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AMCHITKA RADIOBIOLOGICAL PROGRAM

FINAL REPORT

JULY 1970 TO DECEMBER 1979

By

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ABSTRACT

The Amchitka Radiobiological Program, to collect biological and environmental samples for radiological analyses, began in 1970 and continued through 1979. The principal objective was to determine the extent of radionuclide contamination from worldwide atmospheric fallout and from the detonation of three underground nuclear tests on Amchitka. Leakage of radionuclides from the underground test sites would be suspected if the amount of contamination was significantly greater than could be attributed to worldwide fallout or if an unexpected assemblage of radionuclides was detected. No radionuclides from the underground sites were detected, except for tritium from the Long Shot test (1965) which produced increased tritium concentrations in surface water and freshwater plants near the test site.

Results of radiological analyses have been submitted by the Laboratory of Radiation Ecology to the Nevada Operations Office in ten previous progress reports. This final report compiles all the previous data into one report and considers the temporal trends in these data. Two naturally occurring radionuclides, ^{40}K and ^{7}Be, were the most abundantly occurring radionuclides in most samples; in lichen samples either ^{137}Cs or ^{144}Ce had the highest activity. All samples were below applicable Radiation Protection Guides and by 1979 most samples were near or below the statistical detection limits. Increased concentrations of short-lived fallout radionuclides following the Chinese atmospheric tests were found in freshwater and seawater samples and in most indicator organisms.

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INTRODUCTION

Between September 1970 and September 1979, the Laboratory of Radiation Ecology conducted a radiological monitoring program on Amchitka Island, Alaska. According to Held (1971) the program was initiated in July 1970, at the request of the U.S. Atomic Energy Commission, Nevada Operations Office, to provide a periodic documentation of radionuclides, both naturally occurring and man-made, in biological and environmental samples from Amchitka and its environs. The program considered the potential availability of radionuclides to man by emphasizing the measurement of isotopes in seafoods and food web organisms. However, other objectives were to identify indicator organisms for specific radionuclides, to determine the origin of radionuclides on Amchitka, and to estimate transfer coefficients and concentration factors which could be used to predict the fate of radionuclides introduced into the environment from any source (Held, 1971).

Results from this project have been presented previously in numerous reports to the Nevada Operations Office (Table 1). Seymour and Nelson (1977) summarized and integrated the information that was available on radionuclide concentrations in air, water, and biota on Amchitka through August 1975. This final summary report for the Amchitka Radiobiological Program provides an exhaustive compilation of all the radiological data obtained during this monitoring program. These data were all reported in one or more previous reports but were not compiled in a single source.

This program was started as a radiological survey prior to the Cannikin