

NONRECORD

The Environment of AMCHITKA ISLAND, ALASKA

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FOREWORD

The scientific information presented in this volume was acquired in studies initiated by the former U. S. Atomic Energy Commission (AEC) in 1966.

In January 1975 the Atomic Energy Commission as an agency was disbanded. Many of the activities, including the nation's nuclear weapons program, were transferred to the newly created Energy Research and Development Administration (ERDA). Publication of this book has been completed under the auspices of ERDA; however, reference to AEC is frequently made to preserve historical accuracy.

* * * * *

In 1966 a military requirement was established for the development of the Spartan antiballistic missile system. This development required the proof-test of the nuclear warhead before deployment. Because the yield of this warhead would be larger than any underground nuclear test previously conducted by the United States (approximately 5 megatons), locating an appropriate nuclear test site posed a unique problem to the nation's nuclear weapons test complex. The principal problem was to locate a test site within the United States having appropriate geology that would insure containment of radioactivity and that was at a sufficient distance from high-rise man-made structures so that the ground motion from the nuclear detonation would not cause unacceptable damage to such structures. It soon became apparent that no location meeting these requirements could be found within the conterminous forty-eight states, and so attention focused on Alaska. Two locations in Alaska were selected for reconnaissance as possible test sites. One of these was north of the Brooks Range close to the Arctic Ocean in northwestern Alaska. The other was the island of Amchitka in the western Aleutian Islands archipelago. (Amchitka had been used previously for a low-yield nuclear test conducted in 1965 by the Department of Defense with AEC assistance.)

Ultimately, after the consideration of many factors, Amchitka was selected for the supplemental high-yield nuclear test site. It was necessary to take into consideration that the island had been designated as part of the Aleutian Islands National Wildlife Refuge and was under the administration of the U. S. Fish and Wildlife Service of the Department of the Interior. However, when the refuge was established by Presidential Executive Order No. 1733, on Mar. 3, 1913, it contained the following proviso:

Establishment of this reservation shall not interfere with use of the islands for lighthouse, military or naval purposes. . . .

Thus the temporary use of Amchitka as a nuclear weapons test site to fulfill a military need was deemed to be consonant with the spirit of the Executive Order, and the Secretary of the Interior gave permission for AEC to occupy and use Amchitka for nuclear tests.

Because Amchitka is a part of the wildlife refuge and because it possesses environmental and biotic features quite different from locations where other nuclear tests had been conducted, it was considered necessary to carry out a

program of bioenvironmental studies in support of the nuclear test mission. Accordingly, the Division of Military Application at AEC Headquarters provided funds for the Nevada Operations Office to initiate and administer an Amchitka Bioenvironmental Program. There was an important precedent to such bioenvironmental investigations in Alaska in the ones that were performed as part of the AEC's project Chariot studies from 1959 to 1961. The lessons learned from Chariot were very valuable in designing and conducting the Amchitka studies.

The Amchitka Bioenvironmental Program commenced in 1967 and continued to the time when the test activities were concluded, the site restored, and AEC personnel evacuated from the island in 1973. A small series of follow-up studies have been conducted periodically since that time.

It has been the policy of the AEC (and now ERDA) to publish and make available to the scientific community and the public results of the agency's unclassified research. It is the purpose of this book to compile and condense the information developed in these studies and to make this information broadly available. Much of the information was published earlier in progress or special topical reports; however, these reports did not receive very wide dissemination and thus are not readily available to the average reader. It is hoped that this book will be more readily accessible and reach a wider audience.

Since the studies that yielded the information contained herein were conducted to meet the mission needs of the nuclear weapons test program, their scope is not truly comprehensive in an ecological sense, and the reader can readily discover that there are gaps. In spite of these gaps, we believe this compilation of information is a valuable contribution to environmental science. One of the values is the fact that the studies were carried out nearly simultaneously at a common location and thus relate to each other in a more meaningful way than studies occurring in different time periods. The Energy Research and Development Administration is pleased to publish this book with the hope it will be an enduring and valuable contribution to the scientific literature.

/s/ Edward B. Giller
Deputy Assistant Administrator
for National Security

PREFACE

To many a wartime soldier or sailor, the Aleutians were the land that God forgot. The Coast Pilot comments on the weather of the Aleutians, "No other area in the world is recognized as having worse weather in general than that which the Aleutian Islands experience." Yet primitive man lived there and made a good living for thousands of years before the white man came to disturb him. William S. Laughlin points out that it was quite possible for primitive Aleut men or women to live into their eighties; by contrast, Eskimos in the true Arctic were lucky to see past their forties.

