The Journey to PICES

Scientific Cooperation in the North Pacific

Sara Tjossem

North Pacific Marine Science Organization

Published by
Alaska Sea Grant College Program
University of Alaska Fairbanks
AK-SG-05-04

Elmer E. Rasmuson Library Cataloging-In-Publication Data

Tjossem, Sara.

The journey to PICES : scientific cooperation in the North Pacific / By Sara Tjossem. – Fairbanks, Alaska : Alaska Sea Grant College Program, University of Alaska Fairbanks, 2005.

206 p. : ill. ; 23 cm. – (Alaska Sea Grant College Program, University of Alaska Fairbanks ; AK-SG-05-04)

Includes bibliographical references.

1. North Pacific Marine Science Organization—History. 2. North Pacific Marine Science Organization—Research—North Pacific Region. 3. Marine science—Research—North Pacific Region. I. Title. II. Tjossem, Sara. III. Series: Alaska Sea Grant College Program, University of Alaska Fairbanks ; AK-SG-05-04.

GC29.2.P16 T56 2005

ISBN 1-56612-099-3

CREDITS

This book is the result of a joint effort by the North Pacific Marine Science Organization (PICES), and the Alaska Sea Grant College Program. Views expressed in this book are those of the author and her sources.

PICES is an intergovernmental scientific organization established in 1992. PICES member-countries are Canada, Japan, the People's Republic of China, the Republic of Korea, the Russian Federation, and the United States of America. The purposes of PICES are (1) to promote and coordinate marine scientific research in the northern North Pacific and adjacent marginal seas, particularly northward from 30° north; (2) to advance scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impact of human activities on them; and (3) to promote the collection and rapid exchange of scientific information on these issues. PICES Secretariat is in Sidney, B.C., Canada, secretariat@pices.int, http://www.pices.int.

Sea Grant is a unique partnership with public and private sectors combining research, education, and technology transfer for public service. This national network of universities meets changing environmental and economic needs of people in our coastal, ocean, and Great Lakes regions. Alaska Sea Grant is cooperatively supported by the U.S. Department of Commerce, NOAA National Sea Grant Office, under grant no. NA16RG2321, project A/161-01; and by the University of Alaska with state funds. The University of Alaska is an affirmative action/equal opportunity institution.

Copyediting is by Sue Keller, book design and layout are by Jen Gunderson, and cover design is by Dave Partee, all of Alaska Sea Grant College Program. Index is by Nanette Cardon, IRIS, Anacortes, Washington. Cover photo of Bering Sea © 2004 Dan Parrett/AlaskaStock.com.

Alaska Sea Grant College Program
University of Alaska Fairbanks
P.O. Box 755040
Fairbanks, Alaska 99775-5040
Toll free (888) 789-0090
(907) 474-6707 Fax (907) 474-6285
http://www.alaskaseagrant.org

Contents

Preface

This book presents an in-depth look at the activities leading to the adoption and implementation of the North Pacific Marine Science Organization, now a vibrant six-nation international governmental marine organization. It was not an easy birth. On the face of it, it seems obvious that such an organization was needed, and, in retrospect, it is hard to understand why the process took so long, and why it faced substantial impediments. There existed no prior international organizations to fill the role of coordinating research and synthesizing knowledge for the region. The North Pacific Ocean is a huge body of water, but many species, commercial and non-commercial, are shared. The only way for the Pacific Rim nations to gain a reasonable level of knowledge about the area is through cooperative research among the nations surrounding the ocean. PICES has steered away from issues of fisheries management, but rather seeks to provide the broad scientific basis for management urgently needed by the member nations. Yet the organization took two decades to come to fruition.

The reasons for this lengthy incubation become obvious to the reader, through the author's masterful tracing of the events. It took aggressive promotion, incredible patience, and dogged perseverance; these eventually led to success. The recruitment by the University of Washington of Dr. Warren Wooster for the task of pursuing the organization was the primary factor in assuring its ultimate creation. His knowledge, canniness, and experience with international marine affairs and organizations served the process well. Once the planning was under way, many people in many countries played important leadership roles as well.

This book will fulfill several purposes. It is a seminal contribution to the history of international marine scientific organizations. For PICES itself, it will serve as a permanent historical record, not just of the steps leading up to its adoption, but also of the critical first ten years of its existence.

It is appropriate that the Alaska Sea Grant College Program has been selected to publish this volume. Alaska Sea Grant sponsored a pivotal meeting in Anchorage (1986), bringing Chinese participants to the table for the first time, and subsequently put a great deal of effort into promoting the organization. Financial support for both the writing of the book and its publication was provided by the National Science Foundation, Ocean Sciences Division. Although not explicitly mentioned in the text, NSF has played a supportive role in several ways during the past two decades.

Today, the North Pacific Marine Science Organization is a vibrant entity, developing new programs, and contributing to marine science in substantial ways. The Ecosystem Status report, planned as a periodic report, has been initiated with the release of the first issue. Relationships with other international organizations have expanded, and collaborations have been developed. This book leads the reader to the time when the structure and organization has solidified and the activities expanded. PICES has proved itself, and has now come of age.

Vera Alexander
Chairman, North Pacific Marine Science Organization

About the Author

Sara Tjossem is trained both as a scientist and historian of science, with research interests in the history of the biological sciences, especially ecology, marine science, and agriculture. She is intrigued by the intersection of science and society, particularly through the development of scientific cooperation and environmental movements. She has taught at the University of Washington and the University of Minnesota, and is currently Lecturer and Researcher in the School of International and Public Affairs and The Earth Institute at Columbia University in the City of New York.

Acknowledgments

After moving to the University of Washington in 1998, I was warmly welcomed by historian Keith Benson and the local historians of science. Through conversations with Keith I began to sense how the unique environment of the Pacific Northwest has shaped some of the scientific culture of the region. Keith introduced me to fisheries oceanographer Warren Wooster, who was instrumental in creating the North Pacific Marine Science Organization (PICES). I began research on the origins and development of PICES with support from the National Science Foundation grant OCE9729444 to the University of Alaska Fairbanks. NSF also helped support publication of this book through NSF grant OCE0432334.

Most of my archival research was working with the papers of the Warren S. Wooster Collection at the University of Washington Libraries in Seattle, with the able help of the university archivists. As I became immersed in the unfolding story, I frequently referred to the papers collected by Warren Wooster and Megan Callahan on the early meetings of the PICES organizers. I also conducted oral

history interviews with several scientists active in international marine science and committed to the idea of a regional science organization for the northern North Pacific. Among them were Dayton Lee Alverson, Richard Beamish, William Burke, Makoto Kashiwai, Doug McKone, Vladimir Radchenko, William Sullivan, Qi-Sheng Tang, David Welch, and Warren Wooster. I also spoke informally with several other scientists at the 10th Annual Meeting of PICES in 2001, a time of reflection and celebration on the accomplishments of the organization. These scientists are but a small representation of the hundreds of scientists who make the organization what it is.

Fisheries biologist Katherine Myers drew my attention to and granted me access to boxes of documents on the International North Pacific Fisheries Commission and its successor, the North Pacific Anadromous Fish Commission in the University of Washington Fisheries Science Building. Elizabeth Tirpak, Research Vessel Clearance Officer, U.S. Department of State, located early records on preparatory meetings for PICES and read the manuscript. Christina Chiu, Alex Bychkov, and Skip McKinnell of the PICES Secretariat were particularly welcoming and helpful. Historians of science Keith Benson, Helen Rozwadowski, Nadine Weidman, Carmel Finley, and scientist-historians Eric Mills and Gary Duker made valuable suggestions for my story, as did Herbert Tjossem. Vera Alexander and Richard Beamish kindly reviewed and thus improved my manuscript.

PICES could not have come into being without the hard work and perseverance of hundreds of dedicated scientists whose names are recorded in *The PICES Papers* and in the participant lists of annual reports. Because of their numbers their accomplishments cannot be individually explored, but the sum of their participation is the heart of this novel marine science organization. At the helm was Warren Wooster, indefatigable campaigner for improving marine science through international cooperation.

Introduction

Bounding a Limitless Ocean

Oceans are vital to the biosphere, covering almost three quarters of the earth's surface and containing almost all of its water. A striking characteristic beyond their vast size is their constant motion, hinting at the complex interplay between the ocean, atmosphere, and land. The physical and chemical properties of the ocean affect all life within it as they vary over time and space and with atmospheric change, and, in turn, the biological component affects the physical and chemical properties. Marine food webs are equally complex, with organisms influenced by each other, by ocean circulation and mixing, weather and climate, and increasingly, by human influences like fishing. Those vast processes also inextricably link the countries that use the oceans. Understanding such interconnections over space and time requires remarkable cooperative scientific effort, from observations, to theories, experimentation, and modeling.

Traders, explorers, cartographers, and scientists have shaped our understanding of oceans as vital to the development of coastal

states' security, commerce, and prestige. Beginning in the middle of the nineteenth century, merchant sailing vessels started a systematic effort to exchange observations on the state of the seas on their trade routes. Not until the late nineteenth century, however, did marine science begin to reveal the ocean's extraordinary complexity. Extensive seagoing expeditions like those of the HMS *Challenger* of the mid 1870s revealed ever-greater economic and scientific riches from coasts to depths.[1] Although these expeditions required tremendous coordinating and marshalling of people and resources to carry out research at sea, the rewards of ocean exploration seemed well worth the costs. By the early twentieth century a growing number of scientists argued that a robust marine science was essential for the rational exploitation of the ocean and its resources. The ocean was both a source of valuable harvestable resources and a path to loftier goals of international exchange and cooperation. Ideally marine science could foster new understanding among nations and reduce world tensions through its international reach.

Marine systems challenge scientific study with their vastness, and their complex processes that operate over equally extensive temporal dimensions. Exploring their processes is extremely expensive in ship time and researcher effort, encouraging careful planning for greatest cost-effectiveness. Marine expeditions require tightly coordinated teams of researchers working in cramped quarters on expensive research vessels in unpredictable, often poor, weather conditions. Because controlled experiments are difficult and sometimes impractical or impossible, marine scientists must at times interpret their observations by relying on natural experiments. For example, because winds cannot be turned on or off at will, studying the nature of coastal current upwelling requires a natural experiment comparing different coasts around the world. Such an undertaking requires cooperative efforts drawing on scores of field observations, which in turn depend on measurements of comparable quality and technique. Methodology and scientific approaches, however, can differ among fields, institutions, and nations. Producing a plausible explanation for large oceanic processes requires synthesis across these realms.

Marine science is particularly dependent on effective cooperation among scientists, laboratories, disciplines, institutions, and governments. Although marine scientists have a long tradition of collaboration, it is generally through informal, temporary arrangements for particular projects. These ad hoc ventures by their nature lack continuity as researchers gather together for specific projects and disperse at their end. Scientists working on international projects also face scientific, political, and cultural challenges.

Although science has been called a universal language, transcending the limitations of different languages and uniting scientists in a common cause, collaborative research reveals significant variety in scientific goals, styles, and techniques.[2] One account of oceanography during the Cold War era has questioned whether, given disparate styles of scientific inquiry and the desire for national prestige, there could ever be a truly international, universal scientific community. It suggests the rhetoric of universalism and internationalism has been an ideal pursued only from a position of strength.[3]

The shape of ocean science is also influenced by larger geopolitical disputes and economic pressure stemming from competition in commercial fishing. For instance, while one country attributed a decline in catch to overfishing, another countered that the smaller catch was due to predation by other species or to changes in ocean conditions. Even if scientific evidence appeared to favor one hypothesis over another, national policy took precedence in management. Despite the occasional intercession of such national disputes, however, scientists continued organizing joint marine projects, whether motivated by basic or applied concerns or a melding of the two. Although international cooperation is often between individual scientists or agencies, cooperation among governments can provide structure and purpose not possible at a lower scale. Governments are uniquely able to provide financial and political backing, grant access to coastal waters, and develop international organizations and negotiations.

Although investigating large ocean processes has brought together marine scientists across disciplines, they often operate within their specialties, whether fisheries biology, climatology, meteorology, or physical, chemical, geological or biological oceanography. Such disciplinary loyalties can spur or hinder new understandings of complex systems. Integrating commercial fisheries investigations and oceanography proved to be a persistent challenge. From the early days of marine science in the late nineteenth century, fisheries science and oceanography developed mostly isolated from each other in the United States and Canada, unlike northern Europe and Russia. The oceans seemed a limitless source of fish, and the main question was how to find them. Later, as some fisheries suffered catastrophic collapse, the hope was that they only needed to be managed in the right way. Successful management would come from a combination of scientific knowledge and political will. American fisheries scientists most commonly concentrated on the biology of commercially harvested fish and the effects of fishing on their populations, not so much on the reciprocal effects of the physical and biological environment on those fish. American oceanographers, on

the other hand, primarily directed their attention to exploring the ocean environment, not to solving pressing fisheries problems. Institutional differences also distanced the two groups, with fisheries scientists often found in government laboratories, while oceanographers were mainly in academic departments. With a growing awareness in the mid twentieth century of the role marine science could play in understanding and managing multiple uses of the oceans, academic and government scientific laboratories alike sought to contribute scientific data to those issues. Proponents of ocean research insisted that better understanding of the oceans would require sustained, coordinated, and international marine science that could only come from an overarching integration of effort.

On the eastern side of the Pacific, systematic study of marine natural history grew throughout the twentieth century, with Pacific Ocean field stations closely following those established earlier in Europe along the Atlantic seaboard. In the United States, a small, isolated biological research station at La Jolla, California, quickly grew to become Scripps Institution of Oceanography and the leading center of American Pacific oceanography, with other field stations like Friday Harbor in Washington state soon following.[4] Fisheries science was somewhat slower developing on the West Coast, despite its potential utility.[5] Around the world, fishing had for centuries been a craft, learned at sea, not in a classroom. In 1913, however, the commissioner of the U.S. Bureau of Fisheries observed that there was still no college or university in the United States offering training in fisheries.[6] Six years later the University of Washington founded its College of Fisheries, slowly followed by other university fisheries departments along the western coast of the United States and Canada. In 1924 a conference organized by the U.S. Navy highlighted the importance of increased oceanographic research, particularly on fisheries productivity, and the Navy became a steady patron of the marine field, although joint research programs in fisheries and oceanography did not follow directly from this conference.[7] In the Pacific Northwest, the Pacific Biological Station in Nanaimo, British Columbia, Canada (founded in 1908), developed into a leading fisheries research laboratory.[8] From the 1930s onward, such marine research spread to laboratories, coastal universities, and specialized oceanographic institutions on the Pacific coast. Further networks developed with the establishment of the Oceanographic Society of the Pacific in 1935.[9] The growth of ocean research after World War II led to the establishment of the Bedford Institute of Oceanography in Nova Scotia, but there was no analogous institution for the Pacific for some decades. The separate traditions of oceanography and fisheries began to be

more integrated into what Scripps Institution of Oceanography researchers called fishery oceanography starting in the 1950s.

On the western side of the Pacific, fisheries research had an earlier and stronger tradition. Japan established its practical Fishery Training Institute at the end of the nineteenth century, and by the 1930s Japan was the largest fishing nation in the world, taking half the world fish catch. It assessed the potential of fisheries by scientific surveys, meshing together commercial fisheries with research, but it also taught future fishermen in special fisheries high schools.[10] The Russians carried out fisheries research as early as 1853, establishing the Pacific Fisheries Research Station in Vladivostok in 1925, followed by the State Hydrological Institute in 1926.[11] Soviet fishing boats made yearly voyages to the Sea of Japan [Japan/East Sea], then to the Bering Sea and Sea of Okhotsk. The Soviets announced a five-year plan in 1946 for the development of the fishing industry to dramatically increase harvest beyond pre-war levels, and Japan followed suit with several five-year plans of its own.[12] Eight regional fisheries laboratories followed in 1949 as Soviet fisheries continued to expand.[13] The quest to maximize marine fisheries yields produced strong competition and international tension.

On both sides of the Pacific, significant national support for marine science grew from World War II, as technology and equipment used to help navies in wartime were turned toward marine research. The anxiety of the Cold War further stimulated the growth of oceanography and its application to questions of national security. In the United States, research support came from the Department of Defense and its Office of Naval Research, the National Science Foundation, and other government agencies interested in both applied and basic research.[14] Marine scientists, while often motivated by intellectual curiosity, promoted their field as essential to the rational use of ocean resources, atmospheric forecasting, and protection of the marine environment. They used an increasing range of tools from chemistry and physics to geology and biology to examine how the marine environment interacts with the rest of the planet.[15]

INCREASING INTERNATIONAL COOPERATION IN MARINE AFFAIRS

Major international cooperative efforts in marine science during the Cold War relied on military monies and supplies, as well as the promise that science could aid rational development. Scientists attracted by the promise of large-scale coordinated projects with open intellectual exchange saw their science both aiding national security and transcending Cold War politics

that infused other international relations. Prominent scientists presented their views on promising avenues for cooperation, including international scientific unions and congresses, and international exchanges of scholars.[16]

Some of this cooperation was already in place with the formation in 1931 of the International Council of Scientific Unions (ICSU), a collection of scientific unions and national committees dedicated to promoting science and its utility to humanity.[17] It built on existing associations such as the nongovernmental organization the International Association for the Physical Sciences of the Oceans (IAPSO), formed in 1919, one of the seven associations of the International Union of Geodesy and Geophysics (IUGG). Its international unions brought together natural scientists for international exchange on major international and interdisciplinary issues. As with other nongovernmental organizations, it strove to remain above divisive national politics. When scientific problems required expertise from several of ICSU's constituent unions it formed interdisciplinary committees. IUGG demonstrated the value of global international cooperation in science by organizing the International Geophysical Year (IGY) of 1957–58, the dawn of what came to be called "big science," and which served to focus world attention on ocean issues. More than sixty countries, including the Soviet Union, collaborated in collecting data on physical phenomena, from deep ocean ridges to atmospheric radiation belts. Research from the IGY paved the way for the Antarctic Treaty of 1959, which declared the continent free from nuclear weapons and open to international research, making it the first truly international territory.[18] Collaboration in the IGY was not without tension, however, as countries vied for prestigious leadership roles.

In 1957, ICSU created the Special (later Scientific) Committee on Oceanic Research (SCOR) in recognition that marine science clearly required interdisciplinary and international treatment. In its opening session it presented the sea as critical to the future of mankind.[19] SCOR emphasized three practical areas where the sea was critical to the future of humans: as a site for waste disposal, especially nuclear waste; as a source of food; and as an influence on climate.[20] It had no resource management responsibility but did encourage the exchange and standardization of sampling techniques.

SCOR's first major effort was an expedition to the Indian Ocean, the least-investigated ocean basin of all, to study the impact of ocean processes on food resources and interaction of the ocean with monsoon winds.[21] The resulting International Indian Ocean Expedition (IIOE) of the early 1960s was a multinational, multi-ship scientific expedition that highlighted the importance of a common scientific agenda that could share scarce labor,

money, and ships.[22] Beyond the data it collected, it is credited with strengthening the marine sciences at many institutions bordering the Indian Ocean. SCOR built its reputation of innovative, solid science based on its working groups addressing "hot" topics over a set period, then moving on to new pressing questions.

Competition spawned some remarkable growth in science. Early planning for the geophysical year had called for the launching of artificial satellites, and the Soviets were first to do so with Sputnik I and II in 1957. In response, the United States dramatically increased federal support for space, education, and science. The following year the bill creating the National Aeronautics and Space Administration (NASA) was signed into law. The satellites launched a space race, but also furthered an ocean race by increasing American support for projects that would produce fundamental science through international cooperation. One month after Sputnik, the U.S. National Academy of Sciences formed its Committee on Oceanography (NASCO) to assess the state of American oceanography in relation to the Soviets.

Through the postwar decades the United Nations also rapidly expanded its applied programs, giving highest priority to developing countries, the majority of its members.[23] Under its broad mandate to improve the human condition, the U.N. promoted increased fisheries production through services of the Food and Agriculture Organization (FAO), a clearinghouse of information on food supplies, forestry, and fishing but without any regulatory authority.[24] The World Meteorological Organization (WMO) became a U.N. agency in 1951 to create observation stations for meteorology and hydrology. In 1960, the U.N.'s Educational, Scientific and Cultural Organization (UNESCO) established the Intergovernmental Oceanographic Commission (IOC) recognizing that "While pioneering research and new ideas usually come from individuals and small groups, many aspects of oceanic investigations present far too formidable a task to be undertaken by any one nation or even a few nations."[25] The IOC thus became the only global intergovernmental oceanographic organization, and the only U.N. body solely directed to strengthening marine science through training, education, and mutual assistance with developing countries.[26] It gradually developed data and information exchange, sea level monitoring, drifting buoy programs, and a tsunami warning system for the Pacific. It also cooperated with the International Council for the Exploration of the Sea (ICES), a strong marine science organization operating in the northeast Atlantic region.[27] The IOC

created a regional effort in the Western Pacific (WESTPAC) in 1965 because no organization analogous to ICES existed for the Pacific.

The U.S. government hoped for both scientific and political benefits from membership in the IOC. First, the IOC training programs to upgrade the technical capacity of developing countries would ease tensions between developing and developed countries by helping them participate in big projects. Second, U.S. leadership, competence, and cooperation in marine science could create good will and a favorable U.S. image. In addition, using IOC programs and contacts might help the U.S. research community gain access to restricted waters and provide a forum for exchange even in the face of difficult political circumstances. Some scientists, however, worried that the intergovernmental organization with a complex bureaucracy would get mired in Cold War and developing country politics, restricting scientific flexibility and innovative research. Others argued that the IOC fostered education rather than "cutting-edge" science by favoring questions of immediate practical importance rather than promoting marine science per se. Branches of marine science like fisheries might be favored more than physical oceanography in deciding research priorities. The benefits of the IOC, however, must have outweighed its drawbacks, because the United States remained a member during its withdrawal from UNESCO in 1984.[28]

In light of burgeoning ocean use, President Lyndon Johnson created what became known as the Stratton Commission (1967–1969) to review U.S. ocean policy. The commission's report, "Our Nation and the Sea," concluded that because responsibility for ocean activities was fractured among competing departments and agencies, no long-term, rational management was possible. It emphasized the need for a whole systems approach, linking ecosystems and human impact. It called for the creation of a "wet NASA," which became the National Oceanic and Atmospheric Administration (NOAA) in 1970.[29] NOAA was to provide a central and integrated focus for conserving and managing the nation's coastal and marine resources. Although the creation of NOAA was a significant step in unifying ocean policy, several departments and agencies still exercised authority on ocean matters. President Johnson highlighted international cooperation in ocean science in his 1968 proposal to launch the International Decade of Ocean Exploration (IDOE) for the 1970s.[30] Since space seemed conquered, he argued, the ocean was the last unexplored frontier. Cooperation that included governments as well as scientists promised real understanding of ocean processes through access to sensitive data.[31]

By the end of the 1960s, the growth of international organizations having some aspect of ocean research had produced a sea of acronyms such as WMO, ICSU, FAO, SCOR, and IOC, leading many scientists to conclude that there were enough organizations for marine research.[32] Either these organizations were global, with strained capacity, or they did not explicitly address the unique scientific problems and immense fisheries of the North Pacific region. Scientists from many countries, including Canada, Japan, the United States, and the USSR, conducted investigations in this unique region. Despite this strong and longstanding scientific interest in the North Pacific, no general mechanism existed to help plan and coordinate multinational oceanographic and fisheries research programs there.[33] Proponents of international cooperation renewed their efforts to create organizations safeguarding international research in the face of rising national claims to coastal zones.[34] Inspired by experiences in regional, global, intergovernmental as well as nongovernmental organizations, they argued that rapid progress in marine science crucially depended on cooperation among governments, scientists, and scientific fields.

INTEGRATING OCEAN RESEARCH IN MARINE AFFAIRS

The ocean spanning the world's shores encouraged internationalism in science, but the problem of how best to carry out cooperative research on ocean systems was less clear. How should marine scientists generate useful information for decisions about ocean uses? Fisheries scientists appeared well placed to advise on economically important fisheries, while oceanographers offered valuable understanding of oceanic systems. Could these two groups combine to achieve a better understanding of marine processes and products? Traditionally fisheries scientists focused on coastal waters while oceanographers preferred the open ocean, though the development of fishery oceanography at Scripps Institution of Oceanography and elsewhere encouraged the idea that there could be fruitful applications across fields. Would scientific knowledge be best generated through combined efforts of practitioners and academics, fisheries scientists and oceanographers? Opinions differed about the function and utility of scientists in the pragmatic art of fisheries. Should a better understanding of the oceans come from developing complex theoretical constructs and mathematical models combined with observing ocean behavior, or from relying on fishing industry expertise and experience? Should scientific effort focus solely on specific fisheries, or broaden to the complex ecosystems that support those resources?

EARLY MARINE SCIENCE COOPERATION IN THE NORTHEAST ATLANTIC

The earliest formal international cooperation in ocean sciences came in 1902 with the formation of the International Council for the Exploration of the Sea (ICES) in the Northeast Atlantic.[35] Drastic fluctuations and collapses in its herring and plaice fisheries prompted marine scientists and fisheries managers to cooperate across disciplines and international boundaries to study the problem. Inspired by a growing internationalism, they promoted scientific effort that transcended individual and piecemeal projects. For the next century, ICES promoted scientific research on the sea by providing scientifically derived management advice to member nations. Scientists serving on its committees largely drove its governance and actions, though each member nation elected two delegates to represent its country on the ICES council. Given the member countries' varied political agendas and growing national identities, such scientific cooperation was a significant accomplishment. Over the next century, ICES's membership expanded from eight to almost twenty nations, as it became a central scientific forum to address fisheries and oceanographic questions in the North Atlantic. As the organization grew in size it also expanded its scientific and economic influence.

As the world's first intergovernmental marine science organization, it inspired other cooperative scientific efforts in marine sciences. These collaborations helped define the fields of oceanography and fisheries as they served both the growth of scientific understanding and the economic needs of the state. As an international institution, ICES fostered projects using standardized methods and data exchange, striving to link science and management to benefit its members. It gained much of its scientific cohesion and credibility by being on the forefront of new marine science, but also because its mandate was limited to a finite region, the waters and fisheries of the northeast Atlantic.[36]

In 1920 Canada, Newfoundland, and the United States attempted a western Atlantic version of ICES by creating the North American Council on Fishery Investigations, but with no permanent staff and no governmental monies, it disbanded in 1938.[37] Scientists began discussing an international organization to foster marine science in the Pacific similar to ICES as early as 1926. That year, the third Pan-Pacific Science Congress (Tokyo) established an International Committee on Oceanography of the Pacific whose work would ". . . be conducted with the intent of establishing for the Pacific an institution similar to the North Atlantic International Council for the Exploration of the Sea (ICES)."[38]

The Pan-Pacific Science Congress looked to ICES as an inspiration, but was challenged by the Great Depression and growing regional militarism so that no organization developed from these resolutions.[39] In addition, the Pacific fisheries and government institutions were less developed, and the fish stocks were less clearly of common interest across many nations. Similar international cooperation for studying the Pacific was especially challenging to establish because of its sheer size; covering nearly a third of the earth, the whole of the Pacific is about twice the area of the Atlantic Ocean, a vast path to worldwide exploration, attracting competing economic and political visions and claims.[40] Missing from the Pacific were the compelling economic reasons for broad international cooperation as found in the North Sea.[41]

But changing perceptions of the role of nature in human affairs over the twentieth century shaped the scope of international treaties dealing with the environment, and made cooperation increasingly common. In the late nineteenth century, "global" environmental problems were virtually unknown. Nature, predominantly viewed as a source of exploitable resources, had by the late twentieth century been recast as a "life-sustaining global ecosystem."[42] This more expansive view of nature allowed for an expanding portfolio of purposes, producing increased international discourse and activity on the environment, including an exponential increase in international environmental treaties following World War II.

Pacific marine scientists contributed to this increased internationalism by their quest to create an organization dedicated to the northern ocean and its unique scientific phenomena and fisheries.[43] The promoters of a Pacific analog to ICES (thus the nickname, "PICES") argued that better understanding of the North Pacific and its fisheries would come about only through scientific research and exploration of the complex ecosystem. As in all marine science, however, that goal would need a remarkable degree of cooperation and collaboration. The creation of the North Pacific Marine Science Organization (PICES) in 1992 finally gave the much larger Pacific Ocean its own multilateral scientific body to foster marine science. The founders of PICES looked to their experiences and to ICES for lessons about what worked and what failed over the years and why, but they had to create their own solutions to address very different political, geographic, and scientific conditions than in the Atlantic. Establishing such an organization required overcoming many obstacles.

This is the story of the formation of PICES and how it developed into the leading regional intergovernmental science organization for the northern North Pacific Ocean. Perhaps most remarkable is how a loose group of

scientists maintained a consistent vision of international exchange through two decades of scientific and policy review. The earliest articulation of its core mission to better understand North Pacific ecosystems, though tempered through the years by individuals and nations, continues to allow for productive international scientific exchange and accomplishment.

Chapter 1 opens with the question of why a new marine science organization was needed in the North Pacific, and then presents a chronological account of early strategies and discussions. Participants in those meetings frequently raised the question of how to justify yet another science organization, particularly an intergovernmental one, and how it would address the intersection of basic and applied science. The conceptualizing period spanned the years 1978 to 1986. From 1986 to 1992 the organization moved into a period of formal government negotiations. Chapter 2 discusses the challenge of bridging oceanography and fisheries science and delves more deeply into the different perspectives on the role of fisheries science in a broad marine organization. Chapter 3 presents the accomplishments and challenges of the first ten years of the organization's existence, concluding in Chapter 4 with an assessment of those years and a look at the possible future for PICES. This story highlights how marine science requires organizational structure for cooperation across individuals, disciplines, and nations.

Chapter 1

Does the North Pacific Need a New Science Community?

The northern North Pacific includes the temperate and subarctic zones of the Pacific Ocean, bounded by the coast of East Asia and North America, and to the north by the Bering Strait (Figure 1). In oceanography it is considered a distinct region of similar geophysical and biological characteristics, with a well-marked current system and associated fauna.[1] Yet it is also diverse, ranging from the arctic waters of the Bering Sea to the near-tropical waters off southern Japan and China. Such an expanse of water has remarkable influence on climate, weather, and fisheries, with the North Pacific producing more than a quarter of the world production of fish and shellfish.[2] The most economically, politically, and culturally important fisheries are those for Pacific salmon. Recognizing the economic and political importance of Pacific fisheries is essential for understanding the development of marine science in the region.

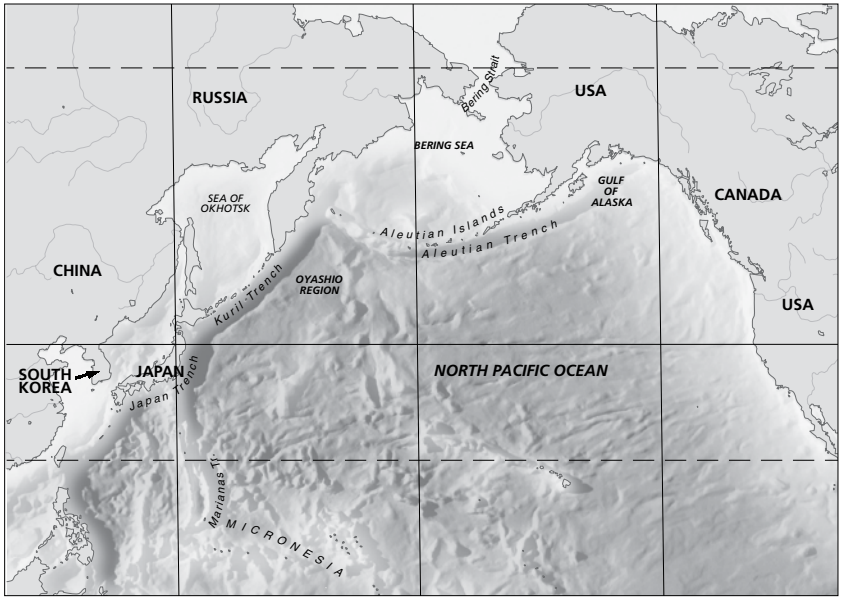

Figure 1.
Map of the North Pacific Ocean. Source: Mountain High Maps ® ©1993 Digital Wisdom, Inc.

In contrast to the tight quarters of the North Atlantic where ICES operates, countries are scarce on the shores of the subarctic Pacific. Only four countries, Canada, Japan, Russia, and the United States, border the vast region. Expanding the marine region to the northern North Pacific Ocean, northward from the limit of the subtropics at about 30°N, encompasses the Japan/East Sea and the Yellow Sea and broadens the country roster to include the People's Republic of China and South Korea. The distance between many of these countries, particularly across the Pacific's eastern and western shores, made sharing information, assessing stocks, and jointly evaluating fisheries management seem for a time either irrelevant or remarkably difficult. When fisheries were managed, it was generally through trilateral or bilateral agreements with near neighbors. At the eastern edge of the ocean, resource sharing primarily involved Canada, the United States, and Mexico. Russia and the United States shared concerns over the western Aleutian Islands and the Kamchatka Peninsula, and Russia and Japan had mutual interests in more southern regions. Longstanding political and military tensions between Japan and China and Korea precluded fisheries agreements. By the latter half of the twentieth century, however, greater exploitation of offshore, deepwater, and highly migratory stocks everywhere

was an incentive for governments to talk about fisheries and the marine science related to them.

CONSTRAINING THE FREEDOM OF THE SEAS

Before the twentieth century, maritime nations had claimed only a narrow belt of sea along their nation's coastline, beyond which lay the high seas, on which any ships could freely sail.[3] This "freedom of the seas" doctrine proved particularly useful to maritime nations such as Britain and later the United States. By custom, resources in international waters belonged to whatever country could harvest them first. Fisheries were a common property, making control fragmentary, though most fishing was carried out in the richest fisheries close to shore. As the principal extractive resource of the oceans, they became a focus of much international tension and negotiation, and shaped the focus of much marine research.

A dramatic reshaping of the freedom of the seas concept began in 1945 when President Harry S. Truman, responding in part to pressure from domestic oil interests as well as concern over Japanese fishing of Bristol Bay salmon off Alaska, unilaterally extended U.S. jurisdiction beyond conventional territorial seas to the nation's continental shelf. He proclaimed rights over the area's natural resources-fish, and oil, gas, and mineral deposits. Truman's action contrasted sharply to the traditional U.S. support of free access to international waters for defense and transportation. It also conflicted with postwar efforts to promote internationalism through the United Nations and other groups, and it had important ramifications for scientific access to coastal waters and the pursuit of general scientific understanding of oceanic processes.[4]

After World War II, maritime transportation dramatically increased, as did the intensity of fisheries, mining, and oil exploration. Technological advances and economic pressures in the twentieth century allowed ever more exploration and exploitation of marine resources. The postwar period brought a marked expansion of distant-water fisheries, technological improvements in fishing gear, and the increased scale of commercial operations. In the 1950s and 1960s, fishermen entered deeper waters aided by echo sounders, sonar, and radar developed during World War II. Diesel engines and power winches allowed boats to operate larger and larger nets.[5] The world fish catch of around 15 million tons in 1938 more than tripled in the mid 1950s.[6] By the late 1950s, armadas of technologically advanced

factory ships were able to stay months at sea and process unprecedented tonnage of fish.

Conflicts mounted worldwide between different fisheries and nations as the fishing industry began to deplete once rich fishing areas, and long-distance ships arrived to fish waters traditionally claimed for local fishermen. As countries scrambled for resources, particularly fish, escalating coastal claims altered international relations. Nations addressed problems of ocean use more and more by political and sometimes military means, complicated by the postwar proliferation of developing coastal nations that sought to protect their fisheries from the long-distance fishing fleets of developed countries. As countries copied the move by the United States to extend jurisdiction, citing the Truman Proclamation as precedent, they sometimes made even more extensive claims for sovereignty, including restricting non-commercial marine research.[7]

INTERNATIONAL FISHERIES TREATIES

The Truman Proclamation, the end of World War II, and expanding fishing fleets prompted revision of old fishing treaties and negotiation of new ones. Coastal nations developed a new raft of bilateral and multilateral fishing conventions to minimize fisheries conflicts caused by fishermen and fish indifferent to political boundaries. These treaties and their management bodies were intended to ensure future fisheries through a combination of enforcement and scientific studies to determine proper conservation measures, such as what kind of fishing gear should be used. Each convention set rules for fish catches among nations, but these ad hoc agreements created a complex network covering different combinations of target species and member states. Management of resources became a matter of continuous negotiation to solve particular problems because the rules applied to only specific stocks or areas.[8] For instance, an early treaty establishing the International Fisheries Commission in 1923 between Canada and the United States was later renamed the International Pacific Halibut Commission (IPHC) to better describe its management of Pacific halibut, not other marine species. Dramatic fluctuations in the size of the halibut fishery between 1920 and 1940 prompted a long, divisive, and unresolved debate over causation that influenced many other fisheries.[9] Nevertheless, even as the number of international fishery treaties proliferated, management plans continued to be restricted to only one or a few species of commercial interest.

Because these fishery agreements had relatively inflexible memberships, it was difficult or impossible for a new country to join them. Participating in fishing treaties could have as much to do with political affiliations, conflicts, or sympathies as with shared fish stocks. Even national claims to expanded coastal areas could not encompass all the valuable fish, which were quickly caught by rogue vessels both inside and outside national waters.

With the growing importance of managing fisheries to ensure maximum possible benefit from a particular stock, the work of fisheries scientists increased in importance. Advancing marine science offered some promise for improving rational use of resources. Fisheries science evolved rapidly after World War II from a mainly descriptive science to one using sophisticated computer analyses based on mathematical models to predict the optimum yields available from fish populations. The vagaries of natural and political systems, however, made stock assessments and recommendations difficult. Although many of the fisheries commissions contributed to a better understanding of specific fish stocks, most were never designed to develop ocean science in general.

A particularly important treaty in developing marine science in the North Pacific, however, was the International North Pacific Fisheries Commission (INPFC) on anadromous fish, such as salmon, that spawn in freshwater and live most of their lives in salt water. The INPFC was the first trans-Pacific fishery group that produced a great deal of scientific information on the range and condition of these fish. It was one of the more successful organizations in linking resource extraction with science-based management practices, and provided organization for international ocean science. A brief outline of its development in relation to changing international law is important for understanding the dynamics of developing a new scientific organization in the Pacific.

THE INPFC AND THE PRINCIPLE OF ABSTENTION

The INPFC Convention was negotiated and signed by Japan, Canada, and the United States in Tokyo in the last months of 1951 to oversee and evaluate scientific research on the condition of salmon and halibut in the eastern North Pacific Ocean. As a sign of the critical role of fishing in the Japanese economy and culture, it was their first international agreement beyond the Peace Treaty.[10] Its convention was to "ensure the maximum sustained productivity of the fishery resources of the North Pacific Ocean," in order to set their catch levels in the high seas. The principle of abstention was that

if a stock were already at a maximum sustainable yield, other nations not historically participants in the fishery had to abstain from fishing. Cold War politics excluded Korea and the Soviet Union from the INPFC, necessitating that Japan and the Soviet Union sign a separate treaty for salmon stocks.[11]

NEGOTIATING A UNIFIED LAW OF THE SEA

The INPFC was just one of many efforts to parcel out the resources of the sea. The long-running effort to develop a unified law of the sea dramatically shaped individual government ocean policies, including for research and cooperation. The close of World War II had brought expectations of steady economic development around the world. Although many economies grew, in Latin America economic growth was at a slower rate than in most of Europe or East Asia, such that the Latin American proportion of world production and trade declined, increasing the gap with the leading industrial democracies. A common response was increased nationalism and protectionism, including extending national control over marine resources. The United Nations responded to increasingly acrimonious and disparate claims on ocean resources by beginning in 1958 a decades-long effort to revise the traditional law of the sea and rationalize access and use of the oceans under a single Law of the Sea (LOS) convention acceptable to all nations.[12]

By the early 1970s it had become apparent that marine development could not be limitless. Several of the largest populations of pelagic fish harvested by purse seiners suffered collapses generally blamed on overfishing, including the northeast Atlantic herring, the South Atlantic pilchard, and West African sardines. Such severe declines in catches caused sufficient concern that coastal states pressed for protection of the resources off their shores. In 1972 Iceland became the first country to claim an extended fisheries limit of 50 miles, and other countries soon followed suit.[13] In response to these territorial claims, the FAO held frequent conferences to address the continuing challenge of optimal fishery development and use. The FAO promoted the ocean as the best source of protein for a rapidly growing human population.

THE SPARK IN VANCOUVER

In February 1973, the FAO brought together fisheries scientists from Canada, Japan, the United States, and the USSR in Vancouver, British Columbia, for a four-day Technical Conference on Fishery Management and Develop-

ment.[14] Taking advantage of the fisheries forum, about a dozen scientists gathered informally to talk more generally about the state of marine science in the North Pacific. The piecemeal nature of bilateral and trilateral fishery agreements became part of the impetus for a new multilateral marine scientific organization. In fisheries, political alliances figured in cooperation, with Cold War politics shaping the membership of existing treaties, countered by growing international exchanges of the postwar era. As economic concerns took precedence over noncommercial interests, scientific researchers stood to lose access to coastal zones. The Vancouver meeting promised a focus on scientific questions removed from contentious fisheries politics.

Several of the participating scientists were concerned that there was no general forum for exchanging ideas and information about the region, yet mounting problems of ocean use demanded an unprecedented level of cooperation across both national boundaries and disciplines. Only the atmospheric and space sciences rivaled the level of scientific cooperation and collaboration needed. In the North Pacific no mechanism existed to pool data on such general environmental threats as pollution, nor to plan and coordinate multinational oceanographic and fishery research programs. Scientific understanding of oceanic processes and phenomena in the Pacific region was hampered by this lack of formal exchange of data and ideas.[15] The physical characteristics of ocean currents had profound consequences for ocean biology and weather, and the atmosphere in turn affected those currents.

Creating a new organization for marine science had the potential of producing the rapid growth of a truly integrated understanding of the North Pacific region, but marshalling political will and financial resources presented a daunting task. Any organization to promote marine research needed to be sufficiently broad to be an effective scientific forum and coordinating mechanism, yet focused on a tractable geographic area and with unifying projects.[16] How, for instance, could scientific challenges or problems in the Sea of Okhotsk be linked to the distant and distinct Bering Sea? Scientists interested in one region might not be as invested in the other unless a common forum could draw plausible links between them. The scientists concluded that it would be very useful to have a larger and more permanent platform than ad hoc gatherings squeezed between formal meetings for discussing and exchanging data. They agreed that what was needed was a regional marine science organization that would draw upon the experience of existing organizations, yet differ in significant ways.[17] With widespread interest in the idea, the next step was to systematically assess its merits.[18]

Two of the American scientists, Dayton Lee Alverson and Donald McKernan, returned home determined to find the right people to lead the effort to create a marine science organization for the North Pacific. Both were skilled in promoting both applied and basic science. Alverson, then director of the Northwest and Alaska Fisheries Center, National Marine Fisheries Service (NMFS), was directly involved with fisheries management, including as a delegate to the International North Pacific Fisheries Commission and advisor to the U.S. Department of State on the Law of the Sea negotiations.[19] McKernan, also a noted fisheries scientist and administrator, was the first director of the Institute for Marine Studies (now the School of Marine Affairs) at the University of Washington. He had helped develop Japanese Pacific fisheries after World War II, became the first director of the U.S. Bureau of Commercial Fisheries in 1957, and then succeeded William C. Herrington in 1966 as special assistant for fisheries and wildlife to the U.S. Secretary of State.[20] Like Alverson, he was instrumental in the INPFC, the most effective international fisheries commission in the North Pacific region.[21]

Alverson and McKernan, former graduate students at the University of Washington, envisioned marine science as bridging fisheries science and oceanography. Too often fisheries scientists focused on their study organism and spent little time studying the effects of the environment on fish. In turn, even biological oceanographers rarely spent much effort investigating individual species of commercial interest. Both Alverson and McKernan wanted to improve international cooperation to strengthen the scientific base for fishery exploitation in the North Pacific. They envisioned a truly interdisciplinary North Pacific marine science organization with a comprehensive international membership of at least Canada, Japan, the United States, and the USSR, or more if it were open to all users of the Pacific.

