programs became better defined. Appendix E contains agency budgets broken down by major sub-elements and cross referenced to the policy objectives. The Arctic Research Commission analysis of funding trends in U.S. Arctic research suggests that in terms of constant 1986 dollars, the total funding has remained nearly level at about \$90 million (ARC 1991).

1.3 Interagency Coordination

The Arctic Research and Policy Act (Appendix F) requires cooperation among agencies of the U.S. Government having missions and programs relevant to the Arctic. It established the Interagency Arctic Research Policy Committee to "promote Federal interagency coordination of all Arctic research activities" [Section 108(a)(9)]. The Interagency Committee, under the chairmanship of the Director of the National Science Foundation (NSF), continues to provide the mechanism for developing and coordinating U.S. Arctic research activities. The biennial revisions of the U.S. Arctic Research Plan serve as guidance for planning by individual agencies and for coordinating and implementing mutually beneficial national and international research programs.

Although the two-year period since the last revision of the Plan was submitted has not been long enough to fully organize and implement all its recommendations, significant progress has been made and accomplishments continue to be identified. These include activities of the Interagency Committee and the Arctic Research Commission, the formation of the IARPC Social Science Task Force, the development by IARPC of a statement on principles for the conduct of research in the Arctic (Appendix G), and interagency data activities and the development of a related data directory and products. Selected accomplishments over the past two years for Federal agencies are summarized under each of the appropriate research mission components in Section 3. Additional information can be found in the journal *Arctic Research of the United States* (Volumes 2-4), published by NSF on behalf of the IARPC.

The Act mandates specific requirements for implementing a coordinated U.S. Arctic research program. Mechanisms for appropriate levels of coordination are still evolving. Three levels of coordination and cooperation are needed for an effective national Arctic research program:

- Specific research conducted in the Alaskan Arctic;
- National coordination; and
- International collaboration.

Each element requires a mechanism for internal program development, review and implementation, and each needs to be linked to the other two. The national effort is performed through the Interagency Committee. A staff oversight group of the Interagency Committee provides coordination, assisted by working groups representing specific agency programs. The Working Group on Arctic

Ocean/Atmosphere has developed specific program strategies, as has the recently formed Social Science Task Force. Data, information and logistics groups are pursuing a number of interagency activities. These are reported in the subsequent sections.

Many interagency agreements and planning and coordinating activities already exist in Alaska. A workshop on Federal research information exchange was held in Anchorage, Alaska, in March 1991 to facilitate coordination and the exchange of information. This activity will continue in Alaska under the direction of an ad hoc coordinating group. Coordination with global change programs is an integral part of Arctic program development and implementation. Improved communication at all levels through existing newsletters and journals will be encouraged.

1.4 International Collaboration

The Arctic is becoming an arena for scientific research that transcends national boundaries and interests. Over the past two years there has been an increasing amount of activity involving international cooperation in the Arctic. Prior to this time, Arctic cooperation was confined to bilateral or regional arrangements. The growing willingness of the Soviet Union to cooperate in international forums has facilitated these discussions on circum-arctic cooperation.

In August 1990 the International Arctic Science Committee (IASC) was formalized (*Arctic Research of the United States*, Fall 1990, p. 65). This nongovernmental body includes representatives of all eight Arctic rim nations and other nations with a significant capability in Arctic research (recent members are France, Germany, the United Kingdom, Japan, Poland and the Netherlands). The functioning of the IASC will facilitate cooperative regional research, unprecedented access to Arctic Ocean continental shelves, and the use of platforms and logistical bases not possible in unilateral efforts. The National Academy of Sciences is the designated U.S. representative. An International Arctic Social Sciences Association was also formed in August 1990 (*Arctic Research of the United States*, Fall 1990, p. 75).

Environmental concerns in the Arctic are being addressed at the intergovernmental level as a result of the Arctic Environmental Protection Strategy. A series of meetings were held in preparation for the full ministerial meeting held in Rovaniemi, Finland, in June 1991. Among the results are a

statement of Arctic environmental principles, a strategy for Arctic environmental protection, elaboration of an international Arctic monitoring program, measures on the protection of the Arctic marine environment and on emergency response, and exchange of information on the conservation of Arctic flora and fauna. These represent commitments to cooperate on future Arctic environmental protection activities. Specifically the Arctic Monitoring and Assessment Program plans to be responsible for preparing reports on the state of the Arctic environment; developing monitoring requirements; and as its first priority, coordinating networks of monitoring and assessment activities in the circum-arctic countries.

The U.S. Man and the Biosphere (MAB) Program, through its High Latitudes Directorate, is participating in the UNESCO MAB Northern Sciences Network, located at the Arctic Center, Rovaniemi, Finland. The NSN focuses on protected areas, sustainable development and subarctic birch forests. US-MAB is supporting a senior fellowship to work with the Network secretariat in developing and implementing international plans. MAB also contributed to the development of an International Tundra Experiment (ITEX) to monitor the impact of global change on specific flora and fauna.

Among several bilateral efforts, the new U.S.-U.S.S.R. Oceans Studies Agreement has identified a number of Arctic scientific research proposals that may be developed into joint projects and thereby offer access to the Arctic Ocean region. The U.S.-U.S.S.R. Agreement on Cooperation in the Field of Environmental Protection continues several major Arctic activities related to climate, flora, fauna, ecosystems and pollution. The increasing pace of Arctic research sponsored by the European community is evident in the proposed International Arctic Ocean Expedition-1991 (IAOE-1991), the Nansen Arctic Drilling (NAD) program and the Norwegian Nansen Drift Program. Japan is also expanding its Arctic research efforts in a number of areas, including buoy technology.

The Arctic Ocean Sciences Board (AOSB), a nongovernmental body that coordinates selected Arctic ocean research, has been successful in defining and organizing international research efforts such as the Greenland Sea Project. AOSB attention is now directed at an International Arctic Polynya Program, proposing comparative investigations of polynyas in the Bering Sea, the Greenland Sea and Baffin Bay.

The North Pacific Marine Science Organizations (known as PICES) was established in December 1990 to promote and coordinate marine scientific knowledge in the subarctic region of the north

Pacific Ocean, including the Bering Sea. Studies of the ocean environment and its role in and response to global weather and climate change, uses and resources, and impacts from human activities are all envisioned as projects PICES will undertake.

The governor of Alaska convened the Northern Forum in September 1990 to agree upon regional approaches to economic and environmental cooperation (State of Alaska 1990). Plans to house a permanent secretariat in Anchorage are well underway.

1.5 Revision to the Plan

This second revision to the 1987 United States Arctic Research Plan includes two major sections:

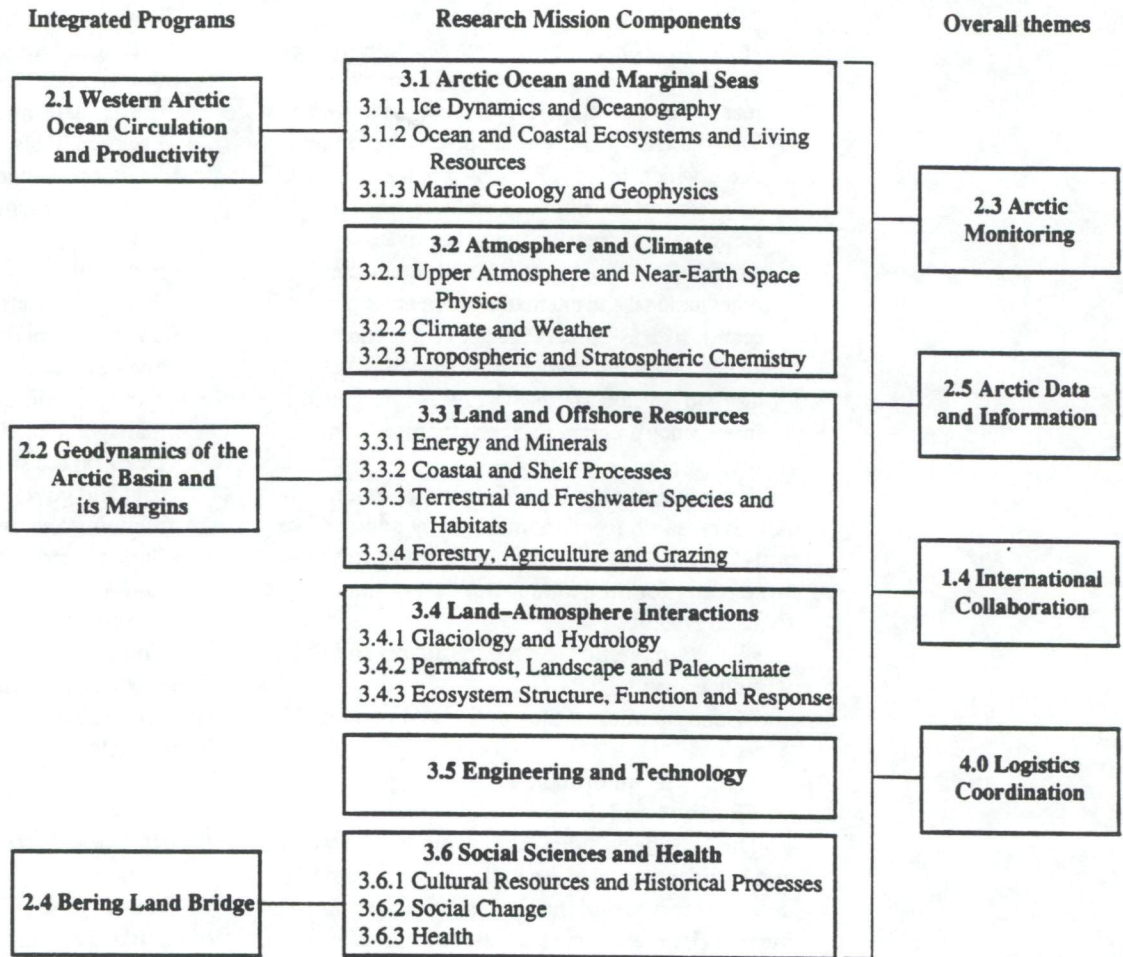
- Section 2. Strategy for Integrated Research Plans
- Section 3. Research Mission Components

As an initial step an interagency program and budget crosscut for the proposed Arctic Ocean Research Strategy program was released in January 1990 at the time of the President's FY 1991 budget submission to Congress (IARPC 1990). The *Strategy for Integrated U.S. Arctic Research Programs*, published in February 1991, builds on earlier suggestions for proposed interagency programs and the Arctic Oceans strategy presented in the 1990-1991 revision. They represent another step in implementing the intent of the Arctic Research and Policy Act. The programs present Federal agency interests in coordinating Arctic programs that involve several agencies and furthering cooperation in the international scientific arena. These cooperative efforts build on existing programs, funding and activities; contribute to the emerging global change programs; and include interagency data and information activities (CEES 1991).

The Research Mission Components represent the individual agency programs and responsibilities. They are presented in six major categories and where common activities exist they are presented as collective activities. The listing does not include every program or project of each agency but represents the major activities and directions. The complementarity of the integrated programs and the research missions is shown in the following figure. Several overall themes transcend essentially all integrated and research mission components.

Section 4 presents current activities related to field operational support necessary for implementation of the proposed interagency programs and research mission activities.

Major Components of the Second Biennial Revision of the U.S. Arctic Research Plan



2. Strategy for Integrated Research Plans

During its meeting of June 28, 1990, the Interagency Committee agreed on the following policy:

"The IARPC agrees that a more comprehensive approach to funding of research and baseline programs is required to ensure a long-term, viable research and development presence in the Arctic. This presence will ensure support of the national needs, which include renewable and nonrenewable resource development, environmental protection, and partnerships with the private sector and residents of the Arctic. It will complement other national and international scientific programs, such as Global Change. To this end the IARPC agencies, in concert with OMB policy, agree to develop, starting in 1992, an integrated interagency program sufficient for meeting national needs."

Subsequently the IARPC agencies examined Arctic research from an interagency perspective and concluded that the following four programs were ready for immediate attention as multiagency focused efforts:

- Western Arctic Ocean Circulation and Productivity;
- Geodynamics of the Arctic Basin and its Margins;
- Arctic Monitoring; and
- Bering Land Bridge.

The U.S. has a substantial economic, strategic and environmental stake in the Arctic. Domestic energy reserves and the explosive growth in Bering Sea fisheries harvests are two examples of our dependence on Arctic resources. Sound management decisions for safe development of Arctic resources hinge on enhanced understanding of the environment, leading to better forecasts. In addition, there is a strong international commitment to collaborate.

Benefits to the Nation from Arctic research includes improved:

- Knowledge of fishery resources and controlling dynamics;
- Models and data for assessing global change and its effects;
- Understanding of past climates;
- International cooperation in a strategic region;
- Forecasts of weather, ice and ocean conditions;
- Protection of the Arctic environment;
- Understanding of causes and effects of air and water pollution; and

- Protection and understanding of historic cultural resources.

These coordinated, multiagency programs are being designed to:

- Focus research activities in concert with national needs and Global Change Research Program plans;
- Build on individual agency efforts in reconnaissance, monitoring, process studies and modeling;
- Facilitate research and logistics coordination through regionally focused programs;
- Take maximum advantage of remote sensing and new technologies;
- Strengthen interagency data and information management;
- Draw on the strengths of the academic, industrial and government research communities in planning and implementing programs;
- Support and enhance programs to acquire long-term measurements of key parameters and environments; and
- Enhance international research collaboration.

The role of the Arctic in meeting national needs and addressing key policy issues is further highlighted below.

Nonrenewable Resources

Currently the U.S. imports approximately 50% of its hydrocarbon needs. Twenty-five percent of our domestic production comes via the Trans-Alaska Pipeline System from Prudhoe Bay, Alaska. The best estimates are that at least 20% of the Nation's future reserves lie on the northern Alaskan coastal plain and adjacent continental shelf. Also, 12% of the Nation's gas reserves lie in the same region, and there are plans for a gas pipeline to transport this resource south. Gas hydrate reserves have been estimated to range from 10^{11} to 10^{14} cubic meters in Alaska and its offshore region.

The Arctic shelves also contain mineral deposits. At least one offshore tin placer has been brought into production in the Soviet Union. Gold placers are being commercially mined near Nome. Dredging for sand and gravel on the Arctic Ocean shelves supports hydrocarbon development and other large coastal and offshore construction projects.

Renewable Resources

Arctic waters support some of the most productive fisheries in the world. The Bering Sea supplies nearly one-tenth of the world's fishery products. An estimated 7 million metric tons of 43 commercial species are caught every year by fishermen from the United States, the Soviet Union, Japan and other nations. Since the passage of the Magnuson Fishery Conservation and Management Act in 1976, American groundfish operations in Alaska have developed into an industry with an annual product value estimated at \$2.2 billion. In 1989, Alaska pollock, with landings of 1.1 million metric tons, was the most important U.S. fish in quantity, amounting to 28% of the U.S. commercial landings. This amount is an 88% increase over landings in 1988 and more than a five-fold increase over the 1984–1988 five-year average. Dutch Harbor–Unalaska, Alaska, was the leading U.S. port in the quantity of commercial fish landings. Alaska leads all states in both total volume and total value of fish landings.

Dramatic and unexplained fluctuations have occurred in the catch of groundfish and shellfish and the stocks of marine mammals. There is considerable concern that walleye pollock population will “crash” as others have in the past. Managing sustainable yields requires further research.

The impact on the coastal economy of Alaska and other northwestern U.S. states is magnified by substantial capitalization in vessels and processing plants and related income to a broad sector of the economy. A sustainable, predictable fishery stock is fundamental to the viability of this sector of the U.S. economy. Research on this marine ecosystem is essential for understanding and managing the resources.

Global Change

High latitudes may experience the earliest unambiguous onset of global warming from the “greenhouse effect.” Global climate models suggest that the amount of warming may be significantly greater in northern high-latitude regions than in lower latitudes, but the models do not agree well on the relative amount of warming to be expected at high latitudes.

Furthermore, there is growing evidence that the polar regions play a key role in the physical processes responsible for global climate fluctuations and in some circumstances may be a prime agent of such fluctuations. For example, North Atlantic deep water formation may be affected by a delicate balancing in the amount of fresh water that is

exported from the Arctic Basin and that flows from the East Greenland Current into the region of deep vertical convection in the North Atlantic. Heat flux through the variable ice cover of the Arctic Ocean may have a profound effect on the surface heat budget and the global climate.

High-latitude warming may disturb the equilibrium of Arctic ice masses and hence global sea levels. Such events are well preserved in the geologic record, and polar regions are a natural repository of information about past climatic fluctuations. Additional data may shed light on the causes and effects of both catastrophic and evolutionary global change. Arctic research applies to virtually every science element in the U.S. Global Change Research Program Priority Framework.

Social and Environmental Issues

Arctic culture is part of, and highly dependent on, terrestrial and marine ecosystems. Northern indigenous communities numbering over 100 in the Alaskan Arctic, with a total population of 50,000, depend on hunting, trapping and fishing. Evidence increases of exposure to contaminants from lower latitudes. Samples of fish tissue and sediments thus far do not show contamination levels as high as in seriously contaminated urban areas in the lower forty-eight states, but they are not as pristine as might have been expected. Recent studies have found that concentrations of carbon dioxide and methane in Arctic haze layers are elevated with respect to background levels. Concentrations of these two gases are correlated, suggesting a common anthropogenic source (fossil fuel combustion) and subsequent transport into the Arctic. Soot carbon has been traced for thousands of kilometers across the Arctic, where it remains suspended in a dry, stable atmosphere. Ozone depletion in the polar vortex has enormous health implications to the people of the Northern Hemisphere.

Opportunities for Arctic Research in the 1990s

Remote Sensing

High-latitude satellite coverage and related data processing will reach a new level of capability in the 1990s. For example, gridded microwave brightness temperatures from both the Nimbus and DMSP satellites, providing low-resolution (50-km) information on sea ice type and distribution, will be available on CD-ROMs through the National Snow and Ice Data Center (NSIDC).

Other satellite data that will be available in the 1990s include ocean color from SeaWiFS (U.S.) and ADEOS (Japan), surface topography from altimeters on ERS-1 (ESA) and TOPEX/Poseidon (U.S. and France), and low-resolution sea ice type and distribution from advanced microwave sounding units on NOAA K, L and M satellites (U.S.). High-resolution (30-m) synthetic aperture radar (SAR) imagery from ERS-1, JERS-1 and RADARSAT satellites (Europe, Japan and Canada), providing ice motion as well as detailed ice type and distribution, will be available from the Alaska SAR Facility (ASF) beginning in 1991. Use of the planned SAR satellites demonstrates the important international dimension of the projected activities. Over the longer term, this capability may be sustained by sensors aboard the planned Earth Observing System (EOS) spacecraft. The prospect of systematic, regional satellite coverage makes major, basin-wide investigations in the Arctic feasible for the first time.

In-situ Sensing

Air-ice-ocean sampling is now being revolutionized by emerging new technologies. Precision navigation from portable, low-power receivers will soon be possible continuously from the satellite-based Global Positioning System now being deployed. A number of options for data telemetry are evolving, including specialized communication micro-satellites, an ionospheric-path HF radio frequency with digital packet switching, and a ground-plane MF radio frequency over ice. Advances in low-power microprocessors and mass storage media (optical disk, digital audio tape, video tape) have provided a new generation of programmable, high-capacity data loggers for field experiments. Innovative sensors and signal processing techniques based on acoustic and optical propagation have opened up new dimensions in probing the structure of the atmosphere, ice and ocean. New materials and high-density energy sources have spawned a new generation of remote platforms such as buoys and autonomous undersea vehicles. Instruments based on such new technology will enable radically new adaptable and interactive observational strategies for process studies, as well as provide the means for long-term, real-time monitoring of primary variables at remote sites.

Fisheries Management

Bering Sea stocks cannot be fished indiscriminately without irreversible changes in the population structure and yield. Agreements between the Presidents of the U.S. and the U.S.S.R. reflect the heightened consciousness regarding the rich fish-

ery, wildlife, mineral and heritage resources of the Bering Sea region.

Representatives of the State of Alaska have called for a study of the Bering Sea aimed at understanding the fisheries dynamics and devising appropriate management options. The Arctic Research Commission has concurred with these concerns and has recommended a multiagency study of the Bering Sea as an ecosystem (U.S. Arctic Research Commission 1991). The existence of long-term fishery and climatic records for this region also helps in investigating fluctuations. PICES (see Section 1.4) is beginning its international activities.

Cultural Exchange

The June 1990 Bush-Gorbachev summit meeting reached a historic agreement on the feasibility of establishing a Soviet-United States International Park in the region of the Bering Strait. At the signing ceremony, President Bush said,

"This park will preserve the unique natural, environmental and cultural heritage of the Bering Sea region of Alaska and Siberia. Just as a bridge of land once joined our two continents, so let a bridge of hope now reach across the water to join our two peoples in this spirit of peaceful cooperation."

Planning for the International Park is proceeding based on a reconnaissance study prepared by the two nations in 1989 (*Arctic Research of the United States*, Fall 1990, p. 13) and a series of joint meetings and planning activities in 1990 and 1991.

Data

Common to all programs is the need for a data management program within the Federal agencies. An Arctic Environmental Data Directory (AEDD) is currently under development. The National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, has a long history of archiving cryospheric data and has recently produced several CD-ROM products of satellite and large experiment data sets. Other national archives hold a variety of data sets. A plan to integrate data archiving activities into an effective and coordinated activity will be developed and implemented over several years. A major Alaska-based bibliographic project (Polar PAC) is producing and updating a CD-ROM that includes listings of all Federal agencies' Arctic reports. Both the data and bibliographic activities will be a continuing effort to support the U.S. participation in an international Arctic Monitoring and Assessment Program.

Budget Analysis

As indicated earlier (Section 1.2), Arctic research budgets within most agencies are not de-

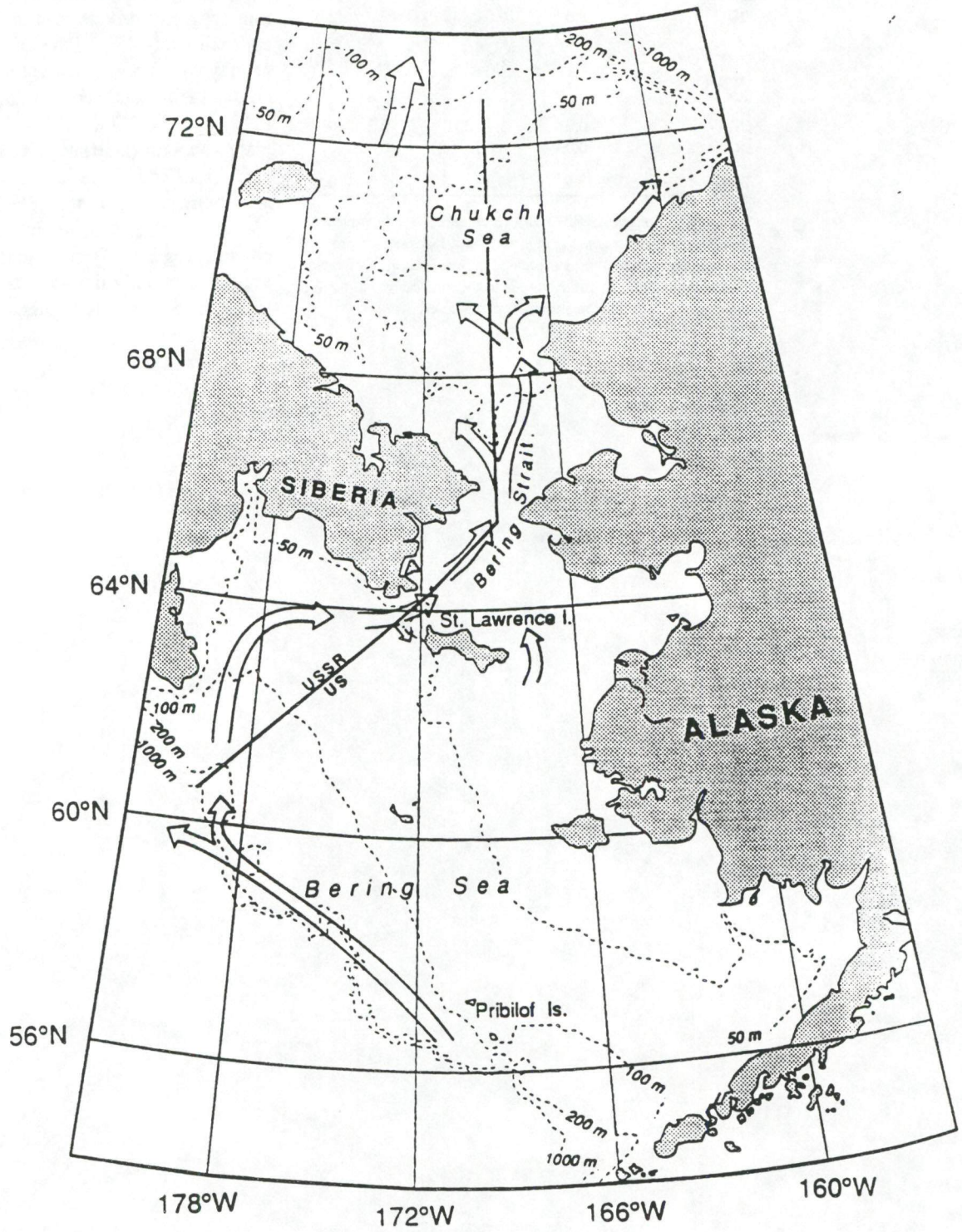
Estimated funds allocated to the integrated research programs* for the interagency Arctic programs (in millions of dollars).

<i>Agency</i>	<i>FY 1990</i>	<i>FY 1991</i>	<i>FY 1992</i>
DOC/NOAA	6.9	9.9 (0.3)	12.1 (0.5)
NASA	5.7	9.0 (9.0)	10.5 (10.5)
NSF	7.0	9.0 (1.5)	11.0 (2.5)
DOD	6.8	6.5 (0)	7.3 (4.2)
DOI	8.0	10.0 (2.0)	10.0 (2.0)
EPA	0.5	0.5 (0.2)	1.3 (0.3)
DOE	2.3	1.9 (0.4)	1.7 (0.4)
USDA	1.7	1.8 (0.2)	1.9 (0.2)
SI	0.6	0.7 (0.3)	0.7 (0.3)
DOT	0.3	1.9 (0)	0.7 (0)
DOS	0.06	0.06 (0)	0.06 (0)
Total	39.9	51.3 (13.9)	57.3 (20.9)

* Includes Western Arctic Ocean Circulation, Geodynamics, Monitoring, Bering Land Bridge and Data. These funds are contained in the line items presented in Appendix E. Estimates for the global change contributions to the total budget in the FY 1991 and 1992 totals are shown in parentheses.

financed as discrete programs or on a regional basis. The same is true for logistics support. The present budget analysis for the integrated programs is subject to the same uncertainties, and it takes into account regional allocations within given programs and the emerging global change programs applicable to the Arctic.

The FY 1991 estimate of \$51.3 million for the four programs described in this report represents approximately 42% of the total anticipated interagency Arctic research and logistics budget. Included in this total is approximately \$6.5 million in FY 1991 (USCG, NOAA and NSF) for large logistics support (ship support) and for data and information. The FY 1992 estimate is \$57.3 million. Approximately 27% and 36% in FY 1991 and FY 1992, respectively, are estimated from global change programs. Descriptions of individual and multiagency activities are provided in the following sections. To fully implement these interagency programs, real growth, including the cost of logistics, is required.



2.1 Western Arctic Ocean Circulation and Productivity

Goal: To understand the processes controlling the physical and biogeochemical variability and the productivity of the marine western Arctic and thus improve both short- and long-term environmental forecasting capabilities.

Background

Both the physical and biological characteristics of the Arctic marine environment are determined by balances between local processes and exchanges with the Atlantic and Pacific oceans. Within the western Arctic region, the Bering Sea, the Northern Bering/Chukchi Shelf and the Arctic Ocean (extending from the shelf approximately to the Lomonosov Ridge) are three coupled yet distinct physical and biogeochemical regimes.

The Pacific source waters for the western Arctic are derived from flow through the Bering Sea, a large portion being nutrient-rich waters that upwell onto the shelf. Upwelling is particularly effective in the northwestern Bering Sea, where it fuels remarkably high biological productivity over the shelf, extending northward to Bering Strait. In contrast, the waters of lower salinity transiting the Bering Shelf farther eastward carry reduced nutrients with correspondingly lower productivity.

From the northern Bering Sea, the Pacific waters continue through Bering Strait into the Chukchi Sea, where, aided by nutrients recycled in winter, they support another extremely productive ecosystem. The carbon production in this region may supply 50% of the respiration demands within the Arctic Basin. Hence, the variability in production and the fate of the carbon are important inputs for calculating the oceanic carbon budget as it pertains to global change. Both the western inflow and the fresher waters entering through eastern Bering Strait are significantly altered in the Chukchi Sea by mixing and by interaction with the atmosphere, the ice cover and the sea floor as they circulate on the shelf. Modified but distinct Pacific waters eventually drain off the Chukchi Shelf into the deep Arctic Ocean. Within the Arctic Ocean the modified Pacific waters spread throughout the Canadian Basin, where they form a distinct layer between the surface ice cover and the warmer water below derived from the Atlantic inflow in the eastern Arctic. In this way the Pacific inflow insulates

the enormous sea ice canopy of the western Arctic from melting and at the same time fertilizes the upper ocean with nutrients originally upwelled across the Bering slope. The stability of this system is critical in maintaining the Arctic climate. There are very few long-term current records for the Arctic Ocean and no hydrographic transects from which to understand the large-scale circulation or water column structure.

Freezing and melting of sea ice in the Bering Sea and on the Arctic Ocean shelves are critical in the process of water mass formation and biological productivity. Ice mechanics also plays a direct role in the transport of energy between the atmosphere and the ocean. Seasonal and interannual variability is extremely large in this system, much of it associated with wind. This region could be critical for future U.S. activity in offshore oil exploration and production. Our ability to proceed with these commercial activities is seriously constrained by the lack of sufficiently accurate forecasts of weather and the strength and movement of the pack ice.

Improving both short- and long-term environmental forecasting capabilities for the western Arctic requires understanding of the role of atmospheric forcing, ice dynamics and the Pacific inflow. What controls the ocean transport and pathways from the deep Bering Sea onto the shelves? What are the principal patterns and scales of the shelf circulation? How does this circulation control production? What are the principal interactions between the variable ice cover and the shelf waters? How are the chemical and biological properties of the northward-moving waters redistributed? How are these waters modified in crossing the vast Arctic shelves? What controls the transport of the shelf-modified waters into the Arctic Ocean and their subsequent spreading? Recommendations contained in *Arctic System Science: Ocean-Atmosphere-Ice Interactions* (Joint Oceanographic Institutions Inc., 1990) and *Priorities in Arctic Marine Science* (National Research Council, 1988) will be considered in implementing the program.

Objectives

- Define the principal pathways, rates and variability of Pacific waters through the western Arctic and the dynamics governing the flow;
- Define the distribution of discrete stocks of important fish, shellfish and marine mammals, and the relationship of these distributions to physical, chemical and biological factors;

- Determine biological production rates and dynamics on the shelves of the western Arctic and assess their susceptibility to change;
- Relate sea ice dynamics to atmospheric forcing and determine the consequences for ocean circulation and biological production;
- Develop an accurate, high-resolution sea ice forecasting system with defined limits of predictability;
- Quantify the relative magnitude and sensitivity of fluxes contributing to the surface heat budget;
- Define the mechanisms and time scales of principal biogeochemical cycles in the western Arctic; and
- Determine the transfer of energy between trophic levels and the sequestration or loss of carbon from the shelf system.

Implementation

Implementation will proceed in phases designed to build data bases and modeling capabilities sufficient to guide the formulation and testing of hypotheses:

Phase I: Reconnaissance site surveys, synthesis of historical data bases, initial model development, interagency and international linkages for collaborative efforts.

Phase II: Multidisciplinary field experiments and process studies with interagency and international collaboration, data assimilation into high-resolution predictive models and long-term observational systems.

Most agencies are prepared to implement a limited Phase I effort with existing resources; several

Summary of existing and planned contributions to the Western Arctic Ocean Circulation and Productivity program.