We who spent intermittent periods of time for six years on Amchitka, however, came to think of the island as a beautiful place in a grand, bleak way. I (Merritt) first went to the island in February 1968. One of the high points of that visit was a journey along the crest of the island on the old jeep trail while the wind swept great sheets of fine snow up the U-shaped valleys from the Bering shore and out in long horizontal fingers over the Pacific. We came to joke about the nearly constant summer fog, wondering if the plane would be able to make it in. Even then there was usually one day a week clear enough that the neighboring island to the north would show the seven peaks for which it was named Semisopochnoi. We recall with pleasure the occasional clear, warm days in the fall when the crowberry and lichen were soft on the hills, spray twisted around the rocks at the edge of the intertidal bench, and sea otter played with their young in the water beyond.

We were there for a purpose, a purpose that was stirring dissent and argument down where we came from and in the great state of Alaska, of which Amchitka is an outlying part. If there must be armaments in this less-than-perfect world, we wanted to know, as well as circumstances allowed, what we were doing in the testing of them, what sort of place we were into, and how we could minimize the effects of our intrusion. Programs in seismology, geology, hydrology, and the various subject matters included in the word biology were carried out to ascertain better what was there, to predict the effects of the nuclear tests to come, to minimize undesirable effects to the extent feasible, and to document what actually did happen.

In the course of this very applied and pragmatic endeavor, a good deal of fundamental, and we hope new, information was gained about a hitherto little-studied part of the world; it is the purpose of this book to bring together in one place a comprehensive summary of these results in the field of the life sciences. Results in the physical sciences are published elsewhere. It is not our primary purpose here to tell what happened as a result of the nuclear tests, although that is not ignored, or to produce an apology for the weapons program. But we do admit pride in the wealth of information that we here offer to the critical eyes of our fellow scientists. We hope that the body of knowledge summarized here will add to the understanding of our world and perhaps even be the basis for further work in these islands in the future.

In 1966 the Department of Defense asked the U. S. Atomic Energy Commission to design a nuclear explosive with an energy output larger than could safely be tested underground at the existing Nevada Test Site, the

limitation there being ground motion and its effects on high-rise buildings in Las Vegas. After a considerable search, the AEC went to Amchitka. Amchitka had geology suitable for the proposed tests and for containment of the resulting radioactivity, it was remote enough to give reasonable assurance of safety, and it was U. S. territory. Safety is first and foremost a concern about people. The most effective way to protect people is to be far from them, and Amchitka is far from people, as far as any place that can be found in the fifty states. The AEC was not entirely unfamiliar with Amchitka; it had participated in a Department of Defense underground nuclear test there in 1965. But unfortunately the biological program on that test was minimal and gave only a slight basis for predicting the consequences of much larger shots. A more comprehensive ecological program was in order.

In 1966 the Battelle Memorial Institute's Columbus Laboratories was managing a program of ecological studies in Panama for the AEC and the Atlantic-Pacific Interoceanic Canal Commission associated with the feasibility and safety of digging a new canal with nuclear explosives. Battelle was asked to organize studies at Amchitka as well.

The broad objectives of the proposed studies, as spelled out in the contract between the AEC and Battelle, were to conduct appropriate field and laboratory studies to predict, evaluate, and document the effects on the bioenvironment of Amchitka Island that might result from the proposed nuclear tests and to recommend measures for minimizing these effects.

Thus in 1967, two years before enactment of the National Environmental Policy Act of 1969, the program whose fundamental results are reported in this book began. These broad objectives had to be brought down to the level of specific concerns, a program outlined, and competent investigators sought. The first list of specific concerns, agreed to with the Fish and Wildlife Service in June 1967, ordered them:

1. Effects on the sea otter population.
2. Transport of radionuclides to man via marine processes.
3. Transport of radionuclides to man via migratory birds.
4. Disturbance of terrestrial habitats.
5. Disturbance of freshwater habitats.

The list and priorities within it changed as time went on. For instance, physical effects were certain; they deserved and later got top priority. Radiological effects were considered improbable since a leak of radioactivity was improbable; so they took second place. Radiation background levels, however, had to be determined, and they are reported in this book. The original work statement and this list of specific concerns emphasize man and his interests over the rest of the biosphere. Effects on the sea otter population took the top place on the list because of the importance of this animal in the public mind, the species having once been endangered as a result of human predation. The emphasis on sea otters continued to the end of the program.