Alverson, as a federal employee of NMFS, had to take positions consistent with those of the U.S. Department of State because fisheries politics were volatile at times and could interfere with scientific research on marine systems. He thought it best to find someone in academia to take the lead to allow for greater autonomy from any industry pressures and potential government restrictions. Alverson recalled that several NMFS scientists were not taken by the idea of a new scientific organization, nor were many at the INPFC. Some scientists thought a new organization would just complicate jurisdictional matters, while others were more receptive to it.[22] Anyone taking on the challenge of creating a new organization would need to bring

together government agencies, private industry, and academics as well as scientific disciplines.

The idea lay dormant for three years until McKernan received a letter of inquiry from oceanographer Warren Wooster, who had worked with several faculty members at the University of Washington, including McKernan, during Law of the Sea hearings.[23] Wooster was looking for new outlets for his interests and his background suggested he might be an effective bridge between scientific fields and policy. With a doctorate in chemical oceanography from Scripps Institution of Oceanography, he had applied physical oceanography to help explain ocean chemistry.[24] From there he became interested in what was coming to be called fishery oceanography, that is, how traditional oceanography could be used to explore fishery questions. He had worked on the so-called "sardine project," now known as the California Cooperative Oceanic Fisheries Investigation (CalCOFI), established in 1949 to investigate the California Current and the massive collapse of the coastal sardine fisheries. The Pacific sardine, once the largest fishery for North America, with peak landings of just over 650,000 metric tons in 1936, had fallen to fewer than 10,000 metric tons by 1965.[25] The fishery collapsed, and the crisis became a textbook example of the boom-and-bust cycles characteristic of sardines. Scripps Institution of Oceanography and CalCOFI became models for bridging fisheries and oceanography.

Wooster also brought extensive national and international experience and leadership to both regional and global scientific expeditions and organizations.[26] McKernan and Alverson jointly sponsored Wooster's recruitment from the University of Miami to the University of Washington in 1976. He came for three reasons: University of Washington's reputation in marine sciences, financial support from both the University and NMFS (through Alverson), and the challenge of creating a Pacific analog to the North Atlantic ICES. Wooster liked joint funding because it acknowledged and joined both the academic and applied parts of marine science. He agreed with many at Scripps that oceanographers had something to offer to fisheries and vice versa. Internationalism appealed to him because his own international work had combined the talent and resources from many countries to address common problems.

RESTRUCTURING COOPERATION IN RESPONSE TO EXTENDED JURISDICTION

The first U.N. Convention on the Law of the Sea (UNCLOS) extended national jurisdiction to the continental shelf in its convention on the Con-

tinental Shelf of 1964, but failed to agree on the breadth of territorial sea or fishery zones.[27] Two decades later the growing threat of pollution from offshore oilrigs, transport ships, and oil tankers reinvigorated concern about ocean jurisdiction.[28] Managers and politicians generally held that coastal nations would most effectively regulate fisheries along their shores because they had a vested interest in them.

During the protracted UNCLOS debates, in response to continued declines in commercial landings of fish, U.S. Congress passed the 1976 Fishery Conservation and Management Act (FCMA) that required sweeping new management of fish stocks.[29] It established regional fishery management councils required to incorporate social, economic, biological, and environmental factors into management plans for each major fishery. It mirrored the expanded coastal zone concept, operating within two hundred miles of the coasts, and required the government to renegotiate all of its international fisheries treaties because international fishery commissions could now function only outside of the national zone. Nations with distant-water fleets, such as Japan, Poland, and Spain now needed permission to fish in their accustomed grounds. The third UNCLOS codified national Exclusive Economic Zones (EEZs), strips of water extending two hundred nautical miles from coastlines.[30]

Also in 1976 McKernan and Alverson had supported the North Pacific Project, an effort led by Edward Miles, from the University of Washington Institute for Marine Studies, and funded by the Rockefeller Foundation, to describe the major marine policy problems of the North Pacific region.[31] It was prompted in large part by the emergence of extended coastal jurisdictions that were dramatically changing ocean use and policy. As part of this project, Wooster joined with William T. Burke, U.W. professor of law and marine affairs, to examine the need for a new organization for marine science in light of these changes.[32] If they convincingly substantiated its need to McKernan, then they could take the next step of marshalling broader support for the idea.

Their underlying rationale was that an ecosystem approach, rather than a piecemeal one, was most rational for a better understanding of the North Pacific marine region. Since the 1960s, both terrestrial and marine sciences increasingly applied that perspective to explain complex dynamics. Instead of the usual anthropocentric focus on landmass as the sole metric of a country, governments could give proper consideration to the vast ocean tying countries together. Bilateral treaties already governed major fisheries, using individual species censuses, but an adequate understanding of whole

systems, they felt, could come only through a holistic, or ecosystem, approach. In addition, the oceans have a great influence on climate patterns and economic well-being of bordering states. An ecosystem approach using climate change as an organizing principle could tie far-flung species into a more coherent picture of the workings of the Pacific Ocean. It could also encourage creating unifying theory for fisheries science, oceanography, and meteorology.

The restructuring of jurisdiction into EEZs had a profound impact on the management and conservation of ocean resources.[33] The many coastal nations with good fishing within two hundred miles could theoretically control access to "their" stocks so long as these fish did not migrate. Large nations with long coastlines such as Canada, the United States, and the USSR, and those in archipelagos, such as Indonesia, stood to benefit the most under the new EEZ regime. Canada, the United States, and the USSR extended their EEZs in 1977, deeply shaking the Japanese offshore and distant-water fleets because Japan drew more than ninety percent of its total catch from the North Pacific.[34] The UNCLOS requirement of conservation measures for nearshore and high seas fishing appeared instead as restrictions on freedom to fish, and the Japanese in particular saw them as striking at their cultural tradition and industry.[35]

The growing national control over resources made it seem as though international accord was less necessary. Were multilateral treaties even required any longer? International cooperation was still very much needed in the newly complex world of EEZs because UNCLOS required that countries make optimum use of fish stocks without depleting them. In exchange for national fishery control, UNCLOS set responsibilities and obligations for each nation. Within its zone, each state had to calculate the total allowable catch for each species, and estimate its harvest capacity and capability. Once its fishermen harvested according to scientific conservation plans, the state was obliged to grant the "surplus" to other states, particularly neighboring and land-locked countries. Coastal nations had to renegotiate international agreements because extending national jurisdiction changed the existing legal authority over marine activities and political relations among nations.[36] It was inevitable that international fisheries treaties would continue to be necessary because so many fish stocks continued to be shared across and beyond zones.[37]

In the Pacific, the three major fisheries arrangements affected were the division of the salmon catch between the United States and Canada under the International Pacific Salmon Fisheries Commission; the INPFC among

the United States, Canada, and Japan; and the International Pacific Halibut Commission (IPHC) between the United States and Canada.[38] When the United States extended its EEZs in 1977, the INPFC could no longer operate within two hundred miles of the U.S. coast. Determinations of stock size had shifted to coastal states and their new U.S. councils. The United States and Canada for the first time became managers of all coastal groundfish, and national legislation and domestic regulations now determined foreign access to the declared surpluses of these stocks. The United States gave notice it intended to withdraw from the INPFC so that the treaty could be renegotiated.[39]

THE RATIONALE FOR A NEW ORGANIZATION

It was in light of these jurisdictional changes in EEZs that in March 1978 Wooster and Burke held their first small and informal workshop in Seattle of twenty participants to discuss objectives, functions, and political concerns for a new regional international marine organization.[40] They invited only a small group in hopes it would be comfortable enough to frankly discuss matters that might prove intractable in a larger group. Although their vision was for a North Pacific organization that included Japan and the USSR, this first meeting involved only American scientists from the University of Washington and NMFS (including Lee Alverson), along with three Canadian scientists, all from West Coast government and academic laboratories.[41] Keith Ketchen, a fisheries biologist at the Pacific Biological Station at Nanaimo, British Columbia, replied to the invitation that if a new organization would "reduce the need for repetitious, often one-sided and useless scientific exchanges generated by a multitude of bilateral agreements," in fisheries, it would be welcome. He observed, however, that there was "some difference of opinion concerning the extent to which oceanographers would wish to be influenced by an international council. Having long been a proponent of a close link between fisheries and oceanography, I would be most disappointed to see the latter remain in its detached and fragmented state."[42] He agreed with the advantages of the North Americans working out a unified position before approaching Japan and the USSR. The United States and Canada had longstanding scientific and political exchange as well as geographical proximity. If they could agree on a vision of PICES, they could present a united case to other potential member states.

The title of Burke and Wooster's preparatory paper for the meeting, "An International Council for Scientific Investigation of the North Pacific,"

echoed the formal name for ICES. The paper presented several reasons for creating such an organization. The first reason was that sound scientific understanding should be the foundation for management decisions on the multiple uses of the ocean, and that understanding was sorely incomplete.[43] Resource conflicts were increasing despite the extensions of national jurisdiction, and there was no common way to exchange data on stocks to support national and international management decisions. Growing marine pollution threatened the health of the marine environment, but there was currently no way to pool efforts to understand and monitor the threat. In addition, although the previous decade had increased the awareness of the ocean's role in modulating weather and climate, once again, a mechanism to improve coordination and cooperation of research promised an improved prediction of weather and climate. Finally, better regional science would improve understanding of global marine systems, particularly since the whole of the Pacific Ocean was the largest part of the world's marine system. Coordinating scientific approaches would also be useful. For instance, offshore studies in the western Pacific tended to emphasize sampling along transects, whereas eastern Pacific research often emphasized time series at set sampling stations.[44] A new scientific organization could structure piecemeal scientific efforts for planning and coordinating multinational oceanographic and fishery research. It could foster the timely, reliable exchange and evaluation of data, identify and review critical research programs, and stimulate cooperative investigations of problems of common interest. That research would encompass both explorations of the natural world and human influences upon it, whether through resource extraction or pollution. The purpose of the organization would be:

> To promote the development of cooperative research activities and the exchange of information concerning (1) the North Pacific marine environment and its interactions with land and atmosphere, (2) uses of the North Pacific and its living and non-living resources, and (3) the effects of man's activities on the quality of the marine environment.[45]

This deceptively straightforward mission statement proved a dynamic start to discussions on its advisability, membership, structure, and activities. It also became a touchstone for the next decade of discussions, persuasion, and negotiation.

The background paper suggested that the organization should be intergovernmental, following Wooster's view that a structure that integrated both intergovernmental and scientific action would allow rapid and ex-

tensive exchange of sensitive data, whether on pollution, fisheries, or other ocean uses. Such were was likely to be more accessible if requested by an intergovernmental organization rather than by individual scientists.

The choice of an intergovernmental model was based on Wooster's experience in ICES, which the United States had rejoined in 1973, and to which he had been appointed as one of two U.S. delegates. Because ICES had arisen from concern about fishery collapses, delegates from other countries were predominantly from fisheries agencies, but Wooster started the U.S. tradition that one delegate would be a scientist from government and the other from nongovernment or academia. He favored broadening delegate expertise from fisheries to marine science in general.

Wooster's familiarity with and admiration for ICES had prompted him to suggest it as a model, though not a template for an analogous organization for the Pacific. He had first heard of ICES almost thirty years earlier, when the director of Scripps Institution of Oceanography, Harald Sverdrup, spoke very highly of it. At the time, Wooster assumed from its name that it was a global organization, and was surprised to find it really functioned in a relatively small part of the Atlantic. As he learned more about its impressive scientific accomplishments in both oceanography and fisheries science, he was equally impressed by its interdisciplinary and international flavor. Wooster, always intrigued by wordplay, suggested calling this new effort "a Pacific ICES" or PICES, to recognize that it would draw upon the experience of ICES without being a slavish model of it. A new organization could strive to emulate ICES's effective melding of all types of marine science, yet must recognize that a marine organization for the northern North Pacific wrestled with a very different geography and political history from ICES. The format of ICES was attractive because it was simple and had from its start brought together oceanographers and fisheries scientists in joint ventures. Only delegates were tied to their government's position, and mostly over nonscientific matters, while participating scientists could maintain independence and take part as individuals. The bureau, as the executive committee for the council, guided the work between meetings. The secretariat organized annual meetings with business and scientific sessions and had sufficient staff to run the daily business of the organization.

The group agreed that a sensible structure would resemble ICES, with a council, a bureau, scientific committees, a secretariat, and annual meetings. The council would conduct the formal business of the organization, directed by a president elected from among the country delegates, and consisting of two delegates from each state. Regardless of their affiliation,

however, delegates tended to be knowledgeable about science rather than career diplomats without scientific training, and scientists were built into its governance structure.

ICES carried out much of its work throughout the year in various standing and ad hoc committees, working groups, and seminars usually not considered governmental meetings. At the committee and working group level, the primary responsibility of scientists was to achieve scientific understanding, not to represent their government's interests. Drawing political implications of the science they produced was left to the delegates who were representatives of the governments. Thus ICES bridged governments and science, linking government and university scientists with national research programs, and exchanging data and advice to member governments.

As with ICES, PICES was proposed to have a science commission with representatives from standing committees that bridged scientific fields such as biological oceanography, fisheries, marine mammals, hydrography, and environmental quality. Scientists would develop research proposals in temporary working groups, then send them for review by the science commission, which would forward them to the council. To safeguard scientific independence, only the delegates in the council could commit the organization to proposed actions. For policy matters, the flow of decisions would reverse, from the council through the science commission to the standing committees and working groups.[46] Like ICES, PICES was to be organized and shaped by and for scientists who would then pass information to the national delegates. In PICES, committee members, while selected by governments, would not be thought of as representing those governments; that responsibility would fall to the delegates.

Supporters of such an intergovernmental structure argued that maintaining a small secretariat was essential to organize and structure a network of scientists working on joint projects and regularly meeting to exchange ideas. A secretariat would provide a framework and services to maintain continued scientific exchange, and an intergovernmental convention would encourage continuity of participation stemming from official government engagement. Only formally committed governments could provide sustained funding for a secretariat, publications, and travel. Governments would pay for their scientists to participate in committees and working groups, and present cutting-edge science at annual meetings. Organizers emphasized how the scientific and economic return from international cooperation would outweigh the minimal expense, though a convincing demonstration was difficult since it was impossible to estimate either the costs or the benefits

of projects. The clearest argument could be made around sustaining the valuable fish resources of the North Pacific. They feared that without government participation it would be just one more voluntary scientific group susceptible to rapidly changing membership and participation, unable to have influence on policy.

As with any intergovernmental body, however, only the delegates of each country were authorized to make policy and position statements. In turn, governments might judge the recommendations coming from high-level exchange as having greater credibility and thus be more likely to implement them.

The premise of an intergovernmental organization became a serious sticking point for some participants who favored nongovernmental meetings, arguing that academic scientists would be more willing to participate and be less subject to national constraints in a more informal setting. There, scientists were more likely to be insulated from political tensions between countries because they participated as individuals, without delegates. In addition, such a nongovernmental organization would be comparatively inexpensive and more flexible without a permanent secretariat. The heart of the matter was that governments, in the midst of negotiating new marine jurisdictions through the Law of the Sea negotiations, were likely wary to take on a new international arrangement. The participants temporarily set aside the matter of intergovernmental versus nongovernmental structure.

A less contentious issue was agreeing on the geographic area for the nascent organization, though there was still discussion over it. Workshop participants, however, agreed that the initial area of concern was the Pacific Ocean north from 30°N and including the Bering Sea, the Pacific subarctic ecosystem. Although not explicitly justified, 30°N was chosen with oceanographic and some geopolitical reasoning. Above 30°N, the northern North Pacific was tied together by a circulation system distinct from that of its tropical and subtropical regions. Within this area, ocean waters moved in large-scale circulations defining the boundaries of an ecosystem.[47] The choice of latitude also incidentally excluded such contentious issues as subtropical ocean bed mining and tuna fisheries associated with more southern latitudes. The region of interest extended from the coasts of Japan and the USSR to those of Canada and the United States.

Which countries should participate in an international and regional organization? Burke and Wooster's draft paper suggested all countries using the North Pacific or bordering on it could be members of some sort.[48] But because Canada, Japan, the United States, and the USSR carried out most

of the scientific research in the North Pacific, they were deemed "major players" and thus targeted as founding members. Their active political and scientific participation would establish their place in the organization. "Minor players," by default, were those countries that had strong interest in the fisheries of the northern North Pacific, but did not have such developed marine research programs as the major players. These categories were meant to reflect the level of involvement a country would likely show in a marine science organization. Some Canadian marine scientists suggested being even more inclusive by inviting all countries bordering on the Pacific, particularly the developing ones.[49]

Those countries that were envisioned to some day bid for membership included the People's Republic of China (PRC), South Korea and North Korea, and, surprisingly, Poland. Although Poland was the only country not on the Pacific Rim, it maintained a strong regional presence through its considerable fishing fleet.[50] China was just becoming more open to international exchange in the early 1970s, and after President Nixon's historic trip in 1972, it seemed a good candidate to join. The establishment of diplomatic relationships between the United States and China in 1978 increased the flow of Chinese students studying oceanography in the United States.[51] The two Koreas, however, potentially posed a more serious political problem, as did Taiwan. The term "minor player" was immediately dropped from further discussions to avoid any impolitic connotations.

The scientists discussed how the proposed organization would be affected by fishery organizations' response to extended jurisdiction. Because the majority of fish are caught along coasts within the new national fishing zones, only a few populations remained for international management. If existing international organizations were sufficient to foster marine science in the region, then that would preclude a new organization. Proponents for a new organization had to convince potential participants that existing groups were too limited in topics of interest, geographic area, or membership, and thus not up to the task of promoting broad marine research.

Participants first discussed the characteristics of two major fisheries organizations, the International North Pacific Fisheries Commission (INPFC) and the International Pacific Halibut Commission (IPHC), whose futures were uncertain under changing international law. Under extended jurisdictions, the INPFC was becoming limited to assessing high seas salmon outside the two hundred mile zones when it originally had the broadest mandate for all sorts of marine research. In addition, it had a limited membership of Canada, Japan, and the United States, but did not have, and seemed

unlikely to ever have the USSR as a member. The IPHC, as its name implied, only worked on halibut, though its responsibilities might be extended to other groundfish.

Most regional bodies had limited membership and considered only specific fisheries. Fisheries commissions were constrained by the language and scope of their treaties and could alter their scientific mandate and management only through cumbersome treaty negotiations. Of all regional marine organizations, only the North Pacific Fur Seal Commission included all states of interest to PICES, but it dealt only with fur seals.

But there were also other intergovernmental and international nongovernmental organizations occasionally operating in the region that had marine components to their missions. The most significant of these were the Food and Agriculture Organization (FAO), the World Meteorological Organization (WMO), and the Intergovernmental Oceanographic Commission (IOC). Once again, however, each proved to have characteristics different from those proposed for PICES. The FAO seemed to focus more on developing countries than on the proposed charter members, and it lacked the USSR, a member crucial to comprehensive marine science. Although the WMO had regional programs, it dealt mostly with weather processes that affected land, and lacked the strong marine interests proposed for PICES. The IOC, like the FAO, tended to concentrate on problems of developing countries. As for international nongovernmental organizations for the Pacific, the only one was the Pacific Science Association, which organized general science meetings every four years. Its intellectual interests and geographic scope were much broader than those proposed for the new marine science organization.

An important question raised was what role PICES would play in giving advice to member countries or regional organizations such as fisheries management bodies. Any international organization providing advice to member countries had to consider how to minimize the inappropriate use of science to support national political positions. This problem was especially acute in fisheries, where economic interests often trumped scientific assessment of stock size. The discussion concluded,

> . . . the practice of fitting science to national positions is fairly common; this is unlikely to be changed by the existence of a multilateral forum. To the extent that PICES emphasizes fishery matters, decoupling from political issues will be particularly difficult. Yet the experience in ICES has shown that this can be done, at least in the areas of periodic review of scientific progress, joint planning, and the promotion of mutually agreed investigations.[52]

Over the decades, ICES had struggled with a balance between providing advice to management bodies, and had come to a generally well-regarded system where the ICES council's statistician compiled and published fishery statistics to be used by managers. Dozens of working groups worked on various aspects of fisheries.[53] From the 1960s through the 1970s, ICES's formal advisory work had expanded greatly with its much closer connection to management when it gave specific recommendations to governments in a proactive way. By the 1970s single species stock assessment had come to overwhelm other activities. In response, some inside the council complained that annual meetings were dominated by this work at the cost of scientific work. They feared that ICES's advising role in management might impinge on the independence of its science unless scientists felt free to formulate regulations and recommend them directly to governments.[54] The ICES Liaison Committee strove to maintain such independence in producing science by responding only to the council, not to nations. ICES created the Advisory Committee on Fisheries Management in 1977 to separate its scientific advisory function further from its management function.[55]

Wooster admired the structure of ICES but did not want to replicate its uneasy relationship with fisheries management. If management remained with national or international authorities, so too would the acrimonious disputes over national fishery allocations. Most proponents for a Pacific ICES did not want direct management responsibility over fisheries, but thought they could contribute useful advice. Despite the complexities of providing advice, participants wanted their work to be useful, focusing on "the collection, evaluation, and production of knowledge . . . achieved through projects and activities designed to answer specific questions and needs" that appealed to both the scientists and member governments. Some participants needed reassurance that the organization would focus on both science and also "appropriate applications of the scientific findings." They discussed whether dividing problems by discipline, subject, or subregion might make them more tractable, but concluded that the virtue of a multidisciplinary approach was integrating fisheries and oceanography. Yet "an organization that deals directly with conflicts and their resolution or with management and the allocation of resources should be separate and distinct from one that is concerned with the development of a credible data base and with the scientific evaluation of information. The latter functions are proposed for PICES."[56] The reference to a "credible data base" stemmed from a longstanding problem of comparable and timely data exchange in marine science. In the political world of international fisheries management the accuracy of

catch data was sometimes questioned. Although PICES might explore the status of stocks, it should avoid fishery quota issues. Scientists working together could build expertise and trust between countries, define the marine science of the region, produce quality information, and give advice about its fisheries only if asked. Fisheries managers could then combine this scientific advice with the usual economic, social, and political considerations.

The participants of the 1978 meeting concluded that the organization should avoid recommendations on total allowable catch, although eventually members might wish such advice.[57] The meeting adjourned with the consensus that significant progress had been made and that another meeting with broader participation was warranted.

ICES AS A TEMPLATE FOR PICES

Because no appropriate name could be found whose initials produced an acronym of "PICES," this working label would prove both a boon and bane to the formation of the organization. Its strength lay in positive associations with the successful ICES, but those associations were detrimental for other scientists with less positive outlook on ICES. Some early proponents and critics alike thought the name PICES signaled that it would be a strict copy of ICES, leading to persistent questions about how large a role it would take in providing fisheries management advice.[58] Its comparison with ICES, and the misperception that PICES must refer to the Latin name for the taxonomic class of fishes, Pisces, meant that throughout its development, many scientists assumed that PICES would be a mainly fisheries body rather than a broad, interdisciplinary marine organization.

In addition, familiarity with the ICES model was dependent on a person's experience and geographical location. Most of the initial participants in planning for PICES came from the West Coast of the United States and Canada, and thus were often less familiar with the structure, goals, and successes of ICES than those who had been American scientists and delegates to ICES. Reflecting ICES's geographical focus, they usually came from East Coast institutions working in the Atlantic. West Coast scientists naturally focused on fisheries of greatest economic and political interest to them, such as Pacific salmon, halibut, and sardines. Salmon had the added complexity of having a large freshwater component to their life histories. In addition, the United States had only recently rejoined ICES after an absence of sixty years, having withdrawn during World War I; so many North American scientists were unfamiliar with its broader work. William "Bill" Sullivan, an

early and strong advocate for PICES in the U.S. Department of State, found his colleagues thought of ICES as doing only fishery work and inferred that was what PICES would do as well.[59] Sullivan updated Wooster on any developments in the government's marine policy.

Some Canadian scientists and government officials also had worries about associations with ICES. Canada had joined it in 1967 as a forum to discuss fisheries science, but found its interests far from Canada's eastern shores.[60] Wooster received a letter in 1978 from the head of the Canadian Institute of Ocean Sciences in British Columbia pointing out "a considerable amount of reserve (by some East Coast Canadian oceanographers) about the wisdom of setting up a Pacific organization parallel to ICES."[61] One of these was Cedric Mann, director of the Atlantic Oceanographic Laboratory, Environment Canada. He questioned whether an ICES of the Pacific would further oceanographic work.[62] Although ICES was useful for sharing information on fish, fisheries oceanography, and marine biology, it had been less so for advancing physical and chemical oceanography. ICES had rarely sponsored such a purely oceanographic effort as its successful Overflow Expedition of 1973.[63] Thus North Atlantic oceanographers operated comfortably outside the framework of any particular North Atlantic organization, using ICES, SCOR, or IOC as was convenient.

L. Scott Parsons, a government official from the Canadian Fisheries Research Board, Ottawa, saw ICES as an elaborate and costly organization that spent most of its time creating stock assessment advice requested by various European fisheries management commissions, detracting from solid oceanographic study.[64] The Canadian delegates to ICES, in protest of activities they found not particularly relevant to Canadian interests, either voted against or abstained from budget increases over several years. Parsons concluded that the only strong support for the idea of a Pacific analog to ICES came from the United States, and that "their position served to cool the interest from others" even though everyone agreed to the need for some sort of a North Pacific science organization.[65] Proponents of PICES argued that it would operate on a considerably smaller budget than ICES by avoiding an advisory role and the large publishing function that ICES had developed.[66]

Parson's position was indicative of the government of Canada's hesitation to enter into new international obligations just after extending its marine jurisdiction. Extended coastal jurisdictions produced a restructuring of Canadian fisheries and fisheries research in response to expanded domestic fishing opportunities. The Fisheries Research Board of Canada became the Fisheries Research arm of Environment Canada in 1970. Soon after the

Department of Environment was established in 1971, it was restructured to include Fisheries and Marine Service and an Environmental Service.[67] The widespread adoption of two hundred nautical mile zones fostered further change as Canada prepared in 1977 for a transition. Managing one of the world's largest EEZs prompted Canada to develop greater capacity for research independent of the analyses of other countries and made them initially reluctant about PICES as an intergovernmental organization. Fearing diffusion of power, it was concerned that a new marine organization might evaluate the status of fish stocks differently and complicate Canadian management of fisheries.[68] A counterargument within Canada, however, maintained that an independent, international assessment would be valuable even though the management of stocks within the two hundred mile zone would remain a national prerogative.[69] In a bid to link fisheries with oceanographic research, in 1979 the Canadian government joined them together in the Department of Fisheries and Oceans (DFO). Although now in the same administrative unit, the two fields largely continued to function separately.[70]

Following the 1978 meeting, participant Ketchen wrote to Wooster on behalf of Canadian fisheries scientists that although most of his colleagues were genuinely interested in the proposal, justification of a Pacific ICES seemed hard to come by.[71] He thought an organization producing fisheries management advice would be hobbled by the new extended jurisdictions to dealing with those few marine species spending all or part of their life beyond coastal state jurisdiction. Support would grow among fisheries people only if they wanted to promote marine science that seemed to have only an indirect connection with management issues.

In response to these concerns, Wooster and Burke continued interviewing fisheries scientists to gain their views on the integration of fisheries with oceanography. Wooster also chatted with several Soviet scientists during a SCOR meeting in 1978, but sensed little initial enthusiasm from them for another intergovernmental organization.[72] Clearly PICES proponents would have to search for sympathetic scientists in each country and build a constituency.

BUILDING SUPPORT ACROSS NATIONS AND DISCIPLINES, 1979

The American scientists held a second informal meeting the next year, this time including five Japanese and two Soviet fisheries scientists along with scientists from the United States and Canada. Beyond international repre-

sentation, Wooster wanted participants from a range of disciplines: fisheries scientists, fisheries managers, physical/atmospheric and biological scientists, and other specialists in marine affairs and pollution. He also wanted representation from their institutions as well as from data centers, and international organizations such as IPHC and INPFC. The central interest of the new organization was marine science, so at least at first the economic, social, and other applied aspects of it, including ocean engineering, would be of secondary importance.

The way in which a meeting was organized could dramatically influence its tenor and results. In searching for the right people and institutions in other countries to participate in PICES, organizers had to contend with individual personalities and different structures of scientific organization. The U.S. organizers, Wooster among them, preferred participants with active scientific interests in the region, both oceanographers and fisheries scientists, over high officials from government, but that approach did not access the real decision-making power in many governments.

The broadened membership produced greater concern about the political ramifications of a new organization. They hoped to highlight science untainted by the political processes of managing and allocating resources within and between countries, stating that the new organization "should have no specific advisory responsibility that directly pertains to resource management."[73] They agreed, however, that the organization could study species and their interactions, periodically assess living resources, develop ecosystem approaches to fisheries management, and examine the interactions between the sea and the atmosphere.

The participants discussed the revised background paper "An International Council for Scientific Investigations of the North Pacific," as well as a paper reviewing existing international organizations affecting marine research in the region. Participants also reviewed a draft convention for the organization that Burke and Wooster had written. The group reasoned that it was most efficient to advance all aspects of planning regardless of the resolution of individual issues like membership or structure.

When the Canadian delegates Richard Beamish and Zbigniew Kabata arrived at the 1979 meeting, it seemed to them that Wooster had already not only decided the agenda, normal enough preparation, but had also prepared the desired minutes. The Canadians had hoped for a more informal, nongovernmental organization than the intergovernmental one proposed by the United States. A formal organization would be expensive and create difficulty with the INPFC, and Canada was in the midst of restructuring

their ocean policy in light of extended jurisdiction. Beamish was instructed by the regional director general of the Department of Fisheries and Oceans to suggest that the nongovernmental SIL, or Societas Internationalis Limnologiae, founded in 1922 in Kiel, Germany, could be a profitable model for a new regional marine organization.[74] SIL was an internationally recognized success at creating significant advances in lake studies. As a nongovernmental organization it was unconstrained by differing government policies, effectively using a rotating roster of scientists in its administration to promote freshwater science. The Canadians found an ally in one of the Russian participants, but the American representatives were adamant that an intergovernmental structure would work better than a nongovernmental one.[75] They reiterated that although the latter suggested independence from political pressures, official government representatives could help secure the necessary leverage for data sharing and for financial and political support of ambitious projects. Exchange of fishery data, for example, would take place only if governments cooperated. The participants thus once again agreed not to settle on the organization structure at the meeting.

At the meeting, the Japanese and Canadians agreed that PICES, unlike ICES, should not have any specific advisory role in resource management. Instead they were more interested in creating an ecosystem approach to indirectly aid fisheries management as well as studying the methods of fish stock assessment. Both topics could be called applied fishery work, but in no way impinged on active fisheries management. The meeting ended with participants agreeing to continue informal discussions, allowing the development of a permanent and formal institution if that seemed useful. The meeting recommended that a steering committee be formed to organize further informal discussions within and among governments about the best approach to establish a new organization. Wooster's assessment was that the representatives for Canada still opposed an intergovernmental organization, preferring instead periodic scientific congresses. The Japanese, however, preferred an intergovernmental body, and only reluctantly went along with the possibility of a less formal structure.[76]

Some observers thought the meeting had unfortunate political undercurrents stemming from Law of the Sea politics, antithetical to a free exchange by scientists about science. K.C. Lucas, Senior Assistant Deputy Minister, Fisheries and Marine Service, Environment Canada, unable to attend, later read the minutes with great interest and inferred that new participants from Japan and the USSR carried "governmental opinions" that extended beyond the scientific merit of the proposal. He reiterated the group's intention to

"explore the views of scientists and to consider the desirability of proceeding further, for example, in an intergovernmental meeting" [underlined in original].[77] The meeting had concluded that informal discussions should continue within and between governments on both governmental and nongovernmental options. The discussions with government representatives did not soon take place.

Soviet scientists from national fisheries laboratories who attended the 1979 informal meetings expressed their strong support for international collaboration and the idea of PICES. While the USSR and the United States had signed an Agreement on Cooperation in Studies of the World Ocean in 1973 for five years, encouraging joint projects,[78] creating the same kind of enthusiasm beyond small workshops was another matter. Communication from the Soviet Union was minimal; though scientists at their fishery institutes were uniformly interested, they were often too busy to correspond. In the Soviet Union, research and development were divided among the Academy of Sciences, where most fundamental research occurred; industrial ministries, doing applied research; and the universities that undertook advanced training. The State Committee for Science and Technology attempted to coordinate national research and development for all of them.

The initial challenge for the Soviets was to reach across agencies involved in marine issues. The head research institute for fisheries resources was VNIRO, the Russian Federal Research Institute of Fisheries and Oceanography located in Moscow. The largest research and fisheries management center for the Pacific was TINRO, the Pacific Scientific Research Fisheries Center in Vladivostok. The Russian Ministry of Fisheries, however, was the participant in PICES discussions, with little involvement from the Academy of Sciences, the State Committee on Hydrology and Meteorology, or the Ministry of Environment. In addition, great geographical distance separated oceanographic institutes in Moscow from the work carried out in Far East seaports such as Vladivostok.

AMENDING THE INPFC

The members of the INPFC had been struggling over how to adjust their mission in light of extended jurisdictions. Just a month after the PICES informal meeting, in February 1979, members of the INPFC reaffirmed its strong support and production of scientific research. While recognizing the large amount of basic ocean science that it had carried out over the years, it reaffirmed that most of its effort should be directed toward anadromous

fish, rather than general fisheries and ocean science. Because the INPFC was then the only place for scientific discussion of non-anadromous fish, two articles of the protocol amending the convention that created the INPFC proved significant to the future of a possible PICES. Six years earlier, Lee Alverson had been one of the original instigators of the PICES efforts. Now, as an INPFC commissioner, he introduced the amendment to Article IV that said in part "The Contracting Parties shall work towards the establishment of an international organization with broader membership dealing with species of the Convention area other than anadromous species . . . When such an international organization becomes functional, the functions of the Commission under the provisions of Article III . . . shall be terminated and transferred to the new organization."[79] His amendment seemed tailor-made for promoting the creation of PICES so that the INPFC could redirect its focus to anadromous fish.

On the other hand, the INPFC opened its 1980 scientific symposium on Pacific cod and other groundfish fisheries to scientists from both member and nonmember countries. Including scientists from the USSR provided a broader, more complete forum for discussing regional marine problems. It also, however, raised the possibility that the original INPFC members of Canada, Japan, and the United States might renegotiate its treaty to formally include new members, thus diminishing the need for a new organization in the region. A restructured INPFC might be a cost-effective and efficient way to improve scientific research in the region, but could possibly derail plans for PICES.

ARTICULATING A FISHERIES JUSTIFICATION FOR PICES, 1981

Although the 1979 meeting had called for creating a steering committee to approach governments, neither of these actions had been followed up by 1981. The effort was renewed with a meeting on the fisheries justification for PICES. It was increasingly clear from the meetings to date and correspondence with government officials that political support for PICES would come first through economic arguments. Appealing to the utility of a marine science organization to the economic field of fisheries was the most strategic approach on both national and international fronts.[80] Making a plausible case for a new intergovernmental marine science organization required that the benefits outweigh the costs, but that was a difficult calculation to make for basic science.[81]

If PICES could forcefully articulate that fisheries oceanography could effectively link oceanography with fisheries science, then they could argue that it would lead to a better understanding of fish production. Improved scientific understanding and cooperation promised to advance fisheries management through forecasting the state of commercially important resources. It was also a strategic approach because other scientific interests, like the ocean's role in climate change, or the impact of human activities on the marine environment, would draw on the same base of scientific disciplines and institutions as fishery studies. Marine research efforts depend in large part on common measurements and facilities and thus could have an important synergistic effect in a broad-based organization such as proposed for PICES.

In 1981 Wooster invited a dozen U.S. fisheries experts to discuss the fishery benefits of a Pacific ICES using the background paper "Fishery Justification for a Pacific ICES" to argue the importance of fisheries to the economics of all coastal nations. Clearly scientific cooperation was needed when fish populations were shared among several countries, such as the case for ICES. But what about the Pacific Ocean, where countries were so much more geographically distant from each other? The answer lay in thinking about ecosystems rather than populations, and that harvesting activities of one country could not be isolated from another within the subarctic Pacific ecosystem. A significant number of commercially important species or those that served as their food lived along the coasts of three or more countries in the subarctic Pacific region, yet little was known about their population dynamics and few of them were under any multilateral management.

An ecosystem approach to management would be superior to the current, narrow species-specific approach because it emphasized that even apparently isolated populations can travel far outside "usual ranges" sometime during their lives. Therefore a country that seemed not to share in specific fisheries might still have use for data on those fisheries. In other cases, when species had a wide distribution in the subarctic, as sixteen species did, management and environmental stresses of one area likely influenced population dynamics in another.[82] Climate change was the ultimate link between seemingly isolated fish populations, as El Niño had changed population distribution throughout the Pacific.

A multidisciplinary approach could also increase understanding of fluctuations in productivity and aid both short and long-term resource planning. Benefits would come from the more extensive and timely exchange of information, cooperative assessment, and cooperative research projects.

Cooperative assessment of stocks, rather than actual management, would avoid the political pressures associated with management and allocation of resources. Multilateral peer review of science to explain and predict fluctuation in stocks would divorce science from political pressures.[83] Like with ICES, the primary benefit would lie in improved ability to forecast the future state of commercial species in response to fishing and changing environmental conditions.

The support of regional fishery management councils was critical, however, because they were most directly involved with management of fishery resources of the region. The fisheries paper emphasized that PICES was not challenging the authority of these regional councils. It would not assume responsibility for the management of any fisheries resources, but rather would gather information that could be used in addressing management problems.

Involving foreign fisheries scientists in the assessment of fish stocks in the U.S. fishery zone could produce controversy over council decisions. This U.S. concern was similar to that expressed earlier by the Canadians in the 1978 meeting. The councils were mandated to take the best available scientific information, although they could choose what assessments they would accept. The group argued that the greater the scientific production, the more accurate the overall picture of the region. Wooster pointed out that scientists, whatever their nationality, would be isolated from political concerns by working on the science underlying, yet removed from, specific management decisions. Thus such broadened scientific participation could lead to more accurate stock assessment by managers.

The 1981 meeting highlighted a difference in perspective between those who saw fisheries benefits as the ultimate goal of the proposed organization and those who favored basic scientific inquiry regardless of its immediate application. It was clear that forecasting impacts of alternative fishing strategies was beyond either current data or available manpower. The summary statement pointed out that PICES could be most important in bringing an ecosystem approach to management, rather than the current species-specific approach. Discussions within PICES might redirect scientific activities to achieve better management through information exchange on stocks, cooperatively evaluating them, and carrying out joint research projects. The experience of international fisheries bodies in the Atlantic suggested ICES was a robust template. While the extension of national economic zones profoundly affected fisheries treaties by shrinking the area for international management, ICES continued to serve as an effective regional forum for the

exchange of information, producing environmental assessments, and developing cooperative research. But the close linkage of ICES with management in the early 1980s had left some participants with the erroneous impression that it directly managed fisheries. Thus the meeting summary clarified that participants did not propose that the organization would assume responsibilities for managing any fishery. That responsibility would either belong to coastal states when the fish were within two hundred miles of shore, or remain with international management bodies.

Despite the generally favorable assessments from these three informal meetings, and the INPFC amendment calling for an organization to promote scientific advancement in the region, advocates for PICES did not meet again for another five years. This hiatus developed when one of PICES's strongest supporters, McKernan, died in 1979, and Alverson retired soon after from the Northwest and Alaska Fisheries Center to pursue private consultancy on groundfish. Efforts for international scientific cooperation were also dramatically slowed by the USSR invasion of Afghanistan in 1979, the U.S. presidential election of 1980, and the renewed crackdown on dissent in Poland starting in 1981.[84] The new U.S. administration meant changes in government positions key to decisions about PICES, such as the Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, the Deputy Assistant Secretary for Fishery Affairs, the Administrator of NOAA, and the Assistant Administrator for Fisheries. Progress was also slowed by continuing Law of the Sea negotiations and with uncertainty about scientific access to EEZs. Nevertheless, Wooster continued to correspond with policy makers, government officials, and colleagues to keep alive the idea of a Pacific ICES.

To fill the gap in PICES activity, in 1982 American and Canadian scientists from fourteen universities, government, and fishery institutions from Oregon, Washington, Alaska, and British Columbia formed a new, nongovernmental group. The International Recruitment Investigations in the Subarctic (IRIS) examined the effects of ocean variability on abundance and distribution of fish stocks. It became a de facto interim organization for interdisciplinary scientific collaboration in the eastern North Pacific, and continued to explore the fisheries justification for PICES.[85] As an informal organization, it did not have to wait for governmental sanction of its agenda, and it sponsored scientific exchange on the northern North Pacific Ocean through several workshops and symposia. IRIS fostered scientific exchange between fisheries scientists and oceanographers, and promoted

an ecosystem approach, just as PICES proposed to do. It acted as a bridge between the first meetings for PICES and its eventual formation.

Richard Beamish, a Canadian fisheries scientist active with both INPFC and IRIS, wrote a proposal for IRIS to hold a joint symposium with the INPFC, which had sponsored other international symposia on non-anadromous fish. The INPFC commissioners agreed to hold the symposium so long as it avoided the topic of anadromous fish, an area that it claimed as its expertise and responsibility. Symposium participants would come from the same countries proposed as future members of PICES, a kind of dress rehearsal so that countries considering PICES could meet in a similar form to that proposed for it. IRIS wanted to help the INPFC implement its Article IV, the amendment that directed that a marine organization should be set up for non-anadromous issues in the Pacific. In proposing the idea of PICES to INPFC, it proved useful to emphasize the marine fisheries aspects of IRIS without diminishing the role for oceanographers.[86] Not surprisingly, in its official correspondence IRIS strongly supported creating PICES.

REINVIGORATED PLANNING FOR PICES AT ANCHORAGE

After five years without an international planning meeting, scientists in Alaska took up the challenge of renewing the push for an intergovernmental meeting. Alaska was a natural place from which to further the PICES idea because of its international marine interests and expertise. Its economy had always been closely tied to resource extraction, with fishing providing over half of the value of its exports and fostering interactions with major fishing nations like Japan, the USSR, and China.[87] The University of Alaska had strong programs in fisheries and oceanography, and had sent scientists to the second informal meeting for PICES in 1979. Dr. Vera Alexander, oceanographer and director of the Institute of Marine Science at the University of Alaska in Fairbanks, strongly supported it.[88] In addition, the U.S. National Sea Grant College Program had a unique role in bringing university scientists together with government needs and activities, especially those of NOAA. In 1984 staff from the North Pacific Fishery Management Council, the Alaska Sea Grant College Program, and Alaska Congressional officials held discussions on the North Pacific Ocean and Bering Sea, with part of their intent to reinvigorate the PICES effort. Following the meeting, Ronald K. Dearborn, director of the Alaska Sea Grant College Program, called a meeting in Anchorage in 1986 to promote marine research and ensure the future of Alaska fisheries.[89] With the University of Washington and

the North Pacific Fishery Management Council as cosponsors, seventeen representatives from the five target member countries of Canada, Japan, the USSR, and the United States met along with two observers, for the first time, from China. This meeting was the start of the negotiating phase of forming the organization.

Participants reviewed the rationale for the organization, especially how it could increase scientific knowledge necessary for the sustainable use of the ocean's resources. One morning's discussion returned to the question of whether the organization should be at a governmental level.[90] As a reply, Wooster revisited Burke's 1978 draft convention modeled after the intergovernmental ICES, and proposed adding China as a founding member. That draft convention formed the basis for discussion. Participants agreed that the organization should be intergovernmental rather than nongovernmental, and involve government agencies of fisheries and oceans as well as universities. It should promote the exchange of currently available data, evaluate it, review research plans of international interest, identify critical research, and plan cooperative investigations.