	<i>Bering Sea</i>	<i>Chukchi Sea</i>	<i>Arctic Ocean</i>
Atmospheric forcing	Interannual variability (NOAA, NSF)		Lead forcing (ONR, NOAA)
Sea ice processes	Interannual variability (NOAA, NSF)		Seasonal variability (NOAA, NSF) Large-scale surface fluxes (NASA, ONR) Lead fluxes and formation processes (ONR, NOAA)
Ocean circulation water mass structure	Seasonal surveys (NOAA, NSF, MMS, USSR, Canada, Japan)		Point monitoring (NOAA, ONR, NSF, Canada) Basin cross section (NOAA, ONR, Canada)
Nutrient distribution	Data synthesis (NSF) Seasonal surveys (NSF, MMS, NOAA)		
Pollutant transport	Seasonal surface trajectories (MMS)		
Carbon cycling	Data synthesis (NSF)		
		Neritic, benthic processes (NSF) Sequestration, export mechanisms (NOAA, NSF)	
Primary, secondary production	Seasonal surveys (NSF)		
	Polynya processes (NSF, NOAA)		
Fish, mammal dynamics	Historical stock analysis (NOAA/NMFS) Pollock recruitment and larvae transport (NOAA/NMFS)	Marine mammal dynamics (NOAA, FWS/MMS)	Polar bear ecology (FWS/MMS)
Instrument development/ application	RNA probe (NOAA)		Autonomous underwater vehicles and oceanographic sampling network (ONR) Buoy systems (ONR) Passive microwave, SAR algorithms (NASA) SEAWiFS color sensor (NASA)

studies were initiated in FY 1990. Phase II represents a significant enhancement with a higher level of coordination. Programs listed under "Future Cooperative Program Elements" have been identified as critical needs that require additional funding for implementation.

Appendix B contains descriptions of specific existing, planned and future cooperative interagency program elements. Activities in Sections 3.1.1, 3.1.2 and 3.3.2 detail specific agency and multi-agency plans that contribute to this integrated program. The diagram on p. 20 is a summary of the overall program.

Future Cooperative Program Elements

Bering Sea

- Expansion of field surveys sufficient to define the spatial and temporal variability in circulation;
- Regional climatology to determine the principal atmospheric and oceanographic forcing of the variable circulation in the Bering Sea;
- Primary and secondary production and its relationship to sea ice dynamics;
- Processes controlling the transfer of energy between trophic levels and the sequestration or export of carbon from the Bering Shelf;
- Coupled modeling of physical dynamics and ecosystem interactions.

Northern Bering/Chukchi Shelf

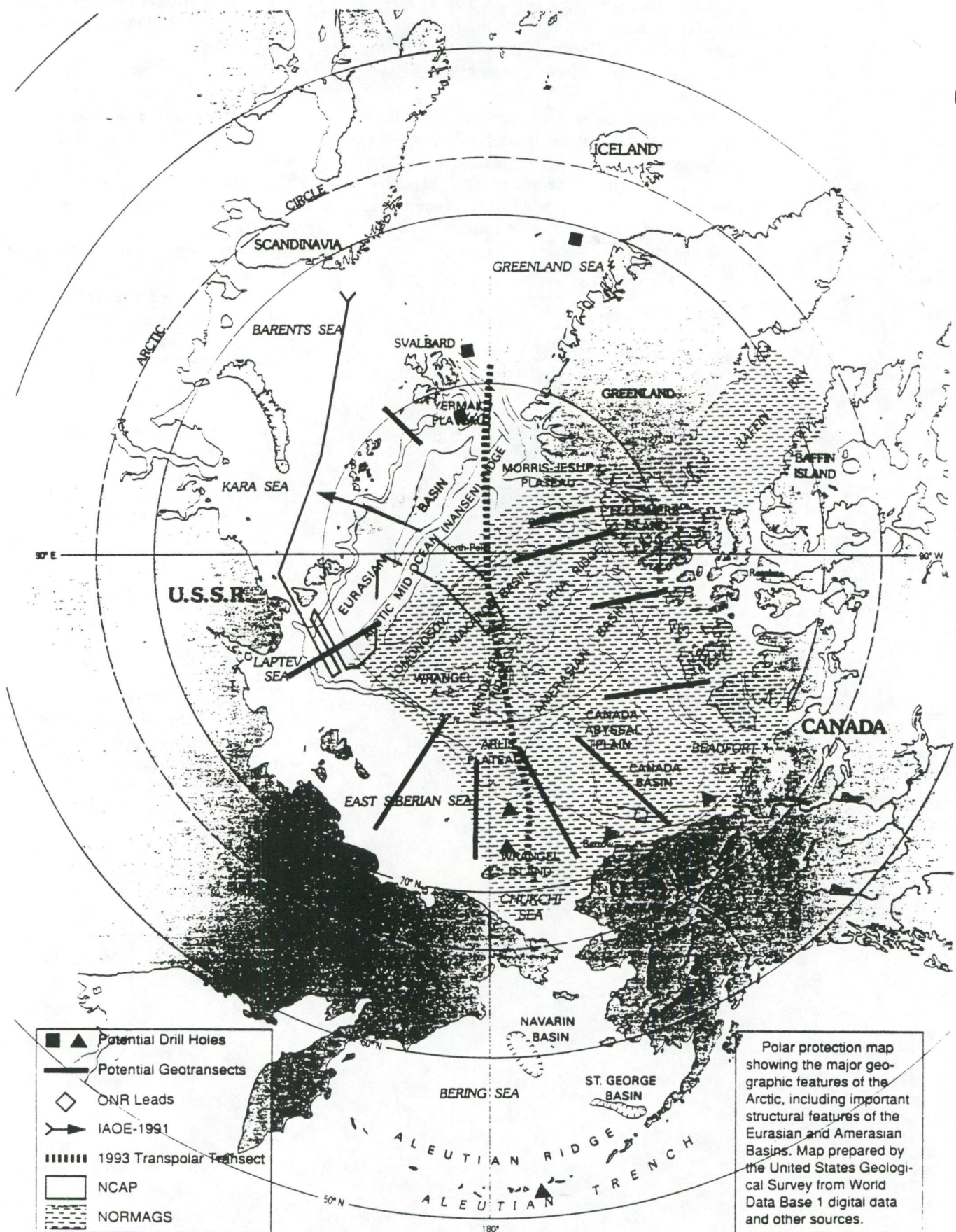
- Shelf-basin exchange, including plume dynamics, export of carbon and nutrients ;

- Expansion of biological sampling and measurements of primary production to define spatial and temporal variability and off-shelf components;
- Monitoring of ice thickness and ice deformation;
- Process studies of ice thermodynamics;
- Integration of SAR data into regional ice models;
- Higher-trophic-level dynamics.

Arctic Ocean

- Proposed coordinated transpolar expedition in the summer of 1993 with a U.S. Coast Guard icebreaker and the Canadian icebreaker *Louis St. Laurent* to obtain oceanographic and geophysical sections across the Arctic Ocean;
- Process studies of circulation dynamics on the continental slope;
- Continuous ocean and ice monitoring for spatial and temporal variability in ice thickness, upper ocean structure, circulation and water column sediment flux;
- Determination of the implications of Leads process studies for the western Arctic (on a regional scale), particularly the consequences for mixed-layer, atmospheric circulation;
- Coupled air-ice-ocean circulation modeling to look at coupling between higher and lower latitudes.

Under the integrated program, agencies will coordinate announcements of research opportunities and will align current research with the goals of the interagency effort. An interagency science steering committee will assure the continuity and integrity of the overall program.



2.2 Geodynamics of the Arctic Basin and Its Margins

Goal: To determine the climatic, paleo-oceanographic and tectonic evolution of the Arctic region and their effects on global climate, the biosphere and the dynamics of world oceans and atmosphere.

Background

The origin of the Arctic Basin is linked to the evolution of adjacent ocean basins and continents. Understanding past and present plate movements in the Arctic is necessary before a complete model of plate motions and paleogeography in the Northern Hemisphere can be constructed. The Cenozoic tectonic history (the past 67 million years) of the Eurasian Basin is relatively well known, since the Eurasian Plate and the North American Plate have been studied extensively to the south. The basin also contains a well-documented and decipherable magnetic lineation history. Little is known about much of the rest of the Arctic Ocean margin system. The evolution of the Amerasian Basin is a major unresolved problem. Rotation of the Arctic-Alaska Plate away from the Canadian NWT during the Cretaceous (prior to 65 million years ago) is consistent with geology of the Canadian Arctic Islands and Alaska. However, interrelationships with the Markarov Basin are unknown.

One of the major unsolved questions in earth sciences is the paleo-oceanographic and paleoclimatic evolution of the north polar deep-sea basins. Identification of greenhouse warming within historical records requires quantifying the magnitudes, frequencies and rates of natural climate change. Of hundreds of samples collected in the Arctic Ocean, only four contain sediments that predate the onset of cold climatic conditions. The oldest black muds (about 80 million years old—Campanian age) and siliceous oozes (about 67 million years old—uppermost Cretaceous and earliest Paleocene) indicate that at least part of the Arctic Ocean was a relatively warm, productive, deep-sea basin prior to 40 million years ago. Three recent cores by the USGS may also record Cretaceous sediments. All other sediment cores from the Arctic Basin contain younger sediment, deposited in a cold, at least partially ice-covered, deep-sea regime. The record documents periods when iceberg-transported, terrigenous sediment was deposited on the basin floor. There are no marine

data from 5 to 40 million years ago when the Arctic climate cooled, and thus no information is available to decipher the forcing functions or time of onset of glacial conditions. Today, dense, cold, Arctic surface waters sink and flow southward, filling the deep basins of the Atlantic and Pacific oceans. This circulation in the past may have been substantially different, with consequent climatic implications. The Alpha and Lomonosov ridges in the past were a greater barrier to circulation than at present; their rates of subsidence are unknown. Understanding the history of the ridges and the basins is critical for reconstructing past climate. Sixty-five million years ago (late Cretaceous), Alpha Ridge may have been a volcanic oceanic plateau. Lomonosov Ridge is probably a sliver of the Barents Sea margin. The geodynamic forces responsible for the origin of the Alpha and Lomonosov slides are unknown.

Twenty-five percent of the Nation's production of hydrocarbons comes from the Alaskan coastal plain, and 20% of reserves are estimated to be within the continental margin. Understanding the geologic history and structure of the Arctic margin is necessary for further development and management of these nonrenewable resources. In permafrost regions in the Northern Hemisphere, both onshore and offshore, considerable quantities of methane in the form of a hydrate are contained within and beneath the permafrost layer. Because global climate warming is postulated to be magnified in the Arctic, accelerated thawing of permafrost may occur, possibly releasing methane into the atmosphere. Continental shelves are potentially rich in gas from suspected frozen methane (clathrate) deposits.

Unlike temperate regions, where water is the only medium of energy exchange with the sea floor, the Arctic continental margin is a unique environmental domain involving not only the water column but also the interaction of two solids, ice and the sea floor. The surfaces of these solids are variable in form, both temporally and spatially, and the dynamics of their interaction results in ever-changing conditions. Erosion rates are extremely high along the low-lying Arctic coastlines, where sea ice and permafrost are common. Specific questions about where to build causeways, man-made islands and other structures can only be answered after basic process information is collected and interpreted. Knowledge of erosion and sediment transport in the Arctic is essential for intelligently managing the coastal region.

The tectonic and paleoclimatic history of the Arctic Ocean margin system needs to be addressed at a minimum of six time ranges:

- The last few hundred years: How precisely do

the sediments record the history of the Little Ice Age and the influence of man on the global system?

- 12,000–18,000 years ago: What changes occurred at the end of the Pleistocene that triggered the decay of the major ice sheets?
- 125,000 years ago: What were the conditions during the last major interglacial period?
- The last 2 million years: What is the timing, magnitude and periodicity of high-amplitude, late-Cenozoic climate oscillations and resultant ice sheets, both continental and marine?
- About 25 million years ago: What conditions triggered the initial Arctic climatic cooling, the formation of sea-ice cover and the earliest glaciations?
- About 67–85 million years ago: What was the climate at the end of the Cretaceous? How can we characterize the preglacial Arctic deep-sea paleoenvironment?

A general question that can be asked for each time range is: What were the paleo-oceanographic and paleontologic (both faunal and floral) responses to climate change, warm–cold oscillations and changes in the depth and width of ocean corridors linking the Arctic with the global ocean?

Objectives

- Determine the tectonic and geologic history of major structural elements of the Arctic Ocean margin system;
- Determine the climatic and paleo-oceanographic evolution and their effects on global climate;
- Understand coastal processes unique to high-latitude shelves;
- Estimate the volume of methane in permafrost regions and how rapidly it would be released by various degrees of warming; and
- Establish the tectonics and sea level oscillations of the Bering land bridge in order to understand the fauna and flora migrations.

Implementation

Implementation is designed to take advantage of planned and proposed international programs, including those of the International Arctic Science Committee and the Arctic Ocean Sciences Board. The initial activities are primarily exploratory.

Multi-year programs involve major additional operational support. Sections 3.1.3 and 3.3.2 present specific agency and multiagency plans that contribute to this integrated program.

Future Cooperative Program Elements

Joint U.S./Canadian Traverse of the Arctic Basin

The geologic component will include a geophysical transect of the Chukchi borderland to obtain seismic refraction and reflection data to define Arctic continental margins. A super corer and gattling gun drill may be used to sample the geologic structure and obtain paleo-oceanographic data.

Northern Magnetic and Gravity Surveys

Detailed aeromagnetic and aerogravity surveys of the Amerasian Basin and continental margins will be required and will provide the basis for a series of up to twelve geophysical and sampling transects. It is anticipated that the Geological Survey of Canada will participate in NORMAGS.

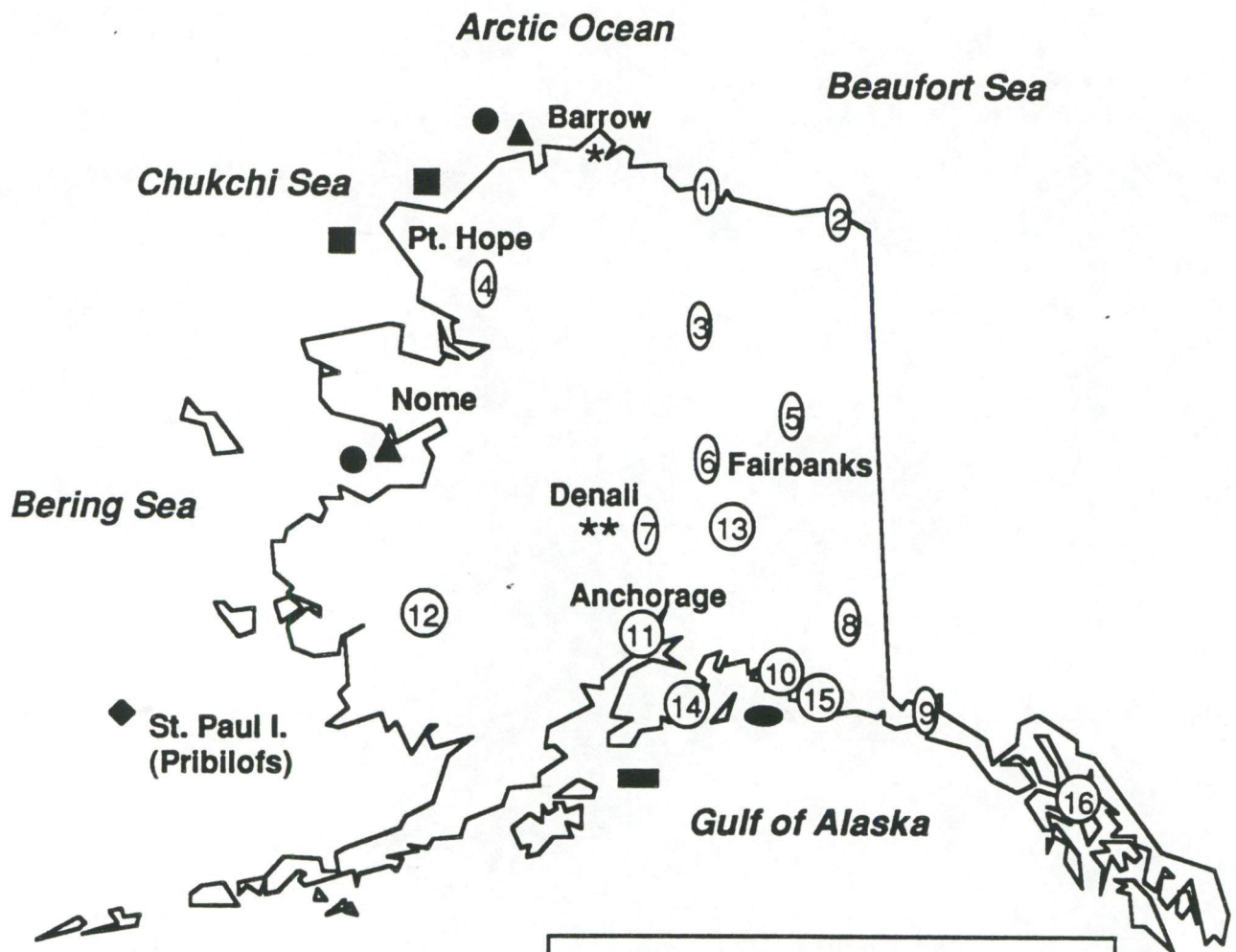
Arctic Gateway Drilling

The Ocean Drilling Program is based on paleo-oceanographic and tectonic objectives and recommendations of thematic panels and will consider Arctic drilling sites.

Nansen Centennial Arctic Program (NCAP)

Norwegian scientists plan to commemorate the Nansen "Fram" drift of 1883–1886 with a freeze-in of an ice-strengthened vessel for a two-year drift, probably starting in the Laptev Sea. The geological objectives are to elucidate the structure and evolution of the Arctic continental margins; the structure and evolution of the marginal plateaus and the Lomonosov Ridge; the structure of the lithosphere and the junction of the Arctic Mid-Ocean Ridge and the Laptev Sea margin; the preglacial Arctic Ocean; the timing and characteristics of initial climatic cooling and glaciation; the timing, magnitude and periodicity of high-amplitude late-Cenozoic oscillations, with emphasis on the late interglacial–glacial cycle; the development of deep circulation adaptations of marine biota to a cold hydrosphere; and sediment flux and carbon cycling in the Arctic Basin.

Selected Alaskan Research and Monitoring Sites



Tissue Sample Sites

- ▲ Ringed Seal
- Bearded Seal
- Beluga Whale
- ◆ Northern Fur Seal
- Harbor Seal
- Northern Sea Lion

Monitoring Sites

- * CDML/Seismic Observatories
- ** Denali NADP/NTN
- 1 Colville
- 2 ANWR
- 3 Toolik Lake LTER
- 4 Noatak
- 5 Yukon Flats
- 6 Bonanza LTER
- 7 Denali/Black Rapids Glacier
- 8 Wrangell/St. Elias
- 9 Hubbard/Malaspina
- 10 Copper River
- 11 Susitna
- 12 Kusko/Bethel
- 13 Gulkana Glacier
- 14 Wolverine Glacier
- 15 Bering Glacier
- 16 Mendenhall Terminus

2.3 Arctic Monitoring

Goal: Building on existing sites and data bases, to participate in a coordinated international network of long-term atmospheric, terrestrial and oceanographic monitoring stations and to facilitate analysis, storage and dissemination of acquired data.

Background

Public, scientific and intergovernmental concerns for the well-being and protection of the Arctic are increasing. It is often difficult to distinguish between changes in the environment due to human-induced activities and those resulting from natural variability. Furthermore, the Arctic is being exposed to increasing inputs or effects of contaminants from lower latitudes due to atmospheric, marine and riverine transport. The spatial and temporal variability of contaminants, their fates and effects, and the overall status and trends in the quality of the Arctic environment and the condition of the biota are generally not well known.

Within the last ten years the governments of the circumpolar states have become increasingly aware of the need, and their responsibility, to combat these threats to the Arctic ecosystem. The June 1990 Bush-Gorbachev joint statement on the environment emphasized the importance of coordination of global atmospheric, terrestrial and ocean monitoring systems.

As indicated in Section 1.4, the Arctic Environment Protection Strategy includes an international Arctic Monitoring and Assessment Program (AMAP), whose primary objective is to measure the levels of anthropogenic pollutants and assess their effects in relevant components of the environment, focusing on pertinent organic contaminants and selected heavy metals and radionuclides.

The U.S. agencies, in accord with national and international programs and agreements, propose to develop their contribution to this international Arctic Monitoring and Assessment Program. The U.S. activities include monitoring chemical, biological and physical conditions and conducting environmental process research. Included are assessments of the nature and degree of contamination, the effects of contamination and other forms of human disturbance on the biota and ecosystems, and variations of physical parameters of the environment. Monitoring the physical parameters of the environment or the cryosphere (sea ice, permafrost, snow cover, glaciers etc.) is identified and also is being addressed in more detail in the U.S. Global Change Research Program.

Monitoring and related research in the Arctic is important for:

- Establishing a quantitative baseline against which natural variability and future changes can be evaluated;
- Detecting food chain contamination in ecosystems and humans;
- Detecting early signals of biological and physical changes in the environment;
- Determining sources and persistence of natural and anthropogenic contaminants;
- Determining sources and effects of natural and anthropogenic disturbances;
- Serving as a basis for management, mitigation and preservation of biodiversity (flora, fauna and habitats); and
- Developing more accurate predictive models of Arctic variables and establishing the information to initiate these models.

Deficiencies in existing national and international Arctic programs include:

- The minimal amount of baseline data from which to establish trends;
- The lack of a comprehensive network of environmentally appropriate sites;
- The lack of standardized strategies and protocols for gathering data across existing sites;
- The lack of a long-term commitment to coordinated, interagency observational programs;
- The lack of systematic storage, access and analyses of Arctic environmental data; and
- The lack of adequate international coordination.

The goals and objectives for program design and data management are to:

- Design a national and cooperative international sampling network and protocols, and provide for intercalibration of instruments and methods;
- Extend baseline measurements at selected U.S. sites and along transects (CMDL, LTER, NADP, parks and refuges, ALERT sites);
- Provide international harmonization of standards for measuring key pollutants and ecosystem health;
- Conduct satellite-based atmospheric observations and marine expeditions and cruises to document transport processes and rates of change;
- Develop habitat indices and inventories of species, populations and communities for assessing impacts and monitoring change;
- Conduct research on the fate and effects of chemical contaminants;
- Further develop centers for the international storage, exchanges and analyses of environmental data; and

Existing chemical, ecological and cryospheric research- and monitoring-related activities within agencies.

Atmosphere	
Climate	DOC/NOAA
Chemical	DOC/NOAA, DOE, DOI/NPS, EPA, NASA, NSF
Oceans	
Physical	DOC/NOAA, DOD/ONR, DOI/MMS, NSF
Ice	DOC/NOAA, DOD/ONR, DOI/USGS, DOT/USCG, NASA, NSF
Chemical	DOC/NOAA, DOI/MMS, NSF
Biological	DOC/NOAA, DOI/MMS/FWS, NSF
Geological	DOI/USGS, NSF
Terrestrial Environments	
Freshwater	DOC/NOAA, DOI/FWS/USGS/NPS, EPA, NSF, USDA/FS/SCS
Land	DOI/BLM/NPS/FWS/USGS, NSF, EPA, DOE, USDA/FS
Snow/Glaciers/Permafrost	DOD/CRREL, DOI/USGS/NPS, NASA, NSF, USDA/FS/SCS
Social	
Socioeconomic	DOC/NOAA, DOI/MMS/BIA
Cultural	DOI/BIA/NPS/MMS, NOAA, NSF, SI

- Identify data sets for input to the Arctic Environmental Data Directory (AEDD) and the Arctic Data Interactive (ADI) CD-ROM.

Implementation

The U.S. monitoring activities will be conducted, in part, on a network of long-term terrestrial and oceanographic stations generally situated along transects and environmental gradients. One component, the Arctic Long-term Environmental Research Transects (ALERT), will consist of monitoring, assessment and research activities on physical, chemical and biological properties and processes. ALERT sites will be coordinated with circumpolar sites and other major U.S. and international programs (LTER, NADP, IGBP, UNESCO-MAB, IHP etc.) and expeditionary programs such as AGASP and routine satellite and oceans monitoring programs. Workshops are planned to design the sampling and monitoring approaches. EPA proposes to convene an international symposium on research and sampling designs to assess the status of, and changes in, the Arctic environment. These activities will be coordinated with AMAP, IASC and other international programs that have provisions for long-term monitoring (IGBP, MAB etc.). Essentially all mission research components presented in Section 3 of this Plan contain monitoring activities as illustrated below. See Appendix B for further details.

Future Cooperative Program Elements

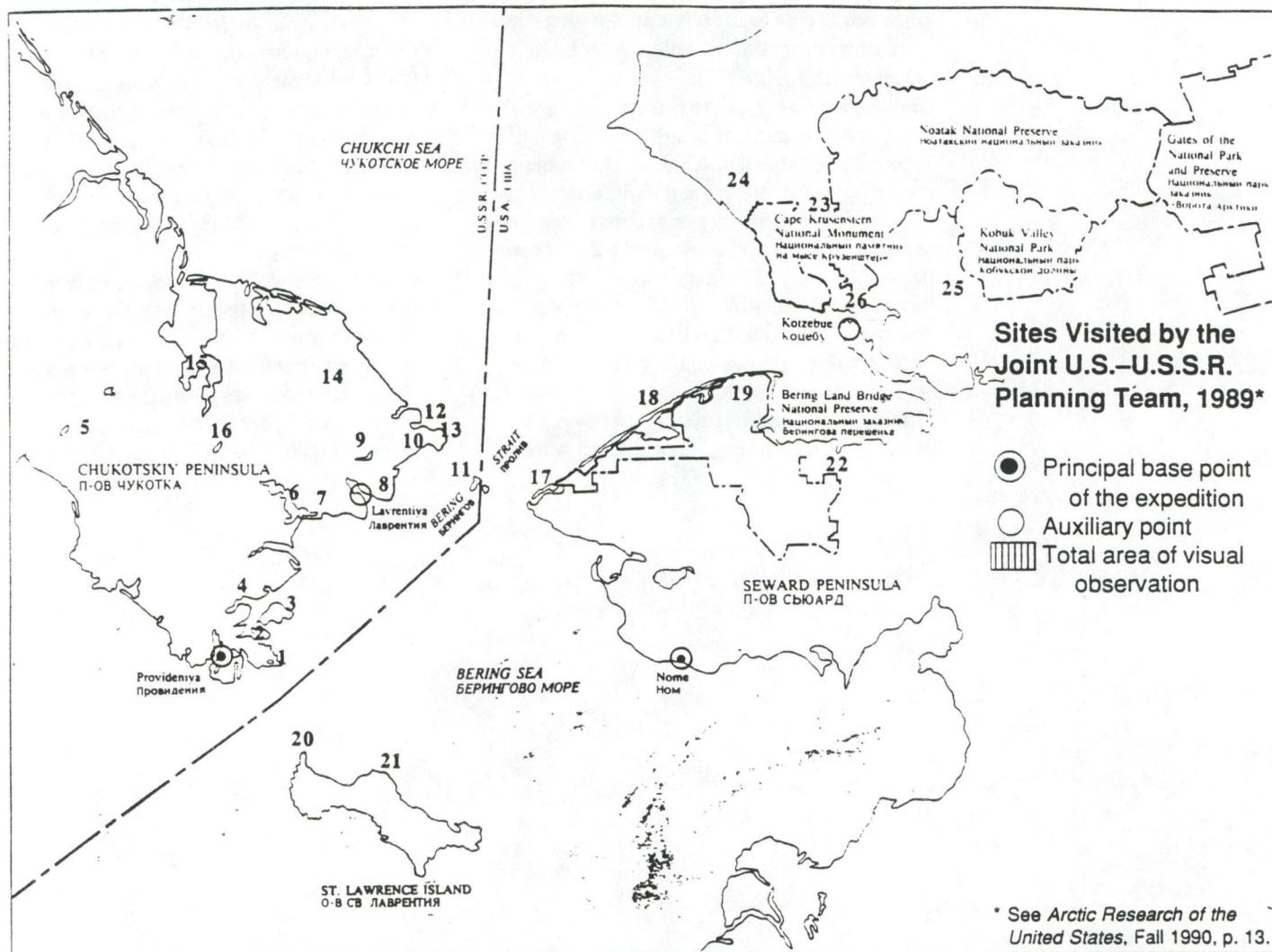
- Design a monitoring program as part of an international Arctic Monitoring and Assessment Program, expand the AEDD and participate in workshops and symposia;
- Further develop appropriate methodologies for assessing the extent and magnitude of pollution in Arctic ecosystems caused by airborne contaminants; lichens, mosses, lacustrine sediments and snow will be sampled using a quantitative spatial sampling design (EPA);
- Under an expanded Arctic Studies Center, renew the Smithsonian Institution's basic systematic, evolutionary and ecological research on the Arctic biota in several key areas: inventory of the plant and animal species in both the terrestrial and marine environments, distribution and ecology of species, systematics and evolution of Arctic taxa, life history and environmental adaptation, and questions relating to the conservation of biodiversity (SI).
- Develop plans for upgrades to the ASF to accommodate SAR data from the Canadian Radarsat, which would offer the first opportunity to obtain weekly synoptic SAR coverage of the entire Arctic ice-covered oceans; together with other satellite and in-situ data, such observations would enable estimates of energy fluxes between the ocean and atmosphere at high latitudes (NASA);
- Develop a quantitative classification system for snow covers based on a broad range of physical properties (DOD/CRREL);
- Establish an Arctic data office to control data quality, promote data exchange, and link data and information; establish a real-time coastal ocean monitoring and analysis capability in the Arctic within NOAA's Coastal Ocean Program. Develop and distribute data on coastal oceanography and fisheries in a CD-ROM, based on a compilation of Beaufort Sea studies (DOC/NOAA);
- Conduct cooperative long-term ecosystem monitoring along two transects: a circumpolar transect in the boreal and Arctic climatic zones, and a Pacific transect from Alaska to Tierra del Fuego; monitor total carbon loading, vegetation vigor and health, employing research tools such as GIS/remote sensing modeling and dendrochronological techniques (USDA/FS);
- As part of the Northwest Alaska Biogeographic Area global change program, centered on the MAB-designated Noatak National Pre-

serve, establish a monitoring and research program that contributes plant, animal and environmental data to the circumpolar long-term monitoring program, including Soviet Arctic preserves (DOI/NPS);

- Undertake a five-year program on contaminants in Arctic fish and wildlife to sample tissues and to establish baseline levels for determining seasonal, annual and individual variations, identifying species or groups of species as contaminant sinks, determining their potential vulnerability to contaminant effects, and identifying the relationship of contaminants to patterns of habitat use and movement known from ongoing satellite telemetry and molecular stock identification studies (DOI/FWS);
- Monitor the effects of subsistence usage on populations and the effects of subsistence on

regional ecology (DOI/BLM/NPS);

- Conduct studies related to global climate change (DOI/BLM/NPS);
- Enhance regional glacier monitoring through the establishment of north-south and east-west transects of "benchmark" maritime and continental glacier basins in North America and further develop sea ice, snow, hydrologic, permafrost and trace gas monitoring programs under the Global Climate Change Program (DOI/GS/NPS); and
- Develop a network of comparative research sites to determine the impacts on tundra ecosystems disturbed 5 years to several decades ago to better predict temporary or long-lasting changes in moisture, permafrost, vegetation and microbial populations, gas flux and soil composition (DOE/ER).



Sites on Chukotka—Area of Interest

- 1 Chaplino—Ethnography, Archeology
- 2 Whalebone Alley—Archeology
- 3 Arakamchechen Island—Archeology, Walrus Haulout Area
- 4 Korgan and Pestsovoi River Valleys—Hot Springs
- 5 Erguveym River Valley—Hot Springs
- 6 Mechigmen Inlet—Archeology, Bird Nesting Area
- 7 Lorino—Hot Springs
- 8 Nunyamo—Archeology
- 9 Lake Koolen—Natural Phenomena, Fish, Migratory Bird Resting Area
- 10 Dezhnev—Archeology
- 11 Big Diomed Island—Archeology, Walrus Haulout Area
- 12 Cape Dezhnev, near Uelen—Archeology, Ethnography, Ivory Carving
- 13 Naukan—Archeology
- 14 Chegitun River Valley—Scenic Views, Rich Flora and Fauna

- 15 Kolyuchinskaya Inlet—Rare Fish Species, Migratory Bird Resting Area
- 16 Lake Ioni—Rare Fish Species, Migratory Bird Resting Area

Sites in Alaska—Area of Interest

- 17 Wales—Coastal Subsistence Lifestyle, Archeology, Ethnography, Reindeer Herding
- 18 Sishmaref—Coastal Subsistence Lifestyle, Archeology, Marine Mammals, Lagoons
- 19 White Fish Lake and Bering Land Bridge National Preserve—Archeology, Geology
- 20 Gambell—Island Subsistence Lifestyle, Ivory Carving, Archeology, Ethnography
- 21 Savoonga—Island Subsistence Lifestyle
- 22 Deering—Coastal Subsistence Lifestyle
- 23 Noatak—Interior Subsistence Lifestyle, Ethnography
- 24 Kivalina—Coastal Subsistence Lifestyle, Ethnography
- 25 Kiana—Interior Subsistence Lifestyle, Archeology, Ethnography
- 26 Kotzebue—Subsistence Lifestyle, Ethnography,

2.4 Bering Land Bridge Program

Goal: To promote the understanding of the common heritage of Beringia and improve our knowledge of human adaptation and the paleo-environments of the region during and since the last glaciation.