The very applied nature of the bioenvironmental program dictated details in the design of the program. The program was selective; emphasis

was put on the highest trophic levels and on those species of greatest public interest. This resulted in important omissions: The whole question of decay of organic matter and return of nutrients to the soil was left out, as was entomology. The Norway rat population was not a subject of formal study, although these recently introduced animals play a role in the terrestrial ecosystem. As editors we now regret this oversight and have tried in this book to bring together information about rats that was gathered late or incidental to other parts of the program.

The AEC-sponsored ecological studies were carried out under the close scrutiny of the U. S. Department of the Interior, and the results of the investigations were reported regularly. The Fish and Wildlife Service of that department assigned four men to it, two refuge-management biologists who rotated to keep one man on the island at all times and two research-oriented men who monitored and participated in the research being carried on. One of these represented the Bureau of Sport Fisheries and Wildlife and the other the Bureau of Commercial Fisheries (now the National Marine Fisheries Service in the Department of Commerce). Annual progress reports went to four libraries in Alaska as well as to a number of repositories in the lower forty-eight states. A special session on Amchitka studies was featured in the 1970 annual meeting of the American Institute of Biological Sciences in Bloomington, Ind., and the papers given there were later published in the June 15, 1971, issue of *BioScience*. (Results of the program in the physical sciences have been published in the December 1972 issue of the *Bulletin of the Seismological Society of America* and elsewhere.)

The idea of putting together a book on the Amchitka investigations had a precedent in the AEC's proposed Chariot project. That project was suspended, but not before several seasons of intensive ecological studies had been completed. The book reporting the results of that program is the classic "Environment of Cape Thompson, Alaska," edited by Norman J. Wilimovsky and John N. Wolfe. Many of us believed that Amchitka too should have its book. This dream remained in the background for six years while more pressing concerns were attended to. However, when Cannikin was past, the test people had left, and cleanup of the island had started, the dream was remembered. It has now been realized in this book.

As an introduction to the discussions that follow, it is appropriate to call attention to the special position Amchitka occupies in a larger setting and to the forces that have influenced it in an ecological sense. The key to understanding the structure and dynamics of Amchitka ecosystems is a recognition that this is a truly oceanic island, a minuscule bit of land remote from any continent, and relatively isolated even from neighboring islands by deep ocean passes. It is important also to note that Amchitka lies along the boundary between two major ocean-water masses that differ significantly in temperature, salinity, and biological properties.

The North Pacific Ocean washes the southwest shore of Amchitka, and the colder, more saline waters of the Bering Sea break against the northeast coast. Through Amchitka Pass and Oglala Pass, at either end of the island, Pacific Ocean and Bering Sea waters mingle and exchange or blend some of

their disparate properties. Together these two water masses provide, in large measure, the environmental determinants and the driving forces that influence the terrestrial, freshwater, and littoral ecosystems of the island. Except for its bedrock geologic structure, there is almost no feature of the island—climate, vegetation, or fauna—that does not reflect the overriding influence of the seas around it and its remoteness from continental land masses. Even the prehistoric and historic intrusions of man onto Amchitka were primarily aimed at exploiting resources that depended on the maritime situation of the island.

The much maligned climate of Amchitka is a product of interactions between passing storm systems, generated by global atmospheric circulation, and the adjacent water masses, which differ in surface temperature. Frequent, abrupt changes in weather occur with the passage of storm fronts along or across the Aleutian arc; yet daily and seasonal fluctuations in air temperature are relatively small owing to the moderating effect of the seas. Fog or low clouds blanket the island much of the time, with the result that insolation is low as compared with continental locations at similar latitudes. The typically maritime climate strongly influences the aspect and productivity of terrestrial vegetation, whereas the composition of the flora reflects the isolation of Amchitka from continental floras.

The influence of the oceans extends as well to almost every other feature of the Amchitka biosphere. Five of the six species of fish found in the freshwaters of the island spend a part of their life cycle at sea, reach maturity in the productive marine environment, and return to freshwater to spawn. Well over half the species of birds of Amchitka derive all or a part of their sustenance from marine littoral or pelagic sources. The native mammals are all creatures of the sea or of the interface between sea and land. Even the nonindigenous Norway rat, which elsewhere subsists mainly on the refuse heaps of man, is found here most frequently on the ocean beaches where food is plentiful. Most of the chapters in this book will show, in greater or lesser detail, the dependence of Amchitka biota on the productivity and tempering influence of the seas around it.

The authors whose papers are gathered here have, for the most part, been with the program since near its inception. In those few instances where there had been a change in investigators, the most recent participants were recruited. Their papers are gathered into major sections on the Land, the Sea, Marine Mammals, and Environmental Contaminants. Preceding those sections is a group of papers that set the stage. After the main sections comes a one-paper section devoted to summarizing the effects of the nuclear tests on the island. As to the overall meaning of what we have learned, we can only say that research is always inherently incomplete and that each reader will have to summarize for himself.