This meeting highlighted an interesting interplay between the ideal of a unified organization with the fact of a changing list of participants. Just because participants at this meeting agreed on an intergovernmental structure did not guarantee that the next round of participants would arrive at the same conclusion. The meeting produced a detailed list of potential benefits to states, including cost-effective and efficient collection and speedy exchange of information, the ability to approach questions on a large scale, and other advantages of an extended scientific community. They outlined potential projects such as reviewing research plans of international interest, identifying critical problems and the appropriate methods for addressing them, creating cooperative investigations on problems of interest to members, and evaluating and interpreting scientific information from those members. At the end of the meeting, participants showed significant commitment to the idea of PICES by agreeing to begin talks with the appropriate representatives of their governments.

Since an intergovernmental organization could come about only after sufficient support for it was built within government agencies, throughout the previous year the NOAA Office of International Affairs had been researching and reviewing the issue of establishing a new research organization for the Pacific. The NOAA administrator subsequently approved consideration of the concept on condition that it was clear that it was too early to make a formal commitment. It would need a full review to commit the government

to a continuing financial obligation such as secretariat dues. The guardedly supportive views of NOAA were then conveyed to the U.S. Department of State.

The United States and Japan had no governmental decision makers at the meeting, and the Japanese university scientists pointed out that as academics they could not convey any official position on the advisability of such an organization.[91] The participation as chair by Barry S. Muir, however, a high level official from Canada's Department of Fisheries and Oceans, gave the proceedings added gravity and promise for the start of more formal meetings.[92] No forum existed for the discussion and exchange of oceanographic information for the North Pacific and no comprehensive one for fisheries research.

Also in 1986 the Canadian, Japanese, and U.S. sections of the INPFC endorsed the idea of PICES at their annual meeting, a significant show of support that cleared away lingering objections that the INPFC could take on whatever tasks that PICES proposed.[93] What was needed now was to get all other governments to meet on the feasibility of a new scientific organization. The organization needed all targeted members to sign on to show its political and scientific stature. If Japan or the USSR did not act quickly, the organizing momentum would suffer a severe setback, perhaps never to recover.

The Anchorage meeting laid the groundwork for the first intergovernmental meeting to follow, when for the first time there was official support in both Canada and the United States to create the organization. Canada offered to coordinate the next crucial step of inviting government representatives, not just interested scientists, together to join in PICES. The University of Alaska would help coordinate all of the necessary information.[94]

It was Canada's acceptance of an intergovernmental structure and willingness to host a formal meeting that prompted other non-Canadian scientists to move ahead in asking their countries to participate. What caused this strengthening of Canadian support? It appeared prompted both by the participation of Barry Muir and a renewed shaping of Canadian national ocean policy during 1986 that placed greater emphasis on linking oceanography and fisheries in a larger systems approach.

Canada had adopted its first national ocean policy in 1973, prompted in part by the interest stirred by the 1957–58 IGY, and in part by concern over the 1969 voyage of the American oil tanker S.S. *Manhattan* through the Northwest Passage of the Canadian arctic archipelago. The Canadian government voiced concern for the fragile arctic environment, for the grow-

ing international oil crisis, and for its jurisdiction, and passed the Arctic Waters Pollution Prevention Act in 1971, followed by its national oceans policy statement. Despite being its first national ocean policy, little action came from it until a systemic reassessment just over a decade later.

In 1985, the U.S. Coast Guard icebreaker *Polar Sea* renewed Canadian concerns over its sovereignty and, in combination with Law of the Sea developments and environmental concerns, led a year later to an ocean forum to discuss strategies for unifying and developing Canada's ocean economy. A survey of government programs and activities related to the oceans had found that there were about seventy-five ocean-related programs carried out in fourteen departments and agencies by more than 13,000 staff, with funding of $1.3 billion annually.[95] Substantial bureaucratic changes encouraged a shift from a preoccupation with fisheries issues to a more balanced one that included oceanographic concerns. In 1987, the Department of Fisheries and Oceans released "Ocean Policy for Canada: A Strategy to meet the Challenges and Opportunities on the Oceans Frontier." Like the 1973 ocean policy, it focused on the development of ocean industries and related science and technologies, and argued for improved ocean management.[96] Where it differed, however, was that the minister of fisheries and oceans announced several specific initiatives to demonstrate governmental commitment. Among these were a national marine council, an ocean technology promotion office, an arctic marine conservation strategy, and most importantly for PICES, promotion of a North Pacific Science Organization. This policy paper made public the 1986 Canadian government support of a new organization to coordinate an integrated and large-scale approach to marine scientific studies.

The step from informal meetings of scientists to one with government representatives was essential to build consensus with governments on what the organization should be. Clear U.S. and Canadian government support signaled that the idea of PICES warranted serious attention from other governments. To build momentum in light of these successes, Wooster wrote in the spring of 1987 to Japanese and Soviet contacts urging them to persuade their government officials to accept the Canadian invitation for multilateral discussions later that year.[97] Each government would send two delegates prepared with terms of reference to be used by its delegation. In the case of the United States, NOAA would create those terms by working with the Department of State. A memo drafted by William Sullivan, U.S. Department of State, to the U.S. Embassy in Tokyo compared a possible PICES with ICES.[98] It listed talking points for discussions with the Japanese

government, reminding it how ICES operated and that it could be a good model for PICES because it drew its participants from both government and academic laboratories and most of its annual meetings were devoted to strictly scientific discussions. What the letter did not point out, however, was that in ICES, due to its origins in concerns over fishery collapses, most national delegates came from national fisheries agencies and fishery departments. Sullivan agreed with Wooster that it would be useful if PICES began with the commitment of participation from scientists in both government and academia.

PICES proponents in Canada and the United States also renewed a letter-writing campaign to build governmental support for the organization. In Canada, L. Scott Parsons, now the responsible Assistant Deputy Minister in Fisheries and Oceans, promoted PICES as part of Canada's marine policy. In the United States, Wooster and others wrote to governors in the Pacific Northwest about the economic importance of fisheries to the region and the need to understand fish dynamics through a coordinated study of the ecosystems. State officials responded by sending letters of support to the U.S. secretaries of state and commerce and Congressional representatives encouraging agency heads to promote PICES. Anthony J. Calio, Under Secretary of Commerce for Oceans and Atmosphere, NOAA, complimented Wooster on his case for PICES, and assured him that NOAA was working with the Department of State and other agencies such as the National Science Foundation (NSF) to formulate the U.S. position. As more nations exploited ocean resources, Calio was especially interested in ecosystem study of changes in the physical environment and variability in marine living resources.[99] Wooster forwarded this letter to a score of other organizations and more congressional representatives, hoping to increase the pace of discussions. Wooster used the imminent hearings for the reauthorization of the National Sea Grant College Program in 1987 to highlight the links among PICES, fisheries oceanography, Sea Grant, and NOAA's broader mission, promising that PICES would work on the international level to broaden the network of information and research needed for national programs.[100] The director of the Alaska Sea Grant College Program, Ronald K. Dearborn, testified before the National Ocean Policy Study and the U.S. Senate Committee on Commerce, Science, and Transportation, and promoted PICES to Senator Claiborne Pell, a longstanding supporter of marine research.[101] Members of Congress sent letters encouraging full participation and support for PICES to the deputy assistant secretary of state, NOAA, and NMFS.[102] Each letter closed with the hope that the Department of State would see fit

to involve nongovernmental experts from U.S. universities and scientific research organizations. Proponents felt such participation would reflect the proper parameters for PICES-related research activities.

For a brief time there was even a promotional group in the United States, PICES Associates, with stationery and recruiting letters inviting people to become members of PICES Associates at no cost. Their names would appear on the organization's letterhead and they would receive PICES Associates newsletters.[103] That public appeal was dropped in favor of directly approaching government and academic figures. The PICES supporters adopted an icon of the proposed area of interest (Figure 2).

Figure 2.
PICES logo. Stylized depiction of the PICES area of interest: the northern North Pacific

It was one thing to gain support for the idea, but another to maintain a consistent vision of how PICES should operate given the constantly growing and changing roster of participants. On the one hand, organizers wanted to incorporate input from participants, but on the other hand, they wanted to remain true to a vision that had at its core an intergovernmental convention with broad representation from serious scientists and with no complicating management responsibilities.

After fostering government ties, Wooster became concerned that an eventual U.S. delegation would be purely governmental (representatives from the Department of State, NMFS, and NOAA), rather than the mix of government, academic, and private affiliations he thought essential for the best science. Most of the preparatory work for PICES in the Pacific Northwest had come from all three, so it was vital to him that they all remain involved.

A MAJOR STEP FORWARD: THE 1987 INTERGOVERNMENTAL MEETINGS

As the Canadian government began to integrate fisheries and ocean sciences in its administration in the late 1980s, it reinvigorated the idea of PICES and became key to persuading more countries to join in the effort.[104] In December 1987 in Ottawa, Barry Muir, Director-General, Fisheries and Biological Sciences, Department of Fisheries and Oceans, opened "The Special Conference on the Concept of a New Marine Science Organization for the North Pacific Ocean and the Bering Sea." It was the first intergovernmental meeting of the five countries of Canada, China, Japan, the United

States, and the USSR. Fourteen years had passed following the first spark in Vancouver in 1973. During this time, the idea was promoted from the ranks of academia and government laboratories, and participants focused on the content and form of the organization without much awareness or active support from higher-level government officials. The shift to governmental meetings redirected effort to a more top-down negotiation. Delegates were required to bring their country's interests to the table in Ottawa. High level representation on official delegations indicated national interests: Deputy Assistant Secretary of State Ambassador E. Wolfe headed the U.S. delegation, Assistant Deputy Minister L.S. Parsons headed the Canadians, and Head of the Far Seas Fisheries Research Laboratory Shigeichi Hayashi led the Japanese delegation.[105]

This meeting laid out the essential aspects of the organization, and served as a template for future discussion. Assistant Deputy Minister Parsons opened the meeting by reviewing previous efforts at creating greater scientific cooperation. He noted that Canada liked the emphasis on oceanography leading to a better understanding of fish distribution and production. Delegates from each country assessed the Canadian government's previously circulated concepts paper that summarized developments over the previous decade. Its emphasis on cooperative research as essential to a better understanding of complex marine systems resonated with participants. The paper pointed out that integration of fisheries and oceanography would come from discussing timely data in workshops and symposia and producing cooperative research plans, especially for monitoring stock abundance trends. Parsons made clear that the paper was not a final document but was meant to promote discussion of topics that did not yet have consensus. Such flexibility reassured all participants that their input was not taken for granted, and so the meeting participants spent most of their time reviewing this paper.

Befitting a formal meeting, delegates thanked Canada for hosting it, acknowledging cooperation as the key to better understanding. They generally agreed that no other organization with such a large potential membership focused on the whole ecosystem of atmosphere, ocean, and fish in the region. All pointed out that they needed to carefully consider and minimize the financial costs of a new organization. Beyond those general agreements, however, they needed to address specific proposals in the draft.

The head of the Chinese delegation was particularly interested in the fisheries benefits of PICES, but pressed for special help and cooperation from other members and to pay smaller dues as a developing country. Several other delegations objected strongly to a sliding scale of dues, arguing that

equal contributions would create equal benefits. Because each country had its own special economic circumstances, opening the door to different treatment would certainly complicate future negotiations. In addition, the Chinese wanted each country to have direct representation in the PICES Secretariat, with new members admitted only by unanimous vote. That latter concern was acknowledged but not acted upon.

The head of the Soviet delegation took a more legalistic approach and surprised the other delegates by insisting that to respect the principles of the International Law of the Sea, the organization should operate only outside the two hundred mile EEZs. Doing so ran counter to the whole emphasis on integrative, ecosystem studies, so other states strongly opposed this condition, arguing that comprehensive oceanographic research required freedom from such geographic limitations. The Soviets later joined the majority view that the organization should not be restricted by EEZs, an approach consistent with their position in ICES and with all previous understandings.[106]

Perhaps indicative of Japan's concern over the utility of PICES, Japan's participation was not a foregone conclusion. Wooster had asked Sullivan for assurances that the U.S. fisheries attaché in Japan was encouraging official governmental support for PICES.[107] The attaché reported that a senior official from the Japan Fisheries Agency said they did not rule out the possibility of attending the meeting if a formal invitation arrived and that official also made some less-than-positive remarks about a new organization. Sullivan found the Japan Fisheries Agency official's response curious, given that the same official had been at the INPFC meeting where the official statement in support of a new marine science organization was on record, and Canada already had renewed the invitation of Japan to the meeting.[108] Sullivan concluded that the Japan Fisheries Agency official was being cautious.

The Japanese officials for the 1987 Canadian meeting were S. Hayashi, head of the Far Seas Fisheries Research Laboratory, and the second secretary of the Embassy of Japan in Ottawa, a nonscientist. Hayashi thought it was still premature to establish a new organization because Japanese scientists had not yet agreed on its advisability. Although he agreed with the concepts paper, that whole systems required holistic thinking, he concluded that oceanography and climate studies should be carried out by existing organizations already focused on them. After all, other organizations, most notably INPFC, FAO, WMO, and IOC, already carried out some of the envisioned research, coordination, and data exchange.[109] Japanese scientific efforts were already spread widely, and they suggested coordination, not duplication, of effort.[110] Frequent reference to the success of ICES was not

convincing for Japan, or any other country unfamiliar with that organization.

The Japanese instead encouraged establishing an international organization that would investigate and manage specific fishery stocks, such as the pollock in the central Bering Sea. This view followed from their interpretation of Article IV in the INPFC as supporting creation of a new management organization, not for general marine science, but for the "donut hole" area of the Bering Sea that fell outside the national jurisdiction of either the United States or the Soviet Union.[111] The Japanese thought the division of the pollock fishery was much more urgent than creating a new science organization. This novel interpretation of Article IV was less surprising in light of a Japanese newspaper article that appeared just a few months before this meeting which warned,

> Japan's fisheries community needs to be particularly concerned that the creation of PICES would not become an opening for the regulation of fisheries resources in the North Pacific. As the United States, China and the USSR have yet to clarify their positions, Japan will have to wait and see exactly what authority PICES will possess. The Japanese government at present recognizes the importance of this problem, but has not yet reached a decision as to what stance it will take. There is much interest in Japan concerning how events will develop as the creation of PICES progresses.[112]

Such skeptical articles did nothing to counter Japanese public opinion that marine organizations mainly existed to restrict the Japanese fishing industry. In light of these different interpretations, Hayashi did not want discussion limited to the Canadian "Concepts Paper," and thought the meeting was best seen as an exchange of views in a spirit of cooperation, rather than an attempt to reach any conclusion.[113]

Canadian and American representatives, fearful of setting progress back by years, replied that existing organizations could not carry out all PICES functions, and reiterated that the organization was scientific rather than geared toward fisheries management, and was complementary to existing groups. They reemphasized that it would not be concerned directly with management, regulations, or resource boundaries. Accordingly this would ensure that the organization remain flexible and welcoming to other relevant countries and institutions as they became interested in the activities of PICES.

All representatives agreed that cost-effectiveness was essential in thinking about the scope of both the science and administration of PICES. Japan repeated its assertion that existing organizations could do the work, suggesting

they needed only coordination of effort rather than a new organization. All other representatives viewed the proposed organization as a good complement to existing global efforts of the IOC and INPFC. The concept of the organization was agreed to by all but Japan. This official Japanese reluctance was quite a change from the earlier positive response of Japanese academics. The Japanese delegates viewed PICES as premature and abstained from the session's endorsement that "the scope of the new organization would be scientific in nature. It would not be concerned with management, regulatory, or resource boundary mandates."[114] The Japanese raised some optimism by observing that the meeting had fostered a cooperative spirit and deepened their understanding of the other countries' positions on the concept. Despite the Japanese abstention, the delegates from all five countries agreed to meet again the following year to resolve their remaining differences and work toward a preliminary draft of a PICES convention.

Just under a year later, in December 1988, Barry Muir reconvened delegates in Sidney, British Columbia, for the second intergovernmental conference where they were welcomed by William Doubleday, acting assistant deputy minister for science in the Department of Fisheries and Oceans. Once again, governments sent high-level representatives, and there were few practicing scientists among them. Only the U.S. delegation included academics. Canada had prepared a set of draft convention articles on the organization. Delegates readily agreed that the new organization should focus on marine biology, oceanography, and climatology of the North Pacific, but questioned the geographic extent; what should be its southern boundary, and should it include adjacent seas other than the Bering Sea? These issues, which had seemed settled several years previously, were once again on the table because meetings were now governmental. The Canadian draft had used a fixed latitudinal boundary, but most delegates preferred a southern boundary based on oceanographic processes and wanted to include the Sea of Okhotsk and South China Sea because they were scientifically interesting and increased the geographic relevance for the western Pacific Ocean members.

Whether additional countries should be invited to be founding members raised the question of criteria for members and whether founders had special privileges. Should membership be restricted to countries doing research in the convention area or open to any country doing interesting work regardless of where it was being done? Everyone wanted the scientific effort to focus on the northern North Pacific. Having a scientific program in the convention area seemed a good criterion for membership. Japan went even

further, though, and was open to having any country with active North Pacific fishing interests join. To expedite the formation of the organization, however, the group concluded that founding members should remain the five countries present.

Canada's greatest concern was that PICES not seek regulatory tasks or authority, instead being ". . . scientific in nature and purpose with no regulatory function whatsoever."[115] If so, how would scientific information reach management groups where it could be used in creating sound policy? The delegates concluded that the PICES convention could include special provisions allowing it to respond to requests for information without taking on management responsibility. At the same time it was important for PICES to develop close ties with international scientific organizations, particularly the INPFC, IOC, and ICES.

A fundamental and potentially sensitive decision for delegates was choosing the official language for the organization. Should PICES mirror the United Nations and the INPFC, where delegates used their own language and were provided with simultaneous translations? All languages would have equal standing, maintaining national pride and allowing everyone to participate equally in discussions. Yet simultaneous translation was costly, cumbersome, and stilted. Only larger organizations like the IOC, ICES, and the fisheries commissions with bigger budgets could afford translation in multiple languages. English already served as the common language of science at international conferences, and adopting one language could produce easy and efficient discussion. After surprisingly little debate, delegates agreed that English would be the official language because most marine science was published in English. This decision, though achieved through consensus, meant that scientists unsure of their English would be less at ease in future discussions.

The Chinese delegates were still concerned about the process of arriving at decisions within the organization. If decisions were made by consensus, would a country be bound to them even if it expressed a dissenting opinion? If it objected to a research program as not directly useful to their country, would it still be required to support the program? Delegates concluded that achieving consensus would be important for matters of science, while voting might be necessary at the policy level for budget and membership matters. Delegates committed to the principle of consensus; any departures from it could be addressed in the convention. At the same time they agreed that the PICES convention document should be kept as simple as possible, with details included in bylaws and rules of procedure.

China repeated its hope that the size of its financial contribution would reflect its status as a developing country, but once again, other delegates favored equal contributions that would be kept reasonable by having a small, efficient secretariat to arrange annual meetings, issue annual reports and documents, and coordinate scientific symposia and conferences. They did not decide on the location of the organization's headquarters, though Canada and the United States were natural choices because of their early and strong promotion of the idea. Although hosting the secretariat would bring national and international prestige, more pressing were matters of substance.

Japan was still not convinced that a formal convention was needed, and the matter had not yet been decided in Japan. Once again, the Japanese delegate questioned the organization's goals and scope, and its overlap with other groups, geographic area, and expected cost. All other countries expressed support for the convention so long as the organization was "purely scientific in nature" and that the wording of the articles emphasized that it was not a management body. As they worked through the draft articles of convention, they recognized that Japan would not be bound by the resulting document, but making progress might move the effort closer to fruition.[116] This first version of the articles bracketed points of disagreement, but they made enough progress to continue between sessions. Canada offered to consolidate, revise, and resubmit the draft to the group, and the resulting text would pass to an ad hoc committee to modify the draft articles. Delegates were urged to submit revisions to Canada by April 1989, with a polished, consolidated draft convention produced by July. While Japan saw no need to rush and urged caution, China suggested, and all other delegates agreed, that they should move forward.

Following the meeting, Canada, the United States, and the USSR suggested modifications of the preamble, with the Canadian one "recognizing the importance of preserving the living resources of the North Pacific Ocean and the need for better scientific understanding of the resources," while the U.S. version emphasized instead, "the importance of scientific knowledge of the ocean and its resources to the countries bordering the North Pacific and Bering Sea." The American focus on scientific research rather than resource preservation was consistent with its longstanding desire that the organization promote general marine science.

The United States and Canada offered to elaborate a list of possible research activities. Two representative activities were examining the North Pacific Ocean circulation in relation to climate and marine resources, and

the role of North Pacific phytoplankton in the global carbon cycle and the greenhouse effect. Areas of potential cooperation ranged from studies of the population structure of trans-boundary species to improving weather forecasting through collecting real-time data. Of the fourteen topics, the majority focused on living marine resources, suggesting that economic interests were particularly important.[117]

SEA CHANGE: JAPAN RECONSIDERS

Each government considered the draft articles for a year, and reconvened in December 1989 in Seattle to move beyond further discussion of principles and concepts, as favored by the Japanese, to become a drafting session of the convention. The participants were surprised and deeply pleased when the head of the Japanese delegation, Shuhei Takahashi, announced without preamble, "Japan is now agreeable to formally enter into negotiations for the establishment of the proposed 'International North Pacific Ocean Marine Science Organization.'"[118] He stressed that the organization should have no regulatory or management functions and emphasized that PICES should have only a catalytic role in marine science, with research funded and carried out by the countries themselves. Japan, a longtime skeptic of the organization, now accepted its broad scientific mandate.

What prompted such a dramatic and significant turnaround from the Japanese government's reluctance of previous meetings? Was it just that continual clarification of PICES goals and relation to other organizations had been persuasive? Or were there more fundamental changes in perspective that prompted the shift? At the time the reasons for the turnabout were not at all clear to the non-Japanese participants; they were just happy to move forward. Whatever the underlying reasons for Japanese acquiescence, the hard work of the meeting could now proceed in earnest. The delegates set to work improving the draft, article by article, with disagreements indicated by brackets. By the end of the first reading, only ten of the nineteen articles still needed some resolution, including whether 30°N should remain the southern boundary of the convention area. Japan had instructions that the 30°N boundary should not appear in the text unless a scientific reason was given to justify it, whereas the USSR needed it for administrative and fiscal reasons. Some delegates wanted a broader convention area, while Canada in particular felt that removing the number might result in a southward shift of scientific interest contrary to the original intent. The Canadian delegation offered to draft new wording to resolve that issue.

Because delegates still contested the nickname PICES, they kept the organization's title blank, moving on to more substantial issues such as whether consensus would be required to admit new members, and whether they would be considered different from founding members. A particularly important question for governments was whether financial contributions would be the same for all and whether officers and the location of meetings would rotate by country to ensure equitable representation. The consensus was that each question should be answered in a way that would provide the most uniform representation. Thus governments would pay the same, and functions would rotate among nationalities and interests.

The preamble was discussed last, with the most contentious issue being whether it should explicitly refer to the marine scientific research provisions of the 1982 Law of the Sea Convention. All countries agreed that the organization's activities had to conform to international laws, but because the 1982 LOS Convention was not yet fully ratified, more general language would be better, omitting any reference to it.

Although the delegates worked through the revised and remaining articles with some success, Wooster suggested an off-the-record discussion might clear up even more issues. These informal talks left only five articles unsettled and such rapid and solid progress prompted the participants to agree to a plenary meeting in Canada to sign the convention in summer 1990. The heads of delegations agreed to alert their governments of the necessity of including at that plenary meeting a person duly authorized to sign the convention on behalf of the country. Everyone hoped that the first meeting of the new organization would be held sometime in 1991. Before signing the convention, however, they needed to produce the Rules of Procedure and Financial Regulations. Chairman Muir closed the session by noting its remarkable progress.

MOVING FORWARD TO THE PLENARY SESSION, 1990

Delegates from Canada, China, Japan, the United States, and USSR gathered in Ottawa, Ontario, in December 1990, to resolve minor points of disagreement in the 1989 draft convention. Once again, Barry Muir chaired the meeting.[119] The head of each delegation expressed great anticipation over the future of the new intergovernmental organization and they unanimously approved the draft convention, the final report recommending it to the respective governments for signature and ratification, and a letter of understanding so that the annual budget could be approved. The delegates

also agreed to an informal working group to discuss rules of procedure and financial regulations to submit to the Governing Council. They symbolically invited scientists from every discipline interested in the North Pacific Ocean to become involved in the working of the organization.

The PICES Convention itself was remarkably brief, with only eighteen articles of a few sentences apiece announcing the establishment of PICES, its geographic area, its purpose, and its structure. Several articles explained the structure and functions of the Governing Council, scientific committees, and Secretariat. The working and official language was to be English, and the remaining articles dealt with budget, scope of its power, and other procedural issues having to do with amendments, right of withdrawal, and termination.

As a last piece of business, it was agreed that although the nickname "PICES" had been informally used for years, the formal name of "North Pacific Marine Science Organization" best described the function of the organization. Thus PICES would be in everyday usage, while the full name would be reserved for official business. The United States offered to host the first scientific workshop in 1991, while the first annual meeting in 1992 would take place in Victoria, British Columbia, near the Secretariat. The delegates of all five countries initialed the final report and the PICES Convention in a formal signing ceremony in anticipation of ratification of the convention (see Figure 3). The long process of garnering governmental approval was almost over, capped by a celebratory dinner. Each country's closing statements expressed the remarkable scope that they hoped PICES would achieve in its future work.[120] Now came the actual work of creating a mutually agreed-upon and exciting scientific program.

Figure 3.
International delegates who initialed the final report endorsing the PICES Convention, December 12, 1990, in Ottawa, Ontario, Canada. Left to right J. Brian Morrissey, Assistant Deputy Minister of Science, Department of Fisheries and Oceans, Canada; S. Takahashi, Deputy Director, Scientific Affairs Division, Ministry of Foreign Affairs, Japan; Yu-Kun Xu, Deputy Director, Department of International Cooperation, State Oceanic Administration, China; Vadim Minin, Lawyer, Foreign Relations Department, Ministry of Fisheries, Russia; A.A. Elizarov, Director, Russian Federal Research Institute of Fisheries and Oceanography, Russia; Jian-San Jia, Deputy Director, Bureau of Aquatic Products, Ministry of Agriculture, China; Hon. Bernard Valcourt, Minister of Fisheries and Oceans, Canada; Sylvia Earle, Chief Scientist, National Oceanic and Atmospheric Administration, United States; Warren S. Wooster, Professor, University of Washington, United States; and Barry S. Muir, Director General, Biological Sciences Directorate, Department of Fisheries and Oceans, Canada.

Chapter 2

The Challenge of Bridging Fisheries and Marine Science

THE FIRST SCIENTIFIC WORKSHOP

After years of organizational meetings and negotiations, the first PICES scientific workshop in Seattle in 1991 was a welcome return to scientific matters.[1] About forty participants from Canada, Japan, China, the United States, and the USSR, met for four days to review the state of the region's marine research and suggest joint research that might be developed through PICES, including collaboration with existing programs. PICES needed to link effectively into ongoing international programs for its regional efforts to strengthen understanding of global processes.

Before the meeting, the organizers divided the participating scientists into four interdisciplinary working groups on climate change, the Bering Sea, environmental quality, and fisheries oceanography.[2] These were chosen as integrating foci for investigations. The Seattle

group then compiled the scientists' reports from each country identifying its agency and university laboratories carrying out relevant research. Participants found few multilateral investigations of Bering Sea ecosystems, suggesting PICES could indeed play an important part in promoting and coordinating such research.

The actual workshop was carefully structured to break the common pattern of organizing scientific meetings by disciplines, institutions, or countries. Recognizing that problems in the subarctic Pacific required overcoming these typical divisions, its interdisciplinary topics were open to all participants. They were encouraged to build the personal connections essential for creating a sense of camaraderie in a new organization. Several participants commented that expanding their personal and institutional contacts had already improved information exchange and general understanding.[3]

Each working group explored its designated topic, some more rapidly and thoroughly than others, but by the end of the meeting all produced documents for the workshop assessment. Each report reviewed the state of knowledge of the North Pacific, and identified research gaps, priorities, and possible cooperative activities, addressing whether a lack of data or its exchange impeded study, how it related to existing international programs, and what joint investigations might contribute to solving its central question. Although the four groups appeared distinct in their topics and had different perspectives, each was linked to the others through an ecosystem perspective. The unifying question that emerged was "What is the nature of the subarctic Pacific ecosystem (or ecosystems) and how is it affected over periods of months to centuries by changes in the physical environment, by interactions among components of the ecosystem and by human activities?" Remarkably, at its core this was substantially the same question articulated thirteen years earlier at the second planning meeting in 1978.[4] By not referring to different disciplines of fisheries or oceanography, it seemed to transcend them.

As an example of overcoming traditional disciplinary boundaries, the climate change working group proposed linking large patterns of climate change with fisheries, but its analysis was seriously hampered by a dearth of catch data. Although PICES might wish to locate such data sets and help exchange them, participants agreed that PICES should not establish its own data archive because it would be both expensive and a duplication of others' efforts. More generally, the working group wanted to understand the

Table 1
Programs during 1992 Complementary with PICES

Program	Area of interest	Presentation by representative from
World Ocean Circulation Experiment (WOCE)	Current: Models to predict climate change, long-term changes in circulation, water mass. Potential for N. Pacific: intergyre exchange, regional seas, heat transport.	Scripps Institution of Oceanography, USA
Joint Global Ocean Flux Studies (JGOFS)	Role of ocean in carbon flux, and sensitivity to climate changes. PICES could coordinate member country exchanges, make sure WOCE transects for Pacific carried out.	Institute of Ocean Sciences, Canada
Global Ocean Ecosystem Dynamics (GLOBEC)	Understand effects of physical processes on population dynamics under global climate change.	Canada Department of Fisheries and Oceans
International North Pacific Ocean Climate Program (INPOC)	Five-year cooperation by U.S., Canada, and Russia on heat and salt budgets, boundary currents, fluxes of elements in N. Pacific. PICES could coordinate INPOC information, continuation of its work after 1994.	Institute of Ocean Sciences, Canada
Global Ocean Observing System (GOOS)	IOC program of data collection network, management, modeling, training, technology transfer. PICES could be involved in pollution investigations, mussel watch, and harmful algal blooms.	Intergovernmental Oceanographic Commission (IOC)
Bering Sea Fisheries Oceanography Coordinated Investigations (FOCI)	Biotic and abiotic factors affecting survival and recruitment of fish stocks, particularly pollock.	National Oceanic and Atmospheric Administration (NOAA), USA
International North Pacific Fisheries Commission (INPFC)	Regulation of salmon fishing in the North Pacific and Bering Sea by Canada, U.S., and Japan (ceased operation 1993). PICES could discuss the transition to the new convention of NPAFC.	Executive director, INPFC

Source: *PICES Scientific Report* No. 22, 2002.

processes of climate change as a foundation for predicting the conditions of physical and biological systems.

The Bering Sea group, more constrained by geography, was more detailed in its proposed studies of the relationship between and variability within circulation, biological interactions, and productivity. The environmental quality group discussed nutrient loading and eutrophication, chemical pollutants, and the role of the North Pacific as a site for waste disposal. Instead of listing pollutants individually and as isolated events, they considered them as part of a dynamic ecosystem. Of secondary importance was research on large-scale environmental impact and on the effects of exploitation on biological communities. Lastly, the fisheries oceanography group asked what biological and physical characteristics govern fish populations, emphasizing the importance of linkages between organisms and the environment. They were interested in the region's carrying capacity, and the cause and predictability of major shifts in abundance.

After meeting separately, the four groups gathered together to address a common set of questions, and their recommendations were reviewed in a plenary session that reasserted that PICES must foster such regional and interdisciplinary approaches to the subarctic Pacific. Regional work could contribute to several global programs already in progress, like the World Ocean Circulation Experiment (WOCE), measuring the ocean circulation over seven years, and the Joint Global Ocean Flux Study (JGOFS) which did not have a site in the subarctic Pacific (see Table 1). PICES could contribute to their models by promoting regional data collection for them. A program just under development, the Global Ocean Observing System (GOOS) might include the PICES region in its study. In addition, participation by PICES members in several programs on fisheries oceanography, including the Global Ocean Ecosystem Dynamics program (GLOBEC), could in turn help develop a fuller regional picture. PICES would be the natural promoter and coordinator of such research on the Bering Sea because there were few multilateral investigations directly on it.

Several groups discussed what joint investigations would best contribute to solving scientific programs. Some possibilities included studying sediments to reconstruct climate change, mapping the distribution of salt water and freshwater for the region, creating tissue banks for monitoring the accumulation of toxic chemicals in marine organisms, and coordinating research requiring technical equipment like satellites and buoys. These were suggestions only, meant as a general review. The actual projects would emerge in the coming years from those scientists most closely involved in the fields.

PICES could work with them by promoting cooperation on mutually agreed upon issues through workshops and organizational sessions.

PICES ADMINISTRATIVE AND SCIENTIFIC STRUCTURE

In early March 1992, delegates of Canada, China, Japan, and the United States, along with a representative of Russia met in Ottawa, Canada, to work out organizational issues in anticipation for the first formal meeting later that month. Canada and the United States had both offered to host the Secretariat, and in recognition of the work Canada had done in moving the intergovernmental meetings forward, an anonymous vote favored Canada's location of Sidney, British Columbia, over Seattle, Washington.[5] The long-used name PICES was officially adopted, and Canadian John Davis was voted the interim executive secretary for the first formal meeting later that month. There was no doubt that Warren Wooster would be elected the first chairman of the PICES Governing Council to serve at least through the first annual meeting, reflecting his pivotal role in shepherding the idea from its earliest days to inception. Davis was directed to issue invitations to a dozen intergovernmental organizations and four nongovernmental ones, along with invitations to Russia, the Republic of Korea, and Poland to participate as observers at the first annual meeting. PICES would share office space in Sidney, with the Institute for Ocean Sciences, Fisheries and Oceans Canada. Delegates adopted rules and regulations for the organization and an interim budget, and formally established the scientific committees of biological oceanography (BIO), fishery science (FIS), marine environmental quality (MEQ), and physical oceanography and climate committee (POC), outgrowths of the four original working groups in 1991. The committees were more clearly discipline-oriented than the working groups to provide a comfortable home for specialists who would then work across disciplines on projects of common interest.

The nested structure of PICES was designed to keep scientists and science as the primary focus of the organization (see Figure 4). Individual scientists would influence the future course of PICES through attending workshops and the open meetings of the four scientific committees. These committees would create working groups (see Table 2) and organize sessions of invited and contributed papers with co-conveners from different countries. In general, working groups and scientific committees were to suggest topics from their discussions that they passed to the Science Board for review and inclusion into a coherent scientific program. The Science Board, consisting

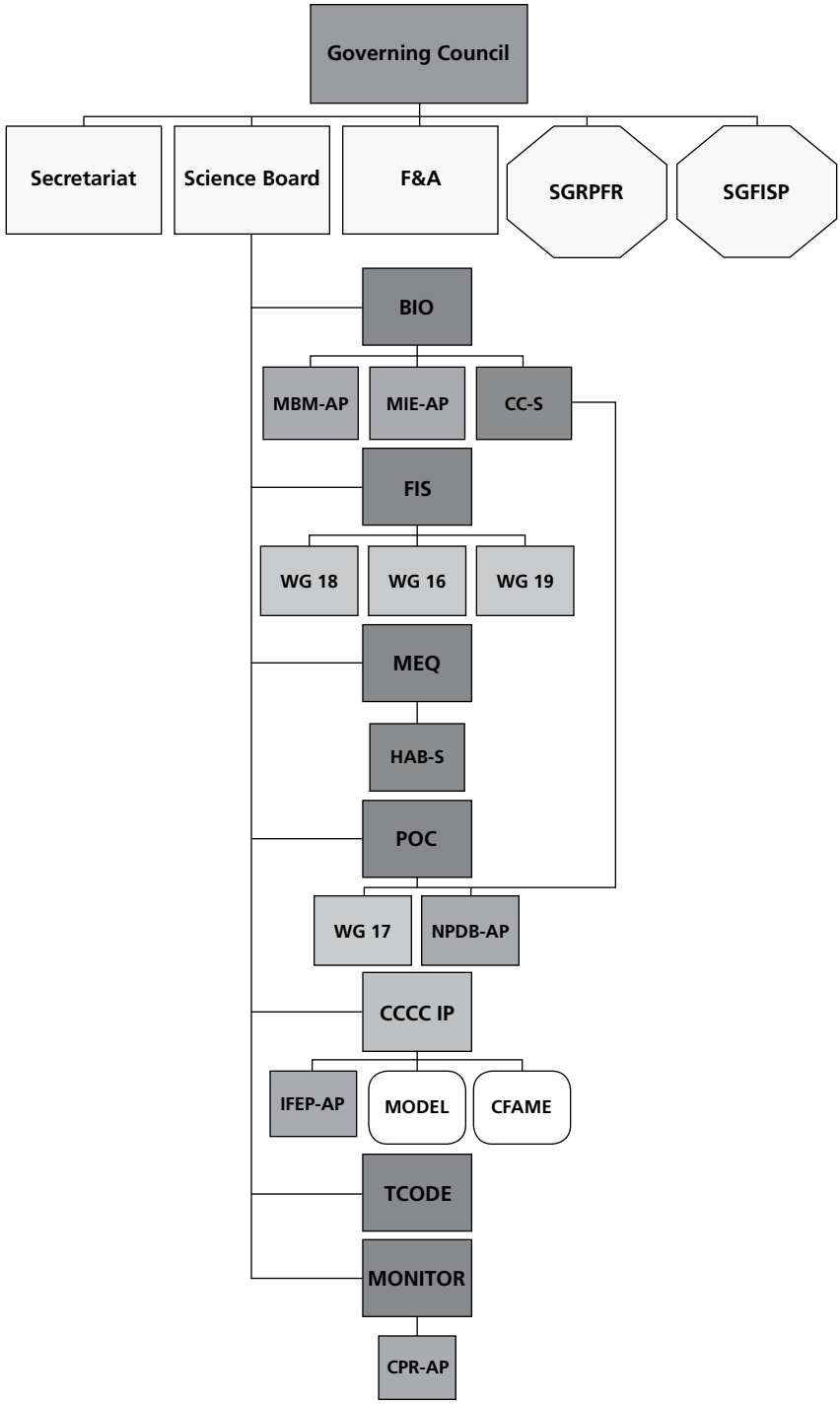
Governing Council
Secretariat
Science Board
F&A
SGRPFR
SGFISP
BIO
MBM-AP
MIE-AP
CC-S
FIS
WG 18
WG 16
WG 19
MEQ
HAB-S
POC
WG 17
NPDB-AP
CCCC IP
IFEP-AP
MODEL
CFAME
TCODE
MONITOR
CPR-AP

Figure 4.
Organization Chart for PICES. Source: http://www.pices.int/about/organization_structure_3.aspx, August 10, 2005.

Permanent
Secretariat
Governing Council
Science Board
F&A Finance and Administration Committee

Active
BIO Biological Oceanography Committee
FIS Fishery Science Committee
MEQ Marine Environmental Quality Committee
POC Physical Oceanography and Climate Committee
TCODE Technical Committee on Data Exchange
MONITOR Technical Committee on Monitoring
WG-16 Climate Change, Shifts in Fish Production, and Fisheries Management
WG-17 Biogeochemical Data Integration and Synthesis
WG-18 Mariculture in the 21st century
WG-19 Ecosystem-Based Management Science and Its Application to the North Pacific
CC-S Carbon and Climate Section
HAB-S Harmful Algal Blooms Section
SGRPFR Study Group on PICES Rules of Procedure and Financial Regulations
SGFISP Study Group on Future Integrative Scientific Programs
CCCC Climate Change and Carrying Capacity Program
MODEL Conceptual/Theoretical and Modeling Studies Task Team
CFAME Climate Forcing and Marine Ecosystem Response Task Team
CPR Advisory Panel on Continuous Plankton Recorder Survey in the North Pacific
IFEP Advisory Panel on Iron Fertilization Experiment in the Subarctic Pacific Ocean
MBM-AP Advisory Panel on Marine Birds and Mammals
MIE-AP Advisory Panel on Micronekton Sampling Inter-Calibration Experiment
NPDB-AP Advisory Panel on North Pacific Data Buoy Advisory Panel

Disbanded
CBSG Study Group on PICES Capacity Building
EBMSG Study Group on Ecosystem-Based Management Science and Its Application to the North Pacific
FERRRS Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts
SISG Study Group on PICES Strategic Issues
BASS Basin Studies Task Team
MONITOR Task Team on Monitoring
NEXT NEMURO Experimental Planning Task Team
REX Regional Experiments Task Team
NPESR Working Group on North Pacific Ecosystem Status Report
WG-1–WG-15 (See Table 2)

Table 2
Chronology and Subject of PICES Working Groups

WG#	Working group name	Parent committee	Year
1	Okhotsk Sea and Oyashio region	POC	1992–1993
2	Development of common assessment methodology for marine pollution	MEQ	1992–1994
3	Dynamics of small pelagics in coastal ecosystems (renamed Coastal pelagic fish)	FIS	1992 1993–1995
4	Data collection and quality control (renamed Data exchange) (replaced with Technical Committee on Data Exchange, TCODE)	Science Board	1992 1993 1994
5	Bering Sea	Science Board	1992–1996
6	Subarctic gyre	Science Board	1992–1994
7	Modeling of the subarctic North Pacific circulation	POC	1993–1995
8	Practical assessment methodology	MEQ	1994–2000
9	Subarctic Pacific monitoring	Science Board	1994–1997
10	Circulation and ventilation in the Japan/East Sea	POC	1995–1999
11	Consumption of marine resources by marine birds and mammals	BIO	1995–1999
12	Crabs and shrimps	FIS	1995–2001
13	Carbon dioxide in the North Pacific	POC	1997–2001
14	Effective sampling of micronekton to estimate ecosystem carrying capacity	BIO	1997–2004
15	Ecology of harmful algal blooms in the North Pacific	MEQ	1999–2003
16	Climate change, shifts in fish production, and fisheries management	FIS	1999
17	Biogeochemical data integration and synthesis	POC	2001
18	Mariculture in the 21st century	FIS, MEQ	2003
19	Ecosystem-based management science and its application to the North Pacific	FIS, MEQ	2004

Source: *PICES Scientific Report* No. 22, 2002 and http://www.pices.int.

Table 3
List of PICES Annual Meetings and Locations

Meeting	Year	Chair and vice chair	Location
First	1992	W.S. Wooster	Victoria, B.C., Canada
Second	1993	W.S. Wooster, C.M. Liu	Seattle, Washington, USA
Third	1994	W.S. Wooster, C.M. Liu	Nemuro, Hokkaido, Japan
Fourth	1995	W.S. Wooster, H.T. Huh	Qingdao, PRC
Fifth	1996	W.G. Doubleday, H.T. Huh	Nanaimo, B.C., Canada
Sixth	1997	W.G. Doubleday, H.T. Huh	Pusan, Republic of Korea
Seventh	1998	H.T. Huh, V. Alexander	Fairbanks, Alaska, USA
Eighth	1999	H.T. Huh, V. Alexander	Vladivostok, Russia
Ninth	2000	H.T. Huh, V. Alexander	Hakodate, Hokkaido, Japan
Tenth	2001	H.T. Huh, V. Alexander	Victoria, B.C., Canada
Eleventh	2002	V. Alexander, T. Kobayashi	Qingdao, PRC
Twelfth	2003	V. Alexander, T. Kobayashi	Seoul, Republic of Korea
Thirteenth	2004	V. Alexander, T. Wada	Honolulu, Hawaii, USA

of the chairmen of the four scientific committees and an elected chairman, would oversee the scientific program and the four committees. It would also organize a session that explicitly transcended the more disciplinary committee sessions. It would identify and rank research problems and approaches, recommend coordinated research programs on a national level, and help the exchange of scientific data and personnel. It would also decide which of the working group reports should be published, and make its recommendations to the Governing Council, consisting of two delegates from each member country. These delegates represented their country's interests, whether they were academic scientists, government officials, or both, and made the final decisions to be taken by PICES.[6] This structure encouraged scientific participation through the power given to scientific committees, expressed through the Science Board decisions, and minimized administration burden on scientists.[7] The Secretariat had a small amount of discretionary funds to help subsidize travel for needy scientists.