Background

The ecologically rich Beringian region has long been seen as the birthplace of New World Arctic cultures and the center from which these cultures spread into other regions of the New World and nearby Asia. Geographically the region is crucial to any understanding of North Pacific and Arctic prehistory. This region saw the first migrations of humans into the New World, has been a center of Eskimo development, and has been an important conduit for Asian-American cultural exchanges for at least the past 15,000 years. The long history of human occupation of the Beringian region provides an unparalleled record of human adaptation to changing climatic, environmental and sociocultural conditions. Today the ecologically diverse and resource-rich Beringian region is home to numerous native groups, whose participation in political and economic development is essential. Archaeological excavations in the Bering region provide long-term data on faunal changes in both marine and terrestrial mammals, as well as changes in invertebrates, plants and soil chemistry. Coastal settlements correlate with changes in sea level and reflect the influences of these changes on local and regional animal and plant populations. Pollen and macrofossil samples from cores and stratigraphy from settlements and sediments can be closely correlated with human activities and environmental change. These data can provide the time depth necessary to construct predictive and testable models of relevance to all aspects of global change research.

The Bering region provides exceptional conditions for research cooperation in the Arctic. Recent political and scientific developments provide research opportunities that have not existed for more than half a century. This program proposes multiagency research with a strong interdisciplinary and international focus. Among the most important research topics that can be addressed in the Bering region are the peopling of the New World,

adaptations and the dynamics of Arctic social and cultural change, the paleoecology of the region, and contemporary cultural, social, psychological and health issues.

In 1989 a joint Soviet-American planning team proposed the creation of a Beringian Heritage International Park and outlined a strategy for its creation. The principal goals would be to promote scientific cooperation, preserve natural and cultural sites, and provide opportunities for coordinating resources.

The proposed Beringian Heritage International Park offers a concrete focus for interagency and international social and natural sciences research coordination and implementation in the Arctic (*Arctic Research of the United States*, Fall 1990, p. 13).

The social sciences (archeology, anthropology etc.) provide the core of this integrated initiative, which involves collaboration with natural sciences, including paleoecology, geology and biology. The research program provides both time depth and a multidisciplinary analysis of human adaptation in the Arctic. Knowledge will be gained about circumarctic cultural development, past and present, and models formulated for human-ecosystem dynamics and demographic change.

Cultural resource management is a mission of numerous Federal agencies. In this regard the Department of the Interior (particularly the National Park Service, the Bureau of Land Management and the Bureau of Indian Affairs), the Smithsonian Institution and the National Science Foundation are important partners in research and surveys having to do with prehistoric and historic sites as well as indigenous cultures of today. Cooperative scientific investigations on Federal lands must be undertaken to accurately document and manage cultural resources. Without accurate documentation, preservation policies cannot be properly assessed. The same is true regarding modern indigenous socioeconomics and health concerns, and collaboration with the Department of Health and Human Services and its Indian Health Service, NOAA's Sea Grant Program, local governments, and Native councils and organizations in Alaska.

The program is presented at two levels: the overall Bering Land Bridge region and the specific proposed Beringian Heritage International Park. Related recommendations contained in the report *Science in Northwest Alaska: Research Needs and Opportunities on Federally Protected Lands* (D.M. Hopkins et al. 1990) will be considered in implementing this program.

Goals and Objectives

Goals

- Increase baseline documentation of Beringian cultures and archeological sites in relation to sea level change;
- Increase baseline information on the ethnography, linguistics and history of Beringian peoples and cultures;
- Document human responses and adaptation to changing climatic, environmental and socio-cultural conditions; and
- Reconstruct paleoenvironments and distributions of flora and fauna in Beringia.

Objectives

- Conduct geological and archeological surveys of coastal regions to establish relationships between prehistoric settlements and sea levels;
- Monitor the effects of coastal erosion on prehistoric and historic sites in the Beringian region;
- Conduct paleoecological studies (e.g. palynology, paleontology, geology) of coastal regions and correlate the results with archeological data;
- Conduct ethnographic, linguistic and oral history surveys to determine key research problems and areas;
- Conduct socioeconomic and cultural studies to minimize the disruption caused by development; and
- Establish resource profiles of coastal regions.

Goals and Objectives of the Proposed Beringian Heritage International Park

- Promote the understanding of the common heritage of Beringia;
- Preserve and protect for research a portion of the 1000-mile-wide land link that intermittently connected Asia and North America between 14,000 and 25,000 years ago;
- Establish joint programs for the benefit of the international park and the preservation of the Beringian heritage;
- Establish a joint center (or centers) to work on projects relevant to resources of the common heritage and to provide scientific support for the international park; and
- Act as a catalyst for research efforts by encouraging international and interdisciplinary research.

Implementation

This focused social and natural sciences initia-

tive will be undertaken within the framework of interagency cooperation. Using cooperative agreements, an interagency working group composed of representatives from Alaska- and Washington, D.C.-based agencies will develop and implement existing and required new programs as described below. Programs under the U.S.-U.S.S.R. Agreement on Cooperation in the Field of Environmental Protection will be utilized to facilitate the international aspects of the bilateral research (Working Groups IV, V, VIII, X, XI).

Missions and research specialties unique to individual agencies are to be combined into a coordinated plan. Each agency will support specific activities: NPS through contract and in-house studies on park lands; NSF through peer-reviewed projects; and the Smithsonian Institution through in-house programs and academic collaborators. Coordination on Federal lands will be through the land managers (NPS, BLM, FWS etc.). These activities will be coordinated with nongovernmental programs of the National Audubon Society, The Nature Conservancy and others. Logistics in Alaska will be coordinated with the National Park Service and cooperating agencies. Sections 3.3.2 and 3.5.1 and Appendix B detail specific agency and multiagency plans that contribute to this integrated program.

Existing and Planned Agency Contributions

Agencies and academic collaborators will use 1991 to coordinate ongoing activities and plan specific scientific investigations on both sides of the Bering Sea. The opening of the Smithsonian's *Crossroads of the Continents* exhibit in Alaska in April 1991 and associated visits of Soviet scholars has provided a focus for such activities. Quaternary scientists having active research programs in the Far East and Alaska are meeting in Alaska in 1991 to reexamine existing hypotheses and evidence of the paleoecology of Beringia and to plan future activities.

Joint U.S.-Soviet meetings were held during 1991 in Moscow, Leningrad, Denver and Alaska to discuss more specific program details and steps required to formally establish the proposed international park. Additional exchange visits are underway, and a joint seminar is planned for August 1991 in Provideniya. A status report on progress and future plans of the international park is in preparation.

A series of joint U.S.-U.S.S.R. field programs in Chukotka, the Heritage Park and northwest Alaska will be carried out over a three-year peri-

od. U.S. participation will be planned by the inter-agency working group and will include major research themes on environmental archaeology, global change, and sociocultural and ethnohistorical research. The summer of 1991 will be the start-up for the U.S. research program in the existing Bering Land Bridge National Preserve. A series of projects identified by the NPS in collaboration with the research community will be initiated. Major conferences and publications will be undertaken to disseminate information on research results and ongoing programs. A series of symposia are planned for 1992.

Funding will be required to strengthen Federal programs relating to Arctic cultural-historical baseline studies in archaeology, geology, anthropology, oral history and subsistence. Data base development and coordination within Alaska and between U.S. and Soviet programs are important parts of the research and will greatly enhance the use of existing research knowledge and data. Specifically needed are:

cifically needed are:

- Compilation and coordination of cultural and natural resource data for the Bering region in the U.S. and U.S.S.R.;
- Archaeological, ethnographic and ethnohistorical investigations; exhibitions and educational programs; mapping in connection with geomorphic, paleoecological and archaeological surveys; and documentation of the people, wildlife, flora and landscape of Beringia;
- Scientific workshops in conjunction with the planned research centers and infrastructure development;
- Continued research relating to the peopling of the New World;
- Documentation of northern maritime cultural adaptations; and
- Academic research grants for disciplinary and multidisciplinary Bering projects relating to global change, stratigraphy, paleoecology and human adaptation.

2.5 Arctic Data and Information

Goal: To facilitate Arctic research by identifying and developing methods to improve the acquisition, storage and dissemination of Arctic data and information.

Two major activities are underway: development of the Arctic Environmental Data Directory (AEDD) and its associated Arctic Data Interactive system (ADI); and the Arctic Bibliographic Information Network. The IARPC requested that funds be made available from each agency to support the AEDD and ADI at the U.S. Geological Survey. Seven agencies are currently contributing direct funds to this effort.

Arctic Data

The area of Arctic data has been active in recent years, and there have been several significant interagency accomplishments.

The Arctic Environmental Data Directory, developed by the USGS with assistance from all agencies, now contains over 350 references to Arctic data bases maintained by government, academic and other organizations in the United States (including Alaska state and local governments), Canada, the Soviet Union, Finland, Norway and Iceland. Coverage is being extended to include the social sciences.

The Council on Northern Resources Information Management (CONRIM) established an AEDD Subcommittee in Alaska to identify additional data entries from state and local government agencies, Alaska-based Federal agencies and other Alaska-based organizations.

The AEDD Working Group coordinated its activities with the Interagency Working Group (IWG) on Data Management for Global Change, the Polar Research Board and the Arctic information sciences community. The IWG sponsored development of the Arctic Data Interactive (ADI) prototype CD-ROM to package and distribute the AEDD, together with selected data sets, scientific reports and bibliographic information. The first CD-ROM containing the AEDD and examples of specific Arctic data sets, which can run on both Macintosh and IBM-PC compatible desktop computers, was issued in the spring of 1991. The USGS was the lead agency for this project.

DOE has developed a user-friendly, menu-driven

data base containing fossil-energy-related information on the Arctic (the Arctic and Offshore Research Information System, or AORIS). It consists of a directory of 85 data bases containing Arctic fossil-energy-related information; over 8000 references and abstracts on fossil-energy-related research; and scientific and engineering information containing over 800 data sets on sea ice characteristics. AORIS is available to the public through DOE's Morgantown Energy Technology Center computer system and the National Energy Software Center.

NOAA has produced the Alaska Marine Contaminants Database on a CD-ROM as a demonstration product that compiled existing data into a single data base and made it accessible to scientific users.

Objective

- Have the AEDD become the source of information on who has what data and information in the Arctic community.

Planned Interagency Activities

- Over the next two years, increase the number of entries from Alaska-based organizations, expand activities in the social and health sciences, continue to acquire data from other Arctic nations, and implement a process to update and review entries periodically to ensure that the directory remains current;
- Develop an interface with the international Arctic Monitoring and Assessment Program;
- Continue to merge digitized and bibliographic data bases and activities into a common national and international information network;
- Integrate the data activities with geographic information systems (GISs) and provide for ease of modification of the data system as computers and storage technologies change;
- Support the data handling requirements of Arctic marine and terrestrial mesoscale ecosystem programs (e.g. Bering Sea) and other integrated U.S. Arctic programs;
- Develop the ADI as a serial publication containing Arctic data and metadata; and
- Establish formal relationships between the AEDD and other related directories, such as the Global Change Data Directory and the directory activities of the Antarctic research community.

Arctic Bibliographies

Literature and bibliographies supporting Arctic research exist in a number of U.S. library collec-

tions and smaller agency libraries, as well as in Canadian and other international collections. Many additional reports accumulate as "gray" literature, uncataloged in organized collections. To avoid duplication of research and to improve access to existing results, it is necessary to provide mechanisms for integrating these resources. Ways of automating, integrating and exchanging Arctic bibliographic references are being developed, in cooperation with the related efforts on Arctic data, to increase the efficiency of access to both digital data and bibliographic information.

The National Science Foundation has supported the creation of an electronic bulletin board on OMNET to facilitate information flow, particularly among libraries (POLAR.LIT).

Several CD-ROM bibliographic products (Polar Pac, NISC and AORIS) were produced and evaluated both within the U.S. and internationally. These products were developed by DOD/CRREL, DOE/FE and NSF.

The Polar Library Colloquy, at their meeting in Rovaniemi, Finland, in June 1990, agreed to develop a process of shared resources for cataloging and disseminating information on polar literature. A U.S.-sponsored group met at Dartmouth College

in Hanover, N.H., in April 1991 to review progress on networking and sharing bibliographic information and activities.

Objectives

- Promote regular exchanges of information on northern collections, new acquisitions and methods of information processing, including the social science disciplines;
- Develop a network of northern libraries to promote dissemination of all Arctic bibliographic information; and
- Provide user-friendly computer searching of global polar-related bibliographic data bases.

Planned Interagency Activities

- Continue to develop and distribute CD-ROM bibliographic products and on-line access for searching Arctic bibliographic data bases;
- Complete the final agreement on the first phase of the shared resources for acquisition and cataloging of polar information during the Polar Libraries Colloquy meeting in Columbus, Ohio, in May 1992; and
- In conjunction with the AEDD activities, continue to improve the networking of digital and bibliographic sources of national and international information on the Arctic.

3. Research Mission Components

This section of the revision to the Plan covers the six major components and their individual mission elements. For each element, selected accomplishments by Federal agencies are highlighted, generally covering the period of the first revision (1990–1991). Objectives and ongoing and planned activities of Federal agencies are briefly described, focusing on the period covered by this revision (1992–1993).

3.1 Arctic Ocean and Marginal Seas

3.1.1 Ice Dynamics and Oceanography

A singular feature of the Arctic Ocean is the permanent, dynamic ice cover. This marine cryosphere significantly impacts the environment on all scales, from climatic to molecular. Critical processes governing this impact occur in the atmosphere and oceanic boundary layers above and below the ice. A major priority is the development of the next generation of operational ice forecasting models. A systematic program of oceanographic, cryosphere and atmospheric measurements by conventional technologies, as well as new technologies such as Autonomous Underwater Vehicles (AUVs), is needed to support the objectives of this mission element and the interagency program (see Section 2.1 of the Strategy Programs).

Selected Accomplishments and Activities

- Acquired the first complete set of ice stress measurements for the initiation and formation of a pressure ridge in the open Arctic ice pack; fracture occurs several minutes after the peak force, indicating large-scale creep behavior previously unknown (DOD/ONR);
- Acquired the most comprehensive air-ice exchange data set to date during the nine months of the Coordinated Eastern Arctic Experiment (CEAREX); this will form the basis of improved synoptic and climatological models through better understanding of boundary layer physics; indications are that microscopic ice crystals may be critical to the surface radiation balance even with a clear sky (DOC/NOAA/OAR, DOD/ONR);
- Discovered a preconditioning mechanism for deep convection associated with mesoscale eddy dynamics by using a high-resolution numerical model formulated for the Greenland Sea marginal ice zone; surface cooling in phase with the secondary circulation of a cyclonic eddy triggers penetrative vertical motion (DOD/ONR);
- Successfully deployed an autonomous underwater vehicle for measuring upper-ocean water properties under ice during CEAREX; this highly portable platform traversed preprogrammed courses before returning to a homing beacon suspended beneath the entry hole; temperature and salinity profiles recorded onboard defined the directional wave number of internal waves at the base of the mixed layer (DOD/ONR);
- Completed initial experiments showing the feasibility of imaging the internal structure of ice using high-frequency acoustic tomographic inversions; determining the evolution of this structure over time will provide insight into the mechanics and thermodynamics of ice in response to forcing (DOD/ONR);
- Developed new statistical techniques for characterizing ice floes in satellite imagery, which will enable ice data from SAR satellites to be efficiently assimilated into numerical forecast models (DOD/ONR);
- Deployed fourteen satellite-tracked drifting buoys were deployed on the Arctic sea ice in 1990; twelve more will be deployed in 1991; these buoys are used to derive ice drift velocity vectors and to report meteorological variables (air temperature and barometric pressure) through the Global Telecommunications System (DOC/NOAA, DOD/ONR/OCEANAV);
- Completed an analysis of the Arctic sea ice observations from the Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) during 1978–1987; the SMMR record, which reveals the complexities of the morphology and dynamics of the Arctic sea ice cover in great detail, serves as a unique baseline for future research on the role sea ice plays in global change (DOI/GS);
- Declared the Digital Ice Forecasting and Analysis System (DIFAS) to be operational for Alaskan ice analysis, and designated the Joint Ice Center as coordinating office for the Arctic Drifting Buoy Program (DOD/DOC/JIC);

- Selected a sea ice algorithm (originally developed for the SMMR) for operational use by the Fleet Numerical Oceanography Center, Monterey, California, for the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/ Imager (SSM/T) (DOD/OCEANAV);
- Delivered all components necessary for analysis of ERS-1 Advanced Microwave Instrument (AMI) Synthetic Aperture Radar (SAR) data to the NASA-sponsored Alaska SAR Facility (ASF) for testing; ERS-1 will launch in 1991, and the ASF will perform processing, archiving and geophysical analyses of these data (NASA);
- Released a research announcement soliciting investigations that will use the ASF facilities; 25 investigations were selected representing a wide range of scientific interests, including studies of the oceans, ice and land cover in the Arctic (NASA);
- Published an ice atlas based on imagery from the Scanning Multichannel Microwave Radiometer; the atlas covers a nine-year period, from 1978 to 1987; all digital data associated with the atlas will be archived at the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado (NASA);
- Completed the validation of ice products derived from the Special Sensor Microwave/Imager and continued to archive these data products in the NSIDC (NASA);
- Procured hardware to augment the Alaska SAR Facility, which will allow the capture and storage of high- and low-resolution SAR data, data compression for high-resolution data, and the communication of SAR data via the NOAA polar domestic satellite (DOMSAT) communications system to the Joint Ice Center; every orbit of low-resolution (4-km) data from the afternoon polar satellite, and occasional readouts of high-resolution (1.1-km) data, are being mapped for the Arctic and Antarctic (DOC/NOAA/NESDIS);
- Completed the analysis of recent measurements in Barrow Canyon and supporting oceanographic and meteorological time series (DOC/NOAA/OAR);
- Recovered two instrumented moorings and deployed a new one in the recirculation region of the southern Greenland Sea to assess the supply of buoyancy by the western boundary current to the interior region of the Greenland Sea; continued analysis of recent data sets related to the contribution of saline sources to the deep mixing regime (DOC/NOAA/OAR);
- Initiated a joint U.S.-U.S.S.R. field investiga-

tion of the shelf circulation from Bering Strait northward with two cruises during the latter part of the 1990 field season; deployed 16 instrumented moorings for a year to provide a detailed time history of currents, sea surface elevation, temperature and salinity; conducted extensive mapping of water properties, including nutrients and dissolved oxygen and a number of trace substances such as chlorinated organics and stable isotopes; used satellite-tracked surface buoys to determine ice drift and meteorological forcing (DOC/NOAA/OAR);

- Completed the Arctic Ocean Buoy Study in 1990 (DOI/MMS);
- Completed Remote Sensing Data Acquisition and Analysis for the northern Bering Sea and Beaufort Sea (DOI/MMS);
- Completed the integration of OSCEAP/ISHTAR data (DOI/MMS); and
- Completed performance and compatibility analyses of oil-weathering and transport-related models for use in environmental assessment of the Alaskan OCS (DOI/MMS).

Objectives

- Determine the processes, dynamics and mechanisms of ice production, deformation, advection and decay;
- Determine the processes of renewal and mixing of Arctic and Subarctic water masses from large to small scales;
- Determine the large-scale circulation of the Arctic Ocean, its variability and its dynamics, including the role of shelf seas, boundary currents and exchanges with adjoining seas;
- Continue to develop advanced methods of unmanned environmental monitoring such as buoys and AUVs; and
- Determine the mean and natural range of variability of currents and hydrographic features in the nearshore region of the Bering, Chukchi and eastern U.S. Beaufort seas.

Ongoing and Planned Activities

- Make long-term systematic observations of ocean, atmosphere and sea ice variables in the Arctic Ocean and adjacent seas (DOC/NOAA, DOD/ONR/OCEANAV, DOI/GS, NASA, NSF);
- Continue improvements at the ASF, including upgrades for processing, archiving and analyzing data from the Japanese ERS-1 SAR (NASA);
- Continue to process and archive Special Sensor Microwave/ Imager data and analyze these data in Arctic investigations (NASA);

- Support science teams who continue research and analyze data and data products derived from the ASF (NASA);
- Augment existing observation systems with more capable instruments to be developed over the next five years (DOC/NOAA, DOD/ONR, NASA, NSF);
- Use observational data bases to validate and refine ocean-ice-atmosphere coupled models (DOC/NOAA, DOD/ONR/OCEANAV, NASA, NSF);
- Conduct biophysical research focused on changes in nutrient cycling associated with upwelling and downwelling (DOC/NOAA, DOD/ONR, NSF);
- Study Arctic Ocean circulation and water mass, conservative tracer movement, and variations and causes of variable transports (DOC/NOAA, DOD/ONR, NASA, NSF);
- Coordinate international programs to address global change, including atmospheric input to water and ice surfaces (DOC/NOAA, DOD/ONR, DOI/GS, NASA, NSF).
- Initiate and continue projects under Arctic System Science and its Oceans-Atmosphere-Ice Interactions program to understand the role of sea ice, atmosphere forcing and ocean circulation in global processes (NSF);
- Conduct field work to quantify air-sea-ice fluxes from upper water layers to the troposphere associated with Arctic leads (DOC/NOAA, DOD/ONR, NASA);
- Begin high-resolution modeling to refine a sampling strategy for shelf processes (DOD/ONR);
- Conduct field and laboratory measurements to determine mechanical responses of sea ice to variable stress fields so that ice-floe-scale responses to synoptic-scale forcing can be integrated into regional models (DOC/NOAA, DOD/ONR, NASA);
- Initiate a five-year program on sea ice mechanics starting in FY 1992 (DOD/ONR);
- Maintain an Arctic Ocean climate monitoring station and expand the program to include a second site; begin measuring ice and freshwater discharge from the Arctic Ocean in a study of Atlantic climate change; conduct a U.S.-Canada oceanographic section across the Arctic Ocean in 1993 (DOC/NOAA/OAR);
- Establish and maintain a series of sampling stations along the Chukchi-Beaufort sea coast to record oceanographic and meteorologic data (DOC/NOAA/NOS);
- Increase satellite data sources for DIFAS (i.e. AVHRR/LAC, SSM/I); demonstrate the operational capability of SAR data for ice analysis; plan to increase the number of drifting buoys in the Arctic to improve ice forecasting models (DOD/DOC/JIC);
- Conduct a pilot study of the ventilation of deep waters in the Greenland-Norwegian seas using CFCs and other tracers (DOC/NOAA/OAR);
- As part of the Atlantic Climate Change Program, begin monitoring the freshwater flux from the Arctic Ocean through Fram Strait (DOC/NOAA/OAR);
- Complete the first set of cruises in the Chukchi Sea in support of the joint U.S.-U.S.S.R. circulation study; calibrate and process the resulting hydrographic data sets (DOC/NOAA/OAR);
- Obtain and analyze synoptic oceanographic and meteorological data to determine the magnitude and temporal and spatial variations of circulation along the Bering Sea continental shelf edge (DOI/MMS);
- Complete modifications to a three-dimensional, variable-scale circulation model and a companion stochastic oil-spill-trajectory model for the Alaskan OCS (DOI/MMS);
- Continue remote sensing and data acquisition and analysis for Alaskan OCS areas (DOI/MMS);
- Acquire and analyze remote sensing data for the Bering and Beaufort seas (DOI/MMS); and
- Revise the Alaska OCS oil-weathering model (DOI/MMS).

3.1.2 Ocean and Coastal Ecosystems and Living Resources

The biota of marine and coastal ecosystems are influenced by physical processes, including seasonal extremes of light and temperature. Arctic marine ecosystems are dominated by sea ice, while coastal ecosystems are influenced by freshwater input and seasonal sediment loads, as well as by seasonal sea ice. There is a need to quantify the influence of the resulting variability in rates of biological production of marine living resources through long-term and well-designed interdisciplinary research (see Section 2.1 of the Strategy Programs).

Selected Accomplishments and Activities

- Used radio-tracking of female polar bears to discover 41 additional maternity dens, bringing the number found in ongoing studies to well over 100; only 35 dens had been located

in all previous studies; monitored survival and reproductive success in 46 radioed female polar bears as part of ongoing efforts to more fully understand the population dynamics of the species (DOI/FWS);

- Conducted cooperative walrus surveys by U.S. and U.S.S.R. scientists, resulting in the development of a formal sampling protocol; solved problems with radio transmitter attachment and function; observations of radioed walrus are expected to lead to information that will increase the accuracy of aerial surveys (DOI/FWS);
- Continued research on the use of biochemical techniques for defining stocks of polar bears to measure and predict the effects of harvest (DOI/FWS);
- Continued research on species of salmon to provide information needed for the U.S./Canada Pacific Treaty negotiations (DOI/FWS);
- Tracked white-fronted geese breeding in Bristol Bay, Alaska, through stopover sites in the Klamath Basin, California, to wintering areas in the interior highlands of Mexico; overwinter survival is 78% (DOI/FWS);
- Processed radar imagery from the Soviet satellite Cosmos-1500, which showed promise of providing a systematic data base of seasonal pack ice distribution in the Bering and Chukchi Seas for use in ecological studies of polar bear and walrus (DOI/FWS).
- Collected tissue samples from Arctic marine mammals taken in native subsistence hunts and archived them, through the Alaska Marine Mammal Tissue Archival Project (AMMTAP), for future retrospective analysis for environmental contaminants; determined levels of environmental toxicants in Arctic marine mammals through analyses of tissue samples collected by the AMMTAP; determined the distribution and temporal trends of selected global micropollutants in biotic and non-biotic compartments of major western Arctic coastal areas; established a set of permanent stations on the Arctic coast of the U.S. to monitor environmental conditions (DOC/NOAA/NOS, DOI/MMS);
- Described the mortality, dispersion and transport of larval king crabs and Pacific herring in the Port Moller region (Bering Sea) and determined the distribution and relative abundances of juvenile and adult life stages and their habitat requirements; described the seasonal abundances and distributional patterns, population characteristics and life histories of the fishery resources of the southeastern Chukchi Sea (DOC/NOAA/NOS, DOI/MMS);
- Described natural processes affecting the concentration and fluxes of nutrients from the Yukon River and the influence of the river effluent on coastal ocean productivity (DOC/NOAA/NOS, DOI/MMS);
- Initiated a comparative study of Arctic coastal ecosystems to describe their relative productivities, community structures and vulnerabilities to environmental alterations (DOC/NOAA/NOS, DOI/MMS);
- Planned and conducted a Bering-Sea-wide acoustic study of the distribution and abundance of pollock (a multinational study that included Japan, the U.S.S.R. and the U.S.) and conducted a binational study (U.S. and U.S.S.R.) of bottom fish and shellfish resources of the eastern and western Bering Sea; U.S. efforts amounted to approximately 6000 trackline miles and 27 midwinter trawls to examine and enumerate spawning pollock aggregations (DOC/NOAA/NMFS);
- Completed third year of research to better understand the consequences of intense unregulated fishing for walleye pollock in the international zone of the Bering Sea (DOC/NOAA);
- Completed histopathology work for 1212 fish and crab samples collected from the eastern Bering Sea, blood analysis from 1500 tanner crab samples to determine the distribution of bitter crab disease, and tissue analysis on 15 marine mammals (DOC/NOAA);
- Continued to update the stock assessment of all commercial bottom and shell fish resources of the eastern Bering Sea (DOC/NOAA/NMFS);
- Placed U.S. observers on domestic commercial fishery vessels that target bottom fish resources in the Bering Sea (DOC/NOAA/NMFS);
- Continued long-term studies of the population dynamics and trends in numbers of the depleted northern fur seals on the Pribilof Islands, Bering Sea, showing that the total population may have stabilized at around 40% of its peak population size as recorded in the 1950s; pup production on St. George Island continues to decline; a conservation plan has been written outlining research and management needed to assess the status and recovery of the population (DOC/NOAA/NMFS).
- Carried out a range-wide survey of northern (or Steller) sea lions in Alaska; the severity of the decline observed between 1985 and 1989 was not seen, although overall the population continues to decline in Alaska; in the southern Bering Sea the species has declined by over

90% since around 1970; in the western Gulf of Alaska the population declined by 63% between 1985 and 1981; in November 1990 the northern sea lion was declared a threatened species under the Endangered Species Act (DOC/NOAA/NMFS);

- Completed six major exchanges as part of the U.S.-U.S.S.R. Marine Mammal Project, a cooperative research program to study the biology, ecology and population dynamics of marine mammal species of interest to both countries; exchanges included the second joint sea otter workshop and a series of joint walrus studies (DOC/NOAA, DOI/FWS);
- Continued studies to measure lengths and to identify individual bowhead whales to help determine calf production, calving intervals, juvenile survival and population abundance of whales migrating past Barrow, Alaska, into the Chukchi and Beaufort seas; new results show that the population is composed of about 40% adult animals (>13 m in length); annual calf production varies greatly, from 3 to 12%; and the calving intervals of three individually identified adult females ranged from 4 to 7 years (DOC/NOAA/NMFS);
- Continued the Fisheries Oceanography Coordinated Investigation (FOCI) to understand the processes that lead to variations in recruitment of commercially valuable stocks of pollock in Alaskan waters; developed a model of the time dependency of larval dispersion and used it to simulate observations (DOC/NOAA/OAR);
- Under FOCI, began to implement a new data management and analysis system, known as Extensive PMEL Information Collection (EPIC), allowing efficient access to many forms of data, including traditional physical oceanographic observations and less standard biological observations; EPIC also permits easy implementation and use of modern analysis programs and display routines (DOC/NOAA/OAR);
- Through the National Status and Trends Program, continued to monitor the levels of toxic contaminants at several reference sites in the Arctic and Subarctic during 1990 and 1991; collected and analyzed samples for the levels of 70 toxic contaminants in bivalve molluscs at two sites in both years (DOC/NOAA/NOS);
- Established OSCURS (Ocean Surface Current Simulations) numerical model as a new tool for describing ocean variability as part of an ecosystems modeling task by using it as part of variability studies in the Gulf of Alaska

and the Bering Sea (DOC/NOAA);

- Synthesized information on the effects of noise and disturbance on major haulout concentrations of Bering Sea pinnipeds (DOI/MMS);
- Developed a method for monitoring the productivity, survivorship and recruitment of the Pacific walrus population (DOI/MMS);
- Analyzed and ranked the acoustic disturbance potential of petroleum industry activities and other sources of noise in the environment of marine mammals in Alaska (DOI/MMS);
- Radio-tagged northern fur seal pups to determine migration routes through the Bering Sea and North Pacific Ocean (DOC/NOAA/OAR, DOI/MMS);
- Linked a whale migration model with an oil-spill trajectory model to estimate the number of whale encounters for any size spill at any site in the Alaskan OCS (DOI/MMS);
- Linked whale behavior models and acoustic transmission loss models to predict ranges of reaction of bowhead and gray whales at various sites in the Beaufort Sea (DOI/MMS); and
- Modeled the effects of oil spills on the population dynamics of sea otters in the southeastern Bering Sea (DOI/MMS).

Objectives

- Determine status and trends of fish, birds and marine mammals and identify their habitat requirements;
- Monitor coastal ecosystems to detect and quantify temporal changes in nutrient and energy exchange and their effect on biota;
- Determine the magnitude and variation of marine productivity in Arctic areas through studies of the structure, dynamics and natural variability of the ecosystems;
- Consider the influence of ice on the environment and of human activities on both the biotic and abiotic environment;
- Study the influence of Arctic marine productivity on the global cycling of biologically active materials, including carbon and nitrogen; and
- Understand the physical and biological processes that affect fisheries recruitment in the U.S. waters of the Bering, Chukchi and Beaufort seas.