Some will say it is a pity that it takes a nasty cause like weapons tests to produce the kind of detailed study that a place like Amchitka deserves. We who have spent an important part of our lives there would rather be glad that a necessary evil can nevertheless produce information of lasting value to mankind.

M. L. Merritt
R. G. Fuller

ACKNOWLEDGMENTS

No project the size of the Amchitka Bioenvironmental Program could possibly have come off as well as it did without the diligent efforts of a great number of people. There are too many to name, and even as we try we will probably omit some just because we could not keep track of them all.

First and foremost, there were the scientists themselves. They are a grand group of people; we enjoyed working with them and regret that we can never all be together again. The very process of having to live together at the end of an extended supply line created an interdependence and an esprit de corps that served wonderfully in smoothing over the inevitable small frictions of human intercourse and the tension of deadlines. Many are among the authors of this book and kept at it even after the money ran out. Then there were our anonymous referees who read these papers in earlier versions. We thank them all.

The program was sponsored by the Atomic Energy Commission, Division of Military Application, headed in its later phases by General Edward Giller, who took a great deal of personal interest in it. Giller's deputies, first Charles Winter and then Frederick Tesche, and his assistant for environmental affairs, Gordon Facer, smoothed our Washington problems a great deal.

The Milrow test was under the technical direction of the Los Alamos Scientific Laboratory, and the Cannikin test was under that of the Lawrence Livermore Laboratory. Their large test staffs, under William E. Ogle and James Carothers, respectively, spent a lot of time they did not have to on our problems.

The Amchitka Bioenvironmental Program reported directly to the AEC's Nevada Operations Office (NVO). James E. Reeves, Manager of NVO until 1969, was a strong early supporter of safety studies, one of which was this program. His successor, Robert E. Miller, gave close personal attention to what was happening within the program and many times made decisions in favor of program projects in the stubborn faith that this work was important too, even at the risk of interfering somewhat with the weapons test itself. Then, of all the wonderful people to work with, we must mention Jerry Davis, Ernie Campbell, and Ray Brechbill of the NVO Effects Evaluation Office. Ernie especially has followed through in support of this book to the very end; his unfailing encouragement and wise counsel have been invaluable.

The NVO supported all the activities on Amchitka through contractors and subcontractors reporting to a series of Site Managers appointed from the NVO engineering staff. We note especially Holmes and Narver, Inc., the basic island support contractor, and Universal Services, Inc., the housekeeping contractor who kept a magnificent kitchen. The Amchitka Bioenvironmental Program itself was set up through the Battelle Columbus Laboratories (BCL), and, although NVO chose to make some direct contractual arrangements later, the BCL influence was important throughout (and a BCL retiree is one of the present editors). Dr. Richard Davidson initially supervised setting up the program; Dr. James Kirkwood (now with the Fish and Wildlife Service) was recruited as overall Project Scientist and Field Director. Also important were Roger Evans as contract officer and Ian Mercier who served in a wide

variety of fields, especially including field coordinator of biological programs.

The Department of the Interior scrutinized the program carefully from the beginning. Refuge biologists were assigned by the Fish and Wildlife Service, one to be on the island at all times: these were John Hakala, LeRoy Sowl, Baine Catron, Clay Hardy, and Vern Byrd. Carl Abegglen (now retired) and Ted Merrell (since transferred to the Department of Commerce with his agency, now the National Marine Fisheries Service) were research-oriented staff members assigned to the project. In many instances Interior representatives took an active part in the field work.

Among other organizations that we interacted with, we especially remember Reeve Aleutian Airways, which gave yeoman service in support of our activities. All program participants remember William "Scotty" Matthews, our principal helicopter pilot, who came to know the island like a book and was just as good at telling stories; this knowledge made him a very effective assistant to the biologists. Bob Rausch from the Arctic Health Research Center did the autopsies on dead sea otters, seals, birds, and fish after Cannikin. Karl Schneider, Alaska Department of Fish and Game, always skeptical and sometimes disagreeing with our methods and purposes, was yet very helpful in sea otter studies and as a devil's advocate.

Finally, we must put in a good word for our collaborators from the Energy Research and Development Administration, Technical Information Center, in Oak Ridge, Tenn., Marian Fox and Jean Smith, who took our scratched-up manuscripts and with patience, good will, and professional expertise put them into the shape you see here.

The Editors

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