Member countries would rotate as hosts of the annual meetings, allowing each to showcase an important maritime city and its national marine sci-

ence programs. Such participation could sequentially reinvigorate national participation through special topics highlighting national concerns. For instance, almost the entire Okhotsk Sea region belonged to the economic territories of Russia or Japan, and studying it was thus particularly attractive to these governments. It would add valuable data to larger scale programs as well, particularly because the Sea of Okhotsk had been generally off limits for international scientific studies since the beginnings of the Cold War until the collapse of the Soviet Union. Meetings would foster cooperation across agencies, and provided easy and inexpensive access to a host country's scientists and students (Table 3).

Meetings were to be more than a place to present papers; they were where scientists contributed additional work to PICES by serving on working groups carrying out defined projects. Ideally, members of working groups would communicate frequently between meetings, report their results either to the scientific committees or to the Science Board, then disband. There was an early consensus that a large number of working groups like in ICES would be unwieldy and fiscally impossible, so it was better to have a small number firmly supported by the member nations who, after all, were supposed to pay for their activities. Subsequent years revealed some growing pains in how efficiently and productively this system worked.

PICES needed to hold its first annual meeting without conflicting with other scientific meetings, and draw a critical mass of scientists to establish a precedent for subsequent years. Annual meetings were to be primarily scientific, with the necessary administrative business handled around the edges. They were important for setting a scientific agenda, exchanging information and ideas, building a sense of shared community, and fostering collective projects. Beamish and the Canadian DFO organized the first PICES venue with the "International Symposium on Climate Change and Northern Fish Populations" to intermingle participants and topics.

The PICES Convention took effect on 24 March 1992, after ratification by Canada, Japan, and the United States, three of the five signatory states. China ratified before August 1992 and took part in the first annual meeting, in October 1992 in Victoria, British Columbia.[8] In June, the U.N. Conference on Environment and Development (informally called The Earth Summit) proclaimed the marine environment an essential part of the global life-support system, an asset for sustainable development.[9] This international focus on the ocean helped highlight its importance and now it was time to build on that attention to increase scientific cooperation and exchange in the northern North Pacific. Exactly how to accomplish this would become

an ongoing negotiation among individual scientists with their disciplines and governmental missions from member countries.

DIFFERENT EXPECTATIONS FOR A MARINE SCIENCE ORGANIZATION

With the conclusion of the scientific workshop, it appeared that PICES had successfully transcended differences in perspectives on the proposed function of the organization. A closer examination of the relations between fisheries and marine science is necessary to explain why it took so many years to establish PICES, and why it still faced challenges of fragmentation into fish and non-fish interest groups. What would it take for PICES to bridge separate traditions of fisheries and fisheries management with oceanography? From the very beginning, PICES organizers promoted the expansive concept of fisheries oceanography as an interdisciplinary generator of insights into general marine science. Although it was a unifying outlook, traditional fisheries had proud tradition and a powerful economic role in forming national science policies.

FISHERY TENSIONS GENERATE SCIENCE

The example of U.S. and Japanese interactions in fisheries sheds light on this challenge. As described in the Introduction, commercial fisheries have always been fraught with tension, particularly for countries with great dependence on the sea. The long and proud tradition of fisheries in Japan made any issue dealing with fisheries a sensitive national matter.

Japan has always depended on the sea for much of its food, lacking sufficient arable land for its population. Fortunately the confluence of such cold and warm currents as the Oyashio and Kuroshio produce one of the richest fisheries in the world, extending north to south between the Japan/East Sea and the Pacific Ocean.[10] For centuries the Japanese gathered most of their animal protein from the sea, particularly from shallow water along the extensive coastline. Fishermen recognized early that the environment heavily influenced the abundance of fish for harvest. They developed strong local regulation of aquatic resources and an elaborate rights system that promoted equitable access and "ownership" akin to land tenure.[11] This system did not apply, however, when the Japanese fished for salmon in the western Pacific.[12] Because Japan and Russia pioneered fishing off the coasts of the Kurile Islands, Sakhalin, and Kamchatka, in the Bering Sea, northeastern Pacific, and the East-China and Yellow seas, the two countries had a

long history of negotiations over fisheries.[13] Fish and profits went to the most competitive fisheries and there was little conservation outside coastal waters.[14] As domestic demand for marine resources increased, Japanese fishing skill, persistence, and competition became recognized and feared by other nations.[15]

Although Japan began using mother ships in the 1930s to develop distant shore fisheries, it confined its fishing to the western North Pacific until venturing into the eastern Bering Sea, then considered international waters.[16] It began a floating mother ship operation canning king crab off Bristol Bay, a resource at the time of little interest to American fishermen. In 1935, however, the Japanese applied to the United States for a three-year permit to conduct a scientific study of the salmon of Bristol Bay.[17] By 1936, the United States was heavily invested in salmon canning itself, with twenty-four canneries employing 8,000 people in Alaska. The life history of Pacific salmon led the countries where they spawn in their natal rivers to feel proprietary even though in the open ocean they mingle with other salmon stocks and with groundfish available to foreign fishing fleets. The United States interpreted the Japanese request as the first step for a Japanese "invasion" of "their" fisheries, even though the fish were in international waters.[18] The flurry of protest from American and Canadian fishermen prompted the U.S. Department of State to demand the withdrawal of the Japanese boats. Although this salmon crisis temporarily cooled, many American and Canadian fishermen later accused the Japanese of using fishing to spy in preparation for World War II. The North Americans clearly wanted to drive the Japanese away, calling their fishing presence an "alien invasion."

The Bristol Bay incident highlighted the conflict between access to and conservation of fisheries. Historically the United States had supported the three-mile limit to support its own fisheries and military interests, but the consequence was that foreign fishermen could severely impact domestic coastal fisheries. The doctrine of freedom of the seas meant that the exercise of fishing rights could potentially harm fisheries. The United States and Canada were beginning to see that unrestricted free access to high seas fisheries was also jeopardizing the conservation of stocks they claimed. For Japan, the high seas fishery was not just an economic enterprise but also an essential cultural heritage.

World War II destroyed not only Japan's industries, but deprived it of fishing bases outside the home islands, particularly those near the Soviet Union and China and in the west and central Pacific.[19] With a tiny landmass and a destroyed infrastructure, Japan faced the daunting task of feed-

ing a large population and of rebuilding. As it had for decades, Japan turned to the ocean to supply most of its protein. As fighting ended, the Japanese government began rebuilding fishing fleets with the support of and under the authority of General Douglas McArthur, Supreme Commander for the Allied Powers (SCAP). From the start of the occupation, McArthur had emphasized the importance of restoring Japanese self-sufficiency in food.[20] He encouraged modernizing the fleet, particularly through factory ships for whales and tuna. The Occupation also built up Japanese trawling fleets and promoted fish exports.

Because nearshore fisheries could not meet burgeoning postwar Japanese demand, a logical expansion was into the northeastern Pacific, with its salmon, halibut, herring, and later, pollock fisheries.[21] Japanese fishing just outside the three-mile limit could seriously affect North American fisheries, negate inshore conservation measures, and even eliminate local fisheries. American fishing interests in the Pacific Northwest, deeply concerned about the progressive loosening of Occupation policy toward Japanese fishing, worried about the fate of "their" salmon. Many influential American fisheries scientists warned against Japanese exploitation of salmon that originated in Alaskan and Canadian waters. Allowing Japan sovereign status with unrestricted access to the high seas would soon permit invasion of waters that Americans felt theirs by virtue of investment in fleets, hatcheries, and conservation policies.[22] The impending Peace Treaty seemed an excellent opportunity to restrict Japanese fishing and perhaps, even in a small way, compensate for lost lives and livelihoods during the war.[23]

The Occupation's fishery policies allowed meeting domestic requirements but forbade any fishing near areas under Allied control unless permitted by those countries. In addition, the Japanese were to provide data that would help other nations exploit fisheries previously fished by them. The U.S. Occupation temporarily excluded the Japanese from the northeastern Pacific fishery, but what would happen after peace was negotiated? Previous international law supported freedom to fish the high seas. Would Japan try to enter the area and compete with Canadian and U.S. coastal fisheries? That seemed increasingly likely, after the USSR had excluded them from the Okhotsk Sea and the Chinese had restrained Japanese re-expansion into the Yellow Sea.[24] The United States offered Japan economic reconstruction aid and multilateral trade agreements in a bid to align it with the United States and its allies against Soviet influence in the Far East. North Pacific fisheries were so important that the U.S. and Canadian governments directed SCAP to confer temporary sovereignty on Japan before the Peace Treaty took effect

solely so that a fisheries treaty could be negotiated.[25] These policies of SCAP were strongly shaped by North American fisheries scientists at a time when fisheries science had not yet been widely accepted as a basis for regulation, except in the ICES region of the northeast Atlantic.[26]

Pressure from the U.S. fishing industry to restrict Japanese fishing, particularly from the northeast Pacific Ocean, resulted in the Truman Proclamation on Coastal Fisheries, which established conservation zones accessible only to U.S. fishing interests. More influential was the appointment of prominent fisheries biologist Wilbert Chapman as first special assistant for fisheries and wildlife in the U.S. Department of State (1948–1951). Chapman thought that a new U.S. policy should contain Japanese fishing as much as possible. If Japan were allowed to exercise its traditional right to fish to three miles from any foreign shore, its severe competition with U.S. and Canadian fisheries would compromise any nearshore conservation efforts for salmon and halibut. On the other hand, the U.S. tuna fishing industry profited from unrestricted access to other countries' coastal waters. Chapman sought to create an agreement that would keep Japan out of the traditional salmon and halibut waters of U.S. and Canadian fleets, without violating the U.S. commitment to freedom of the seas and the three nautical mile coastal limit (despite the Truman Proclamation). Chapman was instrumental in crafting the terms of the 1952 International Convention for the High Seas Fisheries of the North Pacific Ocean.

The 1952 convention created the INPFC, intended to ensure a level of maximum sustainable productivity for halibut, herring, and five species of salmon. The INPFC committed Canada, Japan, and the United States to carry out scientific studies of North Pacific salmon and to enforce conservation recommendations. They began a research program in 1954 to determine the oceanic distribution of the salmon stocks originating from the two continents, and to determine the best line to separate North American and Asian stocks. A large and coordinated research program, it became a model for international cooperation and generation of marine science data.[27] Each country carried out independent research determined by its national interests, and made results public only when it did not risk decreasing their country's fishing. The research proved useful, though at times its deployment was shaped by political expediency. INPFC nevertheless created an innovative conservation plan for high seas fisheries for the signing countries.

In the past, any improvements in catch emerging from expensive research and management programs could be taken advantage of and undone by other countries' offshore fishing. If the burden of research and management

were shared, then in theory everyone would benefit from increased knowledge about stocks. Such mixing of political and scientific aims produced little external scientific review, but a remarkable amount of information on the species.[28] Management decisions had to be unanimous, an important consideration for the Japanese reliance on fisheries.

The INPFC Convention is most well known for introducing the novel concept of the "abstention" doctrine to ocean law, extending control beyond traditional national maritime jurisdiction. The general principle was that if a stock were already at a scientifically determined measure of maximum sustained yield, other nations that had not historically participated in fishing had to abstain from doing so.[29] Not until scientists found improvement in stock or a different demarcation of stocks would additional vessels be allowed to fish. The yield was to be calculated by fisheries scientists, giving scientists a dramatic new role in fisheries management in the Pacific.

The INPFC Convention limited Japanese fishing for salmon east of 175°W (about mid North Pacific), where existing conservation programs were already at maximum sustained yield. The conservation measures effectively applied only to the Japanese because no American or Canadian fishermen yet fished in the western Pacific. Because abstention was by agreement and thus "voluntary," it preserved the larger principle of freedom of the seas. That allowed Japan to appeal to its terms when negotiating with governments elsewhere worried about Japanese fishing fleets.[30] The 1956 Japan-Soviet fisheries agreement made the meridian 175°W its eastern boundary, and combined with the INPFC, constrained Japanese fisheries in the west with the Soviets and in the east with the United States and Canada. When salmon research showed that North American fish in fact migrated farther west of the line to 175°E, the INPFC decision rules allowed Japan to refuse to accept such research and thus keep the original abstention line.[31]

For many Japanese, the INPFC Convention represented an end to the freedom of the seas principle, and was entirely to Japan's detriment. They saw abstention as an unwelcome policy imposed on them during the tensions of negotiating peace. Although called a principle of abstention whose rules could relax as stocks improved, many Japanese thought that those days would never arrive. The INPFC treaty, in force for fifty years, influenced Japan's attitudes about international fisheries management and their approach to broader international scientific collaboration such as PICES. The Japan Fisheries Agency was concerned that increasing scientific information on fisheries would inevitably lead to even further restriction of their fishing.[32]

Despite bureaucratic uncertainty about the advisability of PICES, the principle of international cooperation itself was not questioned. Japanese marine scientists had for decades collaborated with marine scientists from foreign universities, including with the University of Alaska and the University of Washington. The Scripps Institution of Oceanography Trans-Pacific Expedition of 1953 (Transpac) included Japanese and American scientists, and visited Hakodate, Tokyo, and Kobe in its survey of the sea east of Korea and Japan. American scientists were often on board the *Oshoro-maru* from the mid 1950s onward, to carry out research in the Bering Sea and eastern North Pacific.

Another challenge to bridging fisheries and marine science in Japan was that they lacked an umbrella organization to communicate among fisheries, weather, and oceanic affairs.[33] One American observer familiar with Japan suggested that their research in the INPFC suffered from this separation into fields. Once INPFC member countries agreed on what research and data was needed, the Japan Fisheries Agency asked academic oceanography units to carry it out.[34] Such delegation did not foster interdisciplinary communication. Recently an American biological oceanographer suggested that styles of scientific collaboration differ between Japan and the United States. Japanese oceanographers collaborated more often as members of research groups at a given university or research center, while American scientists acted as individuals across university, institution, and government lines.[35] One inference is that it takes more effort to achieve broad support across Japanese marine sciences than it does in the United States. At least six Japanese agencies were responsible for coordinating international marine science: the Japan Fisheries Agency, Ministry of Education, Science and Technology Agency, Japan Meteorological Agency, Hydrographic Department, and the Science Section of the Ministry of Foreign Affairs.[36] It was difficult for outsiders to discern who the right people were to address work in a broad intergovernmental marine science organization. A Japanese scientist suggested that interdisciplinary science has a difficult time fitting into the organization of Japanese marine science. For instance, the Japan Meteorological Agency (JMA) handled climate problems, the Ministry of Education addressed scientific problems, and the Science and Technology Agency (STA) took on "science-technology" problems. The STA sponsored basic research in the JMA, the Hydrographic Department (HD), and the Japan Fisheries Agency. He concluded tongue-in-cheek, "Well balanced, don't you think so?"[37] It became clear to many participants that Japanese

government support could come only if the Japan Fisheries Agency were brought into negotiations.

RELYING ON LONGSTANDING INTELLECTUAL TIES

The initial University of Washington supporters tried to preclude problems of compartmentalization by relying on their many connections to Japanese scientists. Burke, Alverson, McKernan, and Wooster all had longstanding ties to Japanese oceanographic scientists through fisheries, oceanography, and the Institute for Marine Studies (later the School of Marine Affairs). Wooster had first met Japanese marine scientists when he led the 1953 Trans-Pacific Expedition from San Diego by way of the Bering Sea to Japan, and continued to build his connections through the activities of SCOR. As was fitting for an informal meeting, the Japanese emphasized that they spoke not as representatives of the Japanese government, but as individuals. Generally supportive of better cooperation and collaboration in the North Pacific, the Japanese agreed to more discussion of whether the organization should be intergovernmental, nongovernmental, or with informal government support.[38] But although they came from several disciplines, they did not cross another important division; they were primarily academics, not government scientists. Academic and institute scientists were uniformly more interested, but less powerful in garnering government support of an intergovernmental convention. Essential government support for the PICES concept was possible only if government fishery agency scientists became involved.

Participation by Japanese scientists in discussions about PICES was certainly affected by their institutional affiliations.[39] In 1979, the Japanese participants were government scientists Yoshio Fukuda and Daitaro Shoji, and academic scientists Noriyuki Nasu, Syoiti Tanaka, and Ken Sugawara. Wooster knew three of them personally. While they individually expressed strong interest in the idea of PICES, they could not speak in an official capacity. In 1986, only Japanese academics attended the discussions at the University of Alaska in Fairbanks, where discussions were conceptual and informal, without the power of formal negotiations.[40] When it came to the negotiating phase of PICES, after 1986, participants who could speak on behalf of the Japanese government replaced academic scientists. New to the whole idea, they in turn needed to be persuaded of the utility of PICES. Not surprisingly, they also needed to be introduced to the concept of ICES, whose region of interest was far from Asian countries.[41]

Japan's long struggle to maintain a strong fishing presence in the Pacific underlay its concern that PICES was really another forum for fisheries management.[42] Japan strongly objected to Canada's proposal that PICES take a more formal advisory role in marine science.[43] To produce a robust interdisciplinary organization, the often-distinct worlds of fisheries science and oceanography, between basic and applied science, evident in all of the PICES countries, had to be bridged.[44]

STRATEGIES TO GENERATE INFORMATION AND ADVICE

When Burke and Wooster were analyzing different ways to generate quality scientific information, they looked to the strategies used by international fishery bodies.[45] Perhaps they could illuminate challenges to producing marine science. In 1956, Japan and the Soviet Union formed the Japan-Soviet Fisheries Commission. In the same year, the Commission for Fisheries Research in the Western Pacific (CFRWP) was started by North Korea, China, the USSR, Mongolia, and North Vietnam.[46] Though somewhat obscure, the CFRWP was unique because it seemed aimed solely at research and information exchange, not fisheries management, oceanography, or limnology. Planning joint research and presenting conservation measures based on research data, it held annual sessions up to 1964. But by 1967, with the withdrawal of China, it no longer seemed functional.[47] The North Pacific Fur Seal Commission (NPFSC) brought together Canada, Japan, the United States, and the USSR in 1957. The International Pacific Halibut Commission (IPHC) and the International Pacific Salmon Fisheries Commission (IPSFC), were bilateral agreements between the United States and Canada that excluded Japan and the USSR. All these agreements sketched out a role for scientific research in reaching the desired management goals but although each convention invoked research as a necessary path to achieving its goals, it was not clear how or to what extent each incorporated science into its decisions.[48]

There were three general strategies for generating and using science in management. The first, exemplified by the INPFC, drew on national expertise by creating a science committee from the scientific ranks of member nations.[49] Researchers presented and interpreted their work at the annual meetings where they also planned and coordinated further research. The INPFC broadened the scope of scientific input using symposia, though participation tended to be primarily from governmental scientific agencies, not from academia.[50] A second strategy was to create an independent staff

to develop a sustained research program. The IPHC was the first international fishery commission in the North Pacific to use its own research staff, followed by the International Pacific Salmon Fisheries Commission. Such an in-house staff was dedicated solely to its mission, but as a result risked isolation from other institutions.[51] These two approaches were predominant in the North Pacific.[52] A third strategy was to establish a completely independent scientific body, the route that PICES wished to travel.

ICES offered this successful third model for international cooperation that encompassed all of marine science, not just fisheries. It had successfully promoted intergovernmental collaboration and scientific advances. ICES had never directly managed fisheries, only offered the best available scientific advice to managers. Scientists involved in ICES wished to remain separate from the political implications of their research while providing credible scientific information for those decisions. The drawback in using ICES as a model for generating information, however, was that many of the scientists involved in PICES did not know enough about ICES to see its strengths, and instead they worried about PICES data being a source of information that could be deployed for the advantage of one country over another.

Researchers in fisheries have historically been labeled "applied" scientists, while oceanographers are more often seen as "pure" scientists, divisions reinforced by education and training. In each "pure" field or in different contexts, however, researchers might realign themselves depending on their audience or research sponsor. The availability and source of research funds depended in part on whether results were judged to be immediately applicable to pressing societal problems. In the United States, large-scale fishery research tended to be carried out in government laboratories (e.g., NMFS in NOAA) where concern over stock assessment took precedence over large-scale, multifaceted experiments. State agencies were also an important part of regional management in the United States, and had an even more restricted mandate than NMFS. Fisheries scientists in academic labs tended to work on smaller projects with industry support if they were working on commercial species and rarely garnered National Science Foundation (NSF) or NMFS financial support for this. American oceanographers generally turned to the Ocean Sciences Division of NSF and the Office of Naval Research (ONR), with some collaboration from NOAA. Meteorologists had similar funding sources, but they also had the National Center for Atmospheric Research, funded by NSF. Certainly there was cooperation in survey or monitoring work, such as in the statewide California Cooperative

Oceanic Fisheries Investigations (CalCOFI). Canada, Japan, and Russia had similarly separate funding for fisheries science and oceanography.

Canadian Richard Beamish suggested that dividing marine science into "pure" and "applied" obscured the fact that many scientists carried out both kinds of research in their careers. These categories also seemed to have an implicit value judgment, depending on your values. He proposed instead that it was more useful to divide research into "academic" and "government" science. In his view, investigators in academia were often curiosity-driven, first discovering something and then possibly applying their results. Government scientists, on the other hand, had to be quickly responsive to concerns of the public, producing answers for them. This requirement sometimes risked that emotion would overwhelm good science, such as when the Western outcry against whaling led to the outright international ban on it before scientists could carry out a full scientific assessment of its impacts. Those differences in constituencies made for very different perceptions of what constituted sufficient justification for research. Beamish wryly concluded, "In politics perception is reality, and truth needs to be negotiated."[53]

BRIDGING FISHERIES AND OCEANOGRAPHY TRAINING

Some of the factors that impeded cooperation between fisheries science and oceanography were examined in a 1986 paper that explored the different sorts of training within these fields.[54] In the decades after World War II, educational paths for American marine scientists diverged in college, and these divergent paths continued in graduate school.[55] It was possible to get undergraduate training in fisheries or meteorology and then either find jobs immediately, or continue with graduate training in the same field. Undergraduate programs in oceanography were rare, so oceanographic jobs generally required advanced degrees. Potential oceanographers usually first earned their undergraduate degrees in one of the natural sciences and then specialized in that branch of oceanography. Such different tracks made it unlikely that fisheries and oceanography students shared similar coursework and approaches to marine problems.

In graduate school the differences in training become even more marked as students specialized further. Fisheries science was primarily biological, so few graduate students in fisheries took more than introductory oceanography, and in turn, oceanography students did not generally take classes in fisheries science. Meteorologists and physical oceanographers likely shared

some courses, but biological or chemical oceanographers were unlikely to take meteorology or vice versa. These students rarely met in seminars or discussions unless there were concerted efforts to bring them together. At the University of British Columbia, as with the University of Washington, the fisheries and oceanography buildings were close to each other but their scientists rarely interacted. Some U.S. universities attempted to overcome these schisms by reorganizing departments to include both fish and ocean sciences.[56] Wooster and others hoped for a melding of the disparate traditions into the interdisciplinary field of fisheries oceanography.

Differences in training carried over into differing research styles and were reinforced by funding sources and employment. In meteorology, national weather services provided technical staff to monitor the atmosphere, whether directly or by remote sensing. In contrast, status of fish stocks relied heavily on catch data by commercial fishermen. Technicians carried out experimental and survey fishing, along with routine oceanographic monitoring. Fisheries scientists also went out to sea in their own ships for specialized projects. Field research in oceanography more commonly relied on oceanographers carrying out their own research on specialized vessels.

Differences in research approaches were reflected in employment and professional societies in the three fields. In the 1980s, oceanographers were most commonly employed in academic institutions, while meteorologists and fisheries scientists were usually found in government laboratories, with only a scattering in academia.[57] The government and industry employed a significant proportion of bachelor and master's-level meteorologists and fisheries scientists. Professional organizations reflected these differences in training and subsequent employment. Both fisheries and meteorology had professional societies, while oceanography was subsumed in broader scientific societies such as the American Geophysical Union (AGU), and the American Society of Limnology and Oceanography (ASLO), although it also had The Oceanography Society (TOS), formed in 1988. These differences in education and employment made for strong communities but weak exchanges between them.

Fisheries oceanographers and some fisheries scientists held that an improved understanding of fish in dynamic interaction with the environment, rather than in isolation, could improve stock assessments, allowing managers to make more realistic decisions on catch limits. The importance of a more integrated approach was illustrated by the 1983 report of the synchronous explosion and collapse of sardine populations off Japan, California, and Chile over nearly a century; behavior that could only be explained by

response to environmental change.[58] Renewed progress in marine science would come only with increased understanding, communication, and cooperation between fisheries science, meteorology, and oceanography starting early in university education, colleagues, research styles, funding, and institutions.

SCIENTIFIC RESEARCH UNDER THE LAW OF THE SEA

Bridging fisheries and oceanography was not the only challenge to integrating marine science. Lengthy international debates on exclusive economic zones had serious implications for free scientific access to national zones. Coastal nations required scientists to request permission to conduct research in their waters. Although coastal states were expected to grant such permission, by the 1970s there were accounts of coastal states failing to do so, or imposing inconvenient or unacceptable conditions on research cruises. The economic status of a country often influenced its approach to granting access to coastal zones, with lesser-developed countries suspicious that scientific research might serve other countries' economic ends. If the country were not in a position to exploit its own resources, then it could not know whether others were doing so under the cover of research. It did not help matters that the most economically developed countries also had the most developed marine science programs.[59] Many developing countries worried that scientific expeditions were being used as a cover for gathering military or economic intelligence.[60] They might not themselves be able or interested in conducting marine research, but they now had far more control over scientific research than previously.

Scientists from countries with strong oceanographic programs, such as the United States and the Soviet Union, invoked the right to research as a traditional freedom of the seas. Marine researchers, often personally driven by scientific curiosity, argued their work could benefit all nations through increased understanding of ocean currents and improved weather forecasting, and their effect on fisheries and marine transportation. That knowledge had potential economic significance, particularly for relatively uncharted areas. When coastal states limited research access, they stunted the advancement of science, including such potential benefits.

By altering access to coastal waters, the new economic boundaries required existing international oceanography to be reorganized, affecting scientific research and research organizations, particularly in the industrialized northern countries with the strongest oceanographic research programs. In

subsequent LOS negotiations, the U.N. convention attempted to balance the concerns of major research states with the economic concerns of poorer nations. Developed countries were required to give coastal states prior notification of research projects to be carried out on the continental shelf and within the EEZ, and to share any data pertinent to offshore resources. Consent for research for peaceful purposes was to be granted under normal circumstances and was not to be unreasonably delayed or denied, except under certain specific circumstances identified in the U.N. convention. If the requested state did not reply within six months, the coastal state was considered to have implicitly given its consent. These last provisions were intended to overcome long bureaucratic delays and frequent burdensome differences in coastal state regulations. The protracted altercations over coastal jurisdiction drove scientists to renew their international collaboration in marine research.

THE CONSEQUENCES OF A RENEGOTIATED INPFC

The promise of INPFC Article IV had left unsettled how much and what kind of work should be done by the INPFC or a new organization for the region. Some scientists suggested that the existing INPFC could become this new organization, taking on a broad scientific agenda far beyond studying anadromous fish. Japan favored a new scientific organization developing from within the INPFC and then splitting off from it to handle the Bering Sea pollock fishery. Both approaches minimized expenses, but had two significant disadvantages. First, only the United States, Canada, and Japan were signatories to the INPFC, excluding China and the USSR.[61] Second, its longstanding focus on anadromous fish made the INPFC unlikely to ever become an inclusive scientific organization. Too many bilateral agreements had grown around it to deal with fishery problems outside the INPFC protocol. The INPFC would have to address all exploited stocks, not only salmonids. Perhaps most significantly, university scientists and oceanographers with non-fishery research programs had little interest in the INPFC as it was structured. PICES proponents naturally insisted that the INPFC resolution was a clear request for something completely new and outside the INPFC, which would then cooperate with the INPFC to ensure full coverage of all aspects of marine science.

The Japanese delegates were very concerned that PICES would merely duplicate existing efforts of international cooperative research and data exchange. They feared that the extensive overlap of the proposed region with

that of the IOC's WESTPAC program would exacerbate the latter's fiscal difficulties.[62] Louis B. Brown, chairman of the Panel on International Programs and International Cooperation in Ocean Affairs (PIPICO), an ocean forum in the U.S. Department of State, tried to allay their fears.[63] Even though PICES might overlap somewhat with the WESTPAC program in geographic area, he saw little intellectual overlap between them, and PICES would be more effective in coordinating research of interest to American scientists.[64]

From its earliest involvement until at least 1989, the Japan Fisheries Agency was not dissuaded from the view that PICES was an issue of management and allocation of fishery resources. PICES might become the opportunity to impose new fishery regulations by giving them scientific backing. The Japan Fisheries Agency felt that PICES needed to detail its science before conducting any further intergovernmental gathering.[65] The United States and other delegations stressed that membership of PICES could be expanded beyond the present INPFC membership to include at least the USSR and perhaps Poland and South Korea.[66] Japan wanted Poland and South Korea included to strengthen communication between fisheries countries, and to support fisheries issues. Japan saw them as crucial contributors to marine science because they conducted the second and third most intensive fisheries in the world.[67] It was concerned, however, about the special political problems standing in the way of the full participation of Taiwan and South Korea.

Japan was concerned about different coalitions forming in PICES and particularly about maintaining its participation in salmon fishing. The major salmon sources were from North America and Asia, with some intermingling of stocks. The largest runs were on the Asian side, but of lower value, while the North American side had fewer, higher value salmon.[68] The Japanese assumed that PICES would deal with all fish species other than anadromous fish. That meant that, because the INPFC did not have the USSR as a member, the United States and USSR would likely come together in a bilateral treaty for salmon. The Japanese reasoned this bilateral, coastal coalition would weaken their position with the Soviets. Even if high seas salmon capture were banned, and salmon less contentious between Japan and the USSR, the addition of the USSR posed an important political problem for Japan. It was unsettling that Canada, the United States, and the USSR shared more issues with each other than with Japan.

Japanese government reluctance for PICES continued in subsequent meetings and was reflected in their sending participants who solely came from government agencies. These Japanese participants were new each of the next

three years and did not include the academic supporters as in the earliest informal meetings. Only in 1991 did Japanese academics again participate. The Japan Fisheries Agency clearly did not see Article IV of the INPFC Convention as dramatic support for a new organization like PICES. In principle, Japan as part of the INPFC supported its Article IV, but in a very different way from the United States. The Japanese took quite literally the wording to promote a mirror organization of the INPFC that would still be strictly fisheries, but extend to such non-anadromous fish as pollock. That was a more restricted vision for the new organization than the North American desire for an ecosystem approach to marine science. The Japanese were not alone in seeing PICES as a mirror organization to ICES, something that the fishery justification paper had encouraged. Though junior Japanese scholars were more likely to talk about and support such a broad organization along North American lines, it was only senior scientists and official scientific societies whose power could encourage governmental consent.[69] That consent would not be forthcoming until the extent of the parallel between PICES and ICES became clearer.

Despite the proposal's interest to some of their scientists, the Japanese promoted an organization based on their interpretation of Article IV of the INPFC. They also advocated a separate, independent international organization to deal specifically with the problem of the Bering Sea high seas "donut hole," an area created where the U.S. and Russian EEZs do not reach. By their large-scale fishing the United States, Russia, Japan, South Korea, China, and Poland depleted the pollock in this formerly rich fishery. The general feeling was that if the PICES proposal were promoted, then the decision on the high seas would be moved to PICES, and the resolution of the situation would move to the coastal countries' side. Once again, fisheries access would be restricted by their conservation measures.

In addition, the Japan Fisheries Agency reasoned, if PICES gave formal advice to existing international fisheries organizations, as ICES did to the North East Atlantic Fisheries Commission (NEAFC), then Japanese large mesh driftnet fisheries and their dolphin bycatch and fishing could emerge as a focus of new attention. Throughout the first half of the 1980s, political tensions ran high between Japan and the United States over Japanese interceptions of chinook salmon, and the Japanese interpreted U.S. objectives to be the complete cessation of Japanese high seas fisheries for salmon.[70] Certainly that was the intent of western Alaskans, though not of the U.S. Department of State. Tensions escalated to the point of a threatened trade war between the two countries, with Japanese fisheries interests calling for

an embargo of fish imports from the United States. Added to these problems was the perceived bycatch of salmon in squid driftnet fisheries of Japan, South Korea, and Taiwan. A third point of concern, shared among governments, was that a new international organization would need large financial contributions. All of the governments targeted for PICES membership had burgeoning national debt and consequently were concerned about reining in their expenses.

The proposed mandate of PICES was broad, across meteorology, fisheries, and oceanography. The Japanese delegate anticipated that it would be very difficult to integrate these in a meaningful way. If management were part of the picture, then management would be dependent on the individual countries and their style of fishing. Efficient management of fisheries already required a huge amount of material resources.

JAPAN'S SUDDEN APPROVAL

Japan's participation was essential to the organization because it was a major consumer of fish and producer of extensive marine research. The struggle to build a constituency for PICES in Japan depended on the interplay of individual scientists, their institutions, and government interest.[71] On the whole, the fishing industry in Japan regarded the INPFC and other postwar marine treaties like the International Whaling Commission as an infringement on its right to fish. Each round of negotiation seemed just another opportunity for "Japan-bashing."[72] In the early days of PICES talks, Japan was deeply committed to its high seas driftnet fisheries, and worried that the United States could use the organization to monitor and ultimately abolish them. The science produced by fisheries commissions like the INPFC and the IWC inevitably seemed to lead to fishing restrictions, not relaxation. PICES appeared just another avenue for increased restrictions. But if Canada, the USSR, and the United States went ahead without its full participation, Japan's reluctance could have undesirable consequences.

By 1988, the director of the Far Seas Institute, Shigeichi Hayashi, concluded that establishment of PICES was inevitable because of the support shown by other countries.[73] The solid reputations and affiliations of their own scientists who became interested in PICES, along with a changing political climate on fisheries, convinced government officials that joining was in Japan's national interest. In 1989, after thoroughly exploring all possible obstructions to participation, the representative for the Japanese government, Shuhei Takahashi, enthusiastically welcomed forming PICES.[74]

He suggested it was time to view the movement positively rather than see it as a burden. In fact, there were even some advantages to the Japan Fisheries Agency support for PICES. The only strategy for coastal countries was to base fisheries management on multinational agreements. If Japan continued to promote an international organization to deal solely with the Bering Sea high seas, that might intensify further fisheries regulation by coastal countries. If PICES worked as a purely academic organization that did not duplicate research surveys done by any existing organization, then it might check what they perceived as an emotional movement within the U.S. industry to ban all fishing, and also make clear that Japan had nothing to do with the Bering Sea high seas fisheries depletion.[75]

In the face of Canadian, U.S., and USSR objections to high seas salmon fishing, the Japanese realized that they needed to reconsider carefully their reasons for continuing driftnet fisheries and to develop alternative fishing methods. When the end of high seas salmon fisheries seemed likely, the Japanese delegation felt tremendous pressure to acquiesce to joining the new organization, especially when all other participating countries thought PICES was a good idea. The United States and USSR signed a fisheries treaty on May 31, 1988, prohibiting further high seas salmon fisheries as well as offshore catch by fishing countries. Japan could benefit if it could temper the discussion on resource use by joining in, and PICES could be the forum. Salmon fisheries regulations, already dealt with in the INPFC would not be duplicated.

Japan also recognized that PICES had gained support at a high level in the U.S. government. Following the meeting in Ottawa in December 1987, Ambassador E. Wolfe, deputy assistant secretary for oceans and fisheries, U.S. Department of State, agreed to participate, and Canada prepared a draft of the convention. Henry R. Beasely, from the National Marine Fisheries Service, and William Evans, fisheries director of NOAA, showed personal interest in PICES. All this activity created a strong pressure for Japan to join the majority in the coming intergovernmental meeting. Japan would gain nothing if absent and would moreover find itself in the disadvantageous situation of being "except one." Japan had always been "except one" in high seas fisheries and in whaling, a difficult position. To avoid being the sole dissenter to PICES, it needed to ensure that fishing interests were well represented in the new organization.

Finally, fisheries management itself was changing in Japan, making the ecosystem approach favored by PICES more attractive, whether or not it could work in practice. There had been mounting concern in Japan about

drastic decline in stocks of large pelagic fish, and managers began to realize the advantages of forecasting fish abundance from large-scale environmental change. Perhaps the 1980s El Niño convinced Japanese fisheries scientists to support a broad approach that included fisheries oceanography.[76] The delegation to the 1989 meeting made it clear that the Japanese government would no longer object to establishing PICES.

Chapter 3

The First PICES Decade of Cooperation

FIRST ANNUAL MEETING, VICTORIA, CANADA

Chairman Wooster's opening remarks at the first annual meeting in Victoria encapsulated his earliest aspirations for PICES; that it reach beyond fishery questions, oceanographic research, climate, or pollution studies and open up new, interdisciplinary understanding of the region. Although everyone had high expectations for PICES success, he knew that these goals differed among participants, with some people most interested in fishery questions, while others thought the most pressing or neglected problems were in pollution, climate, or broad oceanographic research. He reasserted, " . . . My own view is that the problems are all interconnected and that the study of each depends to some degree on, or contributes to, studies of the others." If they could make progress on the questions formed at the previous year's workshop in Seattle, then both basic

and applied science would benefit because answers to applied questions depended on longer-term fundamental studies. He reminded his audience that an important justification for PICES was the development of "objective advice on scientific questions with great practical implications."[1] In fact, the government of Canada had already asked the PICES Council to detail the advice it was prepared to provide.

Wooster assured his audience that PICES was not in competition with other international organizations or programs, and indeed spokesmen from some programs followed his presentation with descriptions and suggestions for future collaborations. These special presentations included overviews of the World Ocean Circulation Experiment (WOCE), the Joint Global Ocean Flux Study (JGOFS), Global Ocean Ecosystem Dynamics (GLOBEC), the International North Pacific Ocean Climate Program (INPOC), the Global Ocean Observing System (GOOS), the Bering Sea Fisheries Oceanography Coordinated Investigations (FOCI), a program of NOAA, and the International North Pacific Fisheries Commission (INPFC) (see Table 1).[2]

Setting a pattern for future meetings, the opening statement by a dignitary, L. Scott Parsons of the Department of Fisheries and Oceans Canada, focused on the economic importance of the ocean and the special obligation scientists had to address its problems. The program quickly turned to the scientific content of the meeting. Participants in science committee meetings suggested key issues, challenges, and scientific questions to frame the future work of PICES that their chairmen then presented to the Science Board for review.

The FIS committee, under the direction of Dan Ware and Qi-Sheng Tang, concluded that initial work should come through comparative studies on species around the Pacific Rim as well as interdisciplinary studies in the Bering Sea and subarctic Pacific. The MEQ committee, chaired by Jia-Yi Zhou, recommended for the second annual meeting scientific sessions on developing common methods for assessing biological and chemical contaminants, including algal blooms. Chairman Yutaka Nagata of POC emphasized the importance of cooperating with other initiatives and proposed four POC working groups: ocean circulation and climate variability, the Okhotsk Sea and Oyashio region, data quality and control, and new technologies. The BIO position papers shared interest in the large-scale structure and time variability of the subarctic transition zone, the West Wind Drift/North Pacific Current, and the two adjoining oceanic subarctic Pacific gyres. BIO participants, led by Mike Mullin, discussed sponsoring training courses, handbooks, and intercalibration exercises but concluded

that many other international organizations were already working on them, and so those did not seem a pressing responsibility. It did, however, develop questions for future consideration: the carrying capacity in the subarctic Pacific gyre pelagic ecosystem in relation to climate change, the east-west gradient of biological structure and function in the subarctic Pacific, and ecosystem models of the North Pacific transition zone.[3]

Unlike the other three committees, BIO ended the first meeting without any firm scientific proposals for the future, though they posed many questions. Plankton ecologist D.L. Mackas observed that fishery collapses seemed strikingly similar and recurrent worldwide and asked, "What does the trajectory of one collapse tell us about another? Are the sequence and rates similar or drastically different in heavily vs. weakly vs. unexploited systems?"[4] Michael Mullin, also a plankton ecologist, wanted to test whether West Wind Drift and fish stocks were correlated, and to look for causal mechanisms. Oceanographer Tim Parsons proposed a trans-Pacific Continuous Plankton Recorder (CPR) program.

By the end of the meeting, POC, MEQ, and FIS had defined their working groups, but BIO was not yet prepared to recommend any specific scientific programs. It was, however, "interested in developing a large scale, long term approach emphasizing ecological concepts or processes that could be tested in several regions."[5] Despite this underlying interest in the large-scale role of the oceanic subarctic Pacific, the BIO committee did not want to endorse studies limited to a particular region and instead emphasized the interconnectedness of regions, and identified key oceanographic and ecological processes rather than limiting itself to studying specific sites.[6] The reluctance of BIO participants to limit themselves to only a few projects highlights some of the challenges facing the science committees as they struggled with what constituted an ecosystem approach to marine investigations. An oceanic ecosystem viewed broadly comprised every aspect of the ocean and atmosphere, yet that was obviously too cumbersome. Problem-oriented questions put some limits on the system, but the vast number of many interesting problems proved overwhelming.

The first annual report set the pattern for the future. It included the agenda of the meeting, reports from the opening session, Governing Council, Science Board, scientific committees, and finance and administration committee. It also listed the officers, delegates and committee members, as well as participants. The fledgling organization benefited immensely when Beamish arranged to have the papers presented at the first meeting published in an issue of *Canadian Special Publication of Fisheries and Aquatic*

Sciences.[7] If future meetings could have a similar prestigious publication, the organization would build recognition and respect. (Table 4 lists the cumulative publications from 1992 to 2004).

By its second annual meeting in Seattle in 1993, PICES had recruited a three-person Secretariat and equipped its office at the Institute of Ocean Sciences in Sidney, British Columbia. D. James Baker, U.S. Under Secretary of Commerce for Oceans and Atmosphere, was the special guest speaker, and he pledged the continued support of NOAA.[8] Building the tradition that the host country provide a keynote speaker for the opening session to lecture on a topic of general interest to PICES, J.M. Wallace, an atmospheric scientist from the University of Washington, spoke on "Climate Variability in the North Pacific." Eighty papers presented during the four days of the meeting ranged from marine environmental quality and contaminants, invasive organisms, ocean circulation and climate variability, to factors producing shifts in fish abundance and species dominance in coastal waters.

The meetings rotated through member countries, and the fifth annual meeting marked its return to Canada and a chance for the historic fishing city of Nanaimo to host it under the chairmanship of William Doubleday. The area had been the site of marine science study for nearly one hundred years and was home to the Pacific Biological Station of the Department of Fisheries and Oceans. The meeting also acknowledged the major role that Canada played in the formation and direction of PICES. The number of scientists participating had more than tripled, and observers came from ICES, North Pacific Anadromous Fish Commission (NPAFC), and SCOR. Unfortunately this increased number still did not represent all parts of the marine community.

RECURRENT ISSUES FOR THE ORGANIZATION

At the first annual meeting participants identified several intellectual and structural challenges to scientific exchange, and among these, six are further explored below. The first was whether a disciplinary or problem-oriented focus was the most productive for scientific investigations and exchanges. Related to this was how to ensure the timely exchange of data and how to relate to the new NPAFC and fisheries. The structural questions involved how to broaden country membership and attendance of workshops and annual meetings.