Ongoing and Planned Activities

- Establish a capability to monitor ocean productivity in Arctic regions using a satellite ocean-color imager (NASA);
- Extend Bering Sea biological research into

- the Chukchi and Beaufort seas to trace carbon and other nutrients, especially along leads, polynyas and ice edges (DOC/NOAA, DOD/ONR, NSF);
- Study how polynyas form and develop, how they influence the migration, distribution and abundance of marine mammals and birds, and how recurring polynyas can be protected (DOC/NOAA, DOI/FWS/MMS, NSF);
 - Determine production rates of, and transfer of energy between, trophic levels on Arctic continental shelves; clarify the differences in ecosystem structure and function that influence the population dynamics of marine mammals and birds; design models to evaluate the impact of human activities on ecosystem processes (DOC/NOAA, DOI/FWS/MMS/NPS, SD);
 - Develop and conduct periodic monitoring programs to assess contaminant loads for higher-trophic-level animals (DOC/NOAA, DOI/FWS/MMS);
 - Determine the stream origins of anadromous fish species that occur in the coastal waters of the Beaufort Sea; determine the relative abundance and population characteristics of fish in the near-shore coastal waters of the Arctic National Wildlife Refuge; identify the habitats they utilize (DOC/NOAA, DOI/FWS);
 - Investigate shelf-slope exchange processes in the Bering Sea as they affect the transport and recruitment of larval pollock into U.S. fisheries (DOC/NOAA);
 - Initiate and continue projects under Arctic System Science and its Oceans-Atmosphere-Ice Interactions program to understand the role of biogeochemical processes, nutrient regimes and productivity (NSF);
 - Begin to develop products for Alaska under CoastWatch, a theme within the NOAA Coastal Ocean Program, which has as its goal the development and delivery of environmental data and products for near-real-time monitoring of U.S. coastal waters to support environmental science and decision making (DOC/NOAA/NESDIS);
 - Continue programs on pollock, bottom and shell fish in the Bering Sea (DOC/NOAA/NMFS);
 - Begin the Bering Sea FOCI Program; identify the number of spawning stocks of pollock and the controlling oceanographic factors; describe and model the general circulation over the basin; conduct a cruise jointly with Soviet scientists to provide the first synoptic view of the major transport features and flow through the deep western passages and to obtain detailed data on nutrient distributions (DOC/NOAA/OAR/NMFS);
 - Continue long-term FOCI observations, including water properties, currents and pollock eggs and larvae; continue to acquire and process satellite images (DOC/NOAA/OAR/NMFS);
 - Use satellite tags to study the movements and habitat use patterns of northern fur seals and northern sea lions in the Bering Sea, not only the location and time of surfacing by each animal, but also the depth of dive and dive profiles needed to assess total activity patterns and energy budgets (DOC/NOAA/NMFS);
 - Study the status and trends of Pacific harbor seals in the eastern Bering Sea, where they are undergoing significant population changes; study the population dynamics of harbor seals in FY 1992-93, with the primary objective of determining minimum population size and, in the long-term, determining trends in abundance and status of stock assessment (DOC/NOAA/NMFS);
 - Conduct a complete review and synthesis of the life history and ecology of bowhead whales in FY 1992-93 using data collected since 1974 by NMML scientists and others from ice-based studies, aerial surveys and biological studies of harvested animals since; field studies may be terminated for lack of funds (DOC/NOAA/NMFS);
 - Continue the National Status and Trends Program monitoring contaminants in the Arctic; measure levels of contaminants in 1992 at sites that were initially sampled in 1986 or 1988 (DOC/NOAA/NOS);
 - Study the coastal fisheries oceanography of the southern Bering Sea and the North Aleutian Basin to determine stock identity, timing, habitat use and environmental controlling mechanisms of juvenile salmon along the Alaska Peninsula, as well as factors affecting the development, survival and recruitment of larval and juvenile king crab and Pacific herring (DOC/NOAA/NOS, DOI/MMS);
 - Study the fisheries oceanography in the Chukchi and Beaufort seas to examine the habitat requirements and trophic relationships of anadromous and marine fish species (DOC/NOAA/NOS, DOI/MMS);
 - Continue delineation, faunal composition and repeated use of benthic feeding areas of walrus and gray whales in the northeastern Chukchi Sea (DOI/MMS);
 - Determine the effects of oil and gas production activities (sound characteristics in spring lead systems) on bowhead and beluga whales

(DOI/MMS);

- Determine the location and timing of bowhead whale feeding, as well as the age of whales, using stable isotope analysis of prey species and whale tissues (DOI/MMS);
- Compare the behavior of bowhead whales in Davis Strait, where there is little industrial development activity, to the behavior of whales in the western Arctic, where there has been industrial activity (DOI/MMS);
- Refine the use of satellite tags for tracking right and bowhead whales (DOI/MMS);
- Develop a baseline method to evaluate chemobiological interaction involving cetaceans (DOI/MMS);
- Compile the literature on bowhead whales and publish a book (DOI/MMS);
- Study the use of satellite tags to determine pelagic areas important to declining populations of fur seals (DOI/MMS);
- Develop guidelines for OCS operations in polar bear habitats (DOI/MMS);
- Determine the importance of leads to bowhead whales, determine the potential influence of environmental and industrial factors on bowhead whale hunting, and verify the model of site-specific interactions of acoustic stimuli and whale behavior (DOI/MMS);
- Monitor seabird colonies in the Bering and Chukchi seas to determine population numbers, productivity and feeding habits (DOI/FWS/MMS);
- Monitor waterfowl and seabirds in the Beaufort Sea (DOI/MMS);
- Monitor the distribution of whales in the Chukchi and Beaufort seas (DOI/MMS);
- Determine the use of Kasogaluk Lagoon by marine birds and mammals (DOI/MMS);
- Monitor levels of hydrocarbons and trace metals in Beaufort Sea sediments and organisms (DOI/MMS);
- Monitor marine mammals, seabirds and waterfowl in the Alaskan OCS area (DOI/MMS); and
- Study physical processes and ecosystems of the Alaskan OCS area (DOI/MMS).

3.1.3 Marine Geology and Geophysics

The Arctic continental margin and deep ocean basin constitute one of the least understood geological regions of the world, partly because much of the offshore area is covered with sea ice. A better understanding of the tectonic history, geologic

structure, sediment processes and distribution, and climatic and glacial history of the deeper basin will require extensive geophysical and geological research and the integration of newly collected data on an international scale (see Section 2.2 of the Strategy Programs).

Selected Accomplishments and Activities

- Studies confirmed that two major sea ice sources can be distinguished in the eastern Arctic through their sediment load: the East Siberian Sea and the Laptev Sea; sedimentation rates in the eastern Arctic are highly variable in time; during glacial periods they were 2–3 cm/ky, whereas in interglacials they were below 1 cm/ky; based on sediment core analysis during times of maximum glaciation, the ice flow in the Norwegian Sea apparently reversed to flow northward (DOI/GS);
- Successfully recovered two heavily instrumented time-series trap moorings from the Barents Sea after one year of deployment; data indicate major cross-shelf transport of up to 800 mg/m²-day of sediment with high current velocities;
- Recovered sediment cores, geophysical data and ice sediment load data during two cruises; the cores contain a Quaternary sediment and climate record extending back more than one million years (DOI/GS);
- Prepared a science plan for Arctic drilling (DOD/ONR); and
- Convened a workshop on Arctic marine geology and prepared a report recommending a decade of U.S. research on the Arctic Basin (NSF).

Objectives

- Develop and perfect new techniques for deployment of instruments in the harsh Arctic environment (e.g. seismic tomography, geophysical arrays, hydraulic piston coring, scientific deep drilling);
- Initiate Arctic marine geological and geophysical studies to provide information on past and present climate change, support rational development of natural resources, and address fundamental questions of global geologic history and regional tectonic development;
- Define the geologic framework, deep structure and tectonic history and development of the Bering Sea region;
- Develop the capability for systematic and comprehensive collection of geologic data in the ice-covered offshore regions using remote sensing and other technologies; and

- Determine the modern sediment transport by sea ice, icebergs and other processes; characterize the seafloor sediments by coring and reflection methods; and establish a well-dated stratigraphy.

Ongoing and Planned Activities

- Compile all existing U.S. and international sediment and geophysical data on the Arctic Ocean Basin for use in a geographic information system that would combine and index data (DOC/NOAA, DOI/GS/MMS);
- Institute a combined marine and airborne research program for the collection of geological and geophysical data on the continental margins and Arctic and Bering basins using aircraft, ships and ice islands to maximize data collection (DOD/ONR, DOE, DOI/GS, NSF);
- Complete geophysical and sediment coring transects across the northern Alaskan margin including the Chukchi, Beaufort and Bering seas, combining U.S. with Soviet and Canadian data (DOC/NOAA, DOD/ONR, DOI/GS, NSF);
- Evaluate the need for additional stations and obtain additional international support for on-shore digital, broad-band seismographic networks; data can be modeled with new methods in seismic tomography (DOI/GS, NSF);
- Conduct site surveys of areas of geologic and paleoclimatic interest using the same sensors as for transects and polygons; thoroughly analyze data to pinpoint possible drilling sites (DOI/GS);
- Plan a sampling program to determine the paleoclimatic and paleo-oceanographic history of the Arctic Basin and margins as well as the Aleutian Basin of the Bering Sea and the stratigraphy and in-situ geotechnical properties of the surrounding shelves; initiate a U.S.-Canadian drilling project in the Yukon Flats-Old Crow Basin area (see 2.1) (DOI/GS, NSF);
- Collect marine geophysical data in the Beringian and Aleutian areas to verify and understand results of GLORIA data collection (DOI/GS);
- Conduct deep geophysical sounding in the Bering Sea to determine the fundamental tectonic processes that produced the geologic features of the upper crust and generate velocity amplitude anomalies (VAMPs) (DOI/GS, NSF);
- Continue geologic investigations in the Shumagin Basin, Gulf of Alaska and lower Cook Inlet as part of the mission responsibility to assess petroleum and nonenergy mineral potential of the Outer Continental Shelf (DOI/MMS);
- Plan to commence in 1993 a program for collecting geological and geophysical data on the continental margins and the Arctic and Bering basins using aircraft and ships (DOD/ONR, DOI/GS, NSF);
- Conduct a three-nation (Sweden, Germany, U.S.) deep Arctic Basin expedition to collect extensive sediment cores and geophysics in the Laptev Sea, Eurasia and Makarov basins in 1991; investigate biogeochemical processes by inserting two time-series sediment traps (DOD/ONR, Sweden, Germany, Japan);
- Conduct a joint U.S.-Norwegian program to investigate the sedimentary province of the Barents Sea and its controlling processes (DOD/ONR, Norway);
- Conduct a joint U.S.-Canadian program in Kangerlussuak Fjord, East Greenland, to investigate sedimentary processes within a fjord and out across the continental shelf (DOD/ONR, NSF, Canada);
- Install sediment trap(s) in the Bering Sea to monitor biogeochemical fluxes and compare the results to those from the eastern Arctic (DOC/NOAA/OAR, DOD/ONR).
- Assess the oil and gas resources for onshore and offshore areas of Alaska; the USGS will assess onshore and Alaska waters extending three miles from shore, and MMS will assess offshore Alaska from the three-mile limit to approximately 200 nautical miles seaward (DOI/GS/MMS); and
- Update the Chukchi, Beaufort and Bering sea geological reports and prepare a Hope Basin geological report (DOI/MMS).

3.2. Atmosphere and Climate

3.2.1. Upper Atmosphere and Near-Earth Space Physics

The goals of this research are to trace the flow of energy, momentum and mass from the sun to the Earth and to understand the interaction within and between the intervening regions. The impact of most of the variable components of the flow is funneled by the Earth's magnetic field into the polar regions. Arctic studies of this energy flow through the atmosphere help to develop and verify predictive models. Our understanding of the basic phenomena of the coupling processes, and the dramatic consequences across the full optical, radio and particle spectrum, is far from complete.

There is great interest in understanding and separating anthropogenic effects (such as greenhouse gases) and natural variability (such as decadal temperature swings) in the troposphere. Recent evidence suggests that some of the latter is due to solar-induced effects, especially in polar latitudes. It is expected that the coupling of the sun to the troposphere (and the rest of the atmosphere) will become a major topic of study in the next five years. This will be supported partially under the U.S. Global Change Research Program (USGCRP) and will naturally focus on high latitudes, given the way in which the geomagnetic field focuses some forms of solar energy.

Selected Accomplishments and Activities

- Continued the Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) program, which is aimed at a better understanding of the upper atmosphere using observations from ground-based radio and optical instruments (NSF);
- Initiated the Geospace Environment Modeling (GEM) program, which is aimed at understanding the ionosphere and magnetosphere using a well-planned schedule of theory and experiments (NSF);
- Conducted a jointly sponsored field campaign in Greenland in early 1990 to observe the ionospheric signatures of geospace disturbances; the Geophysics Laboratory flew the instrumented Airborne Ionosphere Observatory to make synoptic observations of the dark cusp and cleft dynamics; NSF supported the complementary ground-based measurements, data analysis and workshop; Japanese, NASA and AF satellites provided other data (DOD/

AFGL, NSF);

- Demonstrated the impact of greenhouse gases on the state of the upper atmosphere; the particle inputs in polar regions and the sensitivity to photochemistry, e.g. the ozone hole, makes this an especially important issue for the polar upper atmosphere; research performed at the National Center for Atmospheric Research (NCAR) showed that the thermosphere cools by about 50 K when carbon dioxide and methane are doubled; the stratopause temperature decreases by 17 K; this sensitivity offers the possibility of monitoring global change (NSF);
- Estimated the Earth's reconnection electric field from radar measurements taken at the Sondrestrom Radar Observatory; this variable is important because it describes the rate of transfer of solar wind energy to the closed field-line region of the magnetosphere; such ionospheric measurements represent the first estimates of the reconnection electric field in the ionosphere;
- Conducted experiments at Sondrestrom that exploit simultaneous radar and optical measurements; these studies encompass aeronomical processes within auroral arcs, plasma flow near polar cap arcs and drift of plasma patches from the polar cap toward the auroral cap;
- Developed a world-wide atmospheric noise prediction model for the first time for ELF/VLF/LF, including high latitudes; completed three years of ionospheric heating experiments at the Alaskan HIPAS facility;
- Found an inverse relationship between the speed of the solar wind at Earth and the divergence rate of magnetic field lines in the sun's corona using ground-based solar magnetic field measurements; this relationship has important applications in forecasting the geomagnetic and auroral activities that affect communications, navigation and surveillance;
- Provided the first clear demonstrations of the long-term conjugate nature of auroral activity at these high latitudes using the new Imaging Riometer for Ionospheric Studies (IRIS) at Sondrestrom, Greenland, working in conjunction with an identical IRIS at South Pole, Antarctica (DOC/NOAA, NSF);
- Conducted a study that showed that considerable mesoscale order exists in the polar ionospheric flow, previously perceived as being chaotic. The electrodynamic forces driving these flow patterns provide a new source of polar thermospheric heating that may be of significance to global thermospheric circula-

tion (DOC/NOAA, DOD/AFGL).

- Conducted three-dimensional simulations suggesting that the geometry of the reconnected field lines is much more complicated than anticipated (DOE).
- Launched one sounding rocket mission in FY 1991 to study a variety of phenomena in the areas of auroral and upper atmosphere physics; seven additional sounding rocket missions in these scientific areas are planned for the remainder of FY 1991; FAST, a small explorer satellite for studying the plasma microphysics of the aurora, was approved for a new start in 1990 and is scheduled for launch in 1994 (NASA); and
- Continued research at the Space Environment Laboratory (SEL) to monitor solar activity and its effects on the space environment near Earth and on man's activities; the most dramatic effects on and above Earth occur in the polar regions, where the geomagnetic field lines pass through the upper atmosphere vertically (DOC/NOAA).

Objectives

- Observe the global-scale response of the polar regions through a coordinated program involving a polar network of ground-based optical, radio and magnetic observatories and space-based measurements;
- Develop special research tools to address key problems, including setting up a coordinated rocket program, promoting the use of special facilities and making use of research aircraft;
- Maintain active theoretical programs and promote the evolution of models to describe the unique physics of the atmosphere and ionosphere in Arctic regions;
- Understand solar phenomena that affect Earth's environment;
- Understand electromagnetic waves, fields and particles in near-earth space; and
- Develop an understanding and the ability to make long-term predictions of radio propagation in and through Earth's ionosphere.

Ongoing and Planned Activities

- Continue the placement of remote sensing facilities in the polar cusp region as part of the CEDAR program;
- Expand the GEM program into a more comprehensive theory and observation program; implement the first stage of GEM, which is to understand the ionospheric signatures of near-space processes induced by the sun;
- Expand Interplanetary Magnetic Field (IMF) data collection to maximum full-time cover-

age by establishing receiving stations, encircling the Earth, for existing satellites and deploying a libration-point solar-wind satellite (DOC/NOAA, DOD/AF, NASA);

- Augment particle measurements by high-inclination satellites at appropriate altitudes with simultaneous electric field and current measurements and UV imaging to facilitate long-term monitoring of electromagnetic and particle energy fluxes into the upper atmosphere and develop management procedures to ensure readily accessible data (DOC/NOAA, DOD/AF, NASA, NSF);
- Establish optical, radio, magnetic and plasma drift diagnostics and HF doppler sounding ground-truth stations at a complement of polar cap sites to define the dynamic state of the polar cap and cusp environment (DOD/AFGL/AFOSR, DOI/GS, NASA, NSF);
- Assess, upgrade and operate state-of-the-art diagnostic capabilities in existing Arctic facilities, including optical observatories, for studying auroral and other ionospheric and atmospheric phenomena (DOD/AFGL/AFOSR/NRL, NSF);
- Implement data exchange among magnetometer, radar and other monitoring stations (DOC/NOAA, DOD/AFGL, DOI/GS, NSF);
- Establish a multiagency study of thermal, electrical and chemical effects on the neutral upper atmosphere at high latitudes, including vertical coupling between atmospheric regions (DOC/NOAA, DOD, NASA, NSF);
- Maintain a coordinated national sounding rocket program at auroral (Poker Flat, Alaska) and polar cap (Thule and Sondrestrom, Greenland) sites (DNA, DOC/NOAA, DOD/AF/N, NASA);
- Coordinate the availability of existing research aircraft to support research campaigns in otherwise inaccessible Arctic regions (DOC/NOAA, DOD/AFGL, NASA, NSF) (see Section 4);
- Expand efforts during the sunspot maximum by completing the necessary set of transpolar observing sites (DOD/AFGL, NSF);
- Coordinate U.S. national (Max '91) and international (Flares 22) campaigns of intense observations of solar and geomagnetic activity during the maximum of the solar cycle under the auspices of the Solar-Terrestrial Energy Program (STEP) (DOC/NOAA, NASA, NSF);
- Upgrade polar cusp incoherent scatter radars; establish a polar cap incoherent scatter observatory including radar and optical instruments, emphasizing coordinated ground-

based and satellite studies (DOD/AF, NASA, NSF);

- Establish an Arctic ionospheric active auroral research capability using a high-power HF facility supported by field experiments and theory (DOD/AFGL/ONR/NRL);
- Continue collecting trapped energetic particles aboard the CRRES spacecraft for improved modeling of the Van Allen Radiation Belts (DOD/AFGL/ONR/NRL/AFGML, NASA);
- Expand a long-wave atmospheric noise model to include the ability to predict noise from magnetospheric and auroral sources and from high-altitude nuclear effects (DNA, DOD/ONR/NOSC/NUSC);
- Launch the Maxie-I x-ray satellite in 1991 to measure the precipitation of energetic particles into the high-latitude and polar regions of the ionosphere (NASA, DOD/ONR);
- Continue the sounding rocket program utilizing ranges at Poker Flat, Alaska; Andoya, Norway; and Kiruna, Sweden, to study auroral and upper-atmosphere space physics (NASA);
- Launch the POLAR spacecraft (a component of NASA's Global Geospace Science and the International Solar Terrestrial Physics Programs) in June 1993; POLAR will conduct magnetospheric particle and fields observations, with particular attention to the interrelationship between the visible aurora and the magnetosphere (NASA);
- Launch the Wind satellite (a second component in the GGS and ISTP Programs) in December 1992 to assist in understanding the energy inputs to the magnetosphere (NASA);
- Participate in the major upgrade of the launch and science support facilities at the Poker Flat Research Range in order to improve NASA's sounding rocket capabilities at that site (DOD, NASA); and
- Continue SEL's solar monitoring and predicting activities and plan an initiative to "modernize" these activities (DOC/NOAA).

3.2.2 Climate and Weather

The outstanding characteristic of the Arctic climate and weather is its dramatic variability in clouds, radiation and surface heat exchange. It is necessary to address Arctic weather problems occurring on a variety of spatial and temporal scales that range from microscale to global. A major need is for accurate regional and local weather forecasts, especially to predict hazardous weather, such as Arctic lows, storm surges, icing conditions and fog, which can affect human activities. The Arctic cli-

mate has critical global implications. There is a need to relate Arctic atmospheric circulation to midlatitude weather and to measure and understand long-term temperature trends and the variability of the Arctic heat sink, which may be linked to global warming.

Selected Accomplishments and Activities

- Acquired remote sensing data indicating that major air-sea heat exchanges penetrate through the troposphere on an intermittent basis; this suggests that both tropospheric and stratospheric chemistry are linked to sea ice lead dynamics (DOC/NOAA/OAR, DOD/ONR);
- Completed plans for and acquisition of new technologies for Alaska: with a Doppler wind profiler was installed in Homer, Alaska; a satellite downlink and processing system was installed in Anchorage, Alaska; a C-band radar was installed in Kenai, Alaska; and a new-technologies database is being archived for operational research studies (DOC/NOAA/NWS);
- Completed a study of meridional transport of sea ice in the Bering Sea; began development of an Arctic component to the World Climate Research Program as part of an international planning effort; deployed the first Arctic Ocean climate monitoring station in joint U.S.-Canada effort (DOC/NOAA/OAR);
- Discovered an important climate change signal in Nimbus-7 satellite microwave observations of Arctic sea ice during 1978-1987: a robust statistical analysis of the ice extent data for every two days of the 8.8-year record indicates a decline of $2.1 \pm 0.9\%$ at the 93% level of confidence; during the same period the Antarctic ice extent had no statistically significant trend (DOI/GS); and
- Developed an improved method for predicting vessel icing (DOC/NOAA/OAR).

Objectives

- Develop an Arctic Climate Studies Program as part of the National Climate Program, including studies of climate effects on biological resources and a systematic program of observations and modeling of the Arctic radiation balance and cloud cover, and their effects on climate;
- Understand the extent to which Arctic climate variations are amplified signals derived from elsewhere or are generated locally as a result of the sensitivities of the regional environment;
- Understand whether, how and with what re-

sult Arctic climate anomalies propagate to middle and lower latitudes;

- Quantify sea ice feedback mechanisms that amplify climate change at high latitudes, quantify high-latitude terrestrial ice and snow changes, and consider their effects; and
- Quantify the air-sea-ice momentum and heat exchanges and quantify the role of air-sea interactions in imparting mesoscale tropospheric and stratospheric dynamics.

Ongoing and Planned Activities

- Develop dynamically coupled meteorological models for weather prediction on both regional and local scales, assimilating satellite, aircraft and buoy data (DOC/NOAA, DOD/ONR/OCEANAV/NEPERF, NASA, NSF);
- Assemble existing data from the instrumental record on Arctic climate to enable study of the salient features of climate change, to document observable patterns and to test theories and models (DOC/NOAA);
- Parameterize the effects of physical processes (eddies, upwelling, wave-ice interaction) for use in large-scale models without excessive computations (DOC/NOAA, DOD/ONR/OCEANAV, NSF);
- Study the interactions between the atmosphere and snow cover, glaciers and freshwater ice bodies on land to improve models of the atmosphere with specified lower boundary conditions and to determine the effect of anomalous snow conditions on the polar heat sink and atmospheric circulation (DOC/NOAA, DOI/GS, NASA, NSF);
- Increase linkages among the broader GCM community, encourage use of multiple GCMs in Arctic parameterization experiments, and develop studies of polar radiation, clouds, albedo feedback and high-latitude atmospheric model performance (DOC/NOAA, DOE, NSF);
- Develop a ten-year time series of sea ice cover and seasonal snow cover from SMMR satellite measurements and extend these time series into the future using SMM/I data (NASA);
- Systematically analyze the first-year and multi-year sea ice fractions in the Arctic Basin and Greenland Sea from SMMR and SAR data, including ice, paleoclimate and cryospheric parameters (DOD/ONR, DOI/GS, NASA, NSF);
- Develop plans for an Arctic Climate Studies Program and assess the effects of climate change on biological resources, including humans (DOC/NOAA/NCP, DOI/GS, NSF);

- Analyze existing models and data on "Arctic low" development and evolution to improve the ability to predict Arctic low storms (DOD/ONR);
- Investigate the meteorology of synoptic and mesoscale cyclogenesis over Arctic ice (DOC/NOAA);
- Quantify air-sea heat exchanges of mesoscale tropospheric and stratospheric dynamics during the Leads field program (DOC/NOAA, DOD/ONR);
- Study the Arctic front over Alaska to improve operational forecasting using new technologies, university resources and NWS regional data base (DOC/NOAA/NWS);
- Expand the data base of sea ice climatology for both Northern and Southern Hemispheres (DOD/DOC/JIC);
- Continue to develop the Arctic Climate Systems (ACSYS) component of the World Climate Research Program (DOC/NOAA/OAR); and
- Initiate the Atmospheric Radiation Measurement (ARM) program site selection on the North Slope of Alaska for the field program that is planned to begin in 1994 or 1995 as part of the U.S. Global Change Research Program (DOE).

3.2.3 Tropospheric and Stratospheric Chemistry

The chemistry of the Arctic atmosphere is dynamic, changing in response to natural and man-induced disturbances. Stratospheric ozone depletion is a global process accentuated at the poles. Ice core chemistry reveals current and historic trends in global gas and aerosol concentrations. Expected warming trends could have a significant influence on biosphere-atmosphere interactions, trace gas emissions and retention, and atmospheric photochemical processes. In addition, an average of 1.7 million acres of wildfire annually in Alaska has an impact on airborne particulates and chemistry.

Selected Accomplishments and Activities

- Launched of a series of balloons from Alert, NWT, and Heiss Island, U.S.S.R. as part of a collaborative research project with scientists from the University of Wyoming, Environment Canada and the U.S.S.R.; balloon soundings inside the winter polar vortex and at the latitude of the solar terminator showed a 20% ozone loss at the altitude of observed

polar stratospheric clouds (NASA, NSF);

- Conducted ABLE-3A in the Arctic to assess the flux of greenhouse gases, including CH₄, NO_x, NO_y and O₃, between the land surface and the troposphere and reported the results in a special issue of the *Journal of Geophysical Research* (NASA);
- Completed a major reprocessing of Nimbus-7 TOMS data, which identified a drop in stratospheric ozone in the Arctic and mid-to-upper northern latitudes that was more severe than previously reported (NASA);
- Obtained aircraft measurements of polar stratospheric clouds during the Airborne Arctic Stratosphere Expedition (AASE), along with observations of chemical species including chlorine monoxide, a key player in photochemical ozone destruction; provided the first in-situ evidence supporting the view that important heterogeneous reactions previously identified only in laboratory and theoretical studies do take place in the lower stratosphere (DOC/NOAA/OAR, NASA);
- Continued monitoring by the Climate Monitoring and Diagnostic Laboratory (CMDL), formerly Geophysical Monitoring for Climatic Change (GMCC), of the background atmosphere at Barrow, Alaska, and other non-Arctic sites (DOC/NOAA/OAR);
- Continued to analyze data from the 1983, 1986 and 1989 Arctic Gas and Aerosol Sampling Program (AGASP) (DOC/NOAA/OAR);
- Expanded the Arctic radiosonde data archive activity by successfully acquiring a nearly complete series of soundings from the Soviet ice stations and completing the digitizing of the U.S. Ptarmigan dropwindsonde files; the archive now numbers approximately one million soundings dating back to the 1930s (DOC/NOAA/OAR);
- Calculated monthly mean tropospheric temperatures from the thickness of the 850/700 and 700/500 mb layers for each of 1977 grid points in an octagonal grid centered on the North Pole for the period 1960–1989 as part of an ongoing study of Arctic climatology; estimated temperature trends by comparing mean values between the first and last 13-year periods of the record (DOC/NOAA/OAR);
- Continued to sample and analyze Antarctic and Arctic phytoplankton for bromine production to document further results of the bromine ozone destruction phenomenon in both polar regions (DOC/NOAA/OAR); and
- Continued sampling and analysis at the National Atmospheric Deposition Program site

at Denali National Park (DOI/NPS).

Objectives

- Establish the correlation between the chemistry of polar stratospheric clouds in the Arctic and the ozone concentration at northern mid-latitudes;
- Develop a data base for determining long-term regional trends in climate and air chemistry, including solar radiation levels, across the circumpolar regions of the globe;
- Conduct periodic sampling of the Arctic stratosphere and troposphere to understand ozone depletion, atmospheric transport phenomena and the role of anthropogenic airborne pollutants in the Arctic; and
- Establish regional and seasonal variations in sources and sinks of carbon, nitrogen and sulfur, atmospheric gases and aerosol species and assess the importance of local emissions.

Ongoing and Planned Activities

- Establish and maintain an appropriate number of sampling stations for air quality, atmosphere deposition and climate across the U.S. Arctic (DOC/NOAA, DOE, DOI/NPS/BLM, NASA, NSF);
- Continue to monitor surface-level gases, aerosols and radiation at high-Arctic locations (e.g., Barrow, Alert, Ny Alesund) (DOC/NOAA);
- Install Arctic-based, upward-looking lidars to measure gas and aerosol distributions in both the troposphere and stratosphere (DOC/NOAA, NASA, NSF);
- Develop an extensive Arctic radiation balance program to determine early signals of climate change (DOC/NOAA, DOE, NASA, NSF);
- Accelerate programs to validate satellite measurements of surface and atmospheric parameters in the Arctic (DOC/NOAA, NASA, NSF);
- Continue periodic Arctic-wide aircraft programs to provide continuity with past measurements and deploy new sensors at and develop new research methods for specific Arctic locations (DOC/NOAA, DOD/ONR, DOE, NASA, NSF);
- Conduct necessary follow-up to the 1989 Arctic Ozone Program and AGASP (DOC/NOAA, DOE, NASA, NSF);
- Conduct long-range transport studies of nitrous oxides, trace metals and sulfate aerosols including Processing of Emissions by Clouds and Precipitation (PRECP) (DOE);
- Conduct the second Airborne Arctic Stratospheric Expedition (AASE-II), a six-month

program (October 1991 through March 1992) of aircraft data collection for studying stratospheric chemistry and dynamics, covering the Arctic and midnorthern latitudes throughout the duration of the Arctic vortex (DOC/NOAA/OAR, NASA);

- Continue laboratory investigations into the role of polar stratospheric clouds and sulfate aerosols in modifying the chemistry of the stratosphere in the Arctic and high northern latitudes (DOC/NOAA/OAR, NASA);
- Evaluate the impact of supersonic aircraft transportation on stratospheric chemistry via a program of modeling plus laboratory and field measurements (NASA);
- Provide ground-level instrumentation, science teams and management support for the Network for the Detection of Stratospheric Change (NDSC), which will measure trace gases at sites stationed in Resolute and Alert, Canada; Thule, Greenland; and Kiruna, Sweden (DOC/NOAA, NASA);
- Launch the Upper Atmosphere Research Satellite (UARS) (November 1991), which measures stratospheric chemistry in north and south latitudes up to 80° with its limb-observing instruments, and conduct correlative measurements in the Arctic (DOC/NOAA/OAR, NASA);
- Support modeling and data analysis of stratospheric chemistry and ozone dynamics in the Arctic (DOC/NOAA/OAR, NASA);
- Continue observational and theoretical studies related to the airborne stratospheric studies (DOC/NOAA/OAR);
- Continue CMDL research at the Barrow site by continuing the long-term baseline measurements, continuing to support cooperative projects by university and other-agency scientists, and potentially adding several tasks to the long-term program, including measurements of other trace gases (e.g. CFC-113,

CFC-114 and halons), more detailed ozone measurements, and ultraviolet radiation and regional energy budget measurements (DOC/NOAA/OAR);

- Use a NOAA WP-3D, with support from AGASP scientists, as part of the ONR Leads Experiment (LEADDEX) in the Arctic Ocean basin north of Alaska, which will study the role leads play in the Arctic energy budget; the Wave Propagation Laboratory (WPL) in cooperation with NOARL is planning an Arctic boundary layer and lead plume study as part of LEADDEX; a follow-on AGASP flight program will be planned for 1995 (DOC/NOAA/OAR);
- Conduct a stratospheric-tropospheric exchange study, including mesoscale numerical model simulations and predictions, and aircraft-based chemical lidar measurements of trace constituents, air motions and the associated vertical fluxes of constituents across the Arctic tropopause (DOC/NOAA/OAR);
- Plan further studies on the Arctic stratosphere within the next five years to examine the detailed structure and extent of Arctic ozone decline and to examine the implications for lower latitudes throughout the Northern Hemisphere (DOC/NOAA/OAR); and
- Develop the Network for the Detection of Stratospheric Change (NDSC), a multi-agency international effort that will consist of five to six stations operated world-wide by the mid-1990s for long-term measurements of ozone and the chemical constituents that influence it; the goal of the network is to provide the earliest possible detection of stratospheric ozone changes and the means to understand their origin; there will be one or two sites in the Arctic (probably Thule, Greenland, and Resolute, Canada) (DOC/NOAA/OAR).

3.3 Land and Offshore Resources

3.3.1 Energy and Minerals

The geologic framework of the Arctic is very poorly known because of the complexities of its geologic setting, its remoteness and its relative lack of exploration. The remote frozen environment requires long lead times for energy and mineral development. Additional information is necessary to allow the discovery, assessment and mapping of new and dependable sources of oil, gas, coal and strategic minerals. These resources are important for national security and independence, as well as for local use and economics (see Sections 3.1.3 and 2.2 of the Strategy Program for related activities).