Table 4
Cumulative Publications of PICES 1992–2004

Year	Publication
1992	• Annual Report • Proceedings of PICES Scientific Workshop, Parts A and B
1993	• Annual Report • PICES Press Vol. 1, No. 1 • PICES Scientific Report No. 1 Part 1: Coastal Pelagic Fishes, Part 2: Subarctic Gyre
1994	• Annual Report • PICES Press Vol. 2, No. 1, 2 • The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992 • Proceedings of Nemuro Workshop on "Western Subarctic Circulation"
1995	• Annual Report • PICES Press Vol. 3, No. 1, 2 • PICES Scientific Report No. 2: The Okhotsk Sea and the Oyashio Region • PICES Scientific Report No. 3: Monitoring Subarctic North Pacific Variability
1996	• Annual Report • PICES Press Vol. 4, No. 1, 2 • PICES Scientific Report No. 4: Science Plan, Implementation Plan, Report of the PICES-GLOBEC International Program on Climate Change and Carrying Capacity • PICES Scientific Report No. 5: Modeling of the Subarctic North Pacific Circulation • PICES Scientific Report No. 6: Proceedings of the Workshop on the Okhotsk Sea and Adjacent Areas
1997	• Annual Report • PICES Press Vol. 5, No. 1, 2 • PICES Scientific Report No. 7: Summary of the Workshop on Conceptual/Theoretical Studies and Model Development and the 1996 MODEL, BASS and REX Task Team Reports.
1998	• Annual Report • PICES Press Vol. 6, No. 1, 2 • PICES Scientific Report No. 8: Multilingual Nomenclature of Place and Oceanographic Names in the Region of the Okhotsk Sea • PICES Scientific Report No. 9: PICES Climate Change and Carrying Capacity Workshop on the Development of Cooperative Research in Coastal Regions of the North Pacific

Table 4 (cont.)
Cumulative Publications of PICES 1992–2004

Year	Publication
1999	• Annual Report • PICES Press Vol. 7, No. 1, 2 • PICES Scientific Report No. 10: Proceedings of the 1998 Science Board Symposium on the Impacts of the 1997/98 El Niño Event on the North Pacific Ocean and Its Marginal Seas • PICES Scientific Report No. 11: Summary of the 1998 MODEL, MONITOR and REX Workshops and Task Team Reports • PICES Scientific Report No. 12: Proceedings of the Second PICES Workshop on the Okhotsk Sea and Adjacent Areas • Progress in Oceanography Vol. 43, No. 2–4, 1999 (special issue): Ecosystem Dynamics in the Eastern and Western Gyres of the Subarctic Pacific • Dynamics of the Bering Sea: Biology and Oceanography
2000	• Annual Report • PICES Press Vol. 8, No. 1, 2 • PICES Scientific Report No. 13: Bibliography of the Oceanography of the Japan/East Sea • PICES Scientific Report No. 14: Predation by Marine Birds and Mammals in the Subarctic North Pacific Ocean • PICES Scientific Report No. 15: Report on the 1999 MONITOR and REX Workshops, and the 2000 MODEL Workshop on Lower Trophic Level Modeling • Progress in Oceanography Vol. 47, No. 2–4, 2000 (special issue): The Nature and Impacts of North Pacific Climate Regime Shifts
2001	• Annual Report • PICES Press Vol. 9, No. 1, 2 • PICES Scientific Report No. 16: Environmental Assessment of Vancouver Harbour. Data Report for the PICES Practical Workshop • PICES Scientific Report No. 17: Report of the 2000 BASS, MODEL, MONITOR, and REX Workshops, and the 2001 BASS/MODEL Workshop • PICES Scientific Report No. 18: Proceedings of the PICES/CoML/IPRC Workshop on "Impact of Climate Variability on Observation and Prediction of Ecosystem and Biodiversity Changes in the North Pacific" • PICES Scientific Report No. 19: Commercially Important Crabs, Shrimps and Lobsters of the North Pacific Ocean • Progress in Oceanography Vol. 49, No. 1–4, 2001 (special issue): Pacific Climate Variability and Marine Ecosystem Impacts • Historical Atlas of the North Pacific Ocean (Anniversary Book)

Table 4 (cont.)
Cumulative Publications of PICES 1992–2004

Year	Publication
2002	• Annual Report • PICES Press Vol. 10, No. 1, 2 • PICES Scientific Report No. 20: Report of the 2001 BASS/MODEL, MONITOR and REX Workshops, and the 2002 MODEL/REX Workshop • PICES Scientific Report No. 21: Report of the PICES 2002 Volunteer Observing Ship Workshop • PICES Scientific Report No. 22: PICES Science: The First Ten Years and a Look to the Future • PICES Scientific Report No. 23: Harmful Algal Blooms in the PICES Region of the North Pacific • Journal of Oceanography Vol. 58, No. 5 (special issue): Physics and Biology of Eddies, Meanders and Rings in the PICES Region • Progress in Oceanography Vol. 55, No. 1–2, 2002 (special issue): Variability in the Bering Sea Ecosystem • Deep-Sea Research Part II Vol. 49, No. 24–25, 2002 (jointly with JGOFS): North Pacific Biogeochemical Processes • Canadian Journal of Fisheries and Aquatic Sciences Vol. 59, No. 12 (special section): Migration of Key Ecological Species in the North Pacific Ocean
2003	• Annual Report • PICES Press Vol. 11, No. 1 (jointly with GLOBEC), 2 • PICES Scientific Report No. 24: CO_2 in the North Pacific Ocean • PICES Scientific Report No. 25: The BASS/MODEL Report on Trophic Models of the Subarctic Pacific Basin Ecosystems • Progress in Oceanography Vol. 57, No. 3–4, 2003 (special issue): Plankton Size-Classes, Functional Groups and Ecosystem Dynamics • Journal of Oceanography Vol. 59, No. 4 (special issue): Transitional Areas in the North Pacific Ocean
2004	• Annual Report • PICES Press Vol. 12, No. 1, 2 • PICES Scientific Report No. 26: Proceedings of the Third Workshop on the Okhotsk Sea and Adjacent Areas • PICES Scientific Report No. 27: Report of the MODEL Task Team Second Workshop to Develop a Marine Ecosystem Model of the North Pacific Ocean including Pelagic Fishes • PICES Special Publication 1. Marine Ecosystems of the North Pacific • Journal of Oceanography Vol. 60, No. 1 (special issue jointly with JGOFS): North Pacific Synthesis of the Joint Global Ocean Flux Study • Marine Environmental Research Vol. 57, No. 1–2, 2004 (special issue): PICES Interdisciplinary Assessment of Marine Environmental Quality • Progress in Oceanography Vol. 61, No. 2–4, 2004 (special issue): Physical and Chemical Processes in the Japan/East Sea and Their Influence on Its Ecosystem • ICES Journal of Marine Science Vol. 61, No. 4, 2004 (special issue jointly with ICES and GLOBEC): The Role of Zooplankton in Global Ecosystem Dynamics: Comparative Studies from the World Oceans • Journal of Marine Systems Vol. 50, Issues 1–2, 2004 (special issue): The Role of Biophysical Coupling in Concentrating Marine Organisms Around Shallow Topographies

Source: PICES Secretariat.

DISCIPLINARY VERSUS PROBLEM-ORIENTED QUESTIONS

At times, a disciplinary focus drawing on a coherent body of knowledge and training might be appropriate and productive. At other times, however, pressing problems might call for directed research to solve them. How could PICES adopt an interdisciplinary approach to solve problem-oriented questions? Which scientific committees could best address what questions? In addition, disciplinary scientific committees could focus their efforts either topically or geographically.

BIO considered and rejected several research problems because they seemed better suited to other committees. For instance, toxic algal blooms, though certainly biological, seemed more a matter for marine environmental quality (MEQ) because of its hypothesized linkage to coastal eutrophication. BIO participants emphasized the interconnected nature of all regions and so did not want to limit themselves to any specific area within the PICES region. Those decisions left it without specific proposals for working groups for the first year. Nevertheless, BIO did recommend several topics for future workshops and symposia, such as long-term time series monitoring of the ecology of the subarctic North Pacific, including paleoclimatology and paleoecology.

Modeling efforts promised to link disciplines by transcending them. For instance, the working group on modeling of the subarctic North Pacific circulation produced many models, though not surprisingly their quality matched that of the observations on which they were based. Models of surface circulation, where data are most abundant, reproduced many observable features but models at depth proved more questionable.[9] Overall, the results from models proved too unreliable for the applications in fisheries, pollution, and climate change for which they had been developed. Only better and more complete observations could improve them, suggesting ripe areas for future effort.

MEQ struggled for two years with how to study the pollution of the open North Pacific Ocean, and decided in 1994 to turn its attention to the vastly more affected coastal areas and marginal seas. In the following year they chose the East China Sea as of interest to all member nations because the Three Gorges hydroelectric dam was to be built on the Yangtze River, which proved to be the most important single environmental impact on the East China Sea and its northern circulation, including the Japan/East Sea. It would be the largest construction project in Asia since the Great Wall, taking at least five to ten years. Studies on the Aswan Dam in Egypt

suggested that altered sediment and nutrient fluxes were likely to be the two most critical changes.[10]

Not surprisingly, many of the annual meeting opening remarks stated the crucial importance of the ocean, and then presented PICES as the best route to addressing and solving practical problems of growing pollution and climate change. U.S. delegate Vera Alexander asserted, however, that,

> PICES is only interested in the scientific aspects, even though there will be practical benefits as well. Of greatest importance, though, is the potential for developing young scientific talent by bringing an international team of our future scientific leaders together to address the scientific problems in the North Pacific Ocean.[11]

Her remarks highlighted the unresolved difficulty of defining the organization; would it take on primarily applied or basic research questions? Providing a complete nomenclature list for geographical features like bays, straits, currents, and such in all languages promised a welcome pragmatic task.

THE IMPORTANCE OF TIMELY EXCHANGE OF DATA

From its earliest meeting, PICES struggled with how best to exchange data, but not become a redundant data repository. The World Data Centers, started by the International Geophysical Year in the late 1950s, already collected data, mostly physical, from many sources.[12] Data access and handling was particularly important when observing and describing large systems, and to be readily exchangeable it had to come from comparable methods and standards. All data needed to be quickly accessible to reflect real world events and readily exchanged physical data proved easiest to share, while chemical and biological data were more challenging. Technological improvements and standardization vastly aided data collection and analysis. As new ways of measuring developed (such as the electronic thermometer replacing the reversing type), the need for accurate comparison of methods grew. Improvements in technology now allow physical measurements to be logged directly into data spreadsheets. Comparison of inorganic nutrient concentrations in various parts of the ocean require intercalibration among the participating national institutions. Standardizing biological data continues to be most difficult, subject to different methods of collecting, preserving, and sorting samples. Zooplankton data, for instance, depend on how sampling nets are constructed and used, the ratio of filtering area to net mouth area, how abundance is measured, the use of flow meters, and so

forth. The resulting samples also require laborious and expensive processing because they cannot be as automated as physical and chemical samples. Optical plankton counters might help, but they have their own drawbacks. These challenges may have contributed to why at the first annual meeting BIO failed to produce a definitive plan of action.

In recognition of these problems of sample collection, one of the first working groups constituted was on data collection and quality control and was meant to identify existing international standards and data sets suitable for exchange. They were also to advise on exchange protocols like the consistent naming of measurements and standard formats and production of reference and metadata sets. International standards for data exchange in physical oceanography and meteorology were well established but there were few equivalent standards for biological and fisheries data.[13]

OVERCOMING FISCAL CHALLENGES

By signing the PICES Convention, members agreed to support the Secretariat functions equally with annual dues initially a modest $90,000 Canadian per year. The proposal for equal payments to the Secretariat was agreed upon unexpectedly quickly, in part because the benefits appeared to be equal across member countries. In spite of this agreement, however, the PICES Secretariat received occasional requests for temporary reductions or delays in paying dues in part because each country used a different fiscal calendar. Because the Secretariat had no accumulated funds, such staggered payment was difficult for it to accommodate. ICES, in contrast, weighted its dues by the amount of fishing each member did in the North Atlantic, so there was a direct relationship between economic return and fees paid. Because the United States did little fishing there, it paid proportionately less than France, Germany, Norway, and the United Kingdom.

More problematic than annual dues was that member countries also pledged to send their delegates and scientific participants to annual meetings and working groups, a much larger expense. That commitment was less clearly budgeted by the governments, so when it came time for their scientists to travel, often only the lead agency people were funded to attend workshops and meetings. Just because governments approved working groups and named their representatives was no guarantee that they would provide funds to the between-session meetings of those groups. Although there was a great deal of work to carry on between annual meetings, travel restrictions and shortages of travel funds at national levels weakened par-

ticipation. Many scientists worked on PICES business at their own expense if they could not find external funds. In Canada, government and academic scientists competed for government travel funds that were insufficient to support travel for all scientists interested in participating; any travel awards to academics reduced funding available to government scientists. All governments were intent on fiscal restraint in a time of global recession and found such obligations a continuing challenge. Although working groups could use electronic communication, the likelihood of response and interactions was much greater when the parties met face-to-face. Wooster, among others, argued that the whole cost of PICES was tiny in comparison with the cost of other intergovernmental obligations. For instance, as a member of the IOC, the United States spent about ten times more per year.

In light of governments having limited funding for science, at the annual meeting in 1995 Wooster urged participants to convince their governments that scientific research was not an "idle luxury," but crucial for the world's future. Responding to complaints that research sponsored by PICES was of little practical use because it did not provide information for industry, he asked the audience to consider how science contributed to national welfare, and how it could be marshaled to address specific societal problems.[14] He argued that the research PICES promoted was almost certain to be useful to rational exploitation of marine resources. While fisheries management was forced to work on short time scales to address immediate harvest questions, the solution to many fishery problems would come from study over a longer time. He repeated the fundamental question, "What is the nature of the subarctic Pacific ecosystem (or ecosystems) and how is it affected over periods of months to centuries by changes in the physical environment, by interactions among components of the ecosystem, and by human activities?"[15] Scientists needed to work not only within but also among disciplines, as exemplified by unifying topics such as climate change.

Some scientists mistakenly thought that PICES was going to be a source of significant new money, whether for travel or for project support. Member country dues, however, barely covered the Secretariat expenses and associated activities of the annual meetings and publications. Because little money was available for special expenses, in 1994 the Governing Council established a trust fund of voluntary contributions to foster scientist participation. Its money could be used to support individual scientists coming to meetings or collaborating with foreign laboratories, or for other unforeseen expenses of the organization. It was hoped that the ideas for joint action coming from working groups would sufficiently appeal to governments that they would

fully fund participation. That was in part why PICES needed to show how it addressed recognized problems of real concern, like the climate-driven decline of the rich fisheries harvest of the late 1970s and 1980s. Scientists might also use PICES endorsements of their proposals to pursue their own funding for travel as they did in other international organizations, such as ICES and IOC.

Countries with truly struggling economies would need extra support for their scientists to attend and host meetings. For instance, Russian scientists showed great interest in PICES, with twenty-two Russians submitting papers to the first PICES meeting, but all of them needed full travel support.[16] Some NSF funds were available to bring a few people to enrich the meetings, but such support could not be permanent.[17] By the second meeting, the International Science Foundation (ISF) agreed to provide travel support for three Russian scientists, though the ISF had a rule that it could support only two percent of all participants to a meeting, a rather restrictive clause for a small meeting, and particularly since Russia had many times more marine scientists than any other country.[18] Clearly, to make the meetings accessible to all scientists the PICES Governing Council would need to revisit the matter annually, whether by insisting on the promised government support or by finding supplemental sources. By 1999 PICES established an intern program to encourage junior scientist training and participation. A year later (2000) the Governing Council established the PICES Wooster Award, to be given annually to an individual who had made significant contributions to North Pacific marine science. Such a prize would raise the profile of both the recipient and the organization.

Each host city also had its unique challenges in hosting international gatherings. The most dramatic example was in 1994 when Japan hosted its first meeting in Nemuro, a fishing city on its easternmost coast. Only a week before the meeting, the area suffered its largest ever earthquake of 8.2 magnitude centered about a hundred miles away, which damaged the building where the meeting was to take place.[19] The Japanese hosts hastily relocated the meeting to the local library after rearranging books and shelves to make sufficient space. Despite continuing aftershocks in the area, participants presented 96 papers and held two workshops.

IMPROVING COMMUNICATION WITHIN AND BETWEEN MEETINGS

Effective mechanisms to communicate between meetings still did not exist by the second annual meeting in 1993. Getting people together was effec-

tive yet expensive, while faxes and the Internet were not yet widely reliable across borders and easier to set aside than face-to-face meetings. Although governments had approved working groups and named their members, the effects of an economic recession meant that there was no guarantee that they would grant travel money to these participants. Moreover, larger working groups required more funds, and lack of participation could hinder the group's progress. The committees needed to be efficient and productive, and several of them struggled with members who did not make it to their working group gatherings. Given its low dues, PICES was unlikely ever to be a source of research or operating funds, so that governments had to fulfill their obligation to support all aspects of marine science, including participation at meetings. PICES had the potential to promote and develop marine science but only if its work was made known and available to a large audience.

Because countries were sometimes slow to designate participants for working groups, the groups had a hard time accomplishing anything between annual meetings. For instance, working group 10 on "Circulation and Ventilation in the Japan Sea (East Sea) and its Adjacent Areas" was proposed at the fourth annual meeting in 1995. Half a year later, one country had not yet designated any members and another had only one.[20] Working group 11 was a bit better off, but still missing representatives from two member countries and nothing could get done until its membership was complete. Additionally, countries with a representative chairing a working group needed to find even more financial resources than usual.

The Internet promised to make communication faster, cheaper, and more thorough for anyone with access. The Secretariat could post its publications, news, announcements, and links to other interesting sites as well as its convention, rules of procedure, and directory. Scientific committees could maintain discussion groups and communicate with their working groups, and the task teams could post data, inventories, research cruise schedules, and reports and models. But posting information was still quite laborious and often less pressing than immediate research concerns.

Planning for the fourth annual meeting (1995) in Qingdao, China, revealed more challenges to international communication. Although several member nations had a well-developed Internet, and the Secretariat was authorized to establish a Web site, China did not yet share access.[21] Although a Chinese scientist reported in an article in *Science* that the Chinese had Internet links, the Secretariat staff experienced repeated failures in such networks, and resorted to sending faxes to the State Oceanic Administra-

tion and its several institutes, the Yellow Sea Fisheries Research Institute, and the Institute of Oceanology.[22] Few Chinese marine researchers were on the Internet, the postal system was too slow, and contact by fax was often difficult and expensive since the signal was frequently interrupted during transmission.[23] On the other hand, the National Science Foundation of China, which had supported marine science since 1986 through its Earth and Life Science programs, expressed strong interest in interacting with PICES and promised to promote cooperation. Although this relationship would not improve Internet connections, it held great promise for fostering scientific exchange.

A persistent communication problem stemmed from the early decision by all member countries that English would be the official language at the meetings. It certainly saved on translation services, but the pace of a normal discussion was challenging to those speaking English as a second language. In 1994 the FIS committee recommended that PICES take new steps to help participation. Recognizing that translators were too expensive and cumbersome, they suggested making real-time recordings of discussions and displaying them on large screen video displays, or using blackboards for all discussions, with frequent printing and duplicating of summaries.[24] The fourth annual meeting had six scientific sessions and over two hundred participants, exacerbating problems presenting visual material. As an experiment for the next meeting, speakers were asked to provide advance copies of their presentations to minimize problems of mechanics, technique, and content and make sure they followed a uniform format developed by the Secretariat.

Much PICES work took place outside of annual meetings. An important event was the "Beyond El Niño" conference on Pacific climate variability and marine ecosystem impacts in spring 2000 in La Jolla, California. It drew many scientists from outside the PICES member states, and it was the first large cosponsored meeting led by PICES to include most of the major international fishery organizations. By examining the effects of the strong 1997–98 El Niño, it provided sound evidence of ecosystem variability at interannual and decadal time scales, with information of great importance for fisheries management.[25] The first joint PICES/NPAFC workshop on factors affecting production of juvenile salmon and climate took place in Tokyo in 2000, a promising start to integrating the two organizations. ICES invited PICES for a joint meeting on zooplankton ecology in Hawaii to compare zooplankton distribution and monitoring between the Pacific and Atlantic. They explored the observation that large copepods predominate

in the North Pacific in contrast to smaller copepods in the North Atlantic, and planned future collaboration on comparative zooplankton ecology. The Hawaii meeting resulted in the organizing of the 3rd Zooplankton Production Symposium on the role of zooplankton in global ecosystem dynamics, sponsored jointly by ICES, PICES, and GLOBEC.

Another major event outside the ninth annual meeting was a workshop on "Lower Trophic Level Modeling" in Nemuro, Japan, in February 2000, when modelers and other scientists from all PICES countries discussed the technical problems of creating useful models of ocean dynamics. PICES also sponsored an interdisciplinary cruise organized by the Pacific Oceanological Institute aboard the research vessel *Professor Gagarinsky*. In this case, sponsorship meant lending its name and some small funds. The Institute and the Pukyong National University of Korea sent research vessels full of scientists and students to study the ecosystem structure and dynamics of the northern Japan/East Sea. At the meeting, a workshop to produce an ecosystem status report was planned together with the Census of Marine Life and the International Pacific Research Center, an effort that would contribute to the goals of the IOC's Global Ocean Observing System.[26]

WIDENING COUNTRY MEMBERSHIP

The Soviets had been interested in PICES from the earliest discussions, but as the USSR unraveled politically and economically, its scientific institutions also experienced great hardship. The USSR failed to sign and ratify the PICES Convention in time to join Canada, Japan, and the United States. Russian participation, essential to any comprehensive research into the western subarctic Pacific and especially the Bering and Okhotsk seas, required access to Russian data, scientists, and research. It became even more important to involve them if PICES engaged in applied fishery research and assessment, as proposed by Canada, because Russians fished most of the important shared and straddling stocks.

Despite a strong Russian desire to participate in international science, economic and social conditions arising from the transition from a noncompetitive, centrally planned system to a market-driven, pluralist one led to international isolation.[27] Rampant inflation and shortages of hard currency prevented buying Western scientific journals, supplies, and airline travel. In the former Soviet Union, several major scientific journals suspended publication. The Russian public did not want to fund big science when food, medicine, and consumer goods were in short supply. By 1991 the once-

powerful USSR Academy of Sciences became a temporarily weaker Russian Academy of Sciences (RAS).

By 1992 the Russian Federation was still not an official signatory to the PICES Convention, and it was not clear to PICES members how to help the process along. Certainly contacts with Russian marine scientists able to make a strong case would help in such difficult economic times. A.A. Elizarov, director of the Russian Federal Research Institute of Fishery and Oceanography (VNIRO) was the only recent official contact with Russia that PICES had, and he made clear that he spoke only for the fishery side of science, not the Academy of Sciences, the State Committee on Hydrology and Meteorology, or the Ministry of Environment. Wooster was told that academician Victor Ilyichev, director of the Pacific Oceanological Institute, chaired a regional interagency committee with wide representation for the Far East.[28] But what was its role in relation to Moscow? If an interagency group existed, then PICES could work with it to arrange for PICES membership. It was suggested to Moscow that PICES matters would benefit from being transferred to the Far East with more dynamic interaction. The U.S. Department of State had been making some efforts, without obvious success, so perhaps Canadian External Affairs might be convinced to press the matter in Moscow.[29] Wooster asked L. Scott Parsons for his views on how best to promote Russian membership in PICES. Wooster suggested that a successful strategy to obtain Russian membership must deal with the accession costs of joining PICES. Those membership and travel costs would be less than what the Russians spent on other intergovernmental obligations, such as the IOC and NPAFC. A large Russian delegation attended the IOC meeting in March 1992 (including both the traditional PICES contact, Elizarov, and his deputy) and Russia was a member of the new NPAFC (whose chairman, V. Zilanov, was Russian) where it was actively negotiating new management of Bering Sea stocks. Why were they not taking similar action to join PICES? Although Elizarov insisted that his responsibility in PICES extended only to fishery matters, no other Russian contacts were ever designated, so it was unclear who was the proper contact for PICES. PICES needed links not only with fishery laboratories, but also with relevant laboratories of the Academy of Sciences and the State Committee on Hydrology and Meteorology. A variety of multilateral and bilateral arrangements appeared to be carried on independently, even in the same agency. For example, although U.S.-Russian negotiations on PICES and NPAFC were carried out by the Department of State, they were not coordinated, potential overlaps were not considered, and there was no evidence that the U.S.

representatives in NPAFC were urging Russia to join PICES. Negotiations to establish a regime for managing "donut hole" fisheries were not being referred to PICES as a source of scientific support. Bilateral arrangements, including the Joint Program in World Ocean Studies and other bilaterals involving NOAA, U.S. Fish and Wildlife Service, and perhaps other agencies, were not coordinated with each other or with U.S. interests in PICES.

How or when could the Russians formally join PICES? Wooster and others in PICES were increasingly concerned over their delay in acceding to the convention. The deputy director of VNIRO assured Wooster that they were making their best effort to expedite Russia's action.[30] In the meantime, however, they still needed formal invitations from PICES organizers to gain permission to travel and qualify for travel support, as they did for all such events, and sometimes details stood in the way of participation. For instance, in 1993, VNIRO intended to send Victor Sapozhnikov to a working group meeting in Nemuro, but had not yet received the proper invitation.

Russian scientists, nevertheless, wished for participation in international science through individual, institutional, and bilateral agreements. Finding enough money, especially foreign exchange, seemed the principal obstacle to Russia joining PICES. Wooster calculated that the annual cost of minimal participation was about US $150,000, half to contribute to the PICES Secretariat budget, and half to send key people to annual and working group meetings. The United States searched for funds, and in 1993 the U.S. Department of State Bureau of Oceans and International Environmental and Scientific Affairs (OES) sought Russian accession and more active participation given Russia's extensive research in the North Pacific. To receive help from outside sources, the Russians needed first to organize themselves.[31] Fortunately, during the transition from the USSR to the Russian Federation, TINRO-Center administrators had managed to retain its fifteen-vessel research fleet and even improve its equipment.[32] OES suggested that their correspondence with the Russian Ministry of Science and Technology Policy increased Russian participation and decision to accede to the convention.[33] By the third annual meeting in 1994, Russia had started the process of becoming a member of PICES, effective at the end of the year. Finally, the Russian Federation became a member on 16 December 1995.

The Republic of Korea (South Korea) preceded it on 30 July 1995, and both countries were enthusiastically welcomed to the fourth annual meeting in Qingdao with official status. Both countries carried out significant marine research and would add valuable data, insights, and resources to the expanding picture of the North Pacific Ocean. The Korean government had

increased its interagency cooperation in 1996 by establishing the Ministry of Maritime Affairs and Fisheries (MOMAF), a merger of various marine related government agencies and functions in response to the U.N. Law of the Sea Convention that came into force two years earlier. The Canadian government had just signed a letter of understanding for scientific collaboration with Pukyong National University in Pusan, promising collaborative work between countries, and had continuing relations with the Korea Ocean Research and Development Institute (KORDI). Certainly cooperative applied research was increasing; one presentation was of a joint research program among Japanese, Korean, and Russian scientists.[34] The Republic of Korea hosted its first annual meeting in 1997—a good example of the original intent of PICES to act as a focal point for joint research projects across national boundaries. The year 1997 was also the start of a large El Niño event, increasing public awareness of how changes in the ocean could influence human activities. The question was whether that increased awareness would encourage the public to turn to PICES to explain oceanic processes.

By 1999 all members had hosted at least one annual meeting. Russia's first was appropriately held in Vladivostok, where fisheries and marine transport were the most important part of the region's economy. Alexander Bychkov had just been appointed the new executive secretary of PICES, strengthening the communication between Russian speakers and the organization, and Hyung-Tack Huh from Korea began his appointment as chairman.

BIO had grown into a functioning committee and proposed sponsoring a symposium at the third annual meeting to explicitly compare the eastern and western ocean in the session "Structure and Ecosystem Dynamics of the Subarctic and Transition Zone North Pacific—Is the East Like the West?" The FIS committee, chaired by Qi-Sheng Tang of China, passed along the report of its working group on coastal pelagic fish. Chair Jia-Yi Zhou of MEQ presented its working group report on developing common measurements for assessing marine pollution. Yutaka Nagata of Japan chaired POC and Lynne Talley chaired its group on the Okhotsk Sea and Oyashio region. When the group finished its task it was disbanded, and two new groups were recommended, one on modeling circulation and the other on monitoring large-scale variability. The four committees made lists of priority issues headed by the subarctic gyre and its carrying capacity of salmon.[35]

The organization was carrying out its appointed functions, with working groups, scientific committees, and meetings, and each year participation grew over the previous year, a respectable trend suggesting that scientists

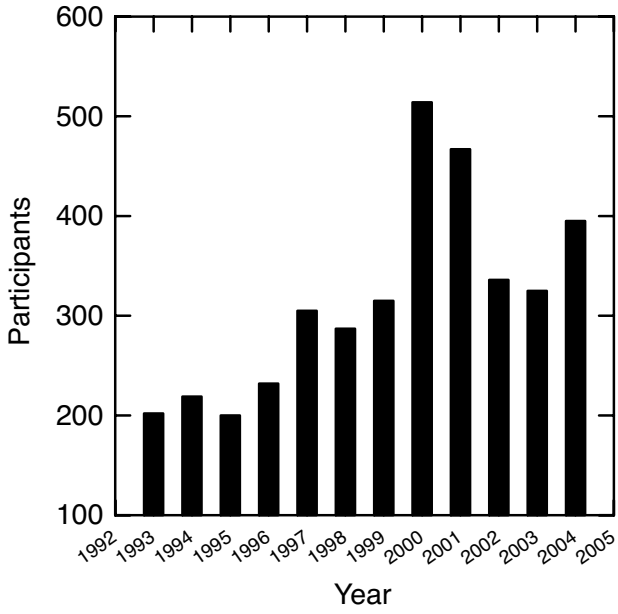

Figure 5.
Number of Participating Scientists at PICES Meetings 1992–2004

were finding PICES useful (Figure 5). By the fifth meeting, about two dozen scientists in each country were formally designated as members of the several PICES scientific and technical committees.

But to step beyond these functions PICES needed an organization-wide, unifying project that would inspire scientists, help governments, and build the goodwill and enthusiasm into a solid accomplishment. Two major projects proved critical in directing PICES's efforts into an ecosystem approach that relied on expertise developed within disciplines but applied to pressing problems. The first project was developed in a joint initiative with GLOBEC International (Global Ocean Ecosystem Dynamics) on climate change and carrying capacity (nicknamed the "Four Cs" or CCCC), and the second was on the development of ecosystem status reports, as outlined below.

RELATING TO THE NEW NPAFC

The three-member INPFC had been made obsolete when extended EEZs passed much of its management authority to coastal nations. That change of responsibilities meant that a new treaty had to replace it, and reshape its management and scientific responsibilities. In 1992 the North Pacific

Anadromous Fish Commission (NPAFC) was established and the new Russian Federation took the opportunity to join Canada, Japan, and the United States in signing the management treaty. The NPAFC prohibited fishing for anadromous fish outside the two hundred mile EEZs, yet it had no jurisdiction within those zones.

How in practice would PICES interact with the bodies that have management responsibilities? The U.S. government participated in creating both NPAFC and PICES without coordinating a discussion on their respective responsibilities. The Office of Fishery Affairs in the U.S. Department of State worked on NPAFC policy, but PICES policy came out of the Office of Ocean Affairs. Although these divisions between fisheries and marine science were consistent with the central interests of each organization, it did not foster discussion on the respective responsibilities of the treaties. Additionally, broadening interest in ecosystem approaches made these agency distinctions seem unnecessarily fractured.

Scientists with longstanding obligations to represent their country in the INPFC promoted NPAFC as its natural successor in both management and scientific work. Simultaneously, others promoted PICES as the proper organization to continue any scientific work. A few scientists served both organizations and prepared papers for each annual meeting. Now that the NPAFC treaty was signed, what should its relationship be with PICES? Because PICES was to foster cooperation among scientists, among member countries, and with other scientific organizations, its relations with the new NPAFC were of great importance.[36] The NPAFC was clearly created for fisheries management, but would it need or take scientific data and advice from PICES?[37] Three broad approaches were possible.

First, the NPAFC might continue where the INPFC left off, carrying out scientific research, now with a coastal focus, and collecting and publishing fishery data in its statistical yearbook on both anadromous and non-anadromous fish. It would interact with PICES only on larger oceanographic matters. Second, NPAFC could limit itself to conservation and management, turning to PICES for advice on scientific questions, including on fisheries. The Canadians favored this latter approach as similar in the way that ICES provides scientific advice on request to fisheries organizations. Even before NPAFC existed, Canada had informally proposed that the INPFC transfer its statistical databases and summary information to the future PICES, reasoning that this would avoid duplicating activities between the two organizations. INPFC members United States and Japan as well as nonmember Russia thought this action premature and should be left to the new NPAFC

to decide. The Canadians viewed NPAFC as an enforcement agency, and wanted to refer all scientific questions to PICES, consistent with ICES's role in the North Atlantic. The advantages of centralizing such responsibility in PICES was that it could conduct multidisciplinary reviews and be independent of management politics, and it would be cost effective not to have two organizations overlap in their research.[38]

Wooster assured the 1993 gathering that PICES was willing to play an advisory role "to the extent wished by its Contracting Parties," but observed that NPAFC had not yet decided whether to seek such scientific advice.[39] At the same meeting, the government of Canada asked that the Science Board address the question of how PICES would handle requests for scientific advice from member countries. To respond to written requests for advice, the Science Board was to form an ad hoc committee that could become permanent if necessary. If requests came from outside PICES, then the Science Board would propose a committee to address them, and any action would require approval by the Governing Council.

Unlike NPAFC, the PICES Secretariat was never designed for direct fisheries management, and thus had no resources to support that function. Even an advisory function for PICES would require a large staff increase to establish bodies analogous to the ICES Advisory Committee on Fishery Management and its fish stock working groups. The membership and interest of PICES, moreover, differed significantly from those of NPAFC. Although Canada wanted the 1993 PICES meeting to discuss these matters, the United States hesitated because it viewed NPAFC as the better place for fisheries management issues. Instead, William Erb, director of the Division of Marine Science and Technology Affairs, U.S. Department of State, knowing that NPAFC could always ask for support from other groups if they wished, encouraged it to identify its research interests as quickly as possible. The NPAFC meeting in Vladivostok recommended further discussions of its relationship to PICES.[40]

In addition, if NPAFC limited itself to conservation and management, turning to PICES for advice on scientific questions, it would leave little scientific work for itself. The third, cooperative approach would be for both to work together to share information and data, and identify what tasks would be best done by each. That approach would necessitate framing requirements, terms of cooperation, and a timetable of cooperation. This third approach got a large boost in 1993 with the start of a novel scientific program for PICES on climate change and carrying capacity. By 1997 it was reported that NPAFC would add fishery catch statistics of non-anadromous fish to

its statistical yearbook, and it requested that PICES produce a database of fishery statistics for all of its members, to be exchanged with NPAFC.[41]

PICES also strove to increase its interactions with other international organizations. The PICES Secretariat extended invitations to observers from international organizations such as FAO and IOC. In 1994 the Governing Council approved a memorandum of understanding with IOC, and discussed one with NPAFC, although the latter was delayed by different meeting schedules. PICES also sent representatives and shared in symposia and projects organized by other organizations. For instance in 2000, the Canadian delegate hoped that PICES would play a strong role in both a drifting buoy project called Argo, and in implementing the Global Ocean Observing System (GOOS). Individual scientists attending other international meetings applied their experience to their work with PICES.

"PICES IS NOT PISCES!" ADVISING ON SCIENTIFIC MATTERS, INCLUDING FISH

Some participants complained that research sponsored by PICES was of little practical use because it was not directed to providing information needed by the fishing industry. Fishery questions required repeated discussion on the advisory role for PICES, and any summary position was not so much a unanimous position on the matter as a common basis for continuing discussion. Participants at the first discussions in 1978 noted that PICES, because of the intensely political nature of stock assessment, management, and allocation, should focus on science, not management.[42] It was assumed that as in ICES, advising in fisheries and environmental quality might someday develop. The 1979 meeting reinforced this view, stating it "should have no specific advisory responsibility that directly pertains to resource management," yet the meeting also discussed the desirability of periodic general assessments of living resources.[43] The 1988 draft convention articles highlighted differences in the Canadian and U.S. positions, with the Canadian proposal "to provide advice to government institutions, international organizations and private sector enterprise . . . by the evaluation and interpretations of available data and information as they apply to agreed problems." The U.S. version omitted an advisory capacity and proposed to "evaluate and interpret available scientific data and information as they apply to agreed problems."[44] The 1990 PICES Convention listed among its scientific functions, "to consider requests to develop scientific advice pertaining to the area concerned."[45] How to do so was not elaborated, left to the Governing Council to decide how to respond to requests from members

or international organizations. The Secretariat would need to analyze the budgetary and structural implications of such a function. One possibility was that PICES could link fishery commissions like NPAFC with scientific data beyond what the commissions could collect on their own.

In 1992 during a meeting between scientists of the Alaska Fisheries Science Center, and Bering Sea industry advisors, the issue of PICES's relationship to fishery commissions was discussed. David Colson, deputy assistant secretary for oceans and fisheries affairs, U.S. Department of State, urged that NMFS prepare a short paper explaining how PICES would interact with both existing and anticipated international fisheries commissions. His request was reinforced by some comments from the Alaska Department of Fish and Game that Alaska and some constituency groups had been left out of participation. They worried that PICES would be setting the fishery research agenda for the North Pacific without input from affected constituents. Alaska Fish and Game had never had a significant role in PICES formation; although they were invited, they did not participate actively, almost certainly because of the clear emphasis that PICES was a scientific group not involved with fisheries management. Neither Washington nor Oregon state fisheries organizations were involved with PICES either and probably for the same reason.[46]

Both NPAFC and PICES made serious efforts to detail their roles and opportunities for cooperation. The PICES Governing Council position by the first annual meeting in 1992 was that it would wait for requests for scientific advice to come to it, and respond on a case-by-case basis. At the meeting Wooster stressed, "PICES is not in competition with other international organizations nor with established international programs. Instead, we (PICES) should find ways to complement and support such organizations and programs to the extent they relate to our objectives."[47] While fisheries management had to respond on short time scales, PICES could provide help understanding problems of production on longer time scales.

William Aron of the Alaska Fisheries Science Center wrote several letters supporting the distinction between PICES and fisheries commissions. He wrote to a NMFS official,

> From its very beginning, PICES stipulated that it would play no role in either management or in regard to anadromous species. It would not seek to replace any other body, such as INPFC or its successor organization, or the pending organization associated with the Bering Sea pollock fisheries issue. It would, on the other hand, work in cooperation with those and other groups to strengthen the research elements of their activities. This is particularly important when

> dealing with non-fisheries research work that may be of critical value to essential ecosystem studies. . . . Any concerns that PICES would interfere with ongoing fisheries organizations or would compromise the role of a variety of needed constituency advisers are without realistic foundations.[48]

The objectives of PICES and NPAFC differed significantly. PICES's broad mandate promoted marine research on climate, weather, and human impacts in the region's ecosystems, facilitating the collection and exchange of marine data on a wide range of research. NPAFC, on the other hand, focused primarily on the management of salmonids, though some scientists argued it could do much more because its convention said it could address "as appropriate, ecologically related species." This allowance for ecologically related species arose because of the achievements of the INPFC in researching beyond anadromous fish to their place in the food web. The NPAFC Convention could be argued to allow for scientific studies just as broad as those of PICES. NPAFC also cooperated in exchanges of scientific personnel and in seminars and workshops. Both NPAFC and PICES addressed the northern North Pacific, but ironically NPAFC management operated only outside EEZs, where salmon fishing was no longer legal.

Regardless of what people in either organization wanted, the government representatives clearly controlled the extent to which both were able to undertake certain activities. Each government was painfully aware of limited budgets and wanted to ensure its money was well spent pursuing the wisest management of resources in the region. Nevertheless, they recognized that each of the two organizations needed to create programs at a pace and a manner that suited their available expertise. Developing a working relationship between PICES and NPAFC would take some time.

Before the first annual meeting of NPAFC in October 1993, its Committee on Scientific Research and Statistics (CSRS) had an agenda item titled "Cooperation with PICES, including a review of the rationale for the cooperation of NPAFC with PICES." The NPAFC delegates reached no agreement. The Canadians wanted NPAFC to seek scientific advice from PICES, but the United States countered that would result in PICES getting involved in activities that it was not intended to perform and would strip NPAFC of any meaningful scientific inquiry. At its first annual meeting, the CSRS suggested that it could jointly look at changes of productivity on salmon carrying capacity and factors affecting salmon biology. The Japan Fisheries Agency wanted NPAFC to promote basic scientific studies of salmon biology for their management, skeptical of the numerical modeling approach, judging it impractical for clarifying the carrying capacity of salmon.[49] Year

by year, both NPAFC and PICES reasserted the need to cooperate but each organization had plenty to do with its own agenda.

Many scientists, particularly fisheries scientists, hoped that PICES would advise fisheries concerns. Wooster thought that, although PICES might provide a useful service to the short-term needs of fisheries, its major contributions would come from studying longer term, multidisciplinary problems for which fisheries agencies had neither time nor money. From the start, Wooster thought PICES would evolve toward a fishery role similar to that of ICES, although he hoped that short-term fishery advisory role would not come to dominate PICES at the expense of its scientific work as it had in ICES for a time. He also did not want to see providing advice "gobbling up PICES energies while driving away non-fishery types," but suspected that neither did the Alaskans or the Japanese.[50] Fisheries were so economically important to the Alaskans and Japanese that they were not willing to alter existing delicate fisheries management arrangements. Wooster suggested that the place to start exploring how PICES might handle questions requiring a quick response would be in an informal "task team" in the fisheries science committee. In a perspectives piece, Wooster exclaimed, "We must keep in mind that PICES is not PISCES!," a play on words highlighting a recurring issue within the organization.[51] In most countries, fisheries science was separate from other marine fields like weather or climate studies. Because several member countries had assigned staff from their fishery agencies to represent them at PICES, other departments as well as important universities and research centers that handled environmental science were left out. Wooster wanted to reemphasize that PICES was an inclusive marine science organization, not a specialized fishery one.[52]

Cooperation got a boost in the formation of a joint PICES-NPAFC task group on fisheries data to begin converting INPFC catch statistics to electronic files.[53] In 1994, the PICES Governing Council advised that, because a short-lived working group could not solve long-term data exchange problems, a new permanent committee should be established to join those of the Science Board, BIO, FIS, POC, and MEQ. TCODE, the Technical Committee on Data Exchange, was to provide stronger data management, a crucial function of the organization. Scientists needed access to information as varied as ship schedules, meteorological data, fish catches, environmental indices, and remote sensing data. Instead of becoming mired in massive data sets, TCODE would compile information on the location of all relevant databases.

THE PICES-GLOBEC "FOUR CS" PROGRAM

In the late 1970s, remarkable changes in ocean temperature and atmospheric pressure occurred in the North Pacific and adjacent seas, now considered evidence of large-scale climate and ecosystem change affecting both physical and biological conditions. Climate variation could be short fluctuations, interannual changes such as El Niño events, or longer-term changes, such as global cooling or warming. Concurrent changes in temperature and atmospheric pressure suggested that in 1976 and 1977 the North Pacific shifted from one climate state to another (a "regime shift"), which persisted into the 1980s. Global models suggested effects of global warming would be strongest and first observed at higher latitudes such as the PICES region. Among the recent physical changes was a warming over Alaska, a change in the distribution of Bering Sea ice, and a cooling over the central and western North Pacific. Growing evidence suggested that biological productivity in the North Pacific had alternated between periods of high and low productivity in response to both short and longer-term variations in global climate. It is of great concern to both basic and applied marine science to observe, track, and predict these variations. For far too long traditional fisheries models ignored the influence of environmental factors on fish, but by the mid 1990s fisheries scientists were convinced that improving knowledge of climate variability was essential to further understanding of marine fisheries.[54] Climate change is now considered by many prominent scientists to be a major problem facing science and society, and predictions are that human activities, such as the release of greenhouse gases, will create significant future change with significant effects from agriculture to fisheries.

The impacts of climate change on fish and fisheries come from a complex interaction of physical, chemical, and biological changes. Changing water temperature and levels, extreme climate events, and changing food web structure interact with fishing to impact both the biology and distribution of commercially important species. For instance, increasing evidence suggests significant relationships between commercial catches, juvenile abundance, and large-scale oceanic factors. Pacific Rim countries have seen dramatic fluctuations in several species over the past century, with increases and collapses of Asian and Californian Pacific sardine populations as one example. Current catches of salmon could change significantly when the next climate regime shift occurs, and large fluctuations in fish abundances, regardless of the cause, have important economic and social effects. The increasingly evident interaction of climate with fish abundance altered the age-old debate

over the relative importance of fishing pressures and environmental change on population size. This problem had been long-standing, as evidenced by the famous example of the Bohuslän herring fishery off the coast of Sweden, whose rebound was associated with a layer of water of particular salinity and temperature.[55] Scientists had their work cut out for them because significant changes in ocean climate did not affect all ecosystems or species in the same way, and these responses were affected by whether one investigated coastal waters or the open ocean.

In 1993 PICES charged two working groups with the task of thinking through the relationship between PICES interests and those of the Global Ocean Ecosystem Dynamics program (GLOBEC), an international umbrella for planning and information exchange between national programs on global change. GLOBEC was particularly focused on how variability in the physical environment impacts the abundance, distribution, and productivity of marine populations. The working groups recommended that PICES hold a workshop to develop a PICES-GLOBEC Program on Climate Change and Carrying Capacity (CCCC).[56] The Four Cs was composed of task teams whose members came from PICES's four permanent scientific committees and proved to be a major unifying focus for PICES efforts.[57] Such a major program required careful study of its feasibility, along with analysis of existing data and model building for the project.

The GLOBEC interdisciplinary program grew from various national research initiatives on climate change in marine systems in the International Geosphere-Biosphere Programme (IGBP of ICSU). The growth of cooperative ocean monitoring systems and new technology allowed for such efficient, large-scale projects. Because GLOBEC work was conducted and paid for by individual nations, its investigations were mostly along coasts, where each country had vested interest. PICES could coordinate and promote these activities, providing ideas and information outside coastal systems on the ocean-scale impacts on these systems. It could also encourage its member states to provide necessary support for connecting these CCCC components.

The 1994 CCCC workshop in Japan, preceding the third annual PICES meeting, had over a hundred participants and was cosponsored by the Japan Fisheries Agency, an optimistic signal for warming relations between marine science and fisheries. The workshop was to develop a plan for a new international science program in the North Pacific. It developed a four-year plan to study how climate variation affects productivity at both small and large geographic scales using an ecosystem approach from plankton productivity

up to fish populations. It strongly emphasized linking atmospheric and oceanic processes as they impacted marine resources, asking eight key scientific questions and outlining four research activities: retrospective analyses, developing numerical models, studying ecosystem processes, and developing observation systems.[58]

Wooster appreciated the need for planning, but he saw an opportunity for PICES to use CCCC to make its mark in marine research. He was eager to prompt PICES to implement the CCCC. PICES needed to act to keep peoples' attention with scientific programs like the CCCC, monitoring, and data exchange where it could make a clear contribution. If scientists could make progress in their working groups between sessions, then PICES would have more to show. He wrote to Burke "We are trying to think how to move PICES along to the next stage of its life. It functions but hasn't really yet accomplished anything that impacts marine research in the region." Its convention and rules and procedure meant that the form of the organization was well established, but its scientific presentations needed strengthening to make a real impact. Wooster wanted to make the meetings so exciting that scientists would make participation a high priority.[59]

Key questions included how variations in ocean conditions affected species dominance, biomass, and productivity, what characterized regime shifts in climate, how coastal and open ecosystems were structured, how they were affected by variations in flow and dynamics of east and west boundary currents, and how salmon were affected by changes in productivity. For instance, if they appeared stunted, then they might have reached their carrying capacity, though the very notion of carrying capacity would have to be refined for such complex systems. The CCCC program would develop a new theoretical and mathematical framework to incorporate many species into the traditional single species concept of carrying capacity.[60] The ultimate goal was to forecast the consequences of climate variability on the ecosystems of the subarctic Pacific. Changes in ocean climate do not affect all ecosystems or species in the same way, nor was it known whether ecosystems or species would respond in the same way to a specific change in ocean climate. Progress in technological oceanography, especially in satellite data collection, promised great advances for a physical and biochemical circulation study on the North Pacific. A workshop on "Monitoring Subarctic Pacific Ocean Variability" was held in cooperation with the Science and Technology Agency of Japan (STA) in Nemuro, Japan, in 1994, to review ongoing and planned monitoring programs and encourage their continuation. A few of its recommendations were to help principal investigators

find long-term funding for continuous plankton recorder projects and aid in the interpretation of such information by providing supplemental environmental data of sea conditions. Participants also thought future acoustic monitoring would be beneficial.

By PICES's sixth annual meeting in 1997 the CCCC program finally moved from its planning stage, though it still needed more atmospheric scientists to join with oceanographers from the PICES community. In 2000, interdisciplinary communication had improved as participation expanded to include climatologists taking part in the North Pacific CO_2 Data Synthesis Symposium. Beyond inclusion of disciplines, one of the problems in implementation was that some governments had appointed working group members and then not paid for their travel, and in one case an appointed member had been unproductive. These were only a couple of unresolved features of an otherwise largely successful cooperative effort.

The CCCC program drew on the PICES scientific committees and working groups, particularly those concerned with coastal pelagic fish, modeling, monitoring, and data exchange. Although CCCC was to provide a stronger scientific base for the rational harvesting and management of marine resources, PICES itself continued not to have any fisheries management responsibility or authority. Instead, the CCCC data would be freely available to both national and international management agencies, and PICES would cooperate with the region's international fisheries organizations (e.g., work on salmonids would be done in close cooperation with NPAFC).

INCREASED INTERACTIONS WITH NPAFC

The CCCC proved to be a promising opportunity for increased exchange between PICES and NPAFC. The NPAFC Committee on Scientific Research and Statistics reaffirmed in its 1994 annual report the need for NPAFC and PICES to jointly examine two critical issues: factors affecting productivity of the North Pacific Ocean and their impacts on salmonid carrying capacity and second, the factors affecting changes in the biological characteristics of Pacific salmon including growth, size and age at maturity, oceanic distribution, survival, and abundance. The CSRS Committee was pleased that the proposed PICES-GLOBEC CCCC program would include studies on anadromous fish. The NPAFC liaison member at the PICES-GLOBEC Workshop in Nemuro, Japan, was charged to convey what NPAFC could contribute to the joint effort. PICES could take the lead by inviting scientists closely linked to NPAFC to participate in planning the program.[61] NPAFC had

inherited from its precursor, INPFC, a large number of valuable documents and data on the oceanography and living marine resources in the North Pacific Ocean, which it would gladly share to implement the CCCC program. NPAFC naturally expected to take the lead in directing that part of the CCCC program dealing with anadromous species and did so.[62] For instance, in 1994 the NPAFC liaison to the CCCC Workshop was instructed to share such data.

A NEW INTEGRATING PROJECT: ECOSYSTEM STATUS REPORTS

The interdisciplinary PICES-GLOBEC CCCC program proved to be a fruitful focus for member countries, national institutions, and individual scientists. The CCCC has been PICES's broadest scientific enterprise, requiring participation of meteorologists, oceanographers of all types, and fisheries scientists, especially those taking an ecosystem approach to examining the causes of fish stock fluctuations.

PICES had not yet directed concerted effort to anthropogenic agents of ecosystem change such as eutrophication, contamination, invasive species, and overfishing. Some of these issues were beginning to be addressed in planning for a North Pacific Ecosystem Status Report. Patricia Livingston, chairman of the Science Board, had, along with others, promoted such reports as a way to periodically review and summarize the status and trends of marine ecosystems in the North Pacific. To be true to the integrating idea of ecosystems, it was not to be merely a static list of species and their abundances, but rather a dynamic assessment of the processes causing or expected to cause change in systems in the near future. This second major PICES program was intended to review and summarize periodically the condition and trends of the marine systems in the North Pacific. It was modeled in part on the Canadian Annual State of the Ocean Reports produced by Fisheries and Oceans Canada and the annual State of the California Current reports of the U.S. CalCOFI program, as well as drawing on previous PICES scientific reports and finer scale studies of specific geographic locations and subjects. PICES would act as the clearinghouse for all material sent to it to detail the current conditions of marine ecosystems and compare them to past observations, providing one window on climate change. These status reports were not to be a static species inventory, however, but dynamic, ongoing assessments, considering the processes causing or expected to cause future changes in ecosystems, invaluable for predicting future impacts on marine resources. Over the past decade, technological improvements in ocean

observations had advanced sufficiently to allow for, though not guarantee, timely exchange of data if other political and financial challenges could be met, and those exchanges increased understanding of the interactions between ocean and atmosphere.

The initial report would first address geographic locations and subjects where time series data or other information was readily available. Later it would identify locations and subjects where data had been collected but were not yet available. If the pilot report proved successful, then the Science Board would make the assessment a regular feature of PICES work.

Ecosystem status reports had the potential to become a unifying project just as the CCCC project had, spanning nations, geographic scales, and disciplines and addressing both basic and applied needs. These reports could combine information on changes in physical and biological oceanography with those in the higher trophic levels, including commercial fishes, marine mammals, and seabirds. Scientists needed to build pictures at all scales of the state of both local and regional ecosystems. The first report, begun in 2002 by a PICES working group, took eighteen months to complete, and relied on information already available, whereas the future reports would attempt to fill in areas not so well covered by gathering recent time series. Each section, arranged by geographic area such as the Bering Sea or the western subarctic gyre, provided its status and trends on climate, hydrography, chemistry, plankton, fish and invertebrates, and marine birds and mammals. Authors then presented current understanding of pressing issues and critical factors causing change. Major commercial fish species of salmon, tuna, and halibut were given their own treatments.

The report, written in an accessible style to aid policy makers, presented its conclusions in light of continuing gaps in predictive ability. For example, although a new atmospheric pattern had changed the North Pacific storm tracks after 1998, knowledge of the climate system was still inadequate to assess whether the new cooler conditions from the Baja Peninsula to northern Vancouver Island would maintain themselves. More comprehensive ocean monitoring would likely help predictive capacity, but that would require strong commitments by institutions and governments. In the biological realm, the occurrence of harmful algal blooms was increasing around the North Pacific, with a cascading effect on other trophic levels. Of particular concern were their effects on mariculture and marine mammals, but a lack of systematic observations of plankton and small fishes limited understanding of the processes, mechanisms, and extent. On the bright side, active

management and conservation of several fish stocks had helped maintain or increase their productivity.

INTERNATIONAL YEAR OF THE OCEAN

The United Nations designated 1998 the International Year of the Ocean, which increased public awareness of the importance of the oceans. The United States announced nine major ocean initiatives, some on improving tools for observing, exploring, and using ocean data, and others on the ocean biota. These initiatives meshed well with the topics of interest in PICES, though they were not explicitly considered by PICES. That same year, the United States and Japan co-hosted the Asia-Pacific Economic Cooperation (APEC) conference that included all contracting parties in PICES.[63] One of the conference's three themes was "understanding the oceans and seas," so clearly it was of interest to both APEC and PICES. The Chinese delegate to APEC remarked that ever since the U.N. Rio Conference and Agenda 21, his government had been attaching greater importance to the development and protection of the ocean.[64]

10TH ANNUAL MEETING, VICTORIA, CANADA (2001)

The jubilee tenth anniversary meeting returned to the Secretariat's home country of Canada, and the city of Victoria, where the first meeting had been held in 1992. It was a time of both celebration and reassessment, with keynote speaker Warren Wooster giving a retrospective of the accomplishments of and challenges for PICES. Almost five hundred marine scientists attended the sessions, a significant increase from the earliest years. For ten years PICES had tackled discrete issues of specific regions like the Okhotsk Sea, and created a major integrative program with the climate change and carrying capacity initiative. The focus of the scientific sessions during the week was on reviewing PICES's scientific productivity and judging its efforts in light of its original mandate. The proposed compilation of the North Pacific Ecosystem Status Report generated discussion on what to do about inefficient PICES committees. The Governing Council agreed to review the current structure, especially the cumbersome task forces developed through the CCCC program.

For the theme of the 2002 meeting, the scientific committees chose "Technological Advancements in Marine Scientific Research." Based on that, they selected topic sessions in food web dynamics and productivity in marginal

seas, responses of upper trophic level predators to variability in prey availability, topographic influences on micronekton, harmful algal blooms, and the nature of regime shifts in physics and biology. In addition, two new groups were formed, a working group on Biogeochemical Data Integration and Synthesis, and the North Pacific Data Buoys advisory panel, and work was begun on the North Pacific Ecosystem Status Report.

The Governing Council took the opportunity to call for an internal audit of the organization to assess whether the original purpose of the organization was being realized, and if the current structure was appropriate for those objectives. The audit was also an opportunity to list accomplishments and challenges for the future. How would they assess whether PICES had measured up to its aspirations of becoming the premier organization for marine studies in the northern Pacific Ocean?

Chapter 4

Epilogue

PICES's broad purpose was promoting and coordinating marine scientific research in the North Pacific, including its role in global weather and climate change, its flora, fauna, and ecosystems, and impacts upon it from human activities.[1] Judging how well the organization was fulfilling this remarkably inclusive goal would take both a pragmatic accounting of accomplishments and an assessment of whether it was addressing the interests of member countries and their scientists. Over its first decade, PICES tackled problems that were sometimes regional and sometimes thematic in focus. Regions included the Bering Sea, the Japan/East Sea, the Okhotsk Sea and Oyashio region, and the subarctic gyre, while themes ranged from iron fertilization experiments to data exchange and coastal pelagic fisheries.

The organization celebrated its first decade with a symposium on "Ten years of PICES science: decadal-scale scientific progress

and prognosis for a regime shift in scientific approach."[2] Former or current chairmen of the four disciplinary committees and the CCCC program reviewed their committees' actions of the previous ten years and speculated on challenges for the future.[3] In addition, scientists from outside the committees were invited to present independent assessments of the state of the field. Timothy Parsons assessed biological oceanography's progress and future, while D.E. Harrison and Neville Smith outlined the promise of new technology aiding ocean development, and Robie Macdonald and others assessed the future of the marine environmental quality program.

For the biological oceanography committee (BIO), Tsutomu Ikeda and Patricia Wheeler identified three major themes from the previous decade of biological oceanography: regional and basin-scale comparisons of trophic levels, the importance of life history strategies for ecosystem analysis, and the role of biogeochemical cycling. Because changes in food web structure can dramatically reverberate across trophic levels, it is crucial to understand linkages between them. For example, large phytoplankton blooms in the Bering Sea and concurrent decline in the abundance of zooplankton had been correlated with a massive die-off of marine birds, highlighting both trophic levels and life history strategies. Trace metals like iron had been shown to dramatically limit phytoplankton production and continued to be of great interest. Ikeda and Wheeler tabulated the topic sessions that the committee sponsored or cosponsored at annual meetings, ranging from paleoecological studies to cross-committee sponsored sessions like carbon and contaminant cycling. The special publication of a symposium organized by CCCC with participation by BIO on the "Ecosystem dynamics in the eastern and western gyres of the subarctic Pacific" highlighted geographical differences in ocean basins.[4] Ikeda and Wheeler called for more work on under-studied micronekton such as small squid and shrimp, as well as on marine birds and mammals. Although successful in coordinating with other committees, BIO called for an increase in PICES scientist participation in the various working groups, task teams, and committees.

The main activities of the fishery science committee (FIS) mirrored those of other committees in developing symposia, supporting working groups, and convening special meetings, in their case on topics ranging from recruitment variability to models linking climate and fish. Douglas Hay et al.'s 2002 review concluded that PICES had improved communication in fisheries science, yet it had not done enough in starting collaborative scientific projects on the health of fisheries. Hay et al. suggested that PICES had been more successful in enhancing communication than in developing

new collaborations. To determine whether fisheries science was being fairly treated within PICES, the review analyzed how much time was devoted to strictly fisheries issues at annual meetings and scientific reports compared to the other committees of physical oceanography and climate, biological oceanography, and marine environmental quality. They concluded that although fisheries science had equal footing with other disciplinary committees at meetings and in publications, it was under-represented in what it had to offer, and they called for expanding its role, though not at the expense of other topics. They suggested PICES create a fifth scientific committee of aquaculture. They hoped that by doing so, PICES could do more to bring good scientific information to groups wanting to understand and respond to the fluctuations of fisheries through the 1990s and after.[5]

For PICES as an organization, however, aquaculture was problematic as a theme. China in particular had become the leading global producer of farmed fish and realized the need for better scientific study of its impact on other marine resources. But because aquaculture was a nearshore operation, it was tied tightly to local conditions and was carried out entirely within EEZs. Thus aquatic scientists from countries with less fish farming thought focusing on aquaculture would be the wrong scale for real international cooperation. Besides, since 1970 there existed an active world aquaculture organization that seemed best suited to such work.[6]

The economist Giulio Pontecorvo attributed the failure of fisheries management in part to the insularity among oceanographers, fisheries biologists, and economists and in part to the inability of the practitioners in individual disciplines to recognize the uncertainty created by the complexity of the marine environment.[7] Fisheries science had long been dominated by a paradigm that attributed changes in fish stocks largely to human activities like fishing, in part because environmental influence was so difficult to assess. Evidence had now accumulated that large effects also arise from other sources, in particular from climate variations, and it has led to greater interest in ecosystem-scale processes. For example, a recent NPAFC newsletter noted, "There is now solid evidence that large fluctuations in salmon abundance occurred for thousands of years [i.e., long before there was significant human fishing]. No longer do scientists believe that fishing is the only factor affecting salmon abundance."[8] Such growing recognition could be used to affect the potential role of PICES in providing advice for fisheries management as well as for other human activities in the subarctic Pacific. The fisheries science review emphasized the opportunity to make significant improvements to human welfare by better fisheries management.

From its beginnings, the marine environmental quality committee (MEQ) had responded to national priorities calling for practical results by emphasizing coastal or regional approaches rather than larger geographical scales. The advantage was that nations were vitally interested in their coastal waters, but the disadvantage was that issues or results were often country-specific, rather than applicable to all member nations. Nevertheless, Richard Addison's review team for MEQ was optimistic about its ability to foster new collaborations because of the applied aspects of its work. Two topics of top priority to it from the first PICES annual meeting were harmful algal blooms and chemical and biological contaminants, both of which required coordinated and calibrated assessment. MEQ had hosted a workshop on comparing different methods of assessing environmental quality problems in order to harmonize them as much as possible. The review team also presented a systematic review of environmental stresses on the North Pacific system and proposed how they should be studied; the proposal included coastal pollution and eutrophication work, mariculture, diseases and their relationship to pollution, and impacts of climate change on coastal systems. Since the definition of what constituted pollution had expanded over the decade from classical chemical contamination to include habitat destruction and invasive exotics, MEQ was rethinking its previous focus on coastal systems and was considering expanding its geographic reach to better match the large scale of the other scientific committees.

Paul LeBlond reviewed the work of the physical oceanography and climate committee (POC), finding that it had kept busy with its original four topics of ocean circulation and climate variability, the Okhotsk Sea and the Oyashio region, new technologies, and improved data collection. Its members hoped that improved data exchange could produce a better understanding of the process of climate change. Underlying all these questions, of course, was improved understanding of the physics of the ocean and its interaction with the atmosphere. Various PICES working groups constituted over the years addressed these questions, and made recommendations. For instance, Working Group 7 on modeling the subarctic Pacific circulation found that limited scientific access to the EEZs seriously restricted international cooperative studies. The dearth of high-resolution bathymetric data from strategically sensitive coastal areas limited the accuracy of coastal circulation models.[9] Pacific circulation remained a central concern. From its beginnings the committee had advocated solid long-term monitoring programs in addition to the more flashy new projects.

Finally, R. Ian Perry, Anne Hollowed, and Takashige Sugimoto examined the PICES Climate Change and Carrying Capacity (CCCC) program. It had been explicitly designed as an integrated program to bridge the four disciplinary committees of PICES and bring physical and biological oceanographers and fisheries scientists into fuller interaction. It eventually included four task teams integrating research activities and spatial scales over twelve regions through modeling, basin and regional scale studies, and monitoring. The modeling task team, for instance, recognized that physical oceanography models were better developed than biological ones, and so developed a lower trophic level model to link with physical and upper trophic level models.[10] The task team modeling oceanic basins was international in both its composition and its comparative focus on the western and eastern Pacific. This marked a departure from the pattern where only Westerners, or only Asians, were doing a study of their own region. Large-scale iron fertilization experiments were another integrating project within CCCC.

CCCC was not designed to carry out its own experimental program, rather it was meant to develop and coordinate national activities that had disparate timetables, goals, and funding cycles. The administrative requirements of such a large project as CCCC produced a nested committee structure that sometimes overwhelmed effectively sharing information and ideas. A second difficulty was that its overall coordinating function did not have its own funding and instead individual nations funded their own programs with their own priorities. Despite these difficulties, CCCC produced a central integrating project resulting in better understanding of the northern Pacific marine system through both modeling and experimentation.

PICES INTERNAL REVIEW

The PICES Governing Council established a review committee to assess the objectives, functions, and role of PICES in light of changing requirements for scientific information, to consider whether it was effectively integrating the disciplines that made up PICES, and to see whether its structure was still appropriate to achieve its objectives. The success of the organization depended on being an essential venue for cutting-edge research that was also responsive to the needs of its governmental members. A risk of any internal audit is that it will not reveal, or that it will be unable to assess, the strengths and weaknesses of its own organization. Thus the eight-person review committee was chosen to be large and diverse enough to clearly assess accomplishments and challenges. It had representation from each member

country, the chairman of Finance and Administration committee, and the previous and current chairman of the Science Board, and included Warren Wooster as founder and first chair. The review committee drew on previous discussions and scientific reports produced by PICES participants.

The preamble of the review committee's report summarized the status of PICES as an internationally renowned organization for coordinating and advancing marine science in the North Pacific. The work and publications of PICES were considered "to be of the highest quality" as judged by the regular production of peer-reviewed articles and the repeated and broadening international attendance of scientists at meetings.[11]

The review acknowledged that the organization's formal purpose comprised every possible facet of scientific study in the northern Pacific Ocean. What was the best direction to take in deepening understanding of the region? Such a broad mandate allowed scientists the greatest flexibility in their work, but it could be a drawback if it failed to organize scientific effort productively. As members of an intergovernmental organization, PICES countries also wanted effort expended on their pressing marine problems. PICES was coalescing just when ecosystem management was being promoted as a way to address serious challenges to resource management, but which required a restructuring of traditional disciplinary divisions in fisheries and oceanography.

Over the past ten years, the principal scientific issues for the North Pacific had changed and expanded. They included a broader recognition that the complexity of ecosystem change included not just climate change, but also fishing pressure, habitat alteration, and contaminants. The complexity of integrating differences in geographic scale, from local to basin, regional, and global scales required unprecedented study, using all available approaches such as box models, case studies, indicator species, and time series. Over the past decade, technological improvements had allowed for better ocean observation networks, making it possible to observe systems, assess data, and distribute and synthesize data for utilitarian forecasts of ocean conditions. That in turn produced better understanding of the interactions between atmosphere and ocean in climate variability and change. Such increasing detail could provide better illustrations of processes to aid policymakers.

The understanding of the complexity of ecosystems had grown with finer distinctions drawn between what was natural or anthropogenic change, and with an increased recognition of human influence on global change and its consequences. The review committee acknowledged that scientific progress was not evenly distributed, with commercially important fish species, for

example pollock, commanding more attention than other noncommercial and hard to sample ecosystem components. Commercial fisheries warranted continuous attention as their stocks fluctuated, sometimes dramatically, affecting national economies. There was growing public recognition that noncommercial fish had impacts on commercial quantities. Unpredictability of harvest produced increased interest in coastal aquaculture by governments and private enterprises, but aquaculture had its costs as well as benefits. In fisheries there was a growing appreciation for the multiple causes of fluctuations in commercial fish stocks, though the timely collection and exchange of fisheries data remained a problem. Only an inclusive approach could produce an understanding of marine ecosystems that would allow effective management or mitigation of human-caused degradation. Dynamic ecosystem assessments rather than static species inventories would provide a realistic picture of the state of the ocean. Because few of the workshops and symposia of the past had focused on the impact of humans on these marine systems, it seemed time to redirect focus to "human dimensions of ecosystem variability" at the 2003 annual meeting.

The review recognized and proposed solutions for a number of problems in carrying out the functions of the organization. Throughout the years the PICES committees were supposed not only to identify, but also to prioritize relevant scientific research. Although they listed pressing issues and challenges, they often did not order them by greatest priority. Because the standing committees were disciplinary by design, they more readily advanced understanding within, rather than across disciplines. In more recent years, however, cosponsorship of scientific sessions had improved. The recommendations of committee working groups needed to be acted upon more vigorously by their parent committees.

One unexpected difficulty was the proliferation of subsidiary bodies within committees, such as advisory panels on marine birds and mammals, data buoys, and various techniques and study groups to help establish new activities. Perhaps this was related to some committees having much broader mandates than others. For instance, BIO spanned the microscopic to the massive, and established its advisory panel on birds and mammals as one way to partition the efforts of the committee. That partitioning, however, drove up the cost of participation in both time and money, so the review committee suggested that member countries form national committees to help coordinate the involvement of their scientists. Clearly participants found the PICES community useful because meetings were well attended, but they needed to make their home countries aware of how useful it was

to their productivity as scientists. In 2000, PICES established the Wooster Award to recognize individuals who made significant scientific contributions to North Pacific marine science through excellence in research, teaching, and administration. The review committee recommended that PICES create two new awards: the PICES Builder's Award, for individuals who contributed to the scientific reputation and/or public awareness of PICES's accomplishments; and the PICES Service Award, to recognize outgoing chairmen of PICES groups upon term completion. These awards, as well as the Wooster Award and the annual meeting Best Presentation and Best Poster awards, would acknowledge and encourage continuing involvement.

Because PICES was predicated on an ecosystem approach, some have suggested that PICES should expand its target area to the whole of the Pacific to allow for true integration of global processes. That, however, would require revisiting the PICES Convention, an unwelcome journey, given the risk and effort of renegotiating an international treaty. The review rejected recommending such an upheaval, and focused on the function of the organization: identifying and ranking scientific research to evaluate the status of North Pacific ecosystems, promoting the collection, synthesis, and exchange of data, and building capacity, or the ability to carry out these functions.

Perhaps most pressing for PICES was that while expectations grew for its mandate, its Secretariat remained at its original level of staffing and budget. The one consistent decision by all delegates at yearly council meetings was that the annual membership dues should not increase. Although early on some scientists had hoped that PICES might be a coordinator of joint international research cruises like NPAFC, it could not possibly do so without a significant increase in operating funds. Nor could it act as a repository of databases, having decided that those latter functions were best continued by other organizations like the World Data Centers. Nevertheless it needed to link effectively to research cruises and data centers. Over the decade, the organization had had to make increasingly difficult decisions about where to direct its constrained capacity.

A new position of science officer could go far in more tightly linking the Secretariat and its administrative duties with the science of the organization. This person could coordinate scientific projects like the North Pacific Ecosystem Status Report, and manage the production and exchange of reports among groups. Of course a new staff position would require an increased budget.

The review committee's general consensus was optimistic, with their recommendations more evolutionary than revolutionary, intended to produce

further and greater recognition in the scientific community and the public at large. Perry and Livingston concluded, "The challenge for PICES in the next decade is to move beyond a focus on scientific communications into a defining role of the principal scientific issues in the North Pacific, and perhaps into providing consensus scientific advice on critical marine problems facing the nations of the North Pacific."[12]

CONCLUSION

What lessons have emerged from the creation of this intergovernmental organization? While the actual establishment of PICES was in signing its treaty, it was the two decades of preparatory discussion, persuasion, and negotiation that formed the strong basis for how it would actually function. Rather than the usual pattern of governments deciding to create an intergovernmental body, the impetus for PICES came from scientists themselves who wanted a more effective organization to coordinate and mobilize scientific effort in the northern North Pacific. A challenge of this bottom up approach was that government interests and immediate goals could be quite different from some of these scientific aspirations for integrative research. Governments are mandated to produce directed research in response to perceived public need. Curiosity-driven science might have applied aspects, but its product was often harder to justify in economic terms. Once governments became involved, proponents had to appeal to applied concerns while reasserting the central focus of fostering diverse marine science. At the same time, governments had to be persuaded that it was not a fisheries management body in disguise. Because of each country's experience with fisheries treaties, it was an ongoing challenge to delineate PICES's role in fisheries science. Its emphasis on an ecosystem perspective rather than a disciplinary perspective led to some unifying projects that recognize all disciplines and scales of study.

As with any organization, PICES struggled between being open to new approaches, while being structured by its initial vision. Over the years, every discussion had at least some new participants who brought their own interpretations of the idea and structure of international scientific cooperation. The PICES Convention allowed flexibility by its brevity, with its scientist participants the real strength of the organization. The scientists have remained the center of the intergovernmental organization, determining what research will best uncover the unknowns of the northern North Pacific Ocean. Through their examination of unanswered questions, the

PICES working groups synthesized existing research and signaled useful new directions by publication and persuasion.

PICES built its reputation for good science by producing peer-reviewed research of interest to both its scientist participants and member countries. The organization could not exist without both constituencies. Within those two groups lie ever more divisions of interests and visions for the organization. Government and public demands for scientific research to address pressing social concerns and public policy will continue. For PICES to grow as an organization it must continually reassess where its efforts will produce the best understanding of the complex interactions of the ocean and its environment. Addressing applied problems, and recasting basic science in applied terms appears to be a productive approach. Mounting concerns over global climate change, the fluctuation and drastic declines in some ocean fisheries, ocean contamination, and eutrophication ensure that scientists using PICES as a regional forum will have plenty of issues to address in the future.

Proponents of PICES desired it to bridge fisheries and oceanography across international boundaries. The effort to create and maintain this regional marine science organization reveals the challenge, complexity, and rewards of fostering international scientific exchange. In practice, this successful initiative for a new major oceanographic program relied on the vision and energy of a few persistent advocates while drawing in a much broader community.

The formation of PICES reveals political, economic, and scientific exchanges that are key to competing visions for marine science among individuals and countries of the Pacific Rim. The institution had to be flexible yet strong enough to withstand recurrent political and scientific disputes and upheaval. Scientists, politicians, and governments shaped its eventual form, as did differing assumptions about its primary function. The dynamic interplay of fishery and oceanographic interests exhibits the uneasy relationship between resource managers and basic scientists or scientific research applied to contemporary problems. Scientific disciplines and national interests were essential to the growth of maritime cooperation in the North Pacific. PICES emerged from years of tenacious individual effort to collaborate among scientific disciplines, institutions, and support from diverse governments. Its goal was no less than to advance scientific understanding of every aspect of the North Pacific Ocean; its interaction with the land and atmosphere, its resources, and its response to human activity. To do so its structure and members had to recognize and accommodate a broad range of

interests, expertise, and competing agendas. As a result, PICES has become the central forum for the international discussion of marine scientific questions in the northern North Pacific

Endnotes

INTRODUCTION

1 Many scientists consider the round-the-world voyage of the HMS *Challenger* in 1873–76 as beginning modern oceanographic research, although there were earlier efforts as detailed by marine historian Eric Mills.

2 The universality of science can also refer to the freedom of association and expression and access to data and information, without discrimination, necessary for effective scientific development.

3 Jacob Hamblin, "Oceanography and International Cooperation During the Early Cold War," dissertation, University of California, Santa Barbara, 2001, p. 24.

4 From its start in 1903, it quickly grew in size and changed its name when it joined with the University of California in 1912. The University of Washington began a marine station, now called Friday Harbor Laboratory, in 1904. Keith R. Benson, "The Naturalist Confronts the Pacific: Marine Biology on the West Coast of North America, 1890–1930," unpublished mss. Arthur F. McEvoy, *The Fisherman's Problem: Ecology and the Law in the California Fisheries, 1850–1980* (Cambridge: Cambridge University Press, 1986). Sketches of Russian, Japanese, and Chinese oceanog-

raphy are in Keith R. Benson and Philip F. Rehbock, *Oceanographic History: The Pacific and Beyond* (Seattle: University of Washington Press, 2003).

5 In 1871 Congress established the U.S. Commission of Fish and Fisheries led by Spencer Fullerton Baird. For a historical review see Arthur Kendall and Gary Duker, "The Development of Recruitment Fisheries Oceanography in the United States," *Fisheries Oceanography* 7.2 (1998). For a historical account of the University of Washington School of Oceanography, see Victor Scheffer and Richard Strickland, "The Origin of the Northwest's First School of Marine Science," *Columbia* 11.1 (1997).

6 Hugh McCormick Smith (1865–1941), in an address to the American Fisheries Society, as quoted in "The Beginnings of Fisheries at the University of Washington," historical timeline at http://www.fish.washington.edu/history/, accessed 15 Feb. 2005.

7 S.B. Nelson, "Oceanographic Prescience: The Deliberations of the First U.S. Interagency Conference on Oceanography, July 1, 1924," as found in Mary Sears and D. Merriman, eds., *Oceanography: The Past*, vol. 3 (Woods Hole, MA: Springer-Verlag, 1980). The University of Washington began their oceanography department in 1930.

8 Keith Benson, "History of American Marine Biology and Marine Biological Institutions," *American Zoologist* 28 (1988). The university-directed Bamfield Marine Station and the Pacific Environment Institute (now the West Vancouver Laboratory) followed much later in the early 1970s, and the Institute of Ocean Sciences (IOS) in 1978.

9 It merged with the Limnological Society of America in 1948 to form the American Society of Limnology and Oceanography. See G.H. Lauff, "A History of the American Society of Limnology and Oceanography," *Limnology in North America*, ed. D.G. Frey (Madison: University of Wisconsin Press, 1963).

10 Kathleen Barnes, "The Clash of Fishing Interests in the Pacific," *Far Eastern Survey* 23. 18 Nov. (1936). Joseph Walter Bingham, *Report on the International Law of Pacific Coastal Fisheries* (New York: Stanford University Press, 1938). References courtesy of historian Carmel Finley.

11 Tim D. Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855–1955* (Cambridge: Cambridge University Press, 1994), p. 35–36.

12 Georg Borgstrom, *Japan's World Success in Fishing* (London: Fishing News, 1964).

13 *Commercial Fisheries Review* 8.11 (1946): 45–47. Much of the Russian fishing fleet was destroyed during World War I and the 1917 revolution. Robert H. Randolph and John E. Bardach, "Soviet Science in the Pacific: The Case of Marine Biology," *Nature in Its Greatest Extent: Western Science in the Pacific*, eds. Roy MacLeod and J.F. Rehbock (Honolulu: University of Hawaii Press, 1988).

14 Toby Appel, "Marine Biology/Biological Oceanography and the Federal Patron: The NSF Initiative in Biological Oceanography in the 1960s," *The Fifth International Congress on the History of Oceanography, July 7–14, 1993*, eds. Keith Benson and

J.F. Rehbock (Seattle: University of Washington Press, 1993). James Capshew and Karen Rader, "Big Science: Price to the Present," *Osiris* 7 (1992).

15 See Henry Bryant Bigelow, *Oceanography: Its Scope, Problems and Economic Importance* (Boston: Houghton Mifflin, 1931). Also Thomas Wayland Vaughn, "The Oceanographic Point of View," *Contributions to Marine Biology: Lectures and Symposia Given at the Hopkins Marine Station* (Stanford: Stanford University Press, 1930). As found in Ronald Rainger, "Constructing a Landscape for Postwar Science: Roger Revelle, the Scripps Institution and the University of California, San Diego," *Minerva* 39 (2001).

16 For instance, Harlow Shapley, director of the Harvard Observatory, spoke on "Scientific Cooperation as an Instrument of International Peace" in 1946, "Wide Cooperation for Science Urged," *The New York Times*, 22 June 1946.

17 In 1998 it changed its name to the International Council for Science to reflect its evolving mission, but retained its original acronym for its rich history. For more details, see Frank Greenaway, *Science International: A History of the International Council of Scientific Unions* (Cambridge: Cambridge University Press, 1996).

18 Gunter Weller, *Antarctica*, 2004, AccessScience@McGraw-Hill, available: http://www.accessscience.com, 18 July 2004.

19 Tanya Levin (2000) unpublished Maury II working paper on "U.S. Oceanography During the Cold War: Forging Democracy through International Cooperation in the Late 1950s and 1960s."

20 SCOR was followed by SCAR (Scientific Committee on Antarctic Research); SCOPE (Scientific Committee on Problems of the Environment); and several other scientific committees. Tony Laughton, "International Affairs in Marine Science," *Ocean Challenge* 1, summer (1990).

21 The IIOE was its first major effort to plan a coordinated international expedition to the least-studied ocean, the Indian Ocean. Although the SCOR committees planned the scientific work of the IIOE, they had no control over national budgets or ships, so full implementation of the plans required the organization and approval of governments by way of the IOC. See Torben Wolff, "The Creation and First Years of SCOR (Scientific Committee on Oceanic Research)," Proceedings of the 4th International Congress on the History of Oceanography. Ocean Sciences: Their History and Relation to Man, eds. W. Lenz and M. Deacon, *Deutsche Hydrographische Zeitschrift* 22 (1987).

22 Planners of the International Geophysical Year (IGY) of 1957–1958 recognized that the scientific problems of the ocean require a truly interdisciplinary and international approach, so thirteen nations pooled resources to carry out the first systematic exploration of the Indian Ocean (IIOE 1959–1965). Daniel Behrman, *Assault on the Largest Unknown: The International Indian Ocean Expedition, 1959–65* (Paris: UNESCO Press, 1981). Also Warren Wooster, "International Studies of the Indian Ocean, 1959–1965," *Deep-Sea Research* 31 (1984). Warren Wooster served as secretary of the Intergovernmental Oceanographic Commission (IOC) when the IIOE was organized under its auspices.

23 Tony Laughton presents detailed organizational charts for three major organizations concerned with marine science. The U.N. (United Nations) and the IOC (Intergovernmental Oceanographic Commission) are intergovernmental, and ICSU (International Council of Scientific Unions) is nongovernmental. Laughton, "International Affairs in Marine Science."

24 In 1945 delegates from twenty-three countries gathered in Quebec City and created the FAO to improve world nutrition. By the 1960s, some fisheries scientists feared that the U.N. had far too much control over marine affairs. Attorney E.W. Allen wrote to fisheries biologist Wib Chapman, "Did you know that the precious son of F.D.R. proposed to turn the oceans over to the U.N. and has actually made too much progress already?" Letter of 14 Feb. 1967, University of Washington Libraries Wilbert McLeod Chapman Collection 1939–1970, Box 57-4.

25 The IOC of UNESCO was founded in 1960, with 40 nations becoming members and with participation by intergovernmental and nongovernmental organizations like ICES, FAO, WMO, and SCOR. Wooster served as first IOC secretary, and recalled that if the participants had been in formal wear, half of them would have had gold braid, an indication that a large number came from navy backgrounds where physical rather than biological oceanography predominated. Tjossem interview with Wooster, 27 April 2001. Hans Ulrich Roll, *A Focus for Ocean Research: Intergovernmental Oceanographic Commission: History, Functions, Achievements* (Paris: UNESCO, 1979). For an account of the development of IOC and internationalism, see Hamblin, "Oceanography and International Cooperation During the Early Cold War."

26 Roger Revelle introduced the idea of TEMA (Training, Education and Mutual Assistance) to emphasize that education is not unidirectional. Training programs for these countries could not always incorporate the most sophisticated research techniques. Laughton, "International Affairs in Marine Science." Laughton points to a more detailed report in Annex 12 of the Report of the CCMST, "Marine Science and Technology in the UK."

27 Helen Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science under ICES* (Seattle: University of Washington Press and International Council for the Exploration of the Sea, 2002).

28 Protesting poor management, the U.S. withdrew from UNESCO in 1984, and the same year the U.S. Department of Commerce conducted an extensive interagency review of the IOC. Anthony J. Calio, U.S. representative to the IOC, U.S. Department of Commerce, NOAA, requested comments on continued participation in IOC. He summarized, "Responses received recommended the full-range of U.S. participation from continuing our participation in the IOC at a significantly increased level of activity and funding to withdrawing completely from the IOC. In some instances, opposite positions were expressed from the same agency, but that is understandable since the IOC's performance from a technical perspective has not been consistently good nor bad across the spectrum of programs and issues you identified in your responses." Warren Wooster Collection, University of Washington Libraries, Box 3: PICES Jan.–July 1986. Hereafter "Wooster Box #: folder."

29 The Commission on Marine Science, Engineering and Resources was chaired by Massachusetts Institute of Technology President Emeritus Julius Stratton. It recommended that the many agencies involved in oceanography be consolidated into a single new civil agency, which in 1970 became the National Oceanic and Atmospheric Administration (NOAA). For more on its formation, see Edward Wenk, *The Politics of the Ocean* (Seattle: University of Washington Press, 1972).

30 National Academy of Sciences (NAS), *The International Decade of Ocean Exploration: An Oceanic Quest* (Washington, D.C.: National Academy Press, 1969). F. Jennings and L. King, "Bureaucracy and Science: The IDOE in the National Science Foundation," *Oceanus* 23 (1980).

31 Historian Jacob Hamblin argues that although the IDOE built government appreciation of oceanography, it politicized science and threatened scientists' autonomy by taking over the power to shape their international scientific community. Hamblin, "Oceanography and International Cooperation During the Early Cold War."

32 For example, SCOR was in ICSU and the WMO and IOC were in the U.N. Laughton, "International Affairs in Marine Science." He notes "There is often concern among scientists that the IOC bureaucracy wants to get its hands on programmes initiated by non-governmental organizations, but when it comes to encouraging governments to commit large resources, or to obtaining the full cooperation and participation of developing countries, the IOC has a vital role." (p. 21).

33 1978 draft of "An International Council for Scientific Investigation of the North Pacific." Wooster Box 1: Burke files.

34 Chief among these efforts was rationalizing ocean use through a universal Law of the Sea.

35 A.E.J. Went, *Seventy Years Agrowing: A History of the International Council for the Exploration of the Sea, 1902–1972* (Rapports et Procès-verbaux des Réunions 165 [ICES], 1972). For the most thorough account of scientific developments and debates in one hundred years of ICES, see Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science under ICES*. ICES continues as a leading forum for marine scientific research and exchange, producing formal advice on fisheries and more recently, marine pollution. The U.S. withdrew from ICES in 1914, and rejoined fifty-nine years later in 1973. Because the U.S. does not fish in the ICES region, the U.S. rejoined primarily for promoting marine science. Wooster was chosen as the nongovernment delegate of the two U.S. delegates to ICES and served as its president in 1982–1985. For early marine work in the Pacific, see Roy MacLeod and Fritz Rehbock, "Developing a Sense of the Pacific: The 1923 Pan-Pacific Science Congress in Australia," *Pacific Science* 54.3 (2000).

36 Member nations were industrialized, with relatively similar scientific capabilities and economic standing.

37 Lecture by William Royce in 1985 at the Fisheries Centennial Celebration, NOAA, in W.F. Royce, "Centennial Lecture IV: The Historical Development of Fishery Science and Management," *Marine Fisheries Review* 50.4 (1988).

38 T. Wayland Vaughn, "Proceedings of the Third Pan-Pacific Science Conference," (Tokyo, 1926), vol. 1, Resolution 3 & 4. The Pacific Science Association, founded

in 1920, met every four years, and is a nongovernmental organization with a broad intellectual and geographical mandate. Its quarterly, *Pacific Science*, published since 1947, focuses on the terrestrial and aquatic sciences of the whole Pacific basin, with a strong sociological component, such as natural disaster reduction.