Selected Accomplishments and Activities

- Continued the Alaska Mineral Resources Assessment Program (AMRAP) with studies in six distinct areas; also continued an analysis of the tectonics and thermal maturity of Arctic margin basin formations (DOI/GS);
- Analyzed the structure of the Brooks Range as part of the TransAlaska Crustal Transect (TACT) study, which will be continued to complete the transect into the Beaufort Sea (DOI/GS);
- Developed a Seafloor Earthquake Measurement System (SEMS) designed to gather seafloor motion data to provide seismic characterizations of offshore oil and gas leasing regions (DOE);
- Identified gas hydrates in 50 exploratory and production wells, with the volume of gas within the hydrates estimated to be twice that of conventional gas in the Prudhoe Bay Field (DOE, DOI/GS);
- Collected and reviewed seismic profiles to develop a base map for studies aimed at accurately estimating the total amount of clathrate deposits containing natural gas within a formation or reservoir (DOI/GS);
- Completed field studies in the Arctic National Wildlife Refuge to identify environmental information and knowledge of the carbonaceous rock in the region (DOE);
- Concluded a four-year study of the 5.7-million-acre Valdez Creek Mining District in south-central Alaska, resulting in the identification of 19 previously unreported mineral occurrences, including placer gold, combinations of gold, silver, platinum, chromium, nickel, cobalt, molybdenum and zinc, and

economic quantities of industrial minerals such as limestone, perlite, zeolite, sand and gravel, and stone (DOI/BOM);

- Began planning and logistics arrangements for a four-year study of the approximately two-million-acre Colville Mining District in north-central Alaska (DOI/BOM/BLM/GS);
- Completed a report on tin and rare-earth placer deposits in the Ray River watershed, north-central Alaska, with preliminary resource estimates of contained tin in recent alluvium of 62–172 million pounds of tin in 300 million cubic yards of gravel; most of the occurrences are considered subeconomic inferred resources (DOI/BOM); and
- Completed oil and gas reservoir quality studies in NPRA and ANWR and petrologic–petrophysical–engineering studies of selected wells near ANWR; extracted geochemistry and biological marker compounds from sediments of the Bulge, northern Alaska and the Yukon Territory (DOI/BLM).

Objectives

- Continue systematic mineral appraisal activities and expand programs to provide for periodic assessment of the undiscovered oil and gas and strategic mineral resources in the Arctic on both broad and local scales;
- Evaluate unconventional energy resources (e.g. heavy oil, tar sands, gas hydrates);
- Identify energy and mineral resources for local use; and
- Use new technologies to develop a more modern, complete geologic data base, increase geologic mapping, expand modeling efforts and design derivative maps to address broader earth science questions.

Ongoing and Planned Activities

- Expand efforts in site-specific drilling, geologic mapping and related analytical techniques for bedrock and surficial deposits, especially at medium and large scales, including geological and geophysical mapping correlation across the U.S.–Canadian Arctic boundary (DOI/BLM/BOM/GS/MMS);
- Assess resources included in unconventional energy forms, including oil shale, heavy oil, tar sands, tight-gas sand, geopressured methane, coalbed methane and offshore gas hydrates (DOE, DOI/BLM/BOM/GS/MMS);
- Increase the use of new and improved technologies, including geographic information systems and remote sensing, to produce geologic maps of critical Arctic onshore regions and continental margins and to combine geo-

logic map data with other earth science and geographic data bases to produce derivative maps that address specific earth science questions (DOI/BLM/GS/MMS);

- Continue research activities such as BLM's Resource Management Planning Effort and MMS's Resource Evaluation Program that aid in evaluating local energy resources (DOI/BLM/GS/MMS);
- Make additional comprehensive, detailed on-shore and offshore transects in northeastern and northwestern Alaska (e.g. TACT) to evaluate the potential for mineral and energy resources, as well as geologic hazards to development (DOE, DOI/GS/MMS, NSF);
- Assess the nonenergy minerals lease sale proposed for 1991 in the Norton Sound area (DOI/MMS);
- Conduct studies using geological modeling of subsurface resources, coupled with time-lapse modeling of subsurface impacts of mineral extraction and reclamation, to determine long-term cultural and environmental impacts (DOI/BLM/BOM/GS);
- Continue to analyze geological and formational characteristics of Alaskan North Slope fields by studying well data to improve the knowledge base of gas hydrate deposits (DOE);
- Assess the production characteristics and economic potential of gas hydrates in northern Alaska and determine the relation between in-situ gas hydrate destabilization and global climate change (DOE, DOI/GS);
- Initiate cooperative research efforts to assess the extent of the gas hydrate resources found in Alaska (DOE);
- Study parameters for the design and development of a production well to recover methane from gas hydrate deposits on Alaska's North Slope (DOE);
- Better define the extent of the deep gas resource base in the North Slope using field, laboratory and modeling activities to improve our understanding of the formation, migration and entrapment of this resource (DOE);
- Characterize Arctic hydrocarbon reservoirs in terms of their reserves, physical and chemical properties, geologic configuration, structure and development potential (DOE, University of Alaska);
- Continue the Colville Mining District study through FY 1994 by examining in detail sites identified from field reconnaissance sampling to delineate the extent, grade and type of mineralization and to determine the potential for development (DOI/BOM);

- Continue to develop a minerals GIS/data base for microcomputers that allows extraction of current lease, well and oil and gas assessment information in text or map overlay format (DOI/BLM); and
- Continue a detailed oil and gas study of the Utukok Special Management Area of the NPRA, petroleum geology and geochemistry studies in ANWR, and a bedrock geology study of the northernmost bulge of the Rocky Mountain Cordillera (DOI/BLM).

3.3.2 Coastal and Shelf Processes

Erosion rates are extremely high along the Alaskan Arctic coast, where sea ice and permafrost are common. Specific questions about where to build causeways, man-made islands and other structures can only be answered after basic process information is collected, interpreted and analyzed carefully. Studies of coastal erosion and sediment transport in the Arctic are needed to understand the long-term history of the coastal area in order to intelligently manage the coastal region (see Sections 2.2 and 2.4 of the Strategy Program for related activities).

Selected Accomplishments and Activities

- Developed and released a National Coastal Geology Program, which addresses erosion and other coastal hazards and in future years will focus on the role of ice and freeze-thaw processes in causing erosion in Arctic Alaska (DOI/GS); and
- Developed a coastline and surf-zone smear model and a handbook of smear model input variables, on a shoreline segment-by-segment basis, for the Alaskan OCS in 1989; the model will be used interactively to make probabilistic predictions of the physical and chemical state, amount and location of spilled oil after it contacts a beach; it accounts for deposition, beach substrate and slope, resuspension, weathering and along-shore transport of spilled oil (DOI/MMS).

Objectives

- Map beach, littoral and nearshore sediment and subsea permafrost and determine their associated physical and chemical properties;
- Define the processes controlling the formation and degradation of the seasonally frozen sea floor;
- Implement long-term measurements of tides, winds, waves, storm surges, nearshore currents and sediment distribution patterns to un-

derstand coastal erosion and sediment transport processes; and

- Investigate the direct and indirect effects of ice on coastal erosion (the influence on waves and currents) and on sediment transport (contact with beach sediments, keel gouging, entrapment in frazil ice).

Ongoing and Planned Activities

- Investigate the volume of sediment and water transported by rivers (DOI/GS);
- Expand the use of remote sensing technologies and other photographic processes as a source of coastal erosion and sediment transport data (DOC/NOAA, DOI/GS, NASA);
- Investigate innovative techniques, such as archaeological surveys, as a means of gauging shoreline stability and measuring rates and amounts of coastal erosion and delta or coastal lowland submergence (DOI/GS, NASA, NSF, SI);
- Develop and implement cooperative studies to sample and assess coastal beaches, bluffs and shore faces (DOC/NOAA, DOE, DOI/GS/MMS);
- Plan and conduct icebreaker-supported programs in coastal areas (DOC/NOAA, DOI/GS/MMS);
- Maintain gauging of three U.S. Arctic rivers to determine sediment type, mineralogy, petrology, provenance and grain size and exchange data with other Arctic Rim nations to understand ancient and modern Arctic stream sediment supply histories (DOI/GS); and
- Collect data on the thaw settlement of subsea permafrost and the engineering properties of frozen sediment; establish long-term investigations on thermal and oceanographic variables of the seafloor and frozen sediment (DOD/CRREL, DOE, DOI/GS).

3.3.3 Terrestrial and Freshwater Species and Habitats

The Arctic supports many unique species of birds, mammals, fish and plants, which are important resources to the Nation, as well as to Alaska Natives. Some of these resources are harvested commercially or for subsistence purposes (e.g. food, shelter, fuel, clothing and tools), and others provide recreation. To assure that biological resources are protected for future generations, management agencies must have adequate data and information on the biology and ecology of these species, as well as information on environmental pa-

rameters of importance to vital processes (e.g. feeding, breeding).

Selected Accomplishments and Activities

- Instituted a Veterinary Science Program at the University of Alaska Agricultural Experiment Station, in collaboration with the Institute of Arctic Biology and the Alaska Department of Fish and Game, to study diseases, parasites and toxicology in wildlife; conducted field investigations and captive-animal research on many animals, including musk oxen, caribou, reindeer, wolves, arctic foxes, lynx, mink and sea otters, with special emphasis on brucellosis, rabies and oilspill toxicology (DA/CSRS);
- Continued studies of wolves at Denali, Gates of the Arctic, and Noatak; muskox at Gates of the Arctic and Bering Land Bridge; caribou, merlins, golden eagles, dall sheep and air quality at Denali; reindeer at Bering Land Bridge; steppe vegetation at Yukon-Charley Rivers; vegetation inventory at Bering Land Bridge; and brown bears and water resources at Noatak (DOI/NPS);
- Completed baseline fish and limnological studies at Gates of the Arctic, Surprise Lake in the Aniakchak Caldera, Yukon-Charley Rivers and Lake Clark (DOI/NPS);
- Evaluated issues related to northern Pacific salmonid enhancement on the Noatak River (DOI/NPS);
- Continued studies evaluating the potential effects of resource development, either by developing baseline information on resources that may be at risk or by measuring the effects of ongoing development on populations of selected species, giving special attention to caribou, musk oxen and species of waterfowl, primarily geese, believed vulnerable to disturbance (DOI/FWS);
- Conducted studies of snow geese on the Arctic National Wildlife Refuge, emphasizing essential habitats and documenting types of vegetation used for food in order to predict the consequences of displacement of the geese from these habitats by development (DOI/FWS);
- Continued research on black brant geese in the Teshekpuk Lake area; about 80% of the time spent there is devoted to feeding in a narrow strip of grasses and sedges along the shorelines of large, shallow, low-relief water bodies; molting brant are sensitive to a wide array of man-caused disturbances (DOI/BLM/FWS/MMS).
- Radiomarked 53 Pacific black brant in the Soviet Union, western Alaska and Canada and

later detected 33 of them staging at Izembek Lagoon, along with 276 banded individuals (DOI/FWS);

- Studied the behavior and energetics of Pacific black brant and other geese in response to aircraft overflights at Izembek Lagoon, Alaska (DOI/FWS/MMS);
- Showed that a reduction of the population of Arctic foxes improves the nesting success of cackling Canada geese somewhat in years when voles, the primary prey of the foxes, are abundant but has little or no effect in years when voles are scarce (DOI/FWS);
- Continued to monitor the population status of musk oxen, which were reintroduced to the Arctic National Wildlife Refuge in 1969; the population appears to have stabilized within a range of 350–400 individuals (DOI/FWS);
- Determined that the survival of nesting female emperor geese on Alaska's Yukon–Kuskokwim Delta varies from 44 to 66% annually and is strongly correlated with nesting; females that nest are apparently less vulnerable to spring and summer subsistence hunting (DOI/FWS);
- Completed the Utility Corridor Resource Management Plan, covering more than 15 million acres of BLM-managed land in northern Alaska along the Trans-Alaska Pipeline System between the Yukon River and the Brooks Range; conducted an integrated resource data collection effort within the Utility Corridor (DOI/BLM);
- Completed an interdisciplinary report for lands in the Central Arctic Management Area; continued to implement the Norton Sound Habitat Management Plan; continued to monitor habitat management plans covering Areas of Critical Environmental Concern (DOI/BLM); and
- Started several riparian enhancement and restoration projects on the Seward Peninsula in cooperation with the Alaska Departments of Fish and Game and Transportation (DOI/BLM).

Objectives

- Determine abundance and distribution of fish and wildlife populations and identify their habitat requirements;
- Develop new techniques and technologies for studying and managing biological resources in the often-remote and cold-dominated Arctic environments, including recovery of ecosystems damaged by wildfires and other natural and human-induced causes; and
- Improve methods for detecting and determin-

ing the effects of human activities on the environment and identify measures to mitigate the declines of Arctic biological resources and the destruction of habitats.

Ongoing and Planned Activities

- Measure the transmittance of photosynthetically available radiation through various ice types, including snow-covered ice, on large lakes and the biological productivity (phytoplankton and zooplankton) that occurs beneath these surfaces (DOC/NOAA);
- Characterize the under-ice surface of lakes as a habitat for planktonic and benthic flora and fauna (DOC/NOAA);
- Examine the role of sediment floc on the under-ice surface of lakes in nutrient and contaminant dynamics (DOC/NOAA);
- Study the influence of the Slave River on the productivity and contaminant loading of Great Slave Lake (in Canada's Northwest Territories) including the potential for adverse effects of increased watershed development and possible effects of climatic warming (DOC/NOAA);
- Direct more emphasis on long-term ecological research and monitoring programs to study terrestrial and aquatic habitats and the resident and migratory species they support; differentiate naturally occurring changes from those related to human activity and identify linkages with coastal and marine ecosystems (DA/CSRS, DOI/BLM/FWS/NPS, NSF);
- Increase the involvement of Alaska Native residents and organizations in research programs and decisions affecting fish and wildlife and other renewable land-based ecosystem resources (DA/CSRS, DOI/BLM/FWS/NPS, NSF);
- Investigate the trophic relationships between higher vertebrate predators and consumers (e.g. seasonal predation rates, prey switching and habitat overlap) (DOI/BLM/FWS/NPS);
- Continue interagency participation in multidisciplinary research efforts, including studies of Teshekpuk Lake waterfowl ecology and the Arctic National Wildlife Refuge (DA/CSRS, DOI/BLM/FWS/MMS/NPS);
- Determine spawning escapement and distribution of Pacific salmon in selected tributaries of the Yukon River (DOI/FWS);
- Determine abundance characteristics, life stage distribution and population characteristics of fish species on the North Slope drainages of ANWR and the extent to which they utilize aquatic habitats (DOI/FWS);
- Investigate the nature, extent and control of

parasite and disease problems in wildlife (DA/CSRS);

- Establish criteria for cultivating and propagating selected Alaska native plants (DA/CSRS);
- Determine methods for treating abandoned gravel pads and roads in Arctic Alaska wetlands to improve their suitability for wildlife habitat by vegetating such sites with indigenous plants, with special reference to Prudhoe Bay and the surrounding oil fields (DA/CSRS);
- Determine the influence of oil hydrocarbons on reproduction in mink (DA/CSRS/SAES);
- Evaluate the effects of jet boats on salmon and trout egg and fry survival at Katmai and Lake Clark (DOI/NPS)
- Continue studies of the relationship of bears to the Red Dog Mine at Noatak, bears and hunting at Aniakchak, merlins and pesticides at Denali, wildlife and road use at Denali, fur-bearers and trapping at Gates of the Arctic, and fire and wildlife in northwest Alaska (DOI/NPS); and
- Begin studies of fire and wildlife in interior Alaska; moose and brown bears at Bering Land Bridge; river ecology and use, and stream fish genetics at Noatak; water resources at Gates of the Arctic; lichens at Noatak; wetlands at Yukon-Charley Rivers and coastal resources at Cape Krusenstern (DOI/NPS).

3.3.4 Forestry, Agriculture and Grazing

Increased knowledge of the current and potential productivity of Arctic and Subarctic forests and soils will lead to improved management practices for increasing the productivity of renewable resources. The goals are to promote self-sufficiency among local inhabitants and to accrue economic benefits.

Selected Accomplishments and Activities

- Completed a risk rating system for Lutz and white spruce stands that incorporates plant community associations as an index to stand risk from attack by spruce beetles (DA/FS);
- Developed a moose habitat enhancement plan for the Copper River Delta and continued data collection on moose habitat preference in riparian areas of the Copper River Delta and in mountainous areas of Denali National Park (DA/FS);
- Began studies of plant succession focused on natural colonization of artificial gravel depos-

its created from petroleum exploration and production, revealing that 75 species from 19 families were colonizing gravel pads that were 5 to more than 15 years old; proposed a revision of revegetation methods to facilitate use of indigenous species for gravel pad rehabilitation (DA/CSRS);

- Examined patterns of nitrogen cycling within primary successional soils associated with open shrub, alder and white spruce stands on the Tanana River flood plain near Fairbanks; alder forest floors had the highest nitrogen-fixing rates: 163 kg of fixed nitrogen per year (DA/CSRS);
- Isolated over 56 cold-tolerant *Trichoderma* and over 400 cold-tolerant bacteria from Alaska soils; *Trichoderma* species were found to be capable of controlling damping-off, snow mold and many economically important soilborne diseases, as well as promoting plant growth and development (DA/CSRS);
- Studied selenium supplementation of beef cattle; small amounts of feedstuffs containing adequate Se and monthly injections, or injections every two months, will supply adequate Se (DA/CSRS);
- Studied safety and nutritional content of reindeer field-harvested during a spring 1989 handling; low total fat content results in a saturated fat content that approximates that of poultry and fish (DA/CSRS);
- Attempted to control brucellosis disease in reindeer herds by treating approximately 15,000 reindeer with a vaccine that has been approved for use in Alaska, with initial results indicating that field protection was provided (DA/CSRS);
- Initiated a five-year strategy for reindeer grazing on the Seward Peninsula (DOI/BLM);
- Continued research on movements and reproductive success of caribou, with emphasis on the interaction of weather and other factors with habitat utilization during critical parts of the life cycle and the consequent influence of habitat availability on populations (DOI/FWS); and
- Used Landsat-TM data as part of a project to study the use of remote sensing for identifying tundra vegetation (DOI/FWS).

Objectives

- Continue and extend forest resource research throughout the underutilized taiga forests, focusing on applying ecological information in sustained-yield management and protection of forest types for subsistence and economic use;
- Enhance soil and crop science research to de-

- Develop effective management practices under conditions of permafrost, low temperatures, wildfire and development impacts; and
- Improve techniques and technologies for research on reindeer management systems, including health, habitat and forage.

Ongoing and Planned Activities

- Acquire long-term baseline data describing taiga forests, including productivity, human occupancy, total carbon production and sequestering, and the vigor and health of key vegetation communities and species including ecotones, employing permanent research sites, GIS and remote sensing, integrative modeling and dendrochronological techniques (DA/CSRS/FS/SCS, DOI/BLM/NPS);
- Addressed remaining problems in distinguishing vegetation classes while using Landsat-TM data to identify tundra vegetation (DOI/FWS);
- Determine the human and environmental impacts, including the effects of fire, insects and diseases, on forest and park resources for use in developing more effective management and protection systems and for supporting subsistence, wildlife habitat and protection of streams and fisheries (DA/CSRS/FS, DOI/BLM/FWS/NPS);
- Monitor climate conditions in areas where soils have the potential for agriculture to determine their suitability for crop production, focusing on the effects of permafrost, erosion and short growing seasons (DA/ARS/CSRS/SCS, DOI/BLM/NPS);
- Develop plant varieties that perform under severe Arctic conditions for use in rehabilitating disturbed environments (DA/ARS/CSRS, DOI/BLM/NPS);
- Collect data on lichens, including nutrient value, sensitivity to disturbance and recovery from overgrazing (DA/SCS, DOE, DOI/BLM/NPS);
- Study the influence of snow cover on the availability of winter range forages, and the interactions and competition of caribou and reindeer on tundra range in western Alaska (DA/SCS, DOI/BLM/NPS);
- Monitor the levels of forest pests in interior Alaska forests (DA/FS/ARS, DOI/NPS/BLM);
- Determine the impact of timber harvests on snowmelt and runoff rates from a boreal forest watershed (DA/CSRS/FS);
- Determine after-fire plant succession on boreal zone rangeland disturbed by oil drilling activities (DA/CSRS);
- Determine methods for treating abandoned gravel pads and roads in arctic Alaska wetlands to improve their suitability for wildlife habitat by vegetating such sites with indigenous plants, with special reference to Prudhoe Bay and surrounding oil fields (DA/CSRS);
- Determine soil nitrogen supplies in relation to forest productivity and successional patterns (DA/CSRS);
- Identify organisms that have a potential for suppressing specific soil-borne plant pathogens and determine the mode of action of these biocontrol agents (DA/CSRS);
- Investigate seleniferous feeds and injectable liquid selenium as supplements to selenium-deficient beef cattle diets (DA/CSRS);
- Study reindeer herding at Bering Land Bridge (DOI/NPS);
- Determine the quality of Alaskan reindeer meat, handled and harvested under existing conditions, as a potentially important market product for Native people (DA/CSRS); and
- Continue development of an effective control program for brucellosis in reindeer herds (DA/CSRS).

3.4 Land–Atmosphere Interactions

3.4.1 Glaciology and Hydrology

Documentation of seasonal, interannual and long-term trends in the physical environment of the Arctic requires attention to the special features of seasonal and perennial snow and ice cover and glaciers, especially as they relate to and record climatic change. Reliable information is also needed on surface water quality and quantity. Collection of this information will provide a climatic and hydrologic baseline for the Arctic.

Selected Accomplishments and Activities

- Combined field observations with Synthetic Aperture Radar and ice-penetrating radar measurements of the Malaspina and Bering Glaciers to show that both glaciers occupy deep fjord basins extending several hundred meters below present sea level; in both instances the basins extend more than 50 km behind the present ice margins (DOI/GS);
- Determined that the recent acceleration in the rate of retreat of the Mendenhall Glacier is not related to global warming but is a function of changes in the drainage system associated with the glacier (DOI/GS);
- Determined that between 1977 and 1988 the Wolverine Glacier thickened by as much as 8.1 m, caused by unusually warm winters accompanied by high amounts of snow precipitation; the climate during the post-1977 period of observations has become warmer and wetter (DOI/GS);
- Continued the Greenland Ice Sheet Project; the major thrust of the GISP II project is to drill and recover ice cores from the entire thickness of the Greenland Ice Sheet, over 3000 m, in order to reconstruct the history of atmospheric chemistry and climate for the Northern Hemisphere over the past 200,000 years (NSF);
- Continued to reprocess Geosat altimeter data, with results suggesting that part of the Greenland ice sheet thickened significantly in the nine-year interval between the Seasat and Geosat altimeter missions (NASA);
- Tracked coarse (gravel) sediments in glacially fed rivers via radio transmitters, providing a major breakthrough for understanding sediment transport regimes in gravel-bed rivers by providing the first comprehensive data on both rates of movement and transport sequences correlated to specific flow events (DOD/CRREL);

- Tested high-resolution ground-penetrating radar's ability to locate and define highly localized sources of water in permafrost at several sites in Alaska; located water conduits at depths between 5 and 25 m below the basal ice layer at the margin of the Matanuska Glacier in southeastern Alaska (DOD/CRREL);
- Developed a model (following field and laboratory studies) to predict the development of impermeable firm (and consequent runoff and discharge to the ocean) in response to predicted future climate change (DOE); and
- Convened an interagency workshop on glacier monitoring in Alaska and developed plans for long-term monitoring (DOI/GS/NPS).

Objectives

- Continue to develop paleoenvironmental records from ice caps, ice sheets and mountain glaciers; conduct research on processes by which gases and aerosols are incorporated into the snow and ice; and correlate these records with adjacent records for other sources and proxy records;
- Document the cause-and-effect relationships between glaciers, sea ice and global hydrology, including the relationship to world sea-level changes and climatic fluctuations, both long-term and short-term, regional and global, and continue to develop models for glacier mechanisms;
- Determine the consequences of specific renewable and nonrenewable resource development and harvest practices on ground and surface water, and develop predictive models for stream flow and water quality;
- Forecast future sea-level change caused by "greenhouse"-induced changes in runoff from polar glaciers and ice caps; and
- Establish the role of land–water interactions in the control of nutrient cycling.

Ongoing and Planned Activities

- Expand systematic programs of ocean–atmosphere–glacier interaction, coupled with field studies to monitor short- and long-term changes in glaciers caused by flow dynamics and climate (DOD/CRREL, DOI/GS, NASA, NSF);
- Expand the use of innovative research techniques, including remotely sensed data collection from microwave satellites and aircraft (DOC/NOAA, DOD/CRREL, DOI/GS, NASA);
- Continue important studies of mass balance and dynamics of representative Alaskan glaciers and expand studies to other glaciers (DA/

FS, DOD/CRREL, DOI/GS, NSF);

- Implement national and international cooperative agreements to augment monitoring networks to study glacier mass balance, glacier fluctuations, stream quality and river behavior across the Arctic, and increase the use of regional facilities for long-term monitoring (DOD/CRREL, DOI/GS, NASA);
- Develop theoretical models for determining the quantity of precipitation and snow distribution by wind drifting, and for forecasting snowmelt and precipitation runoff in glacierized and unglacierized basins in permafrost regions (DOC/NOAA, DOE, DOI/GS, NASA, NSF/NCAR);
- Gauge the quantity and monitor the water quality of Arctic streams to determine discharge cycles (DOI/GS);
- Complete the acquisition of the 3000-m-deep ice core in Greenland, continue analyses of the ice for paleoclimatic and atmospheric chemistry conditions, and conduct ancillary surface studies on depositional regimes (NSF);
- Develop projects under Arctic System Science (ARCSS) to understand the role of hydrologic processes and nutrient cycling in long-term changes of the Arctic (NSF);
- Monitor Alaskan glaciers as an indicator of global climate change (DOI/NPS/GS);
- Use the CRREL Sleepers River Research Watershed, Vermont, as a cold regions research site for the DOI/USGS Water, Energy and Biogeochemical Budgets program (DOD/CRREL, DOI/GS);
- Conduct transect studies of the glaciers of North America using historic photography and maps to establish a retrospective baseline; extend this baseline to the future using field observations and remote sensing (DOI/GS/NPS);
- Conduct an airborne SAR and laser altimeter investigation over Greenland during the summer of 1991, with the goal of applying data from these instruments to a variety of geophysical investigations (NASA);
- Complete the reprocessing of Geosat altimeter data and begin to process and analyze ERS-1 Advanced Microwave Instrument altimeter data (NASA);
- Continue to develop and validate regional-scale snow runoff models for estimating future sea-level changes (DOE);
- Continue to evaluate the influence of various wind shields on snowfall catches on precipitation gauges in the Arctic (DA/SCS, DOC/NOAA/CMDL);

- Continue to monitor and expand to an appropriate sample density the network of Wyoming-shielded precipitation gauges (DA/SCS); and
- Observe precipitation variations over the Greenland ice sheet (DOC/NOAA).

3.4.2 Permafrost, Landscape and Paleoclimate

Additional knowledge is needed about the temperature, distribution, thickness and depth of permafrost throughout all geomorphic provinces of the Arctic, including the continental shelf. Modern geologic processes that are responsible for the present morphology and land surface need to be better understood.

Selected Accomplishments and Activities

- Investigated the concept that variations in the surface concentration of radon gas could indicate the permafrost distribution at depth and provide a rapid means of performing preliminary site investigations for planning and design of facilities (DOD/CRREL);
- Developed a preliminary model to predict heat transfer in the active layer overlying permafrost (DOD/ARO/CRREL);
- Determined continuous vegetation histories from lake deposits in Alaska and the Soviet Far East, providing the first comparisons of events of the late Glacial and Holocene records on both sides of the Bering Sea (NSF);
- Assessed the impact of climate change on permafrost distribution (NSF, DOI/GS); and
- Supported the International Permafrost Association, which began publishing a biannual news bulletin and began preparing a circumpolar permafrost map at 1:7,500,000 in cooperation with government agencies (DOD/CRREL, DOI/GS, NSF).

Objectives

- Undertake a comprehensive program to extract paleoclimatic records from permafrost terrains;
- Understand how geologic processes affecting Arctic morphology and land surfaces have responded to changes in the past, and conversely, how these land surfaces and their constituent sediments document the history of past climate;
- Improve the ability to assess and predict the degree and rate of disturbance and recovery of permafrost terrain following natural or human-induced changes;

- Develop results leading to the ability to predict future climate-induced changes to the Arctic landscape; and
- Reconstruct the late Glacial and Holocene climate history in the Arctic.

Ongoing and Planned Activities

- Conduct integrated studies of modern geologic processes and landforms, relict landforms, and changes in climate-controlled geologic processes with time (DOD/CRREL, DOI/GS, NSF);
- Systematically investigate the temperature characteristics, areal extent, depth structure and response to climate change of Arctic permafrost by implementing a systematic long-term observational network of stations in Alaska designed for active layer and temperature measurements (DOD/CRREL, DOE, DOI/GS/MMS, NASA, NSF);
- Continue to determine and map the character, horizontal distribution and depth of terrestrial and subsea permafrost (DOD/CRREL, DOE, DOI/GS, NASA, NSF);
- Continue projects to recover paleoenvironmental histories from lake sediments, Quaternary deposits and permafrost terrain (NSF);
- Monitor geothermal boreholes in northern Alaska for climate reconstruction (DOI/GS); and
- Revise the permafrost map of Alaska and participate in the preparation of a circumpolar permafrost map (DOI/GS, NSF).

3.4.3 Ecosystem Structure, Function and Response

The Arctic is expected to be especially sensitive to the effects of possible global changes, including possible greenhouse warming on terrestrial, atmosphere and marine environments, as well as contaminant transport and deposition. Research is needed to improve our understanding of the influence of climate on land and freshwater processes and vice versa. Topics of particular importance include heat balance relationships, landscape alteration, impacts of wildfire, identification of biological indicators of change, current contaminant levels, sources and sinks of carbon and trace gases, and long-term trends in biological diversity (see Sections 3.3.3 and 2.3 of the Strategy Programs for related activities).

Selected Accomplishments and Activities

- Continued research at the NSF Long Term

Ecological Research (LTER) site at Bonanza Creek to determine the effects of resource limitations such as moisture and sucrose on ecosystem productivity and resiliency, and to study how the addition of sucrose and sawdust to experimental sites alters the carbon-nutrient balance (DA/FS, NSF);

- Installed climatic monitoring stations on an upland and flood plain area in the Bonanza Creek LTER site for measuring snow load and water content, temperatures of the soil profile, monthly depth of freeze and photosynthetic active radiation (DA/FS, NSF);
- Measured the partial pressure of CO₂ in 29 aquatic ecosystems across Arctic Alaska, showing that in most cases (27 of 29) CO₂ was released to the atmosphere; this CO₂ probably originates in terrestrial environments; if this mechanism is typical of that of other tundra areas, then current estimates of the Arctic terrestrial sink for atmospheric CO₂ may be 20% too high (NSF);
- Determined that tussock tundra vegetation near Toolik Lake, Alaska, is losing carbon to the atmosphere, possibly in response to recent climatic and environmental conditions; given the very large pools of soil carbon in northern ecosystems (390 GT), there is a potential for significant impact on atmospheric CO₂ should a sizeable portion of the stored soil carbon be released to the atmosphere (DOE);
- As part of the LTER lake study, showed that primary production is seasonally dependent on river flow and nutrient inputs, which varies annually, and that sediments act as a strong nutrient sink with no cycling of nutrients (NSF);
- Used remote sensing studies to develop new and more accurate estimates of methane flux in the North American Arctic tundra (NASA);
- Developed an experiment plan and selected candidate sites for the Boreal Ecosystem-Atmosphere Study (BOREAS); the proposed experiment sites are in Prince Albert National Park, Saskatchewan, and Nelson Home, Manitoba (NASA);
- Found 1960s fallout radionuclide of cesium within 10 cm from the ground surface, showing how strongly it is retained on the organic mat (DOE);
- Found that beryllium 7, a naturally occurring radionuclide, moves downslope to the riparian zone in tundra, with very little leakage into streams, suggesting that metals that behave similarly to beryllium (e.g. iron, zinc, cobalt and lead) would tend to concentrate in the riparian zone as well (DOE);

- Developed particle trajectory models (of road dust) to predict alteration of drainage, thaw depth and effects of different ecosystems (DOE);
- Developed models to investigate climate change effects and modifications of surface energy balance and calibrated them with gas and water flux measurements (DOE);
- Implemented a field pilot study, the Arctic Accumulation of Air Toxics Project, across the North Slope of the Brooks Range to evaluate the use of lichens and mosses as environmental surrogates for inorganic and organic contamination (EPA);
- Convened an international workshop to exchange information on experimental approaches and methodologies for evaluating Arctic air toxins; cooperated with a visiting Estonian scientist on sampling protocols and approaches; and shared resources and research information with NPS, USFWS and NSF (EPA); and
- Determined levels of trace metals and hydrocarbons in sediments and organisms of the Beaufort Sea as part of a continuing monitoring study to determine if oil and gas activities are altering environmental chemistry (DOI/MMS).