39 Rozwadowski suggests others called for such an organization outside the field of marine science and used ICES as an inspiration. See Ole A. Mathisen and Donald E. Bevan, *Some International Aspects of Soviet Fisheries* (Columbus: Ohio State University Press, 1968).

40 The whole of the Pacific Ocean is approximately 64 million square miles, larger than the total land area of the world. *Encyclopaedia Britannica* (2003).

41 Helen Rozwadowski, "Internationalism, Environmental Necessity, and National Interest: Marine Science and Other Sciences," *Minerva* 42 (2004).

42 David John Frank, "Science, Nature, and the Globalization of the Environment, 1870–1990," *Social Forces* 76.2 (1997). Frank counted 156 international environmental treaties established between 1870 and 1990. He presents six models for nature, and attributes the rapid post-World War II increase in environmental discourse to a redefining of nature from savage and antisocial to integrated with society through the ecosystem concept, a transition that happened to coincide with increasing environmental degradation.

43 Roy Jackson, director of the International North Pacific Fisheries Commission (INPFC) and later an official with the U.N. Food and Agriculture Organization (FAO), recalled two Russian scientists expressing interest in the idea in the 1950s. Letter from Roy Jackson, Rome, Italy, to Warren Wooster, 28 Aug. 1978. "I can still vividly remember that when I went to Japan for the INPFC in 1955 I met Drs. Moiseev and Bogdanov on the street. We were introduced by someone and in the course of the discussion they both brought up the idea of an ICES for the Pacific and were enthusiastic advocates. Well, they are still on the job so hopefully they will live long enough to see something happen." Wooster Box 1: PICES Corresp.

CHAPTER 1

1 Edward Miles, Stephen Gibbs, David Fluharty, Christine Dawson, and David Teeter, eds., *The Management of Marine Regions: The North Pacific. An Analysis of Issues Relating to Fisheries, Marine Transportation, Marine Scientific Research, and Multiple Use Conditions and Conflicts* (Berkeley: University of California Press, 1982).

2 Its share grew to about 31% by 1991. http://www.fao.org/docrep/v4200e/V4200E1x.htm, accessed 28 Aug. 2003. Nikos Alexandratos, ed., *World Agriculture: Towards 2010, an FAO Study* (New York: Food and Agriculture Organization of the United Nations and John Wiley & Sons Ltd., 1995). The FAO: The State of Fisheries and Aquaculture 2000.

3 Dutch jurist Hugo Grotius asserted the mare liberum doctrine in 1609, arguing that no person or nation could claim any part of the high seas for exclusive use. England became a supporter of this doctrine only with the acceptance of her exclusive rights over nearshore fisheries, contributing to the concept of a territorial

sea. Exceptions to the rule were to counter piracy, and aid in pursuit and rescue. See Ann L. Hollick, *U.S. Foreign Policy and the Law of the Sea* (Princeton: University of Princeton Press, 1981). Herman T. Franssen, "Developing Country Views of Sea Law and Marine Science," *Freedom of Oceanic Research*, ed. Warren S. Wooster (New York: Crane, Russak & Company, Inc., 1973).

4 For more detailed assessment of internationalism in ocean science, see Jacob Hamblin, "Visions of International Scientific Cooperation: The Case of Oceanic Science, 1920–1955," *Minerva* 38 (2000). Hamblin suggests that the core of American marine strategy in the 1950s was to build internationalism through reciprocity of scientific development, rather than promoting scientific dependency.

5 D.H. Cushing, *The Provident Sea* (Cambridge: Cambridge University Press, 1988).

6 S. Garcia and C. Newton, "Current Situation, Trends, and Prospects in World Capture Fisheries," Global Trends: Fisheries Management, eds. E.L. Pikitch, D.D. Huppert, and M.P. Sissenwine, *American Fisheries Society Symposium* 20 (1997). The FAO started reporting world catches in the 1950s, with a 1955 catch of 55 million tons, growing to over 86 million by 1990. FAO statistical reports http://www.un.org/Depts/los/convention_agreements/convention_historical_perspective.htm#Exclusive Economic Zone, accessed 7 Jan. 2002.

7 In 1946, Argentina claimed its shelf and the sea above it, limiting the access of distant-water fishing fleets and attempting to control the depletion of fish stocks in their adjacent seas. The Santiago Declaration of 1952 (Chile, Peru, and Ecuador) established a maritime zone 200 miles wide over which they claimed sovereignty and resource rights. The appearance of several major foreign fleets off Latin American and South American countries prompted half a dozen nations to assert claims over offshore fisheries by the mid 1950s. Soon after World War II, Egypt, Ethiopia, Saudi Arabia, Libya, Venezuela, and some Eastern European countries departed from the traditional three-mile limit by laying claim to a 12-mile territorial sea. Iceland followed with a 12-mile limit in 1958, touching off the so-called Cod Wars with Britain, which lasted until 1961, with lingering disputes. A.F. McEvoy, *The Fisherman's Problem: Ecology and the Law in the California Fisheries, 1850–1980*, p. 192–193. L.S. Parsons, *Management of Marine Fisheries in Canada* (Ottawa: National Research Council Canada, 1993, p. 224). Mark Kurlansky, *Cod: A Biography of the Fish That Changed the World* (New York: Walker and Company, 1997). In 1972, Iceland extended its limit first to 50 miles, then 200 miles in 1975, each time escalating tensions between Iceland and Britain. In 1970, Canada asserted the right to regulate navigation in an area extending for 100 miles from its shores to protect arctic water against pollution.

8 See Hiroshi Kasahara and William T. Burke, *North Pacific Fisheries Management, Resources for the Future Program of International Studies of Fisheries Arrangements* (Washington, D.C., 1973).

9 William Thompson and Martin Burkenroad began what became known as the Thompson-Burkenroad debate in the 1940s over whether changes in halibut abundance could be ascribed solely to fishing pressure or to changes in environmental conditions. See B. Skud, "Revised Estimates of Halibut Abundance and the Thompson-Burkenroad Debate," *IPHC Scientific Report* 56 (1975).

10 Yvonne DeReynier, "Evolving Principles of International Fisheries Law and the North Pacific Anadromous Fish Commission," *Ocean Development and International Law* 29 (1998). For a concise summary of the INPFC negotiations, see Edward L. Miles, *Science, Politics, and International Ocean Management: The Uses of Scientific Knowledge in International Negotiations*, Institute of International Studies, Policy Papers in International Affairs, No. 33 (Berkeley: University of California, Berkeley, 1987).

11 In 1956 the Japanese and the Soviets formed the Japan-Soviet Fisheries Commission (JSFC), designed in large part to regulate Japanese fishing of salmon off the Soviet coast, but also covering king crab and herring. The Soviets had the right to set Japanese catch quotas while retaining the right to set their own. See Tsuneo Akaha, "The Postwar Japan-Soviet Fisheries Regime and Future Prospects," *Ocean Yearbook* 9 (1991).

12 Some twenty national disputes between 1974 and 1979 were over cod, anchovies, tuna, and other species. A.F. McEvoy, *The Fisherman's Problem: Ecology and the Law in the California Fisheries, 1850–1980*, p. 230. The first International Conference on the Law of the Sea (UNCLOS I) met in Geneva in 1958, followed by UNCLOS II in 1960 and UNCLOS III from 1973 to 1982. Each struggled to come to agreement on the width of territorial seas and other matters. UNCLOS III negotiations in 1973 followed the collapse of Peru's seemingly limitless anchoveta fisheries in 1972 and eventually produced a new Law of the Sea.

13 Iceland extended its zone in 1975 to 200 miles. In 1983 the Law of the Sea established an exclusive economic zone, or EEZ, of 200 miles, inside of which each country had exclusive right to the exploitation of natural resources. An immediate result was the exclusion from many areas of high-performance, long-distance foreign fleets, which were replaced by often less-efficient domestic coastal craft.

14 J.C. Stevenson, ed., "Fisheries Research Board of Canada: 1898–1973," *Fisheries Research Board of Canada Miscellaneous Special Publication* 20 (1973), p. 17.

15 Ronald Doel, "Influences of the IGY: Institutions, Interdisciplinary Practice, and Research Aims in the Growth Era of Oceanography 1957–1967," Maury III Workshop on the History of Oceanography, 20–23 June 2001 (Monterey, CA: unpublished, 2001). David K. van Keuren, "Building a New Foundation for the Ocean Sciences: The NSF and Oceanography in the 1950s and 1960s," *Maury III Workshop on the History of Oceanography, 20–23 June 2001* (Monterey, CA: unpublished, 2001).

16 The global scale of both the ICSU's Scientific Committee on Oceanic Research (SCOR), and UNESCO's Intergovernmental Oceanographic Commission (IOC) could not provide the depth of understanding of the northern North Pacific required by fisheries interests and regional scientific programs.

17 Tjossem telephone interview with Lee Alverson (5 Feb. 2002). Alverson recalled that around 8–12 scientists were present, including Americans Lee Alverson, Donald McKernan, and Richard Van Cleve, Canadian Alfred Needler, and Russian Marat Bogdanov (from VNIRO). Alverson credits Van Cleve, then Dean of the University of Washington's College of Fisheries, with leading the discussions in the 1960s that culminated in the informal discussions at the FAO meeting. Megan M. Callahan,

"PICES: A Portrait of an International Organization," Master's thesis, University of Washington, 1994. Needler took part in the first organizational meeting of the INPFC in 1954, and as chairman of the Committee on Biology and Research he developed a research program on salmon distribution, becoming an INPFC commissioner from 1963 to 1967, and again from 1970 to 1971.

18 In an unpublished note from the meeting, Alverson recalled that the Canadians were to follow up on the possibility of an intergovernmental meeting on the creation of a forum similar to that of ICES in the North Atlantic. E.D. Miles, D. Fluharty, and W. Wooster, *Scientific Cooperation and Subarctic Pacific Fishery Management* (Seattle: University of Washington, 1982).

19 Alverson received his Ph.D. in fisheries from the University of Washington, following his undergraduate work there while McKernan was a graduate student. In 1958, he was appointed director of the Exploratory Fishing and Gear Research Base of the U.S. Bureau of Commercial Fisheries. He was scientific advisor to the U.S. National Section of the INPFC, taking part in the research work of the commission throughout the northern part of the Pacific Ocean. He acted as advisor to the U.S. Department of State on negotiations on the Law of the Sea, on the effects of a change in the breadth of the territorial sea, and on fishery problems and relationships between the U.S. and USSR. He also served as chairman of the Advisory Committee on Marine Resources Research of the FAO. Drawn from Roy I. Jackson and William F. Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission* (Farnham, England: Fishing News Books Ltd, 1986).

20 Donald Lynn McKernan (1918–1979) graduated from the University of Washington College of Fisheries in 1940. Ten years later he was on special assignment as a fishery specialist to the staff of SCAP (Supreme Commander for the Allied Powers) in Tokyo. He directed Alaska fisheries research, was first director of the new U.S. Bureau of Commercial Fisheries (1957–1966), and was thus responsible for all aspects of U.S. participation in the INPFC. He taught as a special lecturer at the University of Washington for a short time in 1951, returning in 1974 as professor of fisheries and marine studies and director of the Institute for Marine Studies until his death in 1979. University of Washington Library Archives. Jackson and Royce, Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission.

21 The INPFC entered into force in June 1953, charged with overseeing and evaluating scientific research on salmon, halibut, and a few other stocks in the eastern region of the North Pacific Ocean and establishing their allocation to member nations.

22 Alverson thought some people within the INPFC did not want "an outside science group beyond its control." Tjossem telephone interview with Alverson at National Resources Consultants, Seattle, on 5 Feb. 2002.

23 Wooster received his Sc.B. in chemistry from Brown University in 1943. After serving three years in the U.S. Naval Reserve, he earned his M.S. in chemistry from the California Institute of Technology in 1947 and his Ph.D. in oceanography at Scripps Institution of Oceanography/UCLA in 1953. He became a research oceanographer at Scripps for the next dozen years, sharing the Scripps effort to bring oceanographic insights to fishery questions in the California Current. At the time,

although American oceanographic institutions had good representation of biological oceanography with plankton research, fish were usually studied separately in departments of fisheries. In 1957 Wooster was invited to Peru for a year to work on the Peru Current, then four years later he moved to Paris as director of the Office of Oceanography for UNESCO and as first general secretary of the IOC. He went to his first ICES meeting when he was secretary of the IOC and was attracted by its science and its lack of formality and bureaucracy. In 1963 he returned to Scripps for another ten years as professor. He was secretary to SCOR in 1964–1968, then served two terms as president from 1968 to 1972. From 1973 to 1976 he was Dean of the Rosenstiel School of Marine and Atmospheric Science at the University of Miami, Florida, before moving to the University of Washington. For more details see John Knauss, "Warren S. Wooster," *PICES Press* 5.1 (1997).

24 Wooster's leadership of the Northern Holiday, Shellback, and Transpac expeditions in the 1950s put him at the forefront of academic incursions into the deep sea for oceanographic studies. Transpac was the first U.S. oceanographic expedition to visit Japan after World War II. Its scientists were honored with a palace laboratory visit with Emperor Hirohito.

25 A.D. MacCall, "Population Estimates for the Waning Years of the Pacific Sardine Fishery," California Cooperative Oceanic Fisheries Investigation (CalCOFI) 20 (1979).

26 On the Transpac expedition Wooster insisted that scientific cooperation with the Japanese had to be reciprocal. Hamblin, "Visions of International Scientific Cooperation: The Case of Oceanic Science, 1920–1955." In the late 1970s Wooster became chairman of the National Academy of Science Ocean Sciences Board, a member of several other boards, and advisor on ocean affairs to the U.S. Department of State. In 1982 he was elected the first American president of ICES (1982–1985).

27 Countries with continental shelves were granted rights to those offshore resources out to a depth of 200 meters.

28 Susan Schlee, *The Edge of an Unfamiliar World. A History of Oceanography* (New York: E.P. Dutton, 1973). Eric Mills, *Biological Oceanography: An Early History 1870–1960* (Ithaca, NY: Cornell University Press, 1989). The Santa Barbara oilrig spill of 1968 was particularly important for expanding public awareness of pollution.

29 The FCMA was later renamed the Magnuson Fishery Conservation and Management Act (MFCM). See Bernard Megrey and Vidar Wespestad, "Alaskan Groundfish Resources: 10 Years of Management under the Magnuson Fishery Conservation and Management Act," *North American Journal of Fisheries Management* 10 (1990).

30 In 1983 Presidential Proclamation 5030, signed by President Ronald Reagan, created the U.S. EEZs, as found in the U.S. Federal Archives and Records Administration.

31 Edward Miles was the project's principal investigator. McKernan led its faculty review board until his death in 1979. Miles et al., eds., *The Management of Marine Regions: The North Pacific*.

32 William Burke, professor emeritus, University of Washington School of Marine Affairs, and professor, School of Law, specializes in international marine law, Law of the Sea negotiations, and marine studies. See William Burke, "Towards a Better Use of the Ocean: Contemporary Legal Problems in Ocean Development. Comments and Recommendations by an International Symposium," *SIPRI Symposium* (Stockholm, Sweden: Almqvist & Wiksell, 1969),

33 The UNCLOS III Convention was signed by 117 nations; though the U.S. and many other mostly industrial countries did not sign it, they agreed that each coastal state has sovereign rights over a 12-mile territorial sea and over natural resources and certain economic activities within a 200-mile exclusive economic zone (EEZ). Edward L. Miles, *Global Ocean Politics: The Decision Process at the Third United Nations Conference on the Law of the Sea, 1973–1982* (Cambridge, MA: Kluwer Law International, 1998).

34 Miles et al., eds., *The Management of Marine Regions: The North Pacific*. Although the convention ratified by UNCLOS III did not take effect until 1994, portions of the treaty were adopted as law during the negotiations. The Japanese accepted salmon quotas both inside and outside the Soviet EEZ on the principle devised by UNCLOS that the country of origin had special interest and responsibility for salmon. At the 1988 meeting of the JSFC, the Soviets declared that fishing outside their EEZ for Soviet-origin salmon would be eliminated by 1992, and the Soviets succeeded in halting high seas salmon fishing with support from the U.S. and Canada, concerned about their own salmon. DeReynier, "Evolving Principles of International Fisheries Law and the North Pacific Anadromous Fish Commission."

35 In 1992 the U.N. banned high seas driftnet fishing in international waters.

36 William Burke, "International Arrangements Affecting Marine Scientific Research," *The Management of Marine Regions: The North Pacific*, eds. Miles et al. Renegotiated ones include the protocol to the North Pacific Convention and the protocol to the Halibut Convention.

37 The fishing industries of the Pacific Northwest supported extended jurisdiction, but the U.S. Departments of State and Defense opposed any restrictions to marine navigation. Miles et al., eds., *The Management of Marine Regions: The North Pacific*.

38 Miles et al., eds., *The Management of Marine Regions: The North Pacific*, p. 6. The International Fisheries Commission (1923) was renamed the IPHC in 1953.

39 The INPFC was renegotiated by 1978.

40 Research contract abstract to Northwest Fisheries Center from Wooster and Burke titled "Scientific Coordination for Fisheries in the North Pacific" for 1977 to 1978, requesting $47,827. In part it says, "With enactment of the Fishery Conservation and Management Act of 1976, and with other extensions of national jurisdiction over fishery resources within 200 miles of the coasts . . . , it becomes necessary to modify or replace existing international arrangements for consultation on fishery matters. While separate species-specific management bodies may be established, scientific issues relate to a variety of fisheries and other ocean uses, and eventually it may be desirable to establish a new multilateral scientific organization broadly concerned with ocean problems in the North Pacific. In considering such an or-

ganization, it is necessary to evaluate the political realities within which it must be established and operate, to specify its objectives and functions, and to determine alternative structures within which they could be carried out." Wooster Box 1: PICES 1977.

41 The Canadians were Keith Ketchen, Pacific Biological Station, Nanaimo, British Columbia; Peter A. Larkin, University of British Columbia; and R.W. Stewart, director-general, Ocean and Aquatic Sciences, Institute of Ocean Sciences, Sidney, B.C.

42 Ketchen to Wooster, 4 April 1978. Wooster Box 1: PICES Corresp.

43 "An International Council for Scientific Investigation of the North Pacific," in Warren S. Wooster and Megan M. Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992* (Seattle: University of Washington, 1994).

44 Perry, et al., eds., *PICES Science: The First Ten Years and a Look to the Future*, p. 93.

45 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*, p. 4.

46 It is remarkable that PICES functions much like this today.

47 The Oyashio and Kuroshio flow in the west, the West Wind Drift and the Alaska Current connect the sides of the basin, the Bering Sea has its own circulation, and the California Current connects the subarctic waters with the subtropical region.

48 Wooster thought that open membership might provide the same kind of strength and stability that ICES gained from its many country members. Wooster to Roy Jackson, 8 Sept. 1978. Wooster Box 1: PICES Corresp.

49 Letter from R.W. Stewart, director-general, Institute of Ocean Sciences, B.C., to Wooster, 4 Aug. 1978. Wooster Box 1: Burke files.

50 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*, p. 7.

51 Zuoyue Wang, "Pacific Exchanges: U.S.-China Contacts in Oceanography in the Twentieth Century," *Maury II Workshop on the History of Oceanography* (Woods Hole, MA: unpublished, 1999),

52 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*, p. 7.

53 In 1984, ICES had about 40 working groups, 27 specifically on stock assessment. By 2004 the total number had grown to over 100. ICES, *ICES Annual Report for 2000* (International Council for the Exploration of the Seas, 2001).

54 J.A. Gulland, *The Management of Marine Fisheries* (Seattle: University of Washington Press, 1974), p. 157.

55 Wooster arranged for a social science investigation of whether working group advice was objective, using the ICES North Sea herring working group as a case study. The study concluded that the working groups were remarkably independent from outside influence. See Virginia Broadhurst, "The Influence of National Interests in International Scientific Organizations: What PICES Can Learn from ICES," Master's thesis, University of Washington, 1990.

56 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*, p. 8–9.

57 Wooster to Ken Sugawara, 17 Oct. 1978. Wooster Box 1: PICES Corresp.

58 William Burke to Don McKernan, 22 Feb. 1978. Wooster Box 1: Burke files.

59 William Sullivan was policy advisor for international marine affairs, NOAA, and retired from the Office of Ocean Affairs, U.S. Department of State. He became involved with fisheries and oceanography when he worked in the Office of the Special Assistant to the Under Secretary of State for Fisheries and Wildlife. He met Wooster in the 1960s when he went with a delegation to a meeting of the IOC in Paris.

60 According to Parsons, *Management of Marine Fisheries in Canada*, p. 556.

61 Letter from R.W. Stewart, director-general, Institute of Ocean Sciences, B.C., to Wooster, 4 Aug. 1978. Wooster Box 1: Burke files.

62 C.R. (Ced) Mann, director, Atlantic Oceanographic Laboratory, Environment Canada, 12 July 1978 to R.W. Stewart, director-general, Ocean and Aquatic Sciences, Pacific Fisheries and Marine Service, Institute of Ocean Sciences. Wooster Box 1: Burke files.

63 The expedition studied the flow of arctic bottom water over the submarine sill between Iceland, Scotland, and the Faroe Islands. Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science under ICES*, p. 133.

64 In the mid 1970s Canadian L. Scott Parsons was a member of the task force responsible for planning and implementing Canada's 200-mile fisheries zone. He became Assistant Deputy Minister, first of Atlantic fisheries, and then of science, Canadian Department of Fisheries and Oceans. He headed the Canadian delegation to the International Commission for the Conservation of Atlantic Tuna, the North American Salmon Conservation Organization, and the IOC. He also served as a delegate to ICES, and in 1991 was elected its vice-president.

65 L.S. Parsons, Assistant Deputy Minister, science memo "Report from a meeting to discuss a scientific organization for the Northern North Pacific" to Dr. Peter Meyboom, Deputy Minister, 2 May 1986. Wooster Box 3: PICES Jan.–July 1986.

66 Basil B. Parrish, general secretary, ICES to Wooster 2 Dec. 1987, commiserated with Wooster about cost-conscious members. Wooster Box 2: PICES Sept.–Dec. 1987.

67 In the 1920s the Biological Board of Canada became involved in practical fisheries problems. The board was renamed the Fisheries Research Board of Canada, and then became the Department of Fisheries and Oceans in 1979. (http://www.pac.

dfo-mpo.gc.ca/sci/pbs/english/pages/buildingtext.htm, accessed 27 Sept. 2002). Parsons, *Management of Marine Fisheries in Canada*.

68 Minutes of a meeting of McKernan, Wooster, and Burke at the University of Washington Institute of Marine Studies 6 Sept. 1978 on U.S.-USSR bilaterals, the INPFC, and the IWC. Wooster Box 1: Interviews re PICES Sept. 1978.

69 Wooster to Ken Sugawara, 17 Oct. 1978, Wooster Box 1: PICES Corresp.

70 Parsons, *Management of Marine Fisheries in Canada*, p. 548.

71 Ketchen to Warren Wooster, 29 Aug. 1978. Wooster Box 1: PICES Corresp.

72 Wooster wrote to Alverson, Burke, and McKernan, 21 Nov. 1978 "[K.N.] Fedorov is cynical about intergovernmental organizations and said that he was personally not interested in PICES." Fedorov was IOC secretary. Wooster Box 1: PICES Corresp.

73 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 13.

74 Beamish is a senior fisheries scientist with the Canadian Department of Fisheries and Oceans at the Pacific Biological Station, Nanaimo, B.C., where he was director from 1980 to 1993. In his varied career he has also served on the INPFC and the International Pacific Halibut Commission. He has carried out fundamental work assessing the age and reproduction of fishes and connecting them to climate change. Richard Beamish, *Interview, 10th PICES Meeting* (Victoria, B.C.: 2001). SIL is also known as the International Association of Theoretical and Applied Limnology, and currently has membership from about 80 countries.

75 Wooster recalls that Jackson became rather exercised over the reluctance of the Canadians to reconsider their preference for a nongovernmental organization. The Russian support was probably Dr. S.M. Konovalov from TINRO, Vladivostok. Only two Russians attended, Dr. Konovalov and government representative Dr. B.Z. Grayver, Research Institute of Fishery Technical Economic Information, Moscow.

76 Wooster's unofficial assessment of the meeting to John Negroponte, Deputy Assistant Secretary for Oceans and Fisheries Affairs, DOS, 25 Jan. 1979. Wooster Box 1: PICES Corresp. 1979.

77 The Canadian participants also arrived with a government brief. K.C. Lucas, Senior Assistant Deputy Minister, Fisheries and Marine Service, Environment Canada, to Warren Wooster, 3 Oct. 1978. Wooster Box 1: PICES Corresp.

78 Burke, "International Arrangements Affecting Marine Scientific Research," p. 415.

79 Wooster wrote to William Sullivan 23 Dec. 1987, "Alverson says he was instrumental in getting Article IV adopted [INPFC] specifically to provide for development of PICES. He will discuss this with Elmer Rasmuson and will put together a statement that can be used for clarification in the matter." 1978 INPFC Convention, supra note 34, Article IV. Wooster Box 2: PICES Sept.–Dec. 1987.

80 Royce, "On the Fishery Science Role of PICES." 1981 in Wooster Box 1: PICES Sept.–Dec. 1987. Wooster and Callahan, eds., *The PICES Papers: Reports of Meet-*

ings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992.

81 One argument was that an organization like PICES might have forestalled the collapse of the Peruvian anchovy fishery that resulted in part from inadequate scientific information.

82 Miles et al., *Scientific Cooperation and Subarctic Pacific Fishery Management*.

83 See Choon-ho Park as found in Edward Miles, ed., *Management of World Fisheries: Implications of Extended Coastal State Jurisdiction* (Seattle: University of Washington Press, 1989).

84 The Soviets invaded Afghanistan 1979–1982, and Ronald Reagan served as President from 1981 to 1989. In ocean research, Soviet participation was dropped from the Deep Sea Drilling Project using the *Glomar Challenger* research ship. Walter Sullivan, "East-West Projects Wither as the Chill Deepens," *New York Times* 10 Aug. 1982.

85 IRIS was composed of members from the Alaska Department of Fish and Game; Institute of Ocean Sciences, Sidney, B.C.; the INPFC; Northwest and Alaska Fisheries Center; Oregon State University; Pacific Biological Station, Nanaimo, B.C.; Pacific Fisheries Environmental Group, Monterey, CA; Pacific Marine Environmental Laboratory, Seattle; University of Alaska Fairbanks; University of British Columbia; University of Washington; and the Washington Department of Fisheries, Seattle. Chairs of IRIS were Donald E. Bevan (1982–1984), R.J. Beamish (1984–1986), and Vera Alexander (1986 to the establishment of PICES). Wooster Box 2: IRIS/INPFC Symposium.

86 Beamish wrote a discussion paper proposing a joint INPFC-IRIS symposium to examine oceanographic factors that affect fish recruitment in the North Pacific Ocean to the Committee on Biology and Research of the INPFC, Sept. 1985. Wooster Box 2: IRIS 1985–1986. The 1987 joint IRIS-INPFC symposium attracted about two hundred participants. R.J. Beamish, G.A. McFarlane, W.S. Wooster, "The "Need for Interdisciplinary Research in Fisheries and Ocean Sciences," Effects of Ocean Variability on Recruitment and an Evaluation of Parameters Used in Stock Assessment Models, eds. R.J. Beamish and G.A. McFarlane, *Canadian Special Publication of Fisheries and Aquatic Sciences* 108 (1987).

87 For instance, Japan buys over half of Alaska's seafood. Neal Gilbertsen, "The Global Salmon Industry," *Alaska Economic Trends* 23. Oct. (2003).

88 Vera Alexander, professor of marine science and Dean Emeritus at the University of Alaska Fairbanks, is a biological oceanographer whose research has encompassed ice biology, nitrogen dynamics, and primary production. She was one of two U.S. delegates to PICES from 1992 until 2002, when she was elected chairman of PICES.

89 The meeting was in Anchorage, Alaska, 14–15 April 1986.

90 Wooster to Beamish, 26 March 1986. Wooster Box 3: PICES Jan.–July 1986.

91 The scientists were A. Hattori and K. Kawaguchi from the Ocean Research Institute, University of Tokyo, and K. Ohtani, Hokkaido University. See also Wooster

and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 41.

92 B.S. Muir was Director General, Fisheries and Biological Sciences, Department of Fisheries and Oceans Canada.

93 "Scientific Organization for the North Pacific Ocean and Bering Sea (PICES)," no author, background information, Jan. 1987, U.S. Department of State files.

94 L.S. Parsons, Assistant Deputy Minister, Department of Fisheries and Oceans Canada. Science memo to Dr. Peter Meyboom, Deputy Minister, 2 May 1986. Wooster Box 3: PICES Jan.–July 1986.

95 As quoted in Ronald Crowley and Raymond Bourgeois, "The Development of Canada's Oceans Policy," *Oceans '89. Proceedings* 1 (1989).

96 The 1987 policy initiatives were either abandoned or stalled until years later. For a more detailed review of ocean policy see Lawrence Juda, "Changing National Approaches to Ocean Governance: The United States, Canada, and Australia," *Ocean Development and International Law* 34 (2003).

97 Wooster to F. Nagasaki, Japan Whaling Association, Whales Research Institute, 4 May 1987. Wooster Box 2: PICES April–Aug. 1987.

98 U.S. Department of State telegram drafted by William Sullivan, June 1988, to the fishery attaché at the U.S. Embassy, Tokyo. Wooster Box 2: PICES Jan.–June 1988. William L. Sullivan Jr. was policy advisor for international marine affairs in NOAA. He became a crucial conduit of information and ideas for the gestation of PICES. Wooster and Sullivan met in the 1960s, long before PICES, when Wooster worked with the IOC and Sullivan became part of the U.S. delegation.

99 Anthony J. Calio, Under Secretary of Commerce for Oceans and Atmosphere, U.S. Department of Commerce, and NOAA administrator, to Wooster 2 June 1987. Wooster Box 2: PICES April–Aug. 1987.

100 Letter from Wooster 16 June 1987 to Curt Marshall, c/o Congressman Mike Lowry. Wooster Box 2: PICES April–Aug. 1987.

101 Pell was the Senate author of the National Sea Grant College and Program Act of 1966, which encourages the stewardship of marine resources through research, education, outreach, and technology transfer. Dearborn to Wooster, 19 May 1987. Wooster Box 2: PICES April–Aug. 1987.

102 Copies of letters from John Miller and Mike Lowry, members of Congress, House of Representatives, Washington, D.C., to Ambassador Edward Wolfe, Deputy Assistant Secretary of State, U.S. Department of State; Curtis Mack, acting administrator, NOAA; Henry Beasley, National Marine Fisheries Service, 9 Oct. 1987. Wooster Box 2: PICES Sept.–Dec. 1987.

103 Memo to PICES Associates Executive Committee from Ron Miller, corresponding secretary, 30 June 1987. Wooster Box 2: PICES April–Aug. 1987.

104 Beamish, *Interview, 10th PICES Meeting.*

105 Art May, a former fisheries scientist and the Canadian Deputy Minister of DFO at the time, believed strongly in integrating fisheries and oceanography.

106 Wooster suspected that some lawyer in Moscow had suggested the restriction in their position paper. Wooster to Bill Erb, Bill Sullivan, cc. Ron Dearborn n.d. Wooster Box 2: PICES Sept.–Dec. 1987.

107 Wooster to Sullivan 6 May 1987, "PICES Perseveres." Wooster Box 2: PICES April–Aug. 1987.

108 Sullivan to Wooster 18 May 1987. Wooster Box 2: PICES April–Aug. 1987. The Japanese were interested in a new management program for pollock in the "donut hole" in the Bering Sea. See Sullivan to Wooster 13 Nov. 1987, Wooster Box 2: PICES Sept.–Dec. 1987.

109 Oceanography is mostly within the IOC, meteorology in the WMO, and fisheries in the FAO, though the FAO is mostly involved with agriculture. The USSR was also not a member of the FAO.

110 Kilho Park, a Korean scientist raised in Japan and educated in the U.S. (Ph.D. in chemical oceanography from Texas A&M) interpreted Japanese positions for Wooster. He observed that due to Japanese participation in WOCE, IGBP, JGOFS, and so forth, Japan's scientific manpower for the next 10 years was thinly distributed. Consequently PICES would just add further burden to the Japanese ocean community. Wooster Box 3: PICES Corresp. 23 April 1989.

111 The international water in the central Bering Sea outside the national jurisdictions of the Soviet Union and the U.S. is commonly called the "donut hole." William Sullivan to Wooster 13 Nov. 1987. Wooster Box 2: PICES Sept.–Dec. 1987.

112 From the newspaper *Suisan Keizai*, 1 Oct. 1987 as translated in NOAA, Survey of Foreign Fisheries vol. 6, 15 Nov. 1987. Wooster Box 2: PICES Sept.–Dec. 1987.

113 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*.

114 Callahan, "PICES: A Portrait of an International Organization," p. 35. Also "The status of PICES-FOCI Seminar, 10 Feb. 1988" in Wooster Box 2: PICES Jan.–June 1988.

115 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 42.

116 Japanese representatives were concerned that the original document had not yet received full consideration by the various interested agencies in Japan.

117 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*. Appendix E, p. 62.

118 The Japanese at the 1989 drafting meeting were Shuhei Takahashi, head of delegation from the Ministry of Foreign Affairs, and Joji Morishita and Yasuhiko Shimadzu, both from the Japan Fisheries Agency. Wooster Box 3: PICES Draft

Meet II/XII/89. Opening Statement by the Japanese Delegation on the Proposed "International North Pacific Marine Science Organization" Dec. 1989.

119 Barry Muir retired from Department of Fisheries and Oceans (DFO) in 1993, having served as a prominent member of the Canadian delegation leading up to the formation of PICES.

120 Canada ratified the convention on 22 Oct. 1991, followed by the U.S. on 9 Dec. 1991. The convention took effect sixty days after the third ratification by Japan on 24 Jan. 1992. China followed on 31 Aug. 1992 having been stalled in the legislative bureau under the state council, China's cabinet. After its legislative bureau approved the PICES Convention, five separate governmental organizations then had to review and approve it. Unclassified U.S. Department of Commerce telegram from American Embassy Beijing to U.S. Department of State, Washington, D.C., 4 May 1992. Wooster Box 4: PICES Corresp. from I/IV/92.

CHAPTER 2

1 It was held on 10–13 Dec. 1991 with financial support from NSF, the Marine Mammal Commission, NOAA, and SCOR.

2 These working groups were later formalized in the 1992 intergovernmental organizational meeting in Ottawa as committees in POC (physical oceanography and climate), BIO (biological oceanography), MEQ (marine environmental quality), and FIS (fishery science).

3 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*.

4 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*, p. 103. For the 1978 purpose, see Chapter 1, endnote 45.

5 Although the American delegates concurred, it was a disappointment to them that delegates chose Sidney, B.C., over Seattle, Washington.

6 The Governing Council oversaw the Secretariat, Finance and Administration, and the Science Board.

7 For instance, at the first meeting, China's delegates were Yu Kun Xu, director of international cooperation, State Oceanic Administration; and Ji Xu, division director of the Ministry of Agriculture. Canada's delegates were Tim Parsons, University of British Columbia; and John Davis, regional director of the Institute of Ocean Sciences. Hiroshi Hatanaka, director of the Institute of Far Seas Fisheries and Consul General Y. Hayashi represented Japan. Following the U.S. policy that one of their delegates should be from a major federal government research agency and one from a research university or other academic institution, William Aron, director of Alaska Fisheries Science Center (NOAA) in Seattle, and Vera Alexander, Dean of the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, were the two U.S. delegates to the first PICES annual meeting.

8 Although the USSR had participated in all of the intergovernmental discussions leading to the establishment of PICES, the Russian Federation did not ratify until Dec. 1994. The Republic of Korea became a member in midsummer 1995.

9 Earth Summit Agenda 21, the Rio Declaration on Environment and Development, Chapter 17, called for the protection and sustainable development of the marine and coastal environment and its resources, requiring new approaches to marine and coastal area management, development, and cooperation, at the national, regional, and global levels.

10 For a review of fisheries resources and problems in the North Pacific, see Hiroshi Kasahara and William Burke, *International Fishery Management in the North Pacific: Present and Future* (Seattle: University of Washington, 1972).

11 See Kenneth Ruddle, "Administration and Conflict Management in Japanese Coastal Fisheries" (*FAO Fisheries Technical Paper* 273, 1987).

12 They fished for salmon off Russia from at least mid eighteenth century, and then ventured into more distant waters a century later. For a brief history of Japanese fisheries management, see Yohoji Asada, Yutaka Hirasawa, and Fukuzo Nagasaki, *Fishery Management in Japan* (FAO, 1983).

13 Japan Fisheries Agency, *Fisheries of Japan* (1952). The Soviets took over Japanese salmon, crab, and herring fishing facilities on all of the Kurile Islands, Sakhalin Island, and the Kamchatka Peninsula. Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*. Also Tsuneo Akaha, "Bilateral Fisheries Relations in the Seas of Japan and Okhotsk: A Catalyst for Cooperation or Seed of Conflict?," *Ocean Yearbook* 11 (1994).

14 The Japanese had been fishing for crab in the Bering Sea since 1930. By 1935 they were in the path of the salmon run, and in 1936 and 1937 Japan sent the research vessel *Taiyo Maru* to Bristol Bay to investigate the state of red salmon. Japan was forced to stop investigation activity in 1938. Wooster Box 1: ICSINP (PICES) 1978. For an extensive account of the incident, see Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*.

15 The canning industry benefited from the 1904–1905 Russo-Japanese war and the Sino-Japanese War (1931–45). Japan Fisheries Agency, *Fisheries of Japan (*1952*).*

16 Distant water fisheries included crab along the coast of Alaska in the early 1930s, and salmon in 1937–38.

17 Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*, p. 51, drawn from *Pacific Fisherman*, Aug. 1937, pp. 22–24.

18 Thanks to Carmel Finley for Bingham, *Report on the International Law of Pacific Coastal Fisheries*, p. 14.

19 The northern seas were blocked, and the East China and Yellow seas were forbidden. In addition, the sardine and herring migrations were less than in pre-war days.

20 White House Press Release (23 Sept. 1945), U.S. Initial Post-Surrender Policy for Japan, as in Harry N. Scheiber, "Pacific Ocean Resources, Science, and the Law of

the Sea: Wilbert M. Chapman and the Pacific Fisheries, 1945–1970," *Ecology Law Quarterly* 13.3 (1986).

21 See Jerome B. Cohen, *Japan's Economy in War and Reconstruction* (Minneapolis: University of Minnesota Press, 1949).

22 Edward W. Allen of Allen, Hilen, Froude and De Garmo, Lawyers to Honorable James Webb, Under Secretary of State, Washington, D.C., 15 Sept. 1950. "I say without hesitation that if the Japanese engage in unrestricted fishing of the Pacific Coast Fisheries of Canada and the United States, even though they remain three miles offshore, they can destroy the entire accomplishment of eighteen years work of the International Fisheries Commission, and seriously damage the work of the International Pacific Salmon Fisheries Commission, besides working inestimable injury to other fisheries from Mexico to the Bering Sea. They can throw our fishermen out of employment, close our plants, and force our housewives to be dependent for much of this essential food supply upon the whims of another nation." University of Washington Libraries Wib Chapman papers: Wooster Box 12–8. Hereafter the Chapman papers.

23 Burke, however, recalls that political conflict was minimal before 1960, except in the Southeast Pacific. Conflict with Japan simply did not exist. Personal communication 12 Aug. 2002.

24 Chapman "Whither the Fisheries," Chapman papers.

25 Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*, p. 14.

26 William C. Herrington was the principal scientist, assigned to Japan in 1947, returning to the U.S. in 1951 to become the special assistant for fisheries to the Under Secretary of State. Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*, p. 22.

27 Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*.

28 Dayton L. Alverson, "The Concept of PICES in Relation to Fisheries in the Pacific," *The Law of the Sea and Ocean Development Issues in the Pacific Basin*, eds. Edward Miles and Scott Allen (Honolulu: University of Hawaii Press, 1983).

29 Miles et al., eds., *The Management of Marine Regions: The North Pacific*.

30 For an autobiographical account of negotiations, see William Herrington, "In the Realm of Diplomacy and Fish: Some Reflections on the International Convention on High Seas Fisheries in the North Pacific Ocean and the Law of the Sea Negotiations," *Ecology Law Quarterly* 16.1 (1989). For more on the abstention principle, see Harry N. Scheiber, "Origins of the Abstention Doctrine in Ocean Law: Japanese-U.S. Relations and the Pacific Fisheries, 1937–1958," *Ecology Law Quarterly* 16.1 (1989).

31 Jackson and Royce, *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*.

32 Clinton E. Atkinson, fisheries consultant and advisor, Seattle, to Wooster, 9 March 1979. "It must be at least twenty-five years since we began discussing the idea of an ICES-type Pacific research organization and n-number of times that we have approached the Japanese government and industry for their support—each time receiving a rather firm rejection." Wooster Box 1: PICES March–April 1979. Some programs include the U.S.-Japan Conference on Natural Resources Development (UJNR), the U.S.-Japan Committee on Scientific Cooperation, and the U.S.-Japan Environment Agreement. Burke, "International Arrangements Affecting Marine Scientific Research," p. 416.

33 See Takaaki Sakamoto, "Comparison of Japanese and U.S. National Marine Fisheries Research Institutes," Master's thesis, University of Washington, 1999.

34 Minutes of meeting on oceanographic research and the INPFC with fisheries scientist Felix Favorite at Northwest Fisheries Center, Seattle, 6 Sept. 1978. Wooster Box 1: Interviews re PICES Sept. 1978.

35 From Marsh J. Youngbluth, associate program director for biological oceanography at NSF. Youngbluth visited Japan for three weeks in 1997 (http://www.nsftokyo.org/ssr97-09.html, accessed July 2001.)

36 From Park to Wooster, 1 Apr. 1989. Wooster Box 3: PICES Corresp.

37 Yutaka Nagata to Wooster 17 July 1992 in PICES First Annual Meeting folder.

38 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*.

39 For a quantitative comparison of Japanese and U.S. fishery research institutes, see Sakamoto, "Comparison of Japanese and U.S. National Marine Fisheries Research Institutes." Momentum faltered on the Japanese front with the deaths of Professor Sugawara and Doctor Fukuda. Wooster Box 1: PICES Jan.–July 1986.

40 It is not clear why this happened; it is likely to have been an inadvertent omission.

41 This lack of familiarity with ICES continued to the mid 1990s at least. Wooster wrote to Christopher C.E. Hopkins, ICES general secretary 16 Nov. 1995, ". . . there is still a lot that PICES needs to learn from ICES. One problem in doing so is that there is not much understanding of ICES in the Asian countries (China, Japan, Korea) that make up half of PICES membership." Wooster Box 7: PICES IV Corresp.

42 NOAA, Survey of Foreign Fisheries vol. 6, 15 Nov. 1987 quoted in Japan's fisheries economics newspaper, *Suisan Keizai*, 1 Oct. 1987. "Japan's fisheries community needs to be particularly concerned that the creation of PICES would not become an opening for the regulation of fisheries resources in the North Pacific. As the United States, China and the USSR have yet to clarify their positions, Japan will have to wait and see exactly what authority PICES will possess. The Japanese government at present recognizes the importance of this problem, but has not yet reached a decision as to what stance it will take. There is much interest in Japan concerning how events will develop as the creation of PICES progresses." Wooster Box 2: PICES Sept.–Dec. 1987.

43 Japan Fisheries Agency, *Report: Ocean Fisheries Division* (1990), p. 148. Nov. 1988 document.

44 Warren Wooster, "Immiscible Investigators: Oceanographers, Meteorologists, and Fishery Scientists," *Bioscience* 37.10 (1986).

45 Burke, "International Arrangements Affecting Marine Scientific Research."

46 Kasahara and Burke, *North Pacific Fisheries Management*. For an English translation of the convention, see FAO, Convention, Statutes, and Rules of Procedure of the Commission for Fisheries Research in the Western Pacific, FAO Doc. FTb/T50, 1965. A compilation of treaties of the PRC 1949–1964 is found in *Chug-hua jen-min kung-ho kuo t'iao-yuen-chi* No. 5. Burke, "International Arrangements Affecting Marine Scientific Research," p. 392.