Objectives

- Distinguish ecological changes due to natural causes from changes due to human activities and evaluate management techniques for the conservation and restoration of ecosystems;
- Identify and evaluate the responses of key biological populations and ecological processes to increased CO₂ and to different climatic conditions; monitor the changes in ecotone boundaries, which might serve as integrative indicators of change; and select biological indicators for use in a monitoring program designed to detect, measure and predict the extent of change;
- Expand the number of Long-Term Ecological Research sites and biological observatories into representative Arctic sites under LTER, MAB and ANILCA activities;
- Identify factors contributing to reductions in regional and global biological diversity;
- Integrate process, community, ecosystem and landscape features into a dynamic description that is realistically linked to both finer and coarser scales of resolution;
- Determine the CO₂ flux from tundra the and responses of vegetation to elevated levels of CO₂; and
- Determine the environmental factors control-

ling methane fluxes.

Ongoing and Planned Activities

- Develop and implement techniques for detecting, minimizing and monitoring changes in terrestrial and aquatic systems caused by human activities and environmental factors (DA/FS/SCS, DOE, DOI/BLM/FWS/MMS/GS/NPS, EPA, NSF);
- Institute multiagency planning to establish ecological hypotheses to be tested by field and laboratory research (DA/FS, DOE, DOI/BLM/NPS/MMS, NASA, NSF, SI);
- Conduct studies to determine the most appropriate sites for biospheric observations and transects (DA/FS, DOE, DOI/BLM/GS/NPS, NASA, NSF, SI);
- Conduct studies to evaluate the effects of human activities on the genetic integrity of wild populations of fish, wildlife and vegetation (DA/FS, DOE, DOI/BLM/FWS/NPS/MMS, NSF, SI);
- Expand the use of satellite remote sensing and other technologies (DOC/NOAA, DOE, DOI/BLM/FWS/GS/NPS/MMS, NASA, NSF);
- Conduct multiagency symposia on terrestrial ecosystems and ecological research, including post-season review meetings (DA/FS, DOE, DOI/BLM/FWS/NPS, NASA, NSF, SI);
- Link biosphere reserves and other protected lands to the NSF-sponsored Long-Term Ecological Research program; expand northern LTER candidate sites to include Noatak Preserve and ANWR (DA/FS, DOI/FWS/NPS, NSF, SI);
- Through the U.S. Arctic Directorate of MAB, continue to implement the Northern Sciences Network (DA/FS, DOE, DOI/FWS/NPS, NSF, SI).
- Initiate the first phase of the Arctic System Science program Land–Atmosphere–Ice Interactions; continue the Fairbanks and Toolik Lake LTER program and related terrestrial and aquatic ecosystem projects (NSF);
- Continue interdisciplinary methane investigations to measure methane flux in situ and to understand ecological processes leading to methane flux in the Arctic (DA/FS, DOC/NOAA, DOE, EPA, NASA, NSF);
- Develop direct measurements of integrated soil production and consumption of methane, carbon dioxide, nitrous oxide and carbon monoxide using a technique based on soil fluxes and profiles of radon (222) (EPA);
- Continue investigations to classify and stratify ground cover types for developing statistical estimates of methane flux for the Arctic tun-

dra and taiga (NASA);

- Develop radiative transfer models for synthetic aperture radar to measure structural properties of high-latitude forests (NASA);
- Continue planning for the Boreal Ecosystem-Atmosphere Study (BOREAS), which will be conducted jointly with several Canadian agencies; solicitations for proposals will be released in late 1991; automated data collection will take place from 1992 through the intensive field campaigns planned for 1994 (NASA);
- Investigate the potential effects of global change on the Alaskan boreal forest and re-

generation of boreal tree species (DA/CSRS/FS);

- Expand the impact and recovery program to use existing disturbed sites for measuring changes in important ecosystem parameters (DOE);
- Initiate the development of a circumpolar network for investigating disturbed sites in other regions exposed to different energy-related disturbances (DOE); and
- Assess the risk, in terms of character, magnitude and timing of changes, to Arctic biological systems from atmospherically deposited contaminants (EPA).

3.5 Engineering and Technology

Three recent reports identify research needs in polar engineering. The National Science Board, in its report on the Role of the National Science Foundation in the Polar Regions (NSB 1987), identified research needs in polar engineering.

The Arctic Research Commission (ARC 1990) undertook an examination of the state of Arctic engineering and technology research to identify possible gaps and weaknesses and make appropriate recommendation. The Commission stated that a strong engineering research program is necessary to improve design and construction techniques, equipment, materials and components to make engineering practices more effective under Arctic conditions. The Commission concluded that, in order to satisfy the basic principles of U.S. Arctic Policy and to achieve the desired national competitiveness in the Arctic, it is necessary to significantly improve the nation's Arctic engineering capabilities through a balanced, sustained and coordinated program of Federal support of cold regions engineering research at universities and national laboratories.

Based on its findings the Commission recommended that the U.S. Interagency Arctic Research Policy Committee develop an Arctic engineering research plan with special emphasis on the following priority items:

- Oil spill prevention technology, including innovative containment and cleanup operations in ice-infested waters and permafrost terrain;
- Waste disposal and air pollution control;
- Power generation and energy storage;
- Improved Arctic construction techniques;
- Transportation systems for Arctic conditions; and
- Materials and processes suitable for Arctic operations.

In addition to these topics, priority areas of scientific research whose results are of crucial importance and areas of important technology transfer were recommended to be included in the Arctic engineering research plan:

- Physical properties of ice and snow;
- Physical and chemical behavior of Arctic soils;
- More extensive communications and cooperation to be developed between the various government agencies and the professional societies, conferences with specialized Arctic engineering activities, and more effective mechanisms for technology transfer between government, academia and private industry; and

- New engineering courses and programs specializing in Arctic engineering topics.

A workshop on Cold Regions Engineering Research Needs (Carlson et al. 1989), sponsored by NSF, identified a number of specific research needs:

- Analysis of how current construction procedures, material equipment and personnel performance in Arctic environments can be improved;
- Analysis of building and utility systems for Arctic regions to ensure that they are appropriately based on the nature and constraints imposed by unique environmental conditions;
- Improved comprehensive understanding of ice processes, the effect of ice on structures and the effect of structures on ice;
- Determination of the effects on frozen seabed and permafrost of structures for energy and other development activities; and
- Improved methods and systems for protecting the environment and for improving human habitability.

Selected Accomplishments and Activities

- Conducted in-situ experiments on extending the service lives of grounded spray ice islands into warm weather, on the mechanical properties of saline ice, and on mechanisms that comprise the forces generated by sea-ice-structure interaction (DOI/MMS);
- Continued oil spill response technology research for open water and broken ice fields, largely focusing on the burning of crude oil on water, the use of chemical treating agents, the remote sensing of slicks, and the development of a water jet boom for ice-infested areas (DOI/MMS);
- Acquired and refurbished the now-closed Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility (DOI/MMS);
- Continued to evaluate technologies for reducing engine emissions resulting from OCS operations (DOI/MMS);
- Submitted a patent application for a device to measure the impact of pressure on the internal friction and creep of ice (DOD/CRREL);
- Completed studies on the use of insulation under pavements to reduce frost effects and on the use of scrap rubber from tires in asphalt concrete to reduce the retention of ice on roadways; developed a thermal stress device to test the susceptibility of pavements to low-

- temperature cracking; developed new methods for interpreting nondestructive test data obtained from falling weight deflectometer tests on frozen and thawing pavements; and fabricated a refrigerated test chamber to measure the drainage of water through pavement structures during freezing and thawing (DOD/CRREL);
- Evaluated a unique dual-energy gamma device to nondestructively characterize the performance of insulation subjected to harsh environments (DOD/CRREL);
- Evaluated a commercial icebreaker design, including towed resistance, propulsion and ramming tests of a scale-model icebreaker (DOD/CRREL);
- Developed and tested a hybrid thermosyphon system in support of the USAF Alaskan Over-the-Horizon-Radar project; the concept combines horizontally placed passive thermal piles with backup active refrigeration to stabilize ice-rich, warm permafrost (DOD/CRREL);
- Tested a model hydropower intake trash rack incorporating a new concept in trash rack heating in the CRREL refrigerated flume (DOD/CRREL);
- Reassessed the long-term effects of oil spills on permafrost, vegetation and soil chemical and biological properties at an experimental crude oil spill site established in the late 1970s (DOD/CRREL);
- Showed that solvent mixed with steam further improves the recovery of heavy oil deposits (DOE, University of Alaska); and
- Reached an agreement to share the costs of a coal-fired cogeneration demonstration plant in Healy, Alaska (DOE, State of Alaska).

Objectives

- Develop the extraction technology necessary to recover the Arctic reserves of crude oil, natural gas, heavy oil, methane hydrates and other fossil fuel resources;
- Support technology transfer to the private sector of fossil energy resource recovery and conversion technology, and the environmental impact of such recovery;
- Analyze how current construction procedures, material, equipment and personnel performance in Arctic environments can be improved;
- Ensure that building and utility systems for Arctic regions are more appropriately based

on the nature and constraints imposed by unique environmental conditions;

- Improve on the comprehensive understanding of ice processes, the effect of ice on structures and the effect of structures on ice;
- Determine the effects of placement of structures for energy development and other types of developmental activities on frozen seabed and permafrost;
- Develop expeditious, economic and environmentally sound techniques for developing and transporting Alaskan Arctic oil, gas and other fossil fuel and mineral deposits; and
- Improve methods and systems for protecting the environment and improving habitability.

Ongoing and Planned Activities

- Monitor sea ice and stream ice motion, concentration, floe size and ice type (DOD/COE/OCEANAV, DOI/GS/MMS, NASA, NSF);
- Develop techniques and methods for remotely monitoring and measuring ice, including distribution, frequency and annual occurrence of pressure ridges and rubble field systems (DOD/COE/OCEANAV/ONR, DOI/GS/MMS, NASA, NSF);
- Develop ice erosion control measures (DOD/COE, DOI/MMS);
- Develop the technology for recovering unconventional fossil energy resources such as heavy oil, tar sands, oil shale, tight-gas sand, geopressured methane and gas hydrates (DOE/FE, DOI/GS/MMS);
- Evaluate and promote improved oil transportation technology and oil spill prevention and cleanup systems suitable for Arctic conditions (DOI/MMS);
- Improve equipment and machinery operation in cold regions (DOD/COE);
- Undertake studies of snow physics, drifting and traction on snow and ice (DOD/COE, DOT);
- Improve ice adhesion technologies (DOD/ONR, DOI/MMS, DOT/CG/SHRP);
- Develop and validate improved models of frost heave and thaw weakening for pavement systems (DOD/COE, DOT);
- Develop new materials and designs for lighter structures and improve the durability and performance of building materials for low-temperature applications (DOD/COE, DOI/MMS, NSF);
- Develop innovative water supply and waste treatment systems for remote Arctic areas (DHHS/PHS, DOD/COE);

- Develop technologies to control ice jam formation and to predict ice forces on structures (DOD/CRREL, DOI/MMS);
- Investigate approaches for converting methane to higher hydrocarbons (i.e. syncrude), which can then be easily transported in the existing trans-Alaska crude oil pipeline (DOE);
- Continue to investigate offshore safety, pollution prevention and oil spill response research technologies for open ocean and ice-infested regions (DOI/MMS); and
- Evaluate new technologies to reduce engine emissions and improve hazardous materials management and transportation systems (DOI/MMS);

A series of studies are planned or underway as part of cooperative oil spill response research programs for Arctic waters, including the following:

- The use of aircraft sensing capabilities for oil thickness measurement;
- Development of a water-jet boom for use in broken ice fields;
- Oil slick recovery techniques;
- Chemical treating agents and dispersants;
- Air pollution effects on in-situ burning of spilled oil;
- Development of high-strength contaminant booms for use in ice;
- Development of under-ice oil detector systems;
- The use of ice floes as a means of containing oil spills; and
- Development of mechanical devices that operate in ice fields for separating oil from ice and water.

3.6 Social Sciences and Health

The importance of the North is clearly recognized by the Arctic Research and Policy Act of 1984 and the 1989 National Academy of Sciences report *Arctic Social Sciences: An Agenda for Action*.

The following builds on the recommendations of the 1989 revision. The long-range goal of the plan is:

To investigate the human dimensions of global, regional and local change through the study of past and present northern cultures and societies, and to gain an understanding of human-environment interactions relating to health and well-being.

In accordance with this goal and the recommendations of the IARPC (June 1, 1989), the following actions have been implemented:

- An Interagency Arctic Social Science Task Force was established and Terms of Reference specified and subsequently approved by the IARPC;
- The Arctic Social Science Task Force drafted a Statement of Principles for the Conduct of Research in the Arctic, which was reviewed externally and subsequently approved by the IARPC (Appendix G);
- The NSF has established and funded a multidisciplinary Arctic Social Sciences Program within the Division of Polar Programs; and
- The Polar Research Board's Arctic Social Science Committee prepared a report entitled *Contributions of Arctic Social Sciences to the Social Science Community*.

Coordination and Infrastructure

The Interagency Arctic Social Science Task Force, chaired by the National Science Foundation, meets periodically and consists of representatives from Agriculture (USFS); Commerce (NOAA, NMFS, Sea Grant); Health and Human Services (IHS, NIH, CDC); Environmental Protection Agency; Interior (MMS, BIA, BLM, NPS, FWS); Defense, State (OES), Smithsonian Institution, the Council on Environmental Quality, the U.S. Arctic Research Commission and the National Academy of Sciences (Polar Research Board).

Included within the mandate are the following:

- Prepare Arctic social science and health research and budget crosscuts;
- Facilitate coordination between social science, health, medical and environmental research in the Arctic;
- Promote educational and training opportunities

in the Arctic; and

- Advance public understanding of Arctic social science research.

Principles for the Conduct of Research in the Arctic

All scientific investigations in the Arctic should be assessed in terms of potential human impact and interest. This statement addresses the need to promote mutual respect and communication between scientists and northern residents. Cooperation is needed at all stages of research planning and implementation. This cooperation will contribute to a better understanding of the potential benefits of Arctic research for northern residents and will contribute to the development of northern science through traditional knowledge and experience. The principles (Appendix G) have been formulated to provide guidance for researchers in the physical, biological, behavioral, health, economic, political and social sciences, as well as the humanities. Following approval by the senior representatives of IARPC, each agency has been asked to implement these principles in the management of research under their jurisdiction. The statement has been announced in the *Federal Register* and published in the journal *Arctic Research of the United States* (Spring and Fall, 1990).

Interagency Arctic Social Science Task Force

The Task Force focuses on defining science priorities in three areas: cultural resources and historical processes, social change, and health. These three priorities can be divided into numerous subject areas and two historical dimensions. One dimension, covered by archaeology, ethnography and history, is the long-range cultural historical perspective. The second dimension, addressed by the health sciences, ethnography, sociology and economics, encompasses contemporary issues and problems that are highly correlated with the interactions of northern indigenous and Western cultures, and the consequences for northern communities, subsistence, health and well-being. Because of the unique physical conditions that define the Arctic as a region, the main integrating theme for this research is human-environment interaction. Numerous government agencies have mandates, missions, research interests and programs relating to these science priorities. Coordination and programs among the agencies will increase their effectiveness in this regard and better serve the people of the North.

Resources Management

Human-Environment Interactions

Cultural Resources and Historic Processes

Prehistoric and Historic

Archaeology
History
Ethnohistory
Paleoenvironments
Sea level changes and adaptive strategies
Cultural resources management

DOI, NOAA, NSF, SI, USGS

Contemporary

Cultural, social and economic impacts of environmental change
Adaptive strategies
Land and marine resource uses
Subsistence
Natural and cultural resources management

DOI, EPA, NOAA, NSF, SI

Social Change

Acculturation
Demographic change
Community viability
Technological impacts
Political-administrative dynamics
Education and training

DOI, NSF, SI

Health

Mental and physical well-being
Environmental interactions
Epidemiology
Infectious diseases
Cancer research
Substance abuse
Accidents and suicide
Health-care delivery and engineering

CDC, IHS, NIH, DOD

Cultural and natural resources management is a mission of numerous Federal and state agencies. Cooperative scientific investigations on public lands must be undertaken to accurately document and monitor prehistoric and historic artifacts, sites, structures and landscapes. Effectively formulating, implementing and evaluating resource protection policies requires, first, accurate documentation of baseline data. Equally important are data bases on contemporary indigenous communities and their subsistence and systems of natural resource management. Not only should there be better coordination between agencies, but scientifically motivated research should be encouraged on public lands (Hopkins et al. 1990). Collaboration with local governments, Native councils and organizations should also be encouraged. Such partnerships can be facilitated by specialized groups such as the Alaska Interagency Archaeology Working Group or through integrating projects such as the Beringian Heritage International Park and the Bering Land Bridge Research Program. The NSF Arctic Social Sciences program provides a new source of university funding for research of this kind in Alaska.

Training and Education

The cadre of Arctic researchers in the U.S. is relatively small, and greater efforts must be undertaken to encourage science in the North. This is especially true regarding Native involvement in higher education. It is almost impossible to obtain graduate instruction outside of the major urban centers in Alaska. For these reasons, individual

scientists working in the Arctic have been encouraged to involve local communities in planning and implementing scientific projects. Young people can participate in research projects through programs such as the Research Experience for Undergraduates (REU) program at NSF. Other agency programs are the Resource Apprenticeship Program for Students (RAPS) of BLM, NPS and FWS, which provides summer jobs for Native Alaska students.

Alaska Native Commission

On August 18, 1990, the President signed the Indian Law Enforcement Reform Act (Public Law 101-379), which authorizes the establishment of the Joint Federal-State Commission on Policies and Programs Affecting Alaska Natives. The Congress found that there is a growing social and economic crisis among Alaska Natives in spite of recent laws and policies intended to protect and encourage traditional culture and economic self-sufficiency. The Congress further found that it was timely and necessary to review all policies and programs designed to serve Alaska Natives and to determine specific actions that would help assure that public policy goals for Alaska Natives were being achieved.

The Commission will have 14 members, 7 appointed by the President and 7 appointed by the Alaska Governor. The Commission will hold hearings and make specific recommendations to Congress to help assure that Alaska Natives have comparable life opportunities and that their needs are addressed. These recommendations will respect the traditional and cultural uniqueness and special status of Alaska Natives, as well as cultural differences. The Commission will report to Congress with its recommendations and will make its report available to Alaska Natives, the State of Alaska and the President.

3.6.1 Cultural Resources and Historical Processes

The Arctic affords unique opportunities for studying cultural adaptation and change. It provides an ideal laboratory for research into the interaction of humans with their environment. The ability of humans to adapt to changing conditions is the key to human survival. To predict the effects of environmental change on human populations, it is necessary to have an understanding of both long-term and short-term processes. Studies are needed in archaeology, anthropology and history. These can provide a time depth of at least 15,000

years in Alaska. Paleoecological, zoological and physical anthropological studies provide information about changing environmental and subsistence conditions. Because of the enormous importance of coastal resources and the changing shorelines of the last 10,000 years, sea-level changes are central to northern cultural and historical research. Focusing on the processes of historical change makes Arctic research relevant to the most fundamental issues facing humankind today.

The NSF Arctic Social Sciences program encompasses archaeology, cultural, physical and social anthropology; ethnology, history, geography, sociology, psychology, linguistics, political science, law, economics and related subjects. Interdisciplinary research themes of particular concern are rapid social change, community viability and human/environment interactions, including issues relating to subsistence, sustainable development and global change.

Contemporary issues of paramount importance are the cultural, social and economic impacts of environmental change. These range from the immediate effects of oil spills to global climate change. The melting of the polar ice caps will likely have dramatic impacts on contemporary civilization and on many major urban areas of the planet. For northern indigenous people, the viability of the northern habitat and adaptation to change will largely determine whether or not they can maintain traditional lifeways and survive in their homelands. On a global scale the management of land and marine resources, along with the indirect effects of industrial development, is the core issue of environmental protection.

Both the cultural-historical and contemporary socioeconomic perspectives are needed to formulate predictive and explanatory models for understanding the human dimensions of global change. The Arctic is a region of great scientific relevance to global issues and an area of particular concern in its own right.

Selected Activities and Accomplishments

- Showed the exhibit *Inua: Spirit World of the Bering Sea Eskimo* in Iceland (SI);
- Carried out archaeological investigations on Frobisher Bay in Canada documenting the Martin Frobisher expedition (1576–1578), as well as Eskimo sites in the region (SI);
- Completed studies of deglaciation, land-sea interface changes and paleobotanical changes over the past 8000 years for the Labrador coast (SI);
- Proceeded with research in connection with the Beringian Heritage International Park and in the Beringian region (DOI/NPS);

- Published archaeological data from Cape Krusenstern, Cape Espenberg, the Kobuk valley and the Noatak region (DOI/NPS);
- Completed the Alaska version of the National Archaeological Data Base (DOI/NPS);
- Undertook resource ethnographies in the northwest areas (DOI/NPS);
- Investigated 172 Native allotments since 1989 for cultural resource and archeological clearances; during 1989 and 1990, 130 field investigations were completed on sites of historical, cultural and archaeological significance for conveyance under ANSCA, more than half in the Aleutians; over 1400 taped interviews were conducted with Native elders (DOI/BIA);
- Funded grants for subsistence data gathering and to support the Eskimo Walrus Commission, the Alaska Eskimo Whaling Commission, and the Sea Otter Commission; in addition, special grants were made to study and deal with the impact of the Exxon Valdez oil spill; much of this cultural resources inventory and subsistence-related program research addresses the overall study themes of rapid social change, community viability, and human-environment interactions (DOI/BIA);
- Collected extensive information on kinship, cultural history, subsistence etc. from Point Lay and similar comparative information from Point Hope; the impact of schools, resettlement and, for example, the construction of the DEW line site, was explored with data starting in the 1880s (DOI/MMS);
- Developed and funded research on obsidian hydration dating on archeological sites in northern Alaska (DOI/BLM);
- Documented 20 prehistoric and historic sites during an inventory of about 6300 acres in the Utility Corridor near Coldfoot by cultural resource specialists; other sites north of the Brooks Range and in NPRA were also studied (DOI/BLM);
- Tested an early contact period whaling site at Nanagiatluk (DOI/BLM);
- Collected descriptive material, including maps and photographs of the Gold Rush-era "Wild Goose" Pipeline near Nome (DOI/BLM);
- Excavated four sites undergoing river erosion in the Unalakleet drainage (DOI/BLM);
- Discovered a skull of a pachyrhinosaurus along the Colville River; the University of Alaska Museum continued work at this site and revealed new insights into the late Cretaceous dinosaurs of Alaska (DOI/BLM); and
- Funded Arctic and northern research projects

through the Man and the Biosphere Program High Latitude Directorate, including work on northern ecosystems and northern peoples; the High Latitude Directorate has also provided support for a fellowship position at the Northern Sciences Network Secretariat in Rovaniemi, Finland (DOS).

Objectives

- Document and analyze the origins and transformations of Arctic cultural systems, ethnic groups and languages;
- Research paleoenvironmental changes, including ancient sea levels, in concert with cultural historical investigations;
- Study and analyze traditional knowledge systems, resource uses and subsistence against the background of contemporary technological changes and the development of state and Federal natural and cultural resource management policies; and
- Develop explanatory and predictive models relating Arctic societies and cultural systems to issues of regional and global environmental change.

Ongoing and Planned Activities

- Conduct baseline cultural historical and environmental documentation and research focusing on the proposed Beringian Heritage International Park and the Beringian region, with special attention on paleoecology, environmental and sea level changes, the earliest settlement of the New World, and the ethnography, linguistics and history of Beringian peoples and cultural systems; the Smithsonian's Arctic Studies Center is preparing, with the NPS, the University of Alaska and other state organizations, a new joint Soviet-U.S. exhibition called *Beringia: Arctic Mediterranean* for tour in Alaska and Siberia in 1992-1994, as well as workshops and training opportunities for Native students interested in anthropology and social sciences (DOI/NPS/BIA/BLM/GS, DOS, NSF, SI);
- Through Phase One of the Beringian Heritage Program, beginning in 1991, support the production of a Russian-English archeological dictionary; prepare a traveling mini-Crossroads exhibit; and initiate an ethnographic and ethnoarcheological study in the Bering Land Bridge National Preserve (DOI/NPS);
- Continue Archeological Overviews and Assessments for Gates of the Arctic National Park and Preserve and Noatak National Preserve (DOI/NPS);
- Inventory data bases; develop management

plans for preservation and research; train Native researchers; and enhance Native collaboration in research process (DA, DOC/NOAA, DOI/BIA/BLM/FWS/NPS, NSF, SI);

- Conduct a Traditional Land Use Inventory (TLUI) and a GIS analysis of cultural resources in Alaska (not yet funded) (DOI/BLM);
- Continue to fund multidisciplinary research and provide support for dissertation-level and undergraduate students through the Arctic Social Sciences Program (NSF);
- Fund research on small-group interaction, stress and adaptation, and cognition and performance through the Joint NASA/NSF Research in Human Factors and Human Physiology in the Arctic and Antarctic program; of special interest for the Arctic are studies on social and cultural adaptation, with research sites possible at facilities in Barrow and Kotzebue, along with international collaboration (NASA, NSF);
- Continue cultural resource inventory data gathering and analysis throughout the Arctic (DOI/NPS/BIA);
- Promote cooperative grants to study the subsistence use of resources (DA/FS, DOI/FWS/BIA/NPS/BLM); and
- Examine subsistence resource harvest practices in the Bristol Bay region along with analyses of the key political, economic, social and cultural factors that affect subsistence pursuits (DOI/MMS).

3.6.2 Social Change

Acculturation, the interaction of Native and Western values and cultures, is an ongoing problem of Indian and Inuit (Eskimo) peoples in the Arctic. The technological and economic impacts affect all aspects of traditional lifeways. Whole communities are threatened, as is the organizational control of land, resources and social systems. Such changes alter demographic patterns as well as local, regional and statewide politics. The question of local control is a major concern of northern people. Two areas of special importance in this regard are education and health care.

Selected Activities and Accomplishments

- Continued to support fisheries studies involving management regimes, accident rates, commercial vs recreational fishing, and dynamic economic models of halibut fisheries (DOC/NOAA);
- Provided economic information and assistance to the Pacific and North Pacific Fishery

Management Councils, industry, NMFS and other agencies, including preparing reports and publications, participating on council plan teams in preparing draft regulatory impact reviews of fishery management plan amendments, and preparing and reviewing research proposals and programs (DOC/NOAA);

- Supported education and training for Native Alaska students through the Resource Apprenticeship Program for Students (RAPS); the NOAA Sea Grant and Cooperative Education programs have also supported students in Alaska; this Alaska program is being expanded nationwide (DOC/NOAA, DOI);
- Funded the establishment of a Clearinghouse on Circumpolar Education with representatives throughout village Alaska (NSF);
- Provided dissertation research support for Native students (NSF);
- Received and reviewed over 30 proposals in the first year of the new Arctic Social Sciences Program (NSF);
- Sponsored a social and economic study on the population, economy, sociocultural institutions and infrastructures of all communities of the North Slope Borough; the NSB has emerged as the dominant entity in the region leading to an inevitable cultural homogenization among North Slope communities (DOI/MMS); and
- Initiated the Social Indicators project in 1989 to document changes in the human environment resulting from major actions in the Outer Continental Shelf; interviews have occurred in 31 sample communities from Kaktovik in the northeast to Atka in the southwest; results will be available beginning in 1992 (DOI/MMS).

Objectives

- Gain insight into the short-term and long-term effects of rapid social change on Arctic cultures and societies;
- Determine ecological thresholds relating to economic development and community viability;
- Develop practical applications of social and behavioral science to benefit Arctic residents;
- Develop culturally relevant educational programs; and
- Develop linkages between cultural behavior and health.

Ongoing and Planned Activities

- Continue economic and social impact assessments of harvest allocations between offshore catcher-processor fleets and local, Alaskan-

community-based fisherman and processors, including community profiles and the development of regional economic models; studies of the economic and social effects of privatizing and/or limiting access to the commercial fisheries of the Exclusive Economic Zone are also in progress (DOC/NOAA);

- Fund a project on the effects of privatizing some fishery resources and examine the way fishermen make fishing area decisions in current open access areas (DOC/NOAA);
- Study the economic and social dimensions of fishery and marine mammal conservation, harvest and management; recent amendments to the Magnuson Fishery Conservation and Management Act will require additional fishery impact studies to be developed in the near future; amendments to the Marine Mammal Protection Act have required new environmental impact studies to be conducted; forecasted major effects on commercial fishing and subsistence harvests are being studied (DOC/NMFS); and
- Continue to provide long-term support for research in sociology, psychology, community development, economics and education (NSF).

3.6.3 Health

Health is physical, mental, social and spiritual well-being. Unique cross-cultural interactions and social interdependencies due to harsh environmental conditions in the Arctic highlight this definition of health. Therefore, all Arctic health research must take into account complex human and environmental interactions.

Health research in the Arctic includes the study of the effects of cultural change on Native populations, epidemiology of disease, adaptation of humans to extreme environmental conditions, environmental health risks, contamination and health care delivery in remote and isolated Arctic communities. Health concerns in the Arctic are often related to international health issues. Western culture (and potentially Asian culture) impacts Native people adversely by introducing lifestyle and dietary changes and new infectious agents. Research designed to study these effects and techniques for disease prevention is urgently needed. Funding by DHHS is showing a dramatic increase (see Appendix E).

Selected Activities and Accomplishments

- Completed studies comparing the immunogenicity of three *Haemophilus influenzae* type b

conjugate vaccines, administered to Alaska Native infants; three new conjugate vaccines have been tested, two of which proved highly immunogenic in Alaska Native infants (DHHS/CDC/IHS);

- Completed a study of the level of protection against Hepatitis B virus infection seven years after administration of Hepatitis B vaccine; over 50,000 Alaska Natives were vaccinated leading to a dramatic decline in illness (DHHS/CDC/IHS);
- Continued revaccinations with pneumococcal vaccines in northwest Alaska; bacterial pneumonia is the fourth leading cause of hospitalization and sixth of death among Alaska Natives (DHHS/CDC/IHS);
- Completed studies to determine the prevalence of Human Papilloma Virus in selected Alaska Native populations; cancer among Alaska Natives differs markedly from the general U.S. population; studies have focused on cancers that appear to be related to specific viral infections: nasopharynx, cervix, esophagus and liver (DHHS/CDC/IHS);
- Completed a year-long study examining the effects of prolonged Antarctic residence, resulting in the description of a new syndrome of human physiology and balance called the "Polar T 3 Syndrome;" all indications suggest that extended high-latitude Arctic residence should induce a similar constellation of human adaptation (DOD/NMRI, NSF);
- Undertook research on the bioaccumulation of methylmercury in the food chain associated with dredging; tests of water from Norton Sound determined that mercury levels were an order of magnitude below EPA limits, and tests of human hair samples from Nome showed that mercury did not exceed established EPA criteria (DOI/MMS);
- Undertook research to establish the utility of rewarming hypothermic humans with a microwave-emitting vest and suggested its practical application (DOD);
- Funded a study to evaluate physiological and psychological impairments of human performance in cold-stressed subjects (DOD/MRDC);
- Completed initial work on developing electrically heated gloves for use by aircrew personnel, which will provide protection to -80°F while having a minimal impact on dexterity and tactility (DOD/NRDEC); and
- Supported research and programs on the prevention of cervical cancer in Alaska Native women, tobacco-use prevention, cancer data bases, sleep apnea, physiology in cold regions,

and fractures of the skull and face among Alaska Natives (DHHS/NIH).

Objectives

Health research in the Arctic is done, individually or collaboratively, by the Arctic Investigations Program (AIP) of the Centers for Disease Control (CDC), the Indian Health Service (IHS), the National Institutes of Health (NIH), the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), the Department of Defense (DOD) and the Division of Public Health, State of Alaska. These agencies conduct Arctic research with the following objectives:

- Establish and support basic and applied scientific inquiry for the purpose of improving human health through biomedical and behavioral research programs; and
- Disseminate new information derived from basic and applied research into studies of the etiology, pathogenicity, prevention, diagnosis and treatment of human biomedical disorders and studies of the psychosocial factors associated with poor health status or associated with environmental contaminants.