47 Choon-ho Park, "Fishing under Troubled Waters: The Northeast Asia Fisheries Controversy," *Ocean Development and International Law* 2.2 (1974). Information on treaties found in Burke, "International Arrangements Affecting Marine Scientific Research." Miles says (p. 62) that very little is known about the CFRWP but see Albert W. Koers, *International Regulation of Marine Fisheries: A Study of Regional Fisheries Organizations* (London: Fishing News Books, 1973).

48 For further treatment of marine scientific research in China, see Zou Keyuan, "Governing Marine Scientific Research in China," *Ocean Development and International Law* 34 (2003).

49 Burke, "International Arrangements Affecting Marine Scientific Research," p. 394. The INPFC was dissolved 21 Feb. 1993, and the NPAFC assumed some of the INPFC obligations, including publishing its bulletin. For the northwest Atlantic, see Emory Anderson, "The History of Fisheries Management and Scientific Advice: The ICNAF/NAFO History from the End of World War II to the Present," *Journal of Northwest Atlantic Fishery Science* 23 (1998).

50 Dayton Alverson, "Symposium Summary," Symposium on Biology, Stock Assessment, and Management of Pollock, Pacific Cod, and Hake in the North Pacific Region, *International North Pacific Fisheries Commission Bulletin* 45 (1983). The first symposium was published in Bulletin 42 (1984). The INPFC began its research on salmon in the North Pacific Ocean in 1955. Its basic aim was to provide the Commission with scientific knowledge about the distribution, abundance, and migration of the continental stocks of Pacific salmon.

51 As in Burke, "International Arrangements Affecting Marine Scientific Research."

52 Burke favored the third approach for a new scientific organization. He compiled a table of scientific research monies spent by the International Pacific Halibut Commission for the years 1970–1978 and found that the money spent on research was tiny compared to the value of the resource. He confirmed his suspicion by calculating the balance sheets for the halibut fishery. Burke, "International Arrangements Affecting Marine Scientific Research," Warren Wooster, "The Need for a North Pacific Science Organization," *The Management of Marine Regions: The North Pacific*, eds. Edward L. Miles, Stephen Gibbs, David Fluharty, Christine Dawson, David Teeter (Berkeley: University of California Press, 1982).

53 Beamish, *Interview, 10th PICES Annual Meeting*.

54 Wooster, "Immiscible Investigators: Oceanographers, Meteorologists, and Fishery Scientists."

55 In Japan, these differences in training happened even earlier where students went to fishery high schools to train as fishermen or fisheries scientists.

56 Wooster, "Immiscible Investigators: Oceanographers, Meteorologists, and Fishery Scientists."

57 Notable among these universities in the U.S. were the University of Washington and Oregon State University.

58 Tsuyoshi Kawasaki, "Why Do Some Fishes Have Wide Fluctuations in Their Numbers? A Biological Basis of Fluctuation from the Viewpoint of Evolutionary Ecology," Reports of the Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources, eds. G.D. Sharp and J. Csirke, FAO Fishery Report 291.2-3 (1983).

59 Warren Wooster, "Research in Troubled Waters: U.S. Research Vessel Clearance Experience, 1972–1978," *Ocean Development and International Law* 9 (1981). Oceanography requires expensive equipment and infrastructure. For an examination of the relationship between basic and applied research in oceanography, see C. Mukerji, *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press, 1989). For more extended connections between basic and applied science in the postwar period, see Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial Complex at MIT and Stanford* (New York: Columbia University Press, 1993); and Rebecca Lowen, *Creating the Cold War University: The Transformation of Stanford* (Berkeley: University of California Press, 1997).

60 See University of Washington Wib Chapman collection.

61 Wooster aide memoire, 21 May 1986. Wooster Box 3: PICES Jan.–July 1986.

62 WESTPAC is the IOC subcommittee for the Western Pacific, started formally in 1989 according to the IOC Web site, though the acronym was used earlier according to Ken Sugawara who observed "It was also true that I knew there were circumstances in the Pacific, and particularly in the western Pacific, which hinder the transference of the whole pattern of ICES unchanged to WESTPAC. One obvious example is the problem of finance. . . . I wish to draw your attention to another question on which we have a special concern, that of the relationship between PICES and WESTPAC. As for WESTPAC, its fundamentals have already been worked out by the ad hoc task team for WESTPAC at Noumea in 1977. We know that two representatives each from USA and USSR joined the Noumea meeting so that the problem of PICES-WESTPAC relationships must be of concern to these countries. At Noumea, the Soviet delegates presented 'Proposals for widening expeditionary and scientific researches in the western Pacific under WESTPAC, 1977–1990' which showed that the special Soviet interest centered on the ocean areas identical to those envisioned by PICES. Both the present meeting and the forthcoming Tokyo meeting must attempt to avoid overlap and to coordinate programs as much as possible." Wooster Box 1: PICES Meeting, 17–18 Jan. 1979, Seattle, WA.

63 PIPICO (Panel on International Programs, International Cooperation in Ocean Affairs) coordinated U.S. marine efforts.

64 Louis B. Brown, chairman PIPICO, NSF to Wooster, 29 Dec. 1978. Wooster Box 1: PICES Corresp.

65 Some Japanese scientists suggested to Park that despite the U.S. breadth of focus, most countries were most interested in fisheries matters for PICES, and Japan did not want to share any proprietary information with competitors. Wooster Box 3: PICES Corresp. 23 Apr. 1989.

66 U.S. Department of State telegram sent to involved embassies. Summary of 8–9 Dec. 1987 meeting in Ottawa. Minutes drafted by U.S. delegation. Wooster Box 2: PICES Sept.–Dec. 1987.

67 Park to Wooster. Wooster Box 3: PICES Corresp. 23 Apr. 1989.

68 C. Groot and L. Margolis, *Pacific Salmon Life Histories* (Vancouver, B.C.: UBC Press, 1991).

69 Kohei Kihara, Tokyo University of Fisheries, to Wooster 13 May 1987. Wooster Box 2: PICES April–Aug. 1987.

70 Edward Miles, *The U.S./Japan Fisheries Relationship in the Northeast Pacific: From Conflict to Cooperation?* (Seattle: University of Washington Fisheries Research Institute, 1989).

71 See Asada et al., *Fishery Management in Japan*.

72 Tjossem interview with Makoto Kashiwai, Victoria, B.C., 2003.

73 Japan Fisheries Agency, Ocean Fisheries Division; International Section. *1973 FAO to 1986, 1987, 1988, 1989, and Summary (1988)*. The Japanese Head Delegate at the 1988 meeting was Minoru Morimoto, from the Oceanic Fisheries Department, Ministry of Agriculture, Forestry and Fisheries.

74 The Japan Fisheries Agency representatives in NPAFC continued to voice skepticism over the need and mission for PICES.

75 Miles, *The U.S./Japan Fisheries Relationship in the Northeast Pacific: From Conflict to Cooperation?*, p. 57.

76 Tjossem interview with Makoto Kashiwai, Victoria, B.C., 2003.

CHAPTER 3

1 Wooster, in PICES, *1992 Annual Report*, p. 6–7. An ecosystem approach has been implicit in combining fisheries and oceanography and promoted by scientists such as Canadian Paul LeBlond, who exemplified integration across disciplines and research both pure and applied. LeBlond served on the physical oceanography and climate committee (POC), attending every annual meeting until his retirement. The PICES Secretariat has designated him a "PICES Builder," along with several others pivotal in building the organization, including Wooster, Yutaka Nagata, Richard Beamish, Hyung Huh, Vjatcheslav Shuntov, Michael Mullin, Makoto Kashiwai, Patricia Livingston, and Vera Alexander.

2 The International Geosphere-Biosphere Program (IGBP) adopted GLOBEC in 1995 as a new core project, with cosponsorship from SCOR and IOC. Its goal is to advance understanding of the structure and function of the global ocean ecosystem, its subsystems, and its response to physical forcing to be able to forecast the responses of marine systems to global change.

3 PICES, *1992 Annual Report*, p. 25.

4 PICES, *1992 Annual Report*, p. 27.

5 Chair Michael Mullin, D. Mackas as rapporteur. Members K. Denman, D. Mackas, T. Parsons (Canada); R. Wang (China); T. Ikeda (Japan); and L. Jones, M.M. Mullin (U.S.) studied the dynamics of phytoplankton, zooplankton, and larval fish in the ocean food web. PICES, *1992 Annual Report*, p. 23.

6 The report pointed out that the cost and availability of major research vessels is the major constraint for all participants interested in large-scale, long-term, and distant water research. They wanted the Secretariat to explore such questions as ". . . can we facilitate opportunistic participation by scientists of one nation in the already planned research cruises of another nation?" PICES, *1992 Annual Report*, p. 23.

7 For scientific papers see R.J. Beamish, ed., "Climate Change and Northern Fish Populations," *Canadian Special Publication of Fisheries and Aquatic Sciences* 121 (1995).

8 This is the same D. James Baker, Dean of the University of Washington College of Oceans and Fisheries Science in 1982.

9 PICES, *1995 Annual Report*, p. 35.

10 In 1995, at PICES IV, MEQ concluded that acquiring the necessary permits to work on the controversial Three Gorges Dam would excessively delay addressing basic scientific questions, so it accepted an offer from the Academia Sinica Institute of Oceanology at Qingdao to base the workshop instead at the convenient and well-studied Jiaozhou Bay. It would have been the first practical field study by a PICES committee, but in 1998 the Chinese authorities decided it would not be possible to host the workshop at Qingdao. It was thus moved to Vancouver Harbour, British Columbia, in 1999 (*PICES Scientific Report* 16).

11 PICES, *1997 Annual Report*, p. 9.

12 World Data Centers operate under the auspices of the International Council of Scientific Unions (ICSU) as a resource for the international scientific community, exchanging data in all disciplines related to the earth, its environment, and the sun.

13 They met in Nemuro, Japan 18–23 Oct. 1993. PICES, *1993 Annual Report*, p. 26).

14 PICES, *1995 Annual Report*, p. 7.

15 Question posed at the Dec. 1991 Scientific Workshop. Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 103.

16 Letter from Wooster to Kathryn Sullivan, chief scientist, NOAA, Department of Commerce, 19 Aug. 1993. U.S. Department of State files. The Russian minister of

science, Boris Georgievich Saltykov, an economist and a specialist in science policy, called on Russian scientists to seek contacts to secure Western aid and collaboration. Paul R. Josephson, "The Political Economy of Soviet Science from Lenin to Gorbachev," *Scientists and the State: Domestic Structures and the International Context*, ed. Etel Solingen (Ann Arbor: University of Michigan Press, 1994).

17 Wooster to Karl Banse, Ed Goldberg, Bruce Taft, 24 Feb. 1992.

18 The International Science Foundation (ISF) was a U.S. charitable organization established by George Soros in 1992 to support basic research in the natural sciences on the territory of the former Soviet Union and enable scientists to continue working during the economic crisis. The ISF began operating with emergency grants and support for travel to international conferences. By 1997 ISF had provided emergency grants to over 20,000 scientists. Wooster Box 7: International Science Foundation. The three Russians were V.I. Radchenko, TINRO Vladivostok; and A. Bychkov and V.I. Ilyichev, Academy of Science, Pacific Oceanological Institute. Wooster Box 7: Russia strategy (following paper on "A Russian Strategy" probably written by Wooster, but no name, date).

19 PICES Press, vol. 3, 1. Jan. 1995.

20 PICES, *1996 Annual Report*, p. 111. Wooster to Makoto Kashiwai 5 April 1996. Wooster Box 7: PICES Corresp. from I/IV/96.

21 Decision 95/S/8 during the fourth annual meeting in Qingdao, China, PICES, *1995 Annual Report*, p. 18.

22 Wooster to Xin Hao 20 Mar. 1995. Wooster Box 7: Corresp. China SAM.

23 Interrupted signals often doubled the cost of sending messages, and even then it was not certain that they arrived at the intended destination. Wooster Box 7: Corresp. China SAM.

24 PICES, *1993 Annual Report*, p. 43.

25 It included the Inter-American Tuna Commission, International Pacific Halibut Commission, Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, North Pacific Anadromous Fish Commission, and SCOR. S.M. McKinnell, R.B. Brodeur, K. Hanawa, A.B. Hollowed, J.J. Polovina, and C.-I. Zhang, eds., "Pacific Climate Variability and Marine Ecosystem Impacts," *Progress in Oceanography* 49.1–4 (2001).

26 The Census is an international program to assess and explain changes in marine biodiversity, distribution, and abundance.

27 Josephson, "The Political Economy of Soviet Science from Lenin to Gorbachev."

28 Ilyichev proved instrumental in encouraging full Russian participation.

29 Wooster to L.S. Parsons, Fisheries and Oceans, Ottawa, Canada 27 July 1993. Wooster Box 7: Russia strategy.

30 Boris N. Kotenev, deputy director, Russian Federal Research Institute of Fisheries and Oceanography (VNIRO) to Wooster 25 June 1993. Wooster Box 7: Russia strategy.

31 Letter from Wooster to Kathryn Sullivan, chief scientist, NOAA, Department of Commerce, 19 Aug. 1993. From U.S. Department of State files.

32 PICES, *1999 Annual Report*.

33 The OES also helped Russian participation with its 1994 contribution from the OES Special Fund to the PICES Trust Fund. In addition, they helped secure an Executive Order early in 1994 granting PICES status under the International Organizations Immunities Act "Accomplishments SEOSPA 1942." Anon., no date. U.S. Department of State "PICES History."

34 The joint project was Circulation Research of the East Asian Marginal Sea (CREAMS) that carried out expeditions in the Japan/East Sea in 1993–1997. PICES, *1997 Annual Report*, p. 11.

35 PICES, *1994 Annual Report*.

36 Article VIII of the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean established NPAFC.

37 Warren Wooster, On the Relations between the North Pacific Marine Science Organization (PICES) and the North Pacific Anadromous Fish Commission (NPAFC), Fragments: Miscellaneous Papers of Warren S. Wooster, Seattle. Wooster Box 4: PICES Corresp. from I/XII/91.

38 R. Steinbock, "Interests of the NPAFC Parties in the High Seas Area of the North Pacific Ocean," *Department of Fisheries and Oceans Discussion Paper*. (Ottawa, Canada: Department of Fisheries and Oceans, 1994).

39 PICES, *1993 Annual Report*, p. 7.

40 William Erb to Vera Alexander, University of Alaska, and Bill Aron, director, Alaska Fisheries Science Center, 22 Sept. 1993. U.S. Department of State papers.

41 PICES, *1997 Annual Report*, p. 67.

42 The group concluded, "Management problems, which should be handled by fishery or pollution commissions or other such bodies, require scientific information and evaluation of a multidisciplinary nature which could be supplied through the efforts of PICES and its members. The basic scientific work would be done at the national level; PICES would assist in its development and coordination and would facilitate the compilation and interpretation of its results." Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 9.

43 "Informal Discussions on North Pacific Ocean Science Organization," Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 13.

44 Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 56–57.

45 Article V.1.d of the PICES Convention. Wooster and Callahan, eds., *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992,* p. 95.

46 Wooster Box 4: PICES Corresp. from I/XII/91. Memo from William Aron, Alaska Fisheries Science Center, NOAA, to Michael Tillman 21 Feb. 1992. Subject: PICES vs. Fishery Commissions.

47 PICES, *1992 Annual Report*, p. 7.

48 Wooster Box 4: PICES Corresp. from I/XII/91. Memo from William Aron to Steven Pennoyer 19 Feb. 1992.

49 Such as in the joint PICES-GLOBEC program described later. Japan Fisheries Agency, *Scientific Research on Salmon Resources Should Be Promoted by the North Pacific Anadromous Fish Commission* (Tokyo: Japan Fisheries Agency, 1994).

50 Fisheries are so important to the Alaska economy that it at times had interests different from the lower 48 states. Wooster to Beamish 4 Aug. 1995. Wooster Box 7: Translations.

51 PICES, *1996 Annual Report*, p. 11.

52 Council Decision 96/S/6. Member countries had yet to foster coordination by establishing interagency cooperation, so the Council agreed to encourage all member countries to establish interagency coordinating mechanisms.

53 PICES, *1994 Annual Report*, p. 16.

54 R.J. Beamish, "Introduction," Climate Change and Northern Fish Populations, ed. R.J. Beamish, *Canadian Special Publication of Fisheries and Aquatic Sciences* 121 (1995).

55 Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science under ICES*, p. 18.

56 Pat Livingston, PICES Press, vol. 5, 19 Nov. 1997.

57 The chairman of the CCCC program was not officially a member of the Science Board.

58 *PICES Scientific Report* 4, 1996, p. 4–8.

59 Wooster to Burke about Kashiwai note 16 Nov. 1995. Wooster Box 7: PICES IV Corresp.

60 The carrying capacity of the ocean is a measure of how zooplankton and carnivorous fish size, productivity, and abundance respond to changes in ocean climate. Makoto Kashiwai, "History of Carrying Capacity Concept as an Index of Ecosystem Productivity (Review)," *Bulletin of the Hokkaido National Fisheries Research Institute* 59 (1995).

61 No author, "Prepared as discussion paper, PICES CCCC Workshop, Nemuro, 25 June 1996. Wooster collection, folder NPAFC/PICES meet III/97.

62 PICES, 1994 Annual Report, p. 25.

63 Asia-Pacific Economic Cooperation (APEC) Oceans Conference in Hawaii. PICES, *1998 Annual Report*, p. 11.

64 The U.N. Conference on Environment and Development, also known as the Earth Summit, was held in Rio de Janeiro, Brazil, in 1992. Agenda 21 was one of its documents that called for international cooperation to encourage sustainable development in developing countries.

CHAPTER 4

1 Article III of the PICES Convention for a North Pacific Marine Science Organization (PICES), *PICES Handbook* (1992).

2 The symposium was held on 8 Oct. 2001. Perry et al., eds., *PICES Science: The First Ten Years and a Look to the Future*.

3 The reviewers were Tsutomu Ikeda and Patricia Wheeler (BIO), Douglas Hay et al. (FIS), Richard Addison et al. (MEQ), and Paul LeBlond (POC). Ian Perry et al. reviewed the Climate Change and Carrying Capacity program.

4 R.J. Beamish, S. Kim, M. Terazaki, and W.S. Wooster, eds., "Ecosystem Dynamics in the Eastern and Western Gyres of the Subarctic Pacific," *Progress in Oceanography* 43 (1999).

5 Douglas Hay, R.J. Beamish, George W. Boehler, Vladimir Radchenko, Qi-Sheng Tang, Tokio Wada, Daniel Ware, and Chang-Ik Zhang, "Ten Years FIS in PICES: An Introspective, Retrospective, Critical and Constructive Review of Fishery Science in PICES," *PICES Science: The First Ten Years and a Look to the Future*, eds. R. Ian Perry, Patricia Livingston, and Alexander Bychkov, vol. 22, Scientific Reports (Sidney, B.C.: PICES Secretariat, 2002).

6 The World Aquaculture Society, established in 1970.

7 Pontecorvo, Giulio. "Insularity of scientific disciplines and uncertainty about supply: The two keys to the failure of fisheries management." *Marine Policy* 27 (2003): 69–73.

8 NPAFC Newsletter, 2002, vol. 7(1), p. 2.

9 Paul LeBlond, "The Physical Oceanography and Climate Committee: The First Decade," *PICES Science: The First Ten Years and a Look to the Future*, eds. Perry et al.

10 Its name NEMURO stood for the North Pacific Ecosystem Model for Understanding Regional Oceanography, but also honored the site of the Third Annual Meeting in Japan.

11 See PICES, *2003 Annual Report*.

12 Perry et al., eds., *PICES Science: The First Ten Years and a Look to the Future*.

Bibliography

Akaha, Tsuneo. "Bilateral Fisheries Relations in the Seas of Japan and Okhotsk: A Catalyst for Cooperation or Seed of Conflict?" *Ocean Yearbook* 11 (1994): 384–408.

Akaha, Tsuneo. "The Postwar Japan—Soviet Fisheries Regime and Future Prospects." *Ocean Yearbook* 9 (1991): 28–56.

Alexandratos, Nikos, ed. *World Agriculture: Towards 2010, an FAO Study*. New York: FAO and John Wiley and Sons Ltd., 1995.

Alverson, Dayton. "Symposium Summary." Symposium on Biology, Stock Assessment, and Management of Pollock, Pacific Cod, and Hake in the North Pacific Region. *International North Pacific Fisheries Commission Bulletin* 45 (1983).

Alverson, Dayton L. "The Concept of PICES in Relation to Fisheries in the Pacific." *The Law of the Sea and Ocean Development Issues in the Pacific Basin*. Eds. Edward Miles and Scott Allen. Honolulu: University of Hawaii Press, 1983.

Anderson, Emory. "The History of Fisheries Management and Scientific Advice: The ICNAF/NAFO History from the End of World War II to the Present." *Journal of Northwest Atlantic Fishery Science* 23 (1998): 75–94.

Appel, Toby. "Marine Biology/Biological Oceanography and the Federal Patron: The NSF Initiative in Biological Oceanography in the 1960s." *The Fifth*

International Congress on the History of Oceanography, July 7–14, 1993. Eds. Keith Benson and J.F. Rehbock. Seattle: University of Washington Press, 1993. 332–342.

Asada, Yohoji, Yutaka Hirasawa, and Fukuzo Nagasaki. *Fishery Management in Japan*. FAO, 1983.

Barnes, Kathleen. "The Clash of Fishing Interests in the Pacific." *Far Eastern Survey* 23. November 18 (1936): 243–247.

Beamish, Richard. *Interview, 10th Annual Meeting, PICES*. Victoria, B.C., 2001.

Beamish, R.J. "Introduction." Climate Change and Northern Fish Populations. Ed. R.J. Beamish. *Canadian Special Publication of Fisheries and Aquatic Sciences* 121 (1995).

Beamish, R.J., G.A. McFarlane, W.S. Wooster. "The Need for Interdisciplinary Research in Fisheries and Ocean Sciences." Effects of Ocean Variability on Recruitment and an Evaluation of Parameters Used in Stock Assessment Models. Eds. R.J. Beamish and G.A. McFarlane. *Canadian Special Publication of Fisheries and Aquatic Sciences* 108 (1987).

Beamish, R.J., S. Kim, M. Terazaki, and W.S. Wooster, eds. "Ecosystem Dynamics in the Eastern and Western Gyres of the Subarctic Pacific." *Progress in Oceanography* 43.2–4 (1999): 157–161.

Behrman, Daniel. *Assault on the Largest Unknown: The International Indian Ocean Expedition, 1959–65*. Paris: UNESCO Press, 1981.

Benson, Keith. "History of American Marine Biology and Marine Biological Institutions." *American Zoologist* 28 (1988): 1–34.

Benson, Keith R., and Philip F. Rehbock. *Oceanographic History: The Pacific and Beyond*. Seattle: University of Washington Press, 2003.

Bigelow, Henry Bryant. *Oceanography: Its Scope, Problems and Economic Importance*. Boston: Houghton Mifflin, 1931.

Bingham, Joseph Walter. *Report on the International Law of Pacific Coastal Fisheries*. New York: Stanford University Press, 1938.

Borgstrom, Georg. *Japan's World Success in Fishing*. London: Fishing News, 1964.

Broadhurst, Virginia. "The Influence of National Interests in International Scientific Organizations: What PICES Can Learn from ICES." Master's thesis, University of Washington, 1990.

Burke, William. "International Arrangements Affecting Marine Scientific Research." *The Management of Marine Regions: The North Pacific*. Eds. Edward Miles, Stephen Gibbs, David Fluharty, Christine Dawson, and David Teeter. Berkeley: University of California Press, 1982.

Burke, William. "Towards a Better Use of the Ocean: Contemporary Legal Problems in Ocean Development. Comments and Recommendations by an International Symposium." *SIPRI Symposium*. Stockholm, Sweden: Almqvist and Wiksell, 1969. 231.

Callahan, Megan M. "PICES: A Portrait of an International Organization." Master's thesis, University of Washington, 1994.

Capshew, James, and Karen Rader. "Big Science: Price to the Present." *Osiris* 7 (1992): 2–25.

Cohen, Jerome B. *Japan's Economy in War and Reconstruction*. Minneapolis: University of Minnesota Press, 1949.

Crowley, Ronald, and Raymond Bourgeois. "The Development of Canada's Oceans Policy." *Oceans '89. Proceedings*. Vol. 1, 1989. 170–181.

Cushing, D.H. *The Provident Sea*. Cambridge: Cambridge University Press, 1988.

DeReynier, Yvonne. "Evolving Principles of International Fisheries Law and the North Pacific Anadromous Fish Commission." *Ocean Development and International Law* 29 (1998): 147–178.

Doel, Ronald. "Influences of the IGY: Institutions, Interdisciplinary Practice, and Research Aims in the Growth Era of Oceanography 1957–1967." *Maury III Workshop on the History of Oceanography, 20–23 June 2001*. Monterey, CA: unpublished, 2001.

Frank, David John. "Science, Nature, and the Globalization of the Environment, 1870–1990." *Social Forces* 76.2 (1997): 409–435.

Franssen, Herman T. "Developing Country Views of Sea Law and Marine Science." *Freedom of Oceanic Research*. Ed. Warren S. Wooster. New York: Crane, Russak and Company, Inc., 1973. 255.

Garcia, S., and C. Newton. "Current Situation, Trends, and Prospects in World Capture Fisheries." Global Trends: Fisheries Management. Eds. E.L. Pikitch, D.D. Huppert, and M.P. Sissenwine. *American Fisheries Society Symposium* 20 (1997): 3–27.

Gilbertsen, Neal. "The Global Salmon Industry." *Alaska Economic Trends* 23. October (2003): 3–11.

Greenaway, Frank. *Science International: A History of the International Council of Scientific Unions*. Cambridge: Cambridge University Press, 1996.

Groot, C., and L. Margolis. *Pacific Salmon Life Histories*. Vancouver, B.C.: UBC Press, 1991.

Gulland, J.A. *The Management of Marine Fisheries*. Seattle: University of Washington Press, 1974.

Hamblin, Jacob. "Oceanography and International Cooperation During the Early Cold War." Dissertation, University of California, Santa Barbara, 2001.

Hamblin, Jacob. "Visions of International Scientific Cooperation: The Case of Oceanic Science, 1920–1955." *Minerva* 38 (2000): 393–423.

Hay, Douglas, R.J. Beamish, George W. Boehler, Vladimir Radchenko, Qi–Sheng Tang, Tokio Wada, Daniel Ware, and Chang-Ik Zhang. "Ten Years FIS in PICES: An Introspective, Retrospective, Critical and Constructive Review of Fishery Science in PICES." *PICES Science: The First Ten Years and a Look to the Future*. Eds. R. Ian Perry, Patricia Livingston, and Alexander Bychkov. Vol. 22. Scientific Reports. Sidney, B.C.: PICES Secretariat, 2002. 102.

Herrington, William. "In the Realm of Diplomacy and Fish: Some Reflections on the International Convention on High Seas Fisheries in the North Pacific Ocean and the Law of the Sea Negotiations." *Ecology Law Quarterly* 16.1 (1989).

Hollick, Ann L. *U.S. Foreign Policy and the Law of the Sea*. Princeton: University of Princeton Press, 1981.

ICES. *ICES Annual Report for 2000*. International Council for the Exploration of the Seas, 2001.

Jackson, Roy I., and William F. Royce. *Ocean Forum: An Interpretative History of the International North Pacific Fisheries Commission*. Farnham, England: Fishing News Books Ltd., 1986.

Japan Fisheries Agency. *Fisheries of Japan*, 1952.

Japan Fisheries Agency. *Fisheries of Japan. Scientific Research on Salmon Resources Should Be Promoted by the North Pacific Anadromous Fish Commission*. Tokyo: Japan Fisheries Agency, 1994.

Japan Fisheries Agency. *Ocean Fisheries Division: International Section. 1973 FAO to 1986, 1987, 1988, 1989, and Summary,* 1988.

Japan Fisheries Agency. *Ocean Fisheries Division: Report*, 1990.

Jennings, F., and L. King. "Bureaucracy and Science: The IDOE in the National Science Foundation." *Oceanus* 23 (1980): 12–19.

Josephson, Paul R. "The Political Economy of Soviet Science from Lenin to Gorbachev." *Scientists and the State: Domestic Structures and the International Context*. Ed. Etel Solingen. Ann Arbor: University of Michigan Press, 1994. 259.

Juda, Lawrence. "Changing National Approaches to Ocean Governance: The United States, Canada, and Australia." *Ocean Development and International Law* 34 (2003): 161–187.

Kasahara, Hiroshi, and William Burke. *International Fishery Management in the North Pacific: Present and Future*. Seattle: University of Washington Institute for Marine Studies, 1972.

Kasahara, Hiroshi, and William T. Burke. *North Pacific Fisheries Management. Resources for the Future Program of International Studies of Fisheries Arrangements*. Washington, D.C., 1973.

Kashiwai, Makoto. "History of Carrying Capacity Concept as an Index of Ecosystem Productivity (Review)." *Bulletin of the Hokkaido National Fisheries Research Institute* 59 (1995): 81–101.

Kawasaki, Tsuyoshi. "Why Do Some Pelagic Fishes Have Wide Fluctuations in Their Numbers? A Biological Basis of Fluctuation from the Viewpoint of Evolutionary Ecology." Reports of the Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources. Eds. G.D. Sharp and J. Csirke. *FAO Fishery Report* 291.2–3 (1983): 1065–1080.

Kendall, Arthur, and Gary Duker. "The Development of Recruitment Fisheries Oceanography in the United States." *Fisheries Oceanography* 7.2 (1998): 69–88.

Keyuan, Zou. "Governing Marine Scientific Research in China." *Ocean Development and International Law* 34 (2003): 1–27.

Knauss, John. "Warren S. Wooster." *PICES Press* 5.1 (1997): 2–6.

Koers, Albert W. *International Regulation of Marine Fisheries: A Study of Regional Fisheries Organizations*. London: Fishing News Books, 1973.

Kurlansky, Mark. *Cod: A Biography of the Fish That Changed the World*. New York: Walker and Company, 1997.

Lauff, G.H. "A History of the American Society of Limnology and Oceanography." *Limnology in North America*. Ed. D.G. Frey. Madison: University of Wisconsin Press, 1963. 667–682.

Laughton, Tony. "International Affairs in Marine Science." *Ocean Challenge* 1, summer (1990): 18–23.

LeBlond, Paul. "The Physical Oceanography and Climate Committee: The First Decade." *PICES Science: The First Ten Years and a Look to the Future.* Eds. R. Ian Perry, Patricia Livingston, and Alexander Bychkov. Vol. 22. Sidney, B.C.: PICES Secretariat, 2002.

Leslie, Stuart W. *The Cold War and American Science: The Military-Industrial Complex at MIT and Stanford*. New York: Columbia University Press, 1993.

Lowen, Rebecca. *Creating the Cold War University: The Transformation of Stanford*. Berkeley: University of California Press, 1997.

MacCall, A.D. "Population Estimates for the Waning Years of the Pacific Sardine Fishery." *California Cooperative Oceanic Fisheries Investigation (CalCOFI)* 20 (1979): 72–82.

MacLeod, Roy, and Fritz Rehbock. "Developing a Sense of the Pacific: The 1923 Pan-Pacific Science Congress in Australia." *Pacific Science* 54.3 (2000): 226.

Mathisen, Ole A., and Donald E. Bevan. *Some International Aspects of Soviet Fisheries*. Columbus: Ohio State University Press, 1968.

McEvoy, Arthur F. *The Fisherman's Problem: Ecology and the Law in the California Fisheries, 1850–1980*. Cambridge: Cambridge University Press, 1986.

McKinnell, S.M., R.B. Brodeur, K. Hanawa, A.B. Hollowed, J.J. Polovina, and C.-I. Zhang, eds. "Pacific Climate Variability and Marine Ecosystem Impacts." *Progress in Oceanography* 49.1 (2001): 1–6.

Megrey, Bernard, and Vidar Wespestad. "Alaskan Groundfish Resources: 10 Years of Management under the Magnuson Fishery Conservation and Management Act." *North American Journal of Fisheries Management* 10 (1990): 125–143.

Miles, Edward L. *Global Ocean Politics: The Decision Process at the Third United Nations Conference on the Law of the Sea, 1973–1982*. Cambridge, MA: Kluwer Law International, 1998.

Miles, Edward, ed. *Management of World Fisheries: Implications of Extended Coastal State Jurisdiction*. Seattle: University of Washington Press, 1989.

Miles, Edward L. *Science, Politics, and International Ocean Management: The Uses of Scientific Knowledge in International Negotiations*. Institute of International Studies, Policy Papers in International Affairs, No. 33. Berkeley: University of California, Berkeley, 1987.

Miles, Edward. *The U.S./Japan Fisheries Relationship in the Northeast Pacific: From Conflict to Cooperation?* Seattle: University of Washington Fisheries Research Institute, 1989.

Miles, E.D., D. Fluharty, and W. Wooster. *Scientific Cooperation and Subarctic Pacific Fishery Management*. Seattle: University of Washington, 1982.

Miles, Edward, Stephen Gibbs, David Fluharty, Christine Dawson, and David Teeter, eds. *The Management of Marine Regions: The North Pacific. An Analysis of Issues Relating to Fisheries, Marine Transportation, Marine Scientific Research, and Multiple Use Conditions and Conflicts*. Berkeley: University of California Press, 1982.

Mills, Eric. *Biological Oceanography: An Early History 1870–1960*. Ithaca, NY: Cornell University Press, 1989.

Mukerji, C. *A Fragile Power: Scientists and the State*. Princeton: Princeton University Press, 1989.

National Academy of Sciences (NAS). *The International Decade of Ocean Exploration: An Oceanic Quest*. Washington, D.C.: National Academy Press, 1969.

Park, Choon-ho. "Fishing under Troubled Waters: The Northeast Asia Fisheries Controversy." *Ocean Development and International Law* 2.2 (1974).

Parsons, L.S. *Management of Marine Fisheries in Canada*. Ottawa: National Research Council Canada, 1993.

Perry, R. Ian, Patricia Livingston, and Alexander Bychkov, eds. PICES *Science: The First Ten Years and a Look to the Future*. Vol. 22. Sidney, B.C.: PICES Secretariat, 2002.

PICES. *1992 Annual Report*.

PICES. *1993 Annual Report*.

PICES. *1994 Annual Report*.

PICES. *1995 Annual Report*.

PICES. *1996 Annual Report*.

PICES. *1997 Annual Report*.

PICES. *1998 Annual Report*.

PICES. *1999 Annual Report*.

PICES. *2003 Annual Report*.

Rainger, Ronald. "Constructing a Landscape for Postwar Science: Roger Revelle, the Scripps Institution and the University of California, San Diego." *Minerva* 39 (2001): 327–352.

Randolph, Robert H., and John E. Bardach. "Soviet Science in the Pacific: The Case of Marine Biology." *Nature in Its Greatest Extent: Western Science in the Pacific*. Eds. Roy MacLeod and J.F. Rehbock. Honolulu: University of Hawaii Press, 1988.

Roll, Hans Ulrich. *A Focus for Ocean Research: Intergovernmental Oceanographic Commission: History, Functions, Achievements*. Paris: UNESCO, 1979.

Royce, W.F. "Centennial Lecture IV: The Historical Development of Fishery Science and Management." *Marine Fisheries Review* 50.4 (1988).

Rozwadowski, Helen. "Internationalism, Environmental Necessity, and National Interest: Marine Science and Other Sciences." *Minerva* 42 (2004): 127–149.

Rozwadowski, Helen. *The Sea Knows No Boundaries: A Century of Marine Science under ICES*. Seattle: University of Washington Press and International Council for the Exploration of the Sea, 2002.

Ruddle, Kenneth. "Administration and Conflict Management in Japanese Coastal Fisheries." *FAO Fisheries Technical Paper* 273 (1987): 93.

Sakamoto, Takaaki. "Comparison of Japanese and U.S. National Marine Fisheries Research Institutes." Master's thesis, University of Washington, 1999.

Scheiber, Harry N. "Origins of the Abstention Doctrine in Ocean Law: Japanese–U.S. Relations and the Pacific Fisheries, 1937–1958." *Ecology Law Quarterly* 16.1 (1989).

Scheiber, Harry N. "Pacific Ocean Resources, Science, and the Law of the Sea: Wilbert M. Chapman and the Pacific Fisheries, 1945–1970." *Ecology Law Quarterly* 13.3 (1986).

Schlee, Susan. *The Edge of an Unfamiliar World. A History of Oceanography*. New York: E.P. Dutton, 1973.

Sears, Mary, and D. Merriman, eds. *Oceanography: The Past*. Vol. 3. Woods Hole, MA: Springer-Verlag, 1980.

Skud, B. "Revised Estimates of Halibut Abundance and the Thompson-Burkenroad Debate." *IPHC Scientific Report* 56 (1975).

Smith, Tim D. *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855–1955*. Cambridge: Cambridge University Press, 1994.

Stevenson, J.C. "Fisheries Research Board of Canada: 1898–1973." *Fisheries Research Board of Canada Miscellaneous Special Publication* 20 (1973): 17.

Steinbock, R. "Interests of the NPAFC Parties in the High Seas Area of the North Pacific Ocean." *Department of Fisheries and Oceans Discussion Paper*. Ottawa, Canada: Department of Fisheries and Oceans, 1994.

Sullivan, Walter. "East-West Projects Wither as the Chill Deepens." *New York Times* 10 Aug. 1982, sec. C: 1. ProQuest Historical Newspapers.

van Keuren, David K. "Building a New Foundation for the Ocean Sciences: The National Science Foundation and Oceanography, 1951–1965." *Earth Sciences History* 19 (2000): 90–109.

Vaughn, T. Wayland. *Proceedings of the Third Pan-Pacific Science Conference*. Vol. 1. Tokyo, 1926. 88–89.

Vaughn, Thomas Wayland. "The Oceanographic Point of View." *Contributions to Marine Biology: Lectures and Symposia Given at the Hopkins Marine Station*. Stanford: Stanford University Press, 1930. 40–56.

Wang, Zuoyue. "Pacific Exchanges: U.S.-China Contacts in Oceanography in the Twentieth Century." *Maury II Workshop on the History of Oceanography*. Woods Hole, MA: unpublished. 1999.

Weller, Gunter. *Antarctica*. 2004. Web. AccessScience@McGraw-Hill. Available: http://www.accessscience.com. 18 July 2004.

Wenk, Edward. *The Politics of the Ocean*. Seattle: University of Washington Press, 1972.

Went, A.E.J. *Seventy Years Agrowing: A History of the International Council for the Exploration of the Sea, 1902–1972*. Rapports et Procès-verbaux des Réunions 165 (ICES), 1972.

"Wide Cooperation for Science Urged." Special to the New York Times. *The New York Times* 22 June 1946: 6. ProQuest Historical Newspapers.

Wolff, Torben. "The Creation and First Years of SCOR (Scientific Committee on Oceanic Research)." Proceedings of the 4th International Congress on the History of Oceanography. Ocean Sciences: Their History and Relation to Man. Eds. W. Lenz and M. Deacon. *Deutsche Hydrographische Zeitschrift* 22 (1987).

Wooster, Warren. "Immiscible Investigators: Oceanographers, Meteorologists, and Fishery Scientists." *Bioscience* 37.10 (1986): 728–730.

Wooster, Warren. "International Studies of the Indian Ocean, 1959–1965." *Deep-Sea Research* 31 (1984): 589–597.

Wooster, Warren. *On the Relations between the North Pacific Marine Science Organization (PICES) and the North Pacific Anadromous Fish Commission (NPAFC).* Part III. Fragments: Miscellaneous Papers of Warren S. Wooster, Seattle.

Wooster, Warren. "Research in Troubled Waters: U.S. Research Vessel Clearance Experience, 1972–1978." *Ocean Development and International Law* 9 (1981): 219–239.

Wooster, Warren. "The Need for a North Pacific Science Organization." *The Management of Marine Regions: The North Pacific*. Eds. Edward L. Miles, Stephen Gibbs, David Fluharty, Christine Dawson, and David Teeter. Berkeley: University of California Press, 1982.

Wooster, Warren S., and Megan M. Callahan, eds. *The PICES Papers: Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978–1992*. Seattle: University of Washington, 1994. 143.

Acronyms

AGU	American Geophysical Union
APEC	Asia-Pacific Economic Cooperation
ASLO	American Society of Limnology and Oceanography
BASS	Basin Studies Task Team (within PICES)
BIO	Biological Oceanography Committee (within PICES)
CalCOFI	California Cooperative Oceanic and Fisheries Investigations
CCCC	Climate Change and Carrying Capacity Program (within PICES)
CFRWP	Commission for Fisheries Research in the Western Pacific
CREAMS	Circulation Research of the East Asian Marginal Seas
CSRS	Committee on Scientific Research and Statistics (within NPAFC)
DFO	Department of Fisheries and Oceans
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
FCMA	Fishery Conservation and Management Act
FERHRI	Far East Regional Hydrometeorological Research Institute
FIS	Fishery Science Committee (within PICES)

FOCI	Bering Sea Fisheries Oceanography Coordinated Investigations
GIFA	Governing International Fishery Agreement
GLOBEC	Global Ocean Ecosystem Dynamics
GOOS	Global Ocean Observing System
IAPSO	International Association for the Physical Sciences of the Ocean
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
ICNAF	International Commission for the Northwest Atlantic Fisheries
ICSU	International Council of Scientific Unions
IDOE	International Decade of Ocean Exploration
IFC	International Fishery Commission (became IPHC in 1953)
IGBP	International Geosphere-Biosphere Program
IGY	International Geophysical Year
IIOE	International Indian Ocean Expedition
INPFC	International North Pacific Fisheries Commission
INPHC	International North Pacific Halibut Commission
INPOC	International North Pacific Ocean Climate Program
INPRO	International North Pacific Research Organization
IOC	Intergovernmental Oceanographic Commission
IPHC	International Pacific Halibut Commission
IPSFC	International Pacific Salmon Fisheries Commission
IRIS	International Recruitment Investigations in the Subarctic
ISF	International Science Foundation
IUGG	International Union of Geodesy and Geophysics
IWC	International Whaling Commission
JGOFS	Joint Global Ocean Flux Study
JMA	Japan Meteorological Agency
KORDI	Korea Ocean Research and Development Institute
LOS	Law of the Sea
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEQ	Marine Environmental Quality Committee (within PICES)
MFCMA	Magnuson Fishery Conservation and Management Act
MODEL	Conceptual/Theoretical and Modeling Studies Task Team (within PICES)
MOMAF	Ministry of Maritime Affairs and Fisheries
NASA	National Aeronautics and Space Administration
NASCO	National Academy of Sciences Committee on Oceanography
NEAFC	North East Atlantic Fisheries Commission
NEMURO	North Pacific Ecosystem Model for Understanding Regional Oceanography; also City of Nemuro, Japan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPAFC	North Pacific Anadromous Fish Commission

NPFMC	North Pacific Fishery Management Council
NPFSC	North Pacific Fur Seal Commission
OES	Bureau of Oceans and International Environmental and Scientific Affairs
ONR	Office of Naval Research
PICES	North Pacific Marine Science Organization
PIPICO	Panel on International Programs and International Cooperation in Ocean Affairs
POC	Physical Oceanography and Climate Committee (within PICES)
REX	Regional Experiments Task Team (within PICES)
SCAP	Supreme Commander, Allied Powers
SCAR	Scientific Committee on Antarctic Research
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SIL	Societas Internationalis Limnologiae
STA	Science and Technology Agency of Japan
TCODE	Technical Committee on Data Exchange (within PICES)
TOS	The Oceanography Society
TINRO	Russian Pacific Scientific Research Fisheries Center
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization
VNIRO	Russian Federal Research Institute of Fishery and Oceanography
WESTPAC	Subcommittee for the Western Pacific (under IOC)
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment

Index

Q

R