Ongoing and Planned Activities

- Undertake studies on the sustained levels of immunity and vaccine efficacy ten years following vaccination against Hepatitis B virus (HBV) infection and vaccine efficacy in infants; continue studies of responses to new Hepatitis A vaccines through 1992 (DHHS/CDC/IHS);
- Continue studies on the effectiveness of al-fafetoprotein screening of Hepatitis B virus carriers in prevention of the morbidity and mortality of primary hepatocellular carcinoma (DHHS/CDC/IHS);
- Continue to evaluate strategies for preventing invasive *Haemophilus influenzae* type b (Hib) disease and pneumococcal disease among Alaska Natives (DHHS/CDC/IHS);
- Continue studies of Fetal Alcohol Syndrome among Alaska Natives, including a joint FAS prevention project for research and training designed to counteract this fully preventable problem (DHHS/CDC/IHS);
- Continue studies by the National Institute for Occupational Safety and Health and the Center for Environmental Health in collaboration with the State of Alaska on the epidemiology, risk factors and prevention strategies for occupational injuries in Alaska communities (DHHS/CDC/IHS, State of Alaska);
- Continue evaluation of strategies in the prevention of cervical dysplasia in Alaska Native

- women (DHHS/CDC/IHS);
- Continue epidemiologic studies of spondyloarthropathy in circumpolar populations; these rheumatic diseases are prevalent in Native populations; parallel studies are being carried out by the Soviet Institute of Rheumatology (DHHS/NIH/IHS);
- Continue investigations on the incidence and survival among Alaska Natives with cancer; a five-year surveillance project and the establishment of a data base are part of this project (DHHS/NIH/IHS);
- Expand studies of the Polar T Syndrome for Arctic residents (DOD);
- Begin investigations of the mechanisms of middle-latitude circannual seasonal patterns in energy balance and expenditure to better understand polar physiology (DOD);
- Continue studies on cold-associated amnesia, peripheral cold injury, management of hypothermia and improving cold weather clothing and rations (DOD);
- Assess the accumulation of pollutants at the base of the human food chain (EPA);
- Establish an American Indian and Alaska Native Mental Research Center for promoting excellence in mental health research in Native populations (DHHS/ADAMHA);
- Continue research on suicide among Alaska Native youths (DHHS/ADAMHA); and
- Enhance data collection on alcohol and substance abuse in Alaska (DHHS/ADAMHA, State of Alaska).

4. Operational Support

Several types of facility-related operational support are provided in the Arctic.

Ships and Ice Platforms

Vessels supporting research in ice-covered areas fall into two categories, based on their ice-going capability. The categories are:

- Icebreakers operated by the Coast Guard; and
- Ice-capable and ice-strengthened vessels for research and survey purposes.

The Federal Oceanographic Fleet Coordinating Council (FOFCC) 1990 report supports the need for the Coast Guard to maintain and operate a fleet of icebreakers for polar ice escort, logistic support and research support. It reaffirms that an ice-capable research ship be operated as a national facility for both the Federal and academic communities.

The Arctic Research and Policy Act (ARPA) confirms the Coast Guard's role as manager of the nation's icebreaker fleet to serve the nation's interests in the heavy ice regions of the Arctic. This includes security, economic and environmental interests. Research in support of those interests is specified in ARPA. Coast Guard icebreakers support research in these regions in two general ways: on dedicated science deployments and, as opportunities arise, in conjunction with other missions. Central management of the icebreaker fleet, given adequate resources, permits the interchangeability of ships to ensure mission accomplishment. The Coast Guard has two icebreakers and is acquiring a third.

Ice-going vessels of lesser capability than icebreakers are more economical, and they permit access to the marginal ice zone and other areas of less rigorous ice conditions. The requirement for research in these areas of lesser ice conditions has increased recently. Aside from the USGS research vessel *RV S.P. Lee*, a geological and geophysical vessel that occasionally works in the Arctic, no suitable dedicated U.S. vessel exists to fulfill that need. The UNOLS Fleet Improvement Committee approved a report *Science Mission for an Intermediate Ice Capable Research Vessel*. There is a need for specific identification of research vessels to collect seismic reflection profiles, geopotential data, sediment samples and seismic-refraction profiles in the Bering Sea, Arctic Ocean and Chukchi Sea, and to conduct winter research in the Bering Sea polynyas. FY 1993–1995 plans by NSF in-

clude the construction of an Arctic ice-capable research ship. The conceptual design has been completed and is undergoing community review (as of summer 1991).

Coast Guard icebreakers are available to users on a reimburseable basis. Daily fuel costs and maintenance surcharges are charged to users or paid by researchers. Average costs are \$13,000 per day.

Drift stations and other ice platforms including Soviet and Canadian opportunities will be utilized as research dictates.

Land-Based Facilities

The Polar Ice Coring Office (NSF) provides logistics support for research in Greenland, with emphasis on the Greenland Ice Coring program.

U.S. investigators have access, on a cooperative or reimbursable basis or both, to land-based facilities in Canada and Nordic countries. Cooperative arrangements with the Polar Continental Shelf Project Office in Canada provide for logistics support in the Canadian High Arctic. Facilities in Svalbard are available through the Norwegian Polar Institute, Norwegian universities and other national programs.

Small seasonal camps are maintained in the Alaskan Arctic by individual agencies or groups of agencies to support field programs. The Toolik Lake camp operated by the University of Alaska, and the privately operated facilities at Barrow and Prudhoe Bay, provide fixed bases for land-based research (DOC/NOAA, DOE, DOI/FWS/NPS/GS, NSF).

DOC/NOAA maintains a warehouse building, located at Elmendorf Air Force Base, for storing and maintaining field equipment, scientific instruments, and Arctic gear. The building provides nearly 7000 square feet of heated space (DOC/NOAA/NOS).

Atmospheric Facilities and Platforms

Poker Flat Rocket Range, Alaska, is being upgraded to state-of-the-art upper-atmosphere research capability so that it can support coordinated

rocket and atmospheric monitoring programs.

Subject to the agreement of the Danish authorities, periodic rocket launches take place from Thule and Sondrestrom, Greenland. The U.S. incoherent-scatter radar facility at Sondrestrom is used by several agencies. The U.S. Air Force will terminate operations at Sondrestrom Air Base by the fall of 1992. Science programs that formerly relied on the Air Force for logistics support will be required to seek new means of support.

Central Coordination and Logistics Information Clearinghouse

Several agencies compiled a directory of Federal Arctic research logistics capabilities. The State of Alaska has published a complementary inventory of Arctic logistics capabilities. Federal agencies participated in a logistics planning workshop in September 1989 at the Arctic Science Conference, Fairbanks; a workshop report was published (Kelley et al., 1990). The Department of the Interior supports an Alaska Office of Aircraft Services (OAS), which coordinates aircraft services on a reimbursable basis.

An electronic bulletin board on OMNET is available for posting currently available logistics information (ARCTIC.LOGISTICS).

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Appendix A: Glossary of Acronyms

AASE	Airborne Arctic Stratospheric Expedition	BOREAS	Boreal Ecosystem—Atmosphere Study
AASE-II	Airborne Arctic Stratospheric Expedition-II	CDC	Centers for Disease Control
ABLE	Arctic Boundary Layer Expeditions	CD-ROM	Compact Disk-Read-only Memory
ACSYS	Arctic Climate Systems	CEAREX	Coordinated Eastern Arctic Experiment
ADEOS	Advanced Earth Observation System	CEDAR	Coupling, Energetics and Dynamics of Atmospheric Regions
ADI	Arctic Data Interactive	CES	Committee on Earth Sciences
AEDD	Arctic Environmental Data Directory	CFC	Chlorofluorocarbon
AF	Air Force	CIRES	Cooperative Institute for Research in Environmental Sciences
AFGL	Air Force Geophysical Laboratory	CMDL	Climate Monitoring and Diagnostic Laboratory (formerly GMCC)
AFGML		COE	Corps of Engineers
AFN	Alaska Federation of Natives	CONRIM	Council on Northern Resources Information Management
AFOSR	Air Force Office of Scientific Research	CRREL	Cold Regions Research and Engineering Laboratory
AGASP	Arctic Gas and Aerosol Sampling Program	CRRES	Combined Release and Radiation Effects Satellite
AIP	Arctic Investigations Program	CSRS	Cooperative State Research Service
ALERT	Arctic Long-term Environmental Research Transects	DEW	Distant Early Warning
AMAP	Arctic Monitoring and Assessment Program	DHHS	Department of Health and Human Services
AMI	Advanced Microwave Instrument	DIFAS	Digital Ice Forecasting and Analysis System
AMMTAP	Alaska Marine Mammal Tissue Archival Project	DMSP	Defense Meteorological Satellite Program
AMRAP	Alaska Mineral Resource Assessment Program	DNA	Defense Nuclear Agency
ANCSA	Alaska Native Claims Settlement Act	DOC	Department of Commerce
ANILCA	Alaska National Interest Lands Conservation Act	DOD	Department of Defense
ANWR	Arctic National Wildlife Refuge	DOE	Department of Energy
AORIS	Arctic Offshore Research Information System	DOI	Department of Interior
AOSB	Arctic Ocean Science Board	DOMSAT	Domestic Satellite
APOA	Arctic Petroleum Operators Association	DOS	Department of State
ARC	Arctic Research Commission	DOT	Department of Transportation
ARCSS	Arctic Systems Science	ELF	Extremely Low Frequency
ARM	Atmospheric Radiation Measurement program	EOS	Earth Observing System
ARO	Army Research Office	EPA	Environmental Protection Agency
ARPA	Arctic Research and Policy Act	EPIC	Extensive PMEL Information Collection
ARS	Agricultural Research Service	ERL	Environmental Research Laboratory
ASF	Alaska SAR Facility	ERS-1	European Remote Sensing (Satellite)
AUV	Autonomous Underwater Vehicles	FAST	Fast Auroral Snapshot
AVHRR	Advanced Very High Resolution Radiometer	FE	Fossil Energy
BIA	Bureau of Indian Affairs	FOCI	Fisheries Oceanography Coordinated Investigation
BLM	Bureau of Land Management	FOFCC	Federal Oceanographic Fleet Coordinating Council
BOM	Bureau of Mines	FS	Forest Service

FWS	Fish and Wildlife Service	NDSC	Network for the Detection of Stratospheric Change
FY	Fiscal Year	NEPERF	Naval Environmental Prediction Research Facility
GCM	General Circulation Model	NESDIS	National Environmental Satellite Data and Information Service
GEM	Geospace Environment Modeling	NIH	National Institutes of Health
GGS	Global Geospace Science	NISC	National Information Services Corporation
GIS	Geographic Information System	NMFS	National Marine Fisheries Service
GISP II	Greenland Ice Sheet Project II	NMML	National Marine Mammal Laboratory
GLORIA	Geologic Long Range Inclined Asdic	NMRI	
GMCC	Geophysical Monitoring for Climatic Change (now CMDL)	NOAA	National Oceanic and Atmospheric Administration
GS	Geological Survey	NOARL	
HBV	Hepatitis B virus	NORMAGS	Northern Magnetic and Gravity Surveys
HF	High Frequency	NOS	National Oceanographic Service (NOAA)
HIPAS	High-Power Auroral Stimulation	NOSC	
IAOE-1991	International Arctic Ocean Expedition-1991	NPRA	National Petroleum Reserve-Alaska
IARPC	Interagency Arctic Research Policy Committee	NPS	National Park Service
IASC	International Arctic Science Committee	NRDEC	
IGBP	International Geosphere-Biosphere Program	NSB	National Science Board
IHP	International Hydrological Program	NSB	North Slope Borough
IHS	Indian Health Service	NSF	National Science Foundation
IMF	Interplanetary Magnetic Field	NSIDC	National Snow and Ice Data Center
IPHC	International Pacific Halibut Commission	NSN	Northern Sciences Network
IRIS	Imaging Riometer for Ionospheric Studies	NUSC	
ISHTAR	Inner Shelf Transfer and Recycling	NWS	National Weather Service
ISTP	International Solar-Terrestrial Program	NWT	Northwest Territories
ITEX	International Tundra Experiment	OAR	Office of Oceanic and Atmospheric Research
IWG	Interagency Working Group	OAS	Office of Aircraft Services
JERS-1	Japanese ERS-1	OCEANAV	Oceanographer of the Navy
JIC	Joint Ice Center	OCS	Outer Continental Shelf
JPL	Jet Propulsion Laboratory	OCSEAP	Outer Continental Shelf Environmental Assessment Program
LEADEX	Leads Experiment	OES	
LF	Low Frequency	OHMSETT	Oil and Hazardous Materials Simulated Environmental Test Tank
LTER	Long-Term Ecological Research	OIES	Office of Interdisciplinary Earth Sciences
MAB	Man and the Biosphere	OMB	Office of Management and Budget
MF		ONR	Office of Naval Research
MMS	Minerals Management Service	OSCURS	Ocean Surface Current Simulations
MRDC		PHS	Public Health Service
NAD	Nansen Arctic Drilling program	PICES	Pacific International Council for the Exploration of the Sea
NADP/NTN	National Atmospheric Deposition Program/National Trends Network	PMEL	Pacific Marine Environmental Laboratory (NOAA)
NARL-UIC	NARL-Ukpeagvik Inupiat Corporation	PRECP	Processing of Emissions by Clouds and Precipitation
NASA	National Aeronautics and Space Administration	RADARSAT	Radar Remote Sensing Satellite
NCAP	Nansen Centennial Arctic Program	RAPS	Resource Apprenticeship Program for Students
NCAR	National Center for Atmospheric Research		
NCP	National Climate Program		

REU	Research Experience for Under- graduates program	TOPEX/	meter Poseiden Ocean Topography Experiment
SAES	State Agricultural Experiment Stations	UCAR	University Corporation for Atmo- spheric Research
SAR	Synthetic Aperture Radar	UNESCO	United Nations Educational, Scien- tific and Cultural Organization
SCS	Soil Conservation Service	UNOLS	University National Oceanographic Laboratory System
Sea-WiFS	Sea-Viewing Wide-Field Sensor	USAF	United States Air Force
SEL	Space Environment Laboratory	USCG	United States Coast Guard
SEMS	Seafloor Earthquake Measurement System	USDA	United States Department of Agriculture
SI	Smithsonian Institution	USGS	United States Geological Survey
SMMR	Scanning Multichannel Microwave Radiometer	UV	Ultraviolet
SSM/I	Special Sensor Microwave/Imager	VAMP	Velocity Amplitude Anomalies
STEP	Solar-Terrestrial Energy Program	VLBI	Very Long Baseline Interferometry
TACT	Trans-Alaska Crustal Transect	VLF	Very Low Frequency
TLUI	Traditional Land Use Inventory	WPL	Wave Propagation Laboratory
TM	Thematic Mapper		
TOMS	Total Ozone Mapping Spectro-		

Appendix B: Strategy for Integrated U.S. Arctic Research Programs

Western Arctic Ocean Circulation and Productivity

Phase I: Existing and Planned Agency Contributions

Bering Sea

- DOC/NOAA: *Initial surveys of the circulation and hydrographic structure of the deep Bering Sea and its shelves in relation to wind forcing*
- Bering Fisheries Oceanography Coordinated Investigations (FOCI) initiated in FY 1991 under the NOAA Coastal Ocean Program with emphasis on the role of cross-shelf transport of pollock larvae from the deep Bering basin to the U.S. continental shelf in enhancing recruitment to U.S. fishery.
 - Initial surveys of the eastern Bering shelf in cooperation with MMS during cruises in FY 1990.
 - FY 1991 cruises with the Soviets will define the seasonal variability in the ocean response to wind by conducting hydrographic transects extending from the deep basin onto the shelf in all directions.
- Synthesis, analysis and modeling of historical data on bottomfish, shellfish and marine mammal (Steller sea lion, bowhead whale, northern fur seal) stocks (NOAA/NMFS)*
- Development of techniques such as RNA probe for fishery stock identification*
- FOCI
- NSF: *Synthesis of primary productivity and biogeochemical data sets*
- ARCSS (Arctic System Science).
- Field studies to evaluate spatial and temporal variations in primary and secondary production and biogeochemistry*
- Follow the modification of seawater as it transits the Bering Sea (ARCSS).
- DOI/MMS: *Building on previous investigations, undertake studies of pollutant transport and living resources and long-term monitoring of key species*
- Continue reconnaissance of fur seal and sea lion feeding areas*
- DOI/FWS: *Dynamics of marine mammal population*
- Ongoing research on polar bears examines local and large-scale movements of satellite-telemetered individuals, location and productivity of maternity dens, and biochemical and genetic indicators of subpopulations. Enhanced cooperation with Soviet scientists in FY 1990 and FY 1991 allows investigations of maternity sites in Soviet territory.

Northern Bering/Chukchi Shelf

- DOC/NOAA: *Initial surveys of circulation and water properties on the Chukchi shelf including Soviet territorial waters*
- Ice Edge Ecosystem (ICE) study to be initiated under NOAA Coastal Ocean Program in FY 1991.
 - Build on joint cruises with the U.S.S.R. begun in FY 1990 including deployment of long-term moorings, land meteorological stations, ice drifters, surveys of nutrients and chlorinated organics to acquire the data base for interannual variability of atmospheric forcing, sea-ice processes and ocean transport, mixing and nutrient distributions, and the resultant distribution and magnitude of production. U.S.S.R., Canada, Japan and NSF will collaborate.
- Modeling of ocean-ice coupled circulation*
- ICE
- Preliminary analysis of historical data set for atmospheric variability*

NSF: *Synthesis of historical data*

- Under ARCSS, continue synthesis of previous oceanographic studies, especially ISHTAR.

Pilot studies of primary productivity and biogeochemical cycling

- Under ARCSS, focus on sub-ice, neritic and benthic communities within the annual ice edge zone.
- Coordinated moored sensors and regional studies and transects to extend measurements into the Soviet region of the Bering and Chukchi seas.

NASA: *Processing and distribution of passive-microwave data (at NSIDC) and of SAR data on ice type distribution and motion (at the Alaska SAR Facility)*

- Initial emphasis will be on refining algorithms and supporting research to demonstrate and verify applications of the SAR data.

DOI/MMS: *Field surveys and refinement of circulation model of the eastern Bering shelf*

DOI/FWS: *Distribution and productivity of polar bears*

- Distribution relative to ice movement and ringed seal abundance, as well as to physical and biological factors, including factors contributing to reproductive success.

Distribution of walrus

- Ongoing studies of walrus population distributions and behavior.

Arctic Ocean

DOC/NOAA: *Initial measurements of ice thickness, currents, sedimentation and hydrography off Beaufort Sea shelf*

- Established single Arctic Ocean climate monitoring station (long-term fixed mooring) in FY 1990 in conjunction with IOS/Canada.
- Observations will be continued in FY 1991.

DOD/ONR: *Field studies of winter leads*

- Under the DOD/ONR Leads program initiated in FY 1990, examine the mechanics and patterns of lead formation in response to applied stress fields, the atmospheric and oceanic dynamics associated with individual leads, and the properties and structure of recently generated ice.

NSF: *Field and analysis program on atmospheric, sea ice and oceanographic variations and controls in the Basin*

- Conduct joint U.S.-U.S.S.R. transpolar cruise.
- Participate in IAOE-1991; physical and chemical oceanography.

NASA: *Processing and distribution of passive-microwave data (at NSIDC) and of SAR data on ice type, distribution and motion at the Alaska SAR Facility*

Research to estimate energy mass and salt fluxes at the ocean/ice/atmosphere interfaces, develop realistic models to describe these fluxes, and incorporate these models into GCMs

DOI/MMS: *Continued monitoring of whale migrations and assessment of leads to bowheads; continued monitoring of Beaufort Sea waterfowl and marine birds; study polar bear densities around oil and gas facilities*

DOI/FWS: *Distribution of polar bears*

- Track polar bears in the Arctic Ocean to examine the long-term exchange of individuals with populations in the Chukchi and Bering seas.

Phase II: Planned Agency Contributions

Bering Sea

DOC/NOAA: *Continuation of FOCI with field surveys; application of biological and chemical techniques to determine spawning origin, mixing and recruitment success of pollock populations from the central Bering; analysis and integration of biological and physical data to determine factors affecting recruitment success*

NSF: *Participation in polynya and other oceanographic research based on funding of peer-reviewed proposals*

NASA: *Planned launch of SeaWiFS to provide an opportunity to acquire synoptic estimates of ocean productivity*

DOI/MMS: *Continuation of Phase I studies*

DOI/FWS: *Continuation of development and evaluation of census methods for walrus*

- Enhanced cooperation with Soviet scientists seeks to standardize survey methods and data handling to provide more comprehensive information on regional populations and trends.

Continuation of investigations of movements and subpopulations of polar bears

- Collection of additional data on long-term movements and further development of biochemical and genetic indicators of subpopulations will enable better assessment of information needed for managing populations.

Future Cooperative Program Elements:

Expansion of field surveys sufficient to define the spatial and temporal variability in circulation
Regional climatology to determine the principal atmospheric and oceanographic forcing of the variable circulation in the Bering

Primary and secondary production and its relationship to sea ice dynamics

Processes controlling the transfer of energy between trophic levels and the sequestration/export of carbon from the Bering shelf

Coupled modeling of physical dynamics and ecosystem interactions

Northern Bering/Chukchi Shelf

DOC/NOAA: *Field surveys of physical parameters and circulation on the Chukchi shelf*

- Intensive spring and summer field campaigns under ICE, collaborative with the U.S.S.R.

Modeling of sea ice physics

- Continuation under ICE, with application of SAR data.

NSF: *Expansion of field measurements of particle flux, chlorophyll and chemical parameters with emphasis on Bering Sea-Chukchi Sea transition*

- ARCSS will support moored arrays and expanded cruise transects to examine temporal and spatial variability of biogeochemical processes and variables.

Development and improvement of coupled models

- ARCSS

NASA: *Processing and distribution of passive-microwave and SAR data on ice type distribution and motion*

DOI/MMS: *Continuation of studies of sea ice, pollutant transport, living resources, endangered species, oil-spill and transportation effects, and marine and anadromous fisheries*

DOI/FWS: *Expansion of polar bear and sea bird studies along Soviet coasts*

- Access to Soviet coastal areas to examine reproductive success of polar bears to provide information needed for managing regional populations; access to important breeding or stopover sites for shared geese populations and data sharing with Soviet scientists to provide important information on resources needed by these populations.

Expansion of biological sampling and measurements of primary production to define spatial and temporal variability and off-shelf component
Monitoring of ice thickness and ice deformation
Process studies of ice thermodynamics
Integration of SAR data into regional ice models
Higher trophic level dynamics

Arctic Ocean

- DOC/NOAA: *Field studies of atmospheric variability and effects on ice deformation*
- Participate in DOD/ONR Leads program to examine the mechanics and patterns of lead formation in response to atmospheric stress, and the effect of leads on atmospheric dynamics and the flux of heat and momentum.
- DOD/ONR: *Process studies of atmosphere–ocean exchange associated with leads*
- Leads
- NSF: *Extension of ARCSS studies of atmosphere–ice–ocean processes and related modeling*
- NASA: *Processing and distribution of passive-microwave and SAR data on ice type, distribution and motion*
Research to estimate energy, mass and salt fluxes at the ocean/ice/atmosphere interfaces, develop realistic models to describe these fluxes, and incorporate these models into GCMs
- DOI/MMS *Continuation of long-term observational studies and ecosystem studies in Kasegaluk Lagoon and the Beaufort Sea; continuation of studies of Arctic marine and anadromous fisheries*
- DOI/FWS: *Extension of polar bear studies*
- Enhance the base of information on Arctic Ocean populations to help determine the relative contributions of land- and ice-based maternity dens to recruitment; expected increases in the longitudinal data base on movements to aid in quantifying mixing between Arctic Ocean and other populations.
- Multiagency: *Monitoring of ice movement and surface pressure field*
- Support of Arctic drifting ice buoy network with international collaboration.
- Future Cooperative Program Elements:
- Proposed coordinated transpolar expedition in the summer of 1993 with a U.S. Coast Guard icebreaker and the Canadian icebreaker Louis St. Laurent to obtain oceanographic and geophysical sections across the Arctic Ocean*
 - Process studies of circulation dynamics on the continental slope*
 - Continuous ocean and ice monitoring for spatial and temporal variability in ice thickness, upper ocean structure, circulation, water column sediment flux*
 - Determination of the implication of Leads process studies for the western Arctic (regional scale)—the consequences for mixed layer, atmospheric circulation*
 - Coupled air–ice–ocean circulation modeling to look at coupling between higher and lower latitudes*

Arctic Monitoring

Existing and Planned Agency Contributions

Arctic Monitoring

- EPA: An Alaskan pilot program initiated in summer 1990 will continue to evaluate the nature, extent and effects of exposure of Arctic ecosystems on a regional scale to atmospheric contaminants.
- NSF: Activities include long-term observations at the Fairbanks and Toolik LTER sites in Alaska, specific process-related research including development of research contributing to the International Tundra Experiment (ITEX), and oceanographic measurements (ARCSS and related programs).
- USDA/FS: Activities include long-term monitoring of regional snow and stream conditions; physical and chemical environment, vegetation and soil parameters on the Bonanza Creek Experimental Forest LTER site; monitoring of timber harvest and placer mining effects, prescribed fire effects on hydrologic regimes, and stream sedimentation on water quality on Caribou-Poker Creeks Research Watershed; and further development of inventories of total carbon storage and vegetation vigor and health.
- DOE: Ongoing activities include radionuclide monitoring at Barrow, Alaska, and Thule and Constable Point, Greenland; plant effects from CO₂ enhancement; and dynamics of disturbed ecosystems (R4D program) covering biogeochemical cycling in atmosphere and streams into tundra vegetation and soils.
- DOC/NOAA: Within the National Status and Trends network, triennial sampling of sediments, fish and shellfish is conducted along the Bering, Chukchi and Beaufort sea coasts to determine trends in contaminant concentrations. The marine mammal tissue archive program extant in Alaska, sponsored by MMS and carried out by NOAA OCSEAP, is maintained in conjunction with the National Institute of Standards and Technology to provide a baseline for tissue contaminant concentration. Annual, triennial and special-purpose surveys of marine mammals and Bering Sea groundfish and shellfish are conducted. The GMCC atmospheric monitoring station at Barrow, Alaska, measures carbon dioxide, ozone, CFCs, nitrous oxide, methane and other trace constituents. NOAA collects, archives, processes and distributes data from operational earth-observing satellites and supports the National Geophysical Data Center activities to maintain and distribute snow and ice data sets and products. In conjunction with the DOD/Navy, models and work station technology are developed to improve sea ice analysis and forecasting by the Joint Ice Center (JIC). A SAR communications link is being established to bring ERS-1, JERS-1 and Canadian RADARSAT data in near-real time to the JIC. A tide station is operated at Prudhoe Bay, and new technology for measuring tides in polar regions is being developed. Support is provided along with other agencies for the international Arctic drifting ice buoy network.
- NASA: Activities include continuing development of data systems at the NSIDC, using passive-microwave data to measure sea-ice extent and concentration; at Goddard Space Flight Center, using radar-altimetry data to measure ice-sheet surface topography and changes in surface elevation; and at the Alaska SAR Facility using SAR data to determine detailed characteristics of the ice and land surface, including sea-ice concentration, type and motion.
- DOD/NAVY: The Department of the Navy (Oceanographer of the Navy) continues to modernize and improve its sea ice analysis and forecasting capabilities at the Navy/NOAA Joint Ice Center through the development of the Digital Ice Forecasting and Analysis System (DIFAS), the Polar Ice Prediction System (PIPS) ice forecasting model, and a communications link between the U.S. and Canadian ice centers for the routine exchange of sea ice and iceberg data and products. Data are obtained to measure sea ice extent, elevation and drift using the Defense Meteorological Satellite Program, Special Sensor Microwave/Imager (SSM/I), Geosat follow-on and TOPEX/Poseidon, and Arctic drifting buoys.

DOD/CRREL:	Data are acquired from selected northern locations on climate, snow and vegetation covers, hydrologic balance and permafrost.
DOI/NPS:	A program of inventory and monitoring is being implemented for Alaskan parks, including population dynamics of selected animal species, occurrence and nature of natural fires, characteristics of soil thaw, water and air quality, wet and dry deposition of airborne contaminants, and climatic parameters.
DOI/FWS:	Activities include baseline contaminants studies along the Arctic coastline and on northern Alaska wildlife refuges, including trace metals, organochlorine pesticides and hydrocarbons in sediments, water, invertebrates, birds and Arctic foxes; contaminants studies at reserve pits and on offshore discharge in the Prudhoe Bay area; and studies of terrestrial mammals, waterfowl, fishery resources, other wildlife, and habitat interrelationships.
DOI/MMS:	Several multiyear, multidisciplinary projects monitor the marine and coastal ecosystems and the human environment to detect changes resulting from offshore oil and gas development activities, including monitoring seabird, whale and ringed seal populations in the Beaufort and Chukchi seas, periodic sampling and chemical analysis (heavy metals and petroleum hydrocarbons) of marine sediments and organisms in the Beaufort Sea, and monitoring socioeconomic and sociocultural changes in selected Alaskan communities.
DOI/USGS:	Activities include monitoring surface and ground water quality and quantity; monitoring representative Alaskan glaciers and permafrost ground temperature at selected stations; operating the seismic observatory (Barrow); conducting mineral assessments and studies on earthquakes and volcanoes; and maintaining the AEDD and numerous map and photographic inventories.
DOI/BLM:	Existing monitoring activities include impacts of human activities on public lands, changes in these impacts due to mitigation measures imposed by management, and changes in habitats of various wildlife and fisheries species.

Bering Land Bridge Program

Existing and Planned Agency Contributions

DOI/NPS:	The National Park Service is the lead agency for the Beringian Heritage International Park and cultural resource management in this region. NPS archaeologists, anthropologists and natural scientists will collaborate with university researchers in the U.S. and institutions in the U.S.S.R. Support is available for Native heritage studies, museum development and exchange of personnel.
NSF:	The National Science Foundation's Arctic Social Sciences program can support university-based research in archaeology, anthropology, ethnography and related subjects. NSF can also promote multidisciplinary projects involving human-environmental interactions, earth sciences, ecology and global change.
SI:	The Smithsonian Institution's Arctic Studies Program can focus resources on the Bering region through field projects, archival and museum collections and exhibits such as <i>Crossroads of the Continents</i> . Coordination with other SI programs in paleobotany, geology and natural history is central to the Bering research program.
DOI/BIA:	The Bureau of Indian Affairs input focuses on education, communication and Native programs. Support is also provided for archaeological and anthropological research.
DOI/MMS:	The Minerals Management Service has had a major commitment to baseline studies and research on the socioeconomic impacts of offshore gas and oil development on contemporary societies in this region of Arctic Alaska.

DOI/BLM: The Bureau of Land Management, like the NPS, is concerned with cultural resource management and cultural historical analysis through archaeology and anthropology, as well as subsistence studies.

DOC/NOAA: The National Oceanic and Atmospheric Administration supports research on social and cultural change relating to marine resources, economic policies and maritime communities. The Bering region is an area of special interest because of the rich fish and sea mammal resources, which still are a major basis for settlement. Sea Grant programs support state and university research.

Appendix C: Third Biennial Report of the Interagency Arctic Research Policy Committee to the Congress

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

nsf

January 26, 1990

OFFICE OF THE
DIRECTOR

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

I am pleased to transmit through you to the Congress the enclosed report required under Public Law 98-373, the Arctic Research and Policy Act of 1984.

This report is submitted on behalf of the Interagency Arctic Research Policy Committee for which the National Science Foundation serves as chair agency. The report lists activities and accomplishments of the Interagency Committee and describes the activities of the Arctic Research Commission. Both entities are authorized by the Act and were established by Executive Order 12501 of January 28, 1985.

It is a distinct honor for the member agencies to serve on the Interagency Committee and for the National Science Foundation to chair it.

Sincerely,


Erich Bloch
Director

Enclosure: Biennial Report

THIRD BIENNIAL REPORT OF THE
INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE
TO THE CONGRESS
(FEBRUARY 1, 1988 TO JANUARY 31, 1990)

Prepared by the National Science Foundation
on behalf of the Interagency Arctic Research Policy Committee

Section 108(b) of Public Law 98-373, the Arctic Research and Policy Act of 1984, directs the Interagency Arctic Research Policy Committee (IARPC) to submit to Congress, through the President, a biennial report containing a statement of the activities and accomplishments of the Interagency Arctic Research Policy Committee and a description of the activities of the Arctic Research Commission. Both the Interagency Committee and the Commission are authorized by the Act and were established by Executive Order 12501 dated January 28, 1985.

During the period February 1, 1988 to January 31, 1990, the Interagency Arctic Research Policy Committee has:

- Prepared and published the first biennial revision to the United States Arctic Research Plan, as required by Section 108(a)(4) of the Act. The revised Plan was formally submitted to the President on August 1, 1989, and the President transmitted the Plan to Congress on August 2, 1989.
- Published and distributed four issues of the journal Arctic Research of the United States. The issues reviewed all Federal agency arctic research for FY 1987 and 1988 and included summaries of the IARPC and Commission meetings and activities. The fall 1989 issue contained the full text of the biennial revision to the U.S. Arctic Research Plan.
- Consulted with the Commission on policy and program matters described in Section 108(a)(3), was represented at all meetings of the Commission, and responded to Commission reports on goals and objectives, logistics and data.
- Continued the processes of cooperation and coordination required under Section 108(a)(6), (7), (8) and (9);
- Provided input to an integrated budget analysis for arctic research for the President's budget, which identified \$97.0 million in Federal support for fiscal year 1988, and \$106.0 million in fiscal year 1989.
- Provided for public participation as required in Section 108(a)(10), which culminated in active public involvement in the development of the recommendations and the biennial revision to the Plan at consultative meetings in Anchorage, Barrow, and Kotzebue, Alaska, in March 1989;
- Prepared a strategy report, published in January 1990, for an FY 1991 interagency Arctic Oceans Research Program which identified six key science elements for future research.

- Developed the Arctic Environmental Data Directory, which now contains information on 250 arctic data sets, and developed a demonstration model for a prototype CD ROM (compact disc - read only memory) containing arctic environmental data and information.
- Conducted a formal interagency review of the National Academy of Sciences report on development of an Arctic Social Science Program, and formally supported establishment of an arctic social sciences research program at the National Science Foundation. The program has now been established.
- Participated in discussions on the development of a non-governmental International Arctic Science Committee.

In addition to four meetings of the Committee (May 2, 1988; March 27, 1989; June 1, 1989; and November 6, 1989), other meetings were organized and sponsored by the Interagency Arctic Research Policy Committee (IARPC) over the past two years and included:

- Social Science Workshops: Fairbanks, Alaska (September 1988) and Washington, D.C. (January 1989)
- Data Workshops: Boulder, Colorado (March 1988 and June 1989)
- Logistics Workshop: Fairbanks, Alaska (September 1989)

All of these activities have served to increase awareness of arctic research, both within and outside the Federal government. These activities have provided opportunities for outside involvement in the establishment of arctic research policy and research plans.

During this period, the U.S. Arctic Research Commission meet eight times and:

- Published a Statement of Goals and Objectives to Guide United States Arctic Research (December 1988). The report addresses guiding principles, priority research areas, support and management as well as new opportunities for research. This guidance was used by the Interagency Arctic Research Policy Committee in preparing the biennial revision of the United States Arctic Research Plan.
- Published a comprehensive report, Arctic Data and Information: Issues and Goals (June 1989), which addresses a series of specific issues concerning arctic data and information including policy considerations, and recommends steps to implement a comprehensive national policy and an Arctic Data and Information System.
- Reviewed the environmental impact statement (EIS) process and developed recommendations for its improvement in the Arctic with emphasis on the need for external scientific and technical review at all stages in the process.
- Prepared an explanatory brochure on the Arctic Research Commission, its basic objectives, principal duties, and the priority areas of arctic research.

*Appendix D: Enhancing Research and Expanding the
Human Frontier*

**IV.C. ENHANCING RESEARCH
AND EXPANDING THE HUMAN
FRONTIER**

Reprint of pages Two-35 through Two-76 of
the *Budget of the United States Government*,
Fiscal Year 1992

U.S. policy in the Arctic consists of four elements: protection of essential security interests; support for sound, rational development of the region; promotion of scientific research contributing to knowledge about the Arctic; and promotion of mutually beneficial international cooperation in the Arctic. Federal Arctic research is guided by a 5-year research plan developed by the Interagency Arctic Research Policy Committee (IARPC) (in consultation with the Presidentially-appointed Arctic Research Commission and other interested groups) and updated biennially.

The budget includes \$134 million for Arctic research, an increase of about \$12 million over the 1991 level. Activities included in the USGCRP account for approximately 50 percent of this increase. Within the total for 1992, \$60 million is proposed to implement the four integrated programs covering the western Arctic: oceans research, geodynamics, studies of the Sering Sea and land mass, and monitoring and data collection activities. Approximately \$6 million of this amount is for ship and aircraft support in five agencies, NSF, Transportation, NOAA, Interior, and DOD/Navy. These programs support bilateral and multilateral environmental, space, oceans, and social science agreements and cooperative activities.

One area that has received special emphasis is Arctic research, though U.S. activities in the Arctic go beyond the range of programs included in the USGCRP.

Table C-17. UNDERSTANDING THE ARCTIC
(Dollar amounts in millions)

Category	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Resource development ¹	49	56	+7	+14
Arctic as laboratory ²	48	50	+2	+4
National security ³	25	28	+3	+12
Total	122	134	+12	+10

¹Includes the Departments of Interior, Commerce, Agriculture, Energy, Transportation, State, and the Environmental Protection Agency.

²Includes the Department of Health and Human Services, and the National Aeronautics and Space Administration, the National Science Foundation, and the Smithsonian Institution.

³Includes the Department of Defense. The 1991 enacted level includes a one-time increase for Defense of about \$13 million specifically for upper atmosphere research and associated facilities, including the High Frequency Active Auroral Research Program (HAARP). For the purposes of comparison with 1992 levels, this funding has been excluded.

Appendix E: Arctic Research Budgets of Federal Agencies

16-May-91 TABLE 1. ARCTIC RESEARCH BUDGETS OF FEDERAL AGENCIES

AGENCY Dept/ Agency	Program Name	CAT	ELEMENT C	FY90 est (thousands of dollars)	FY91 prop (thousands of dollars)	FY92 prop (thousands of dollars)
DOD	Arctic Engineering	S	L	3,510	3,980	3,530
DOD	Permafrost/Frozen Ground	S	L	1,300	1,370	1,400
DOD	Snow and Ice Hydrology	S	L	3,370	3,680	3,480
DOD	Oceanography	S	O	9,760	10,160	12,590
DOD	Lower Atmosphere	S	A	1,630	1,610	1,480
DOD	Upper Atmosphere	S	A	3,800	3,630	4,220
DOD	Medical and Human Engr	S	H	1,170	770	1,390
	total.....			24,540	25,200	28,090
DOI/MMS	Technology Assessment/Research	R	O	1,700	2,100	4,400
DOI/MMS	Environmental Studies	R	O	5,200	5,200	5,200
DOI/USGS	Energy and Minerals	R	L	2,534	2,534	2,534
DOI/USGS	Natural Hazards	R	L	1,209	1,209	1,209
DOI/USGS	Ice and Climate	R	L	350	1,500	1,000
DOI/USGS	Hydrology	R	L	310	150	200
DOI/USGS	Glaciology and Quaternary	R	L	150	1,150	1,150
DOI/USGS	Marine Geology	R	O	980	500	500
DOI/USGS	Magnetosphere	R	A	25	25	25
DOI/USGS	Mapping	R	L	915	1,070	1,070
DOI/FWS	Marine Mammals	R	O	1,330	1,340	1,700
DOI/FWS	Migratory Birds	R	L/O	1,900	1,900	1,900
DOI/FWS	Fisheries Research	R	L	375	375	375
DOI/FWS	Cooperative Research	R	L	350	350	350
DOI/FWS	Terrestrial Ecology	R	L	1,075	1,075	1,100
DOI/BLM	National Wildlife Refuge	R	L	100	50	50
DOI/BLM	Habitat-Arctic	R	L	348	276	200
DOI/BLM	Habitat-Kobuk	R	L	372	259	409
DOI/BLM	Pipeline Studies	R	L	175	175	175
DOI/BLM	Fire Control	R	L	350	350	350
DOI/BLM	Nat Petro Reserve/Alaska	R	L	112	181	200
DOI/BLM	Minerals/Mining	R	L	360	456	500
DOI/BLM	Global Change	R	L	0	50	50
DOI/NPS	Cultural Resources	R	H	337	590	790
DOI/NPS	Natural Ecology	R	L	1,100	1,350	1,550
DOI/BIA	Cultural	R	H	1,700	1,700	1,700
DOI/BIA	Subsistence	R	H	1,075	750	750
DOI/BOH	Minerals	R	L	781	1,028	1,028
	total.....			25,213	27,693	30,465
NSF	Atmospheric Sciences (a)	L	A	7,264	7,400	7,400
NSF	Ocean Sciences/Ship Support (a)	L	O	3,134	3,200	3,300
NSF	Biological Sciences	L	L/O	1,988	2,000	2,100
NSF	Glaciology (a)	L	L	2,000	2,100	2,100
NSF	Earth Sciences	L	L	2,094	2,500	2,600
NSF	Arctic Systems Science (a)	L	O/L	5,300	7,600	9,400
NSF	Engineering	L	L	613	600	600
NSF	Social Science/Education	L	H	964	1,400	1,500
NSF	Coordination	L	C	247	270	270
NSF	Arctic Research Commission	L	C	485	497	535
	total.....			24,088	27,567	29,805
	(a) includes major operational support \$ 5.5 million/yr (avg)					

Dept/ Agency	Program Name	CAT	ELEMENT	FY90	FY91	FY92
NASA	Polar Ocean/Ice Sheets	R	O	7,800	8,500	9,000
NASA	Land Processes	R	L	800	1,100	1,600
NASA	Solid Earth Science	R	L	1,200	1,200	1,200
NASA	Atmospheric Sciences	R	A	3,000	1,000	1,000
NASA	Arctic Ozone	R	A	1,000	2,500	7,500
NASA	Sounding Rocket Program	R	A	1,000	1,050	1,100
NASA	Dynamics Explorer	R	A	1,300	1,365	600
NASA	Space Plasma Research	R	A	850	895	895
NASA	Solar Terrestrial Theory	R	A	400	420	420
	total.....			17,350	18,030	23,315
DOC/NOAA	Arctic Haze	R	A	200	100	100
DOC/NOAA	Solar Terrestrial	R	A	250	250	250
DOC/NOAA	Atmos Trace Constituents	R	A	180	180	180
DOC/NOAA	Climate Modeling	R	A	300	300	300
DOC/NOAA	Environmental Prediction	R	A	735	810	1,065
DOC/NOAA	Fisheries Assessment	R	O	1,900	1,900	2,400
DOC/NOAA	Marine Mammal Assessment	R	O	1,200	1,200	1,200
DOC/NOAA	See Grant	R	O	150	260	170
DOC/NOAA	Ocean Assessment	R	O	150	150	160
DOC/NOAA	Stratospheric Ozone	R	A	400	400	1,000
DOC/NOAA	Arctic Ecosystems	R	O	390	1,890	1,890
DOC/NOAA	Data Management	R	O	437	1,161	1,415
DOC/NOAA	Human Resources	R	H	366	619	679
DOC/NOAA	Aircraft/Vessels	R	O	1,102	1,928	2,805
DOC/NOAA	Global Change	R	A/O	768	1,718	2,000
	total.....	R		8,528	12,866	15,614
DOE	Ecosystem Response	R	L	1,574	1,298	1,300
DOE	Response to Carbon Dioxide	R	L	532	444	444
DOE/FE	Gas Hydrates	R	L	183	200	0
DOE	Aurora	R	A	140	140	140
	total.....			2,429	2,082	1,884
DHHS	Indian Health Service	L	H	250	250	250
DHHS	National Institutes of Health	L	H	1,770	1,850	1,850
DHHS	Communicable Disease Con. Ctr.	L	H	3,010	4,023	4,130
DHHS	ADAMHA	L	H	2,971	3,145	3,331
	total.....			8,001	9,268	9,561
SMITHSONIAN	Anthropology	L	H	555	630	630
SMITHSONIAN	Arctic Biology-	L	L	75	75	75
	total.....			630	705	705
DOT/USCG	Int'l Ice Patrol	R	O	250	250	250
DOT/USCG	Test and Evaluation	R	O	0	0	430
DOT/USCG	Extramural Support	R	O	55	55	55
	total.....			305	305	735
EPA	Arctic Research Program (ALERT)	R	L	250	250	1,000
EPA	High Latitude Methane	R	L	250	250	250
	total.....			500	500	1,250
AGRICULTURE	Forest Service	R	L	1,013	1,147	1,150
AGRICULTURE	Agricultural Research Service	R	L	778	778	778
AGRICULTURE	Cooperative State Res Service	R	L	1,197	1,247	1,275
AGRICULTURE	Soil Conservation Service	R	L	974	980	980
	total.....	R		3,962	4,152	4,183
STATE	MAB: Arctic Directorate	R	L	20	60	60
GRAND TOTALS -----				115,566	128,428	145,667
CAT: S=National Security, R=Resource Development, L=Arctic as Laboratory						

Appendix F: Arctic Research and Policy Act, As Amended

PUBLIC LAW 98-373 - July 31, 1984; amended as
PUBLIC LAW 101-609 - November 16, 1990

An Act

To provide for a comprehensive national policy dealing with national research needs and objectives in the Arctic, for a National Critical Materials Council, for development of a continuing and comprehensive national materials policy, for programs necessary to carry out that policy, including Federal programs of advanced materials research and technology, and for innovation in basic materials industries, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:

TITLE I-ARCTIC RESEARCH AND POLICY

SHORT TITLE

SEC. 101. This title may be cited as the "Arctic Research and Policy Act of 1984, as amended".

FINDINGS AND PURPOSES

SEC. 102.(a) The Congress finds and declares that--

(1) the Arctic, onshore and offshore, contains vital energy resources that can reduce the Nation's dependence on foreign oil and improve the national balance of payments;

(2) as the Nation's only common border with the Soviet Union, the Arctic is critical to national defense;

(3) the renewable resources of the Arctic, specifically fish and other seafood, represent one of the Nation's greatest commercial assets;

(4) Arctic conditions directly affect global weather patterns and must be understood in order to promote better agricultural management throughout the United States;

(5) industrial pollution not originating in the Arctic region collects in the polar air mass, has the potential to disrupt global weather patterns, and must be controlled through international cooperation and consultation;

(6) the Arctic is a natural laboratory for research into human health and adaptation, physical and psychological, to climates of extreme cold and isolation and may provide information crucial for future defense needs;

(7) atmospheric conditions peculiar to the Arctic make the Arctic a unique testing ground for research into high latitude communications, which is likely to be crucial for future defense needs;

(8) Arctic marine technology is critical to cost-effective recovery, and transportation of energy resources and to the national defense;

(9) the United States has important security, economic, and environmental interests in developing and maintaining a fleet of icebreaking vessels capable of operating effectively in the heavy ice regions of the Arctic;

(10) most Arctic-rim countries, particularly the Soviet Union,

possess Arctic technologies far more advanced than those currently available in the United States;

(11) Federal Arctic research is fragmented and uncoordinated at the present time, leading to the neglect of certain areas of research and to unnecessary duplication of effort in other areas of research;

(12) improved logistical coordination and support for Arctic research and better dissemination of research data and information is necessary to increase the efficiency and utility of national Arctic research efforts;

(13) a comprehensive national policy and program plan to organize and fund currently neglected scientific research with respect to the Arctic is necessary to fulfill national objectives in Arctic research;

(14) the Federal Government, in cooperation with State and local governments, should focus its efforts on the collection and characterization of basic data related to biological, materials, geophysical, social, and behavioral phenomena in the Arctic;

(15) research into the long-range health, environmental, and social effects of development in the Arctic is necessary to mitigate the adverse consequences of that development to the land and its residents;

(16) Arctic research expands knowledge of the Arctic, which can enhance the lives of Arctic residents, increase opportunities for international cooperation among Arctic-rim countries, and facilitate the formulation of national policy for the Arctic; and

(17) the Alaskan Arctic provides an essential habitat for marine mammals, migratory waterfowl, and other forms of wildlife which are important to the Nation and which are essential to Arctic residents.

(b) The purposes of this title are--

(1) to establish national policy, priorities, and goals and to provide a Federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences;

(2) to establish an Arctic Research Commission to promote Arctic research and to recommend Arctic research policy;

(3) to designate the National Science Foundation as the lead agency responsible for implementing Arctic research policy; and

(4) to establish an Interagency Arctic Research Policy Committee to develop a national Arctic research policy and a five year plan to implement that policy.

ARCTIC RESEARCH COMMISSION

SEC. 103. (a) The President shall establish an Arctic Research Commission (hereinafter referred to as the "Commission").

(b)(1) The Commission shall be composed of seven members appointed by the President, with the Director of the National Science Foundation serving as a nonvoting, ex officio member. The members appointed by the President shall include--

(A) four members appointed from among individuals from academic or other research institutions with expertise in areas of research relating to the Arctic, including the physical, biological, health, environmental, social and behavioral sciences;

(B) one member appointed from among indigenous residents of the Arctic who are representative of the needs and interests of

Arctic residents and who live in areas directly affected by Arctic resource development; and

(C) two members appointed from among individuals familiar with the Arctic and representative of the needs and interests of private industry undertaking resource development in the Arctic.

(2) The President shall designate one of the appointed members of the Commission to be chairperson of the Commission.

(c)(1) Except as provided in paragraph (2) of this subsection, the term of office of each member of the Commission appointed under subsection (b)(1) shall be four years.

(2) Of the members of the Commission originally appointed under subsection (b)(1)--

(A) one shall be appointed for a term of two years;

(B) two shall be appointed for a term of three years; and

(C) two shall be appointed for a term of four years.

(3) Any vacancy occurring in the membership of the Commission shall be filled, after notice of the vacancy is published in the Federal Register, in the manner provided by the preceding provisions of this section, for the remainder of the unexpired term.

(4) A member may serve after the expiration of the member's term of office until the President appoints a successor.

(5) A member may serve consecutive terms beyond the member's original appointment.

(d)(1) Members of the Commission may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code. A member of the Commission not presently employed for compensation shall be compensated at a rate equal to the daily equivalent of the rate for GS-18 of the General Schedule under section 5332 of title 5, United States Code, for each day the member is engaged in the actual performance of his duties as a member of the Commission, not to exceed 90 days of service each year. Except for the purposes of chapter 81 of title 5 (relating to compensation for work injuries) and chapter 171 of title 28 (relating to tort claims), a member of the Commission shall not be considered an employee of the United States for any purpose.

(2) The Commission shall meet at the call of its Chairman or a majority of its members.

(3) Each Federal agency referred to in section 107(b) may designate a representative to participate as an observer with the Commission. These representatives shall report to and advise the Commission on the activities relating to Arctic research of their agencies.

(4) The Commission shall conduct at least one public meeting in the State of Alaska annually.

DUTIES OF THE COMMISSION

SEC. 104. (a) The Commission shall--

(1) develop and recommend an integrated national Arctic research policy;

(2) in cooperation with the Interagency Arctic Research Policy Committee established under section 107, assist in establishing a national Arctic research program plan to implement the Arctic research policy;

(3) facilitate cooperation between the Federal Government and State and local governments with respect to Arctic research;

(4) review Federal research programs in the Arctic and recommend improvements in coordination among programs;

(5) recommend methods to improve logistical planning and support for Arctic research as may be appropriate and in accordance with the findings and purposes of this title;

(6) recommend methods for improving efficient sharing and dissemination of data and information on the Arctic among interested public and private institutions;

(7) offer other recommendations and advice to the Interagency Committee established under section 107 as it may find appropriate;

(8) cooperate with the Governor of the State of Alaska and with agencies and organizations of that State which the Governor may designate with respect to the formulation of Arctic research policy;

(9) recommend to the Interagency Committee the means for developing international scientific cooperation in the Arctic; and

(10) not later than January 31, 1991, and every 2 years thereafter, publish a statement of goals and objectives with respect to Arctic research to guide the Interagency Committee established under section 107 in the performance of its duties.

(b) Not later than January 31 of each year, the Commission shall submit to the President and to the Congress a report describing the activities and accomplishments of the Commission during the immediately preceding fiscal year.

COOPERATION WITH THE COMMISSION

SEC. 105. (a)(1) The Commission may acquire from the head of any Federal agency unclassified data, reports, and other nonproprietary information with respect to Arctic research in the possession of the agency which the Commission considers useful in the discharge of its duties.

(2) Each agency shall cooperate with the Commission and furnish all data, reports, and other information requested by the Commission to the extent permitted by law; except that no agency need furnish any information which it is permitted to withhold under section 522 of title 5, United States Code.

(b) With the consent of the appropriate agency head, the Commission may utilize the facilities and services of any Federal agency to the extent that the facilities and services are needed for the establishment and development of an Arctic research policy, upon reimbursement to be agreed upon by the Commission and the agency head and taking every feasible step to avoid duplication of effort.

(c) All Federal agencies shall consult with the Commission before undertaking major Federal actions relating to Arctic research.

ADMINISTRATION OF THE COMMISSION

SEC. 106. The Commission may--

(1) in accordance with the civil service laws and subchapter III of chapter 53 of title 5, United States Code, appoint and fix the compensation of an Executive Director and necessary additional staff personnel, but not to exceed a total of seven compensated personnel;

(2) procure temporary and intermittent services as authorized by section 3109 of title 5, United States Code;

(3) enter into contracts and procure supplies, services and personal property;

(4) enter into agreements with the General Services Administration for the procurement of necessary financial and administrative services, for which payment shall be made by reimbursement from funds of the Commission in amounts to be agreed upon by the Commission and the Administrator of the General Services Administration; and

(5) appoint, and accept without compensation the services of, scientists and engineering specialists to be advisors to the

Commission. Each advisor may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code. Except for the purposes of chapter 81 of title 5 (relating to compensation for work injuries) and chapter 171 of title 28 (relating to tort claims) of the United States Code, an advisor appointed under this paragraph shall not be considered an employee of the United States for any purpose.

LEAD AGENCY AND INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE

SEC. 107. (a) The National Science Foundation is designated as the lead agency responsible for implementing Arctic research policy, and the Director of the National Science Foundation shall insure that the requirements of section 108 are fulfilled.

(b)(1) The President shall establish an Interagency Arctic Research Policy Committee (hereinafter referred to as the "Interagency Committee").

(2) The Interagency Committee shall be composed of representatives of the following Federal agencies or offices:

- (A) the National Science Foundation;
- (B) the Department of Commerce;
- (C) the Department of Defense;
- (D) the Department of Energy;
- (E) the Department of the Interior;
- (F) the Department of State;
- (G) the Department of Transportation;
- (H) the Department of Health and Human Services;
- (I) the National Aeronautics and Space Administration;
- (J) the Environmental Protection Agency; and
- (K) any other agency or office deemed appropriate.

(3) The representative of the National Science Foundation shall serve as the Chairperson of the Interagency Committee.

DUTIES OF THE INTERAGENCY COMMITTEE

SEC. 108. (a) The Interagency Committee shall--

(1) survey Arctic research conducted by Federal State, and local agencies, universities, and other public and private institutions to help determine priorities for future Arctic research, including natural resources and materials, physical and biological sciences, and social and behavioral sciences;

(2) work with the Commission to develop and establish an integrated national Arctic research policy that will guide Federal agencies in developing and implementing their research programs in the Arctic;

(3) consult with the Commission on--

(A) the development of the national Arctic research policy and the 5-year plan implementing the policy;

(B) Arctic research programs of Federal agencies;

(C) recommendations of the Commission on future Arctic research; and

(D) guidelines for Federal agencies for awarding and administering Arctic research grants;

(4) develop a 5-year plan to implement the national policy, as provided in section 109;

(5) provide the necessary coordination, data, and assistance for the preparation of a single integrated, coherent, and multiagency budget request for Arctic research as provided for in section 110;

(6) facilitate cooperation between the Federal Government and State and local governments in Arctic research, and recommend the undertaking of neglected areas of research in accordance with the

findings and purposes of this title;

(7) coordinate and promote cooperative Arctic scientific research programs with other nations, subject to the foreign policy guidance of the Secretary of State;

(8) cooperate with the Governor of the State of Alaska in fulfilling its responsibilities under this title;

(9) promote Federal interagency coordination of all Arctic research activities, including--

(A) logistical planning and coordination; and

(B) the sharing of data and information associated with Arctic research, subject to section 552 of title 5, United States Code; and

(10) provide public notice of its meetings and an opportunity for the public to participate in the development and implementation of national Arctic research policy.

(b) Not later than January 31, 1986, and biennially thereafter, the Interagency Committee shall submit to the Congress through the President, a brief, concise report containing--

(1) a statement of the activities and accomplishments of the Interagency Committee since its last report; and

(2) a statement detailing with particularity the recommendations of the Commission with respect to Federal interagency activities in Arctic research and the disposition and responses to those recommendations.

5-YEAR ARCTIC RESEARCH PLAN

SEC. 109. (a) The Interagency Committee, in consultation with the Commission, the Governor of the State of Alaska, the residents of the Arctic, the private sector, and public interest groups, shall prepare a comprehensive 5-year program plan (hereinafter referred to as the "Plan") for the overall Federal effort in Arctic research. The Plan shall be prepared and submitted to the President for transmittal to the Congress within one year after the enactment of this Act and shall be revised biennially thereafter.

(b) The Plan shall contain but need not be limited to the following elements:

(1) an assessment of national needs and problems regarding the Arctic and the research necessary to address those needs or problems;

(2) a statement of the goals and objectives of the Interagency Committee for national Arctic research;

(3) a detailed listing of all existing Federal programs relating to Arctic research, including the existing goals, funding levels for each of the 5 following fiscal years, and the funds currently being expended to conduct the programs;

(4) recommendations for necessary program changes and other proposals to meet the requirements of the policy and goals as set forth by the Commission and in the Plan as currently in effect; and

(5) a description of the actions taken by the Interagency Committee to coordinate the budget review process in order to ensure interagency coordination and cooperation in (A) carrying out Federal Arctic research programs, and (B) eliminating unnecessary duplication of effort among these programs.

COORDINATION AND REVIEW OF BUDGET REQUESTS

SEC. 110. (a) The Office of Science and Technology Policy shall--

(1) review all agency and department budget requests related to the Arctic transmitted pursuant to section 108(a)(5), in accordance with the national Arctic research policy and the 5-year program under section 108(a)(2) and section 109, respectively; and

(2) consult closely with the Interagency Committee and the Commission to guide the Office of Technology Policy's efforts.

(b)(1) The Office of Management and Budget shall consider all Federal agency requests for research related to the Arctic as one integrated, coherent, and multiagency request, which shall be reviewed by the Office of Management and Budget prior to submission of the President's annual budget request for its adherence to the Plan. The Commission shall, after submission of the President's annual budget request, review the request and report to Congress on adherence to the Plan.

(2) The Office of Management and Budget shall seek to facilitate planning for the design, procurement, maintenance, deployment and operations of icebreakers needed to provide a platform for Arctic research by allocating all funds necessary to support icebreaking operations, except for recurring incremental costs associated with specific projects, to the Coast Guard.

AUTHORIZATION OF APPROPRIATIONS: NEW SPENDING AUTHORITY

SEC. 111. (a) There are authorized to be appropriated such sums as may be necessary for carrying out this title.

(b) Any new spending authority (within the meaning of section 401 of the Congressional Budget Act of 1974) which is provided under this title shall be effective for any fiscal year only to such extent or in such amounts as may be provided in appropriation Acts.

DEFINITION

SEC. 112. As used in this title, the term "Arctic" means all United States and foreign territory north of the Arctic Circle and all United States territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers; all contiguous seas, including the Arctic Ocean and the Beaufort, Bering and Chukchi Seas; and the Aleutian chain.

Appendix G: Principles for the Conduct of Research in the Arctic

Prepared by the Social Science Task Force of the U.S. Interagency Arctic Research Policy Committee

Introduction

All researchers working in the North have an ethical responsibility toward the people of the North, their cultures, and the environment. The following principles have been formulated to provide guidance for researchers in the physical, biological, behavioral, health, economic, political, and social sciences and in the humanities. These principles are to be observed when carrying out or sponsoring research in Arctic and northern regions or when applying the results of this research.

This statement addresses the need to promote mutual respect and communication between scientists and northern residents. Cooperation is needed at all stages of research planning and implementation in projects that directly affect northern people. Cooperation will contribute to a better understanding of the potential benefits of Arctic research for northern residents and will contribute to the development of northern science through traditional knowledge and experience.

These "Principles for the Conduct of Research in the Arctic" were prepared by the Interagency Social Science Task Force in response to a recommendation by the Polar Research Board of the National Academy of Sciences and at the direction of the Interagency Arctic Research Policy Committee. This statement is not intended to replace other existing Federal, State, or professional guidelines, but rather to emphasize their relevance for the whole scientific community. Examples of similar guidelines used by professional organizations and agencies in the United States and in other countries are listed in the publications.

These principles are to be observed when carrying out or sponsoring research in Arctic and northern regions or when applying the results of this research.

Implementation

All scientific investigations in the Arctic should be assessed in terms of potential human impact and interest. Social science research, particularly studies of human subjects, requires special consideration, as do studies of resources of economic, cultural, and social value to Native people. In all instances, it is the responsibility of

the principal investigator on each project to implement the following recommendations.

1. The researcher should inform appropriate community authorities of planned research on lands, waters, or territories used or occupied by them. Research directly involving northern people or communities should not proceed without their clear and informed consent. When informing the community and/or obtaining informed consent, the researcher should identify—

- a. all sponsors and sources of financial support;
- b. the person in charge and all investigators involved in the research, as well as any anticipated need for consultants, guides, or interpreters;
- c. the purposes, goals, and time frame of the research;
- d. data-gathering techniques (tape and video recordings, photographs, physiological measurements, and so on) and the uses to which they will be put; and
- e. foreseeable positive and negative implications and impacts of the research.

2. The duty of researchers to inform communities continues after approval has been obtained. Ongoing projects should be explained in terms understandable to the local community.

3. Researchers should consult with and, where applicable, include northern communities in project planning and implementation. Reasonable opportunities should be provided for the communities to express their interests and to participate in the research.

4. Research results should be explained in non-technical terms and, where feasible, should be communicated by means of study materials that can be used by local teachers or displays that can be shown in local community centers or museums.

5. Copies of research reports, data descriptions, and other relevant materials should be provided to the local community. Special efforts must be made to communicate results that are responsive to local concerns.

6. Subject to the requirements for anonymity, publications should always refer to the informed consent of participants and give credit to those contributing to the research project.

7. The researcher must respect local cultural traditions, languages, and values. The researcher should, where practicable, incorporate the following elements in the research design:

- a. Use of local and traditional knowledge and experience.
- b. Use of the languages of the local people.

c. Translation of research results, particularly those of local concern, into the languages of the people affected by the research.

8. When possible, research projects should anticipate and provide meaningful experience and training for young people.

9. In cases where individuals or groups provide information of a confidential nature, their anonymity must be guaranteed in both the original use of data and in its deposition for future use.

10. Research on humans should only be undertaken in a manner that respects their privacy and dignity:

a. Research subjects must remain anonymous unless they have agreed to be identified. If anonymity cannot be guaranteed, the subjects must be informed of the possible consequences of becoming involved in the research.

b. In cases where individuals or groups provide information of a confidential or personal nature, this confidentiality must be guaranteed in both the original use of data and in its deposition for future use.

c. The rights of children must be respected. All research involving children must be fully justified in terms of goals and objectives and never undertaken without the consent of the children and their parents or legal guardians.

d. Participation of subjects, including the use of photography in research, should always be based on informed consent.

e. The use and disposition of human tissue samples should always be based on the informed consent of the subjects or next of kin.

11. The researcher is accountable for all project decisions that affect the community, including decisions made by subordinates.

12. All relevant Federal, State, and local regulations and policies pertaining to cultural, environmental, and health protection must be strictly observed.

13. Sacred sites, cultural materials, and cultural property cannot be disturbed or removed without community and/or individual consent and in accordance with Federal and State laws and regulations.

In implementing these principles, researchers may find additional guidance in the publications listed below. In addition, a number of Alaska

Native and municipal organizations can be contacted for general information, obtaining informed consent, and matters relating to research proposals and coordination with Native and local interests. A separate list is available from NSF's Division of Polar Programs.

Publications

Arctic Social Science: An Agenda for Action. National Academy of Sciences, Washington, D.C., 1989.

Draft Principles for an Arctic Policy. Inuit Circumpolar Conference, Kotzebue, 1986.

Ethics. Social Sciences and Humanities Research Council of Canada, Ottawa, 1977.

Nordic Statement of Principles and Priorities in Arctic Research. Center for Arctic Cultural Research, Umea, Sweden, 1989.

Policy on Research Ethics. Alaska Department of Fish and Game, Juneau, 1984.

Principles of Professional Responsibility. Council of the American Anthropological Association, Washington, D.C., 1971, rev. 1989.

The Ethical Principles for the Conduct of Research in the North. The Canadian Universities for Northern Studies, Ottawa, 1982.

The National Arctic Health Science Policy. American Public Health Association, Washington, D.C., 1984.

Protocol for Centers for Disease Control/Indian Health Service Serum Bank. Prepared by Arctic Investigations Program (CDC) and Alaska Area Native Health Service, 1990. (Available through Alaska Area Native Health Service, 255 Gambell Street, Anchorage, AK 99501.)

Indian Health Manual. Indian Health Service, U.S. Public Health Service, Rockville, Maryland, 1987.

Human Experimentation. Code of Ethics of the World Medical Association (Declaration of Helsinki). Published in *British Medical Journal* 2:177, 1964.

Protection of Human Subjects. Code of Federal Regulations 45 CFR 46, 1974, rev. 1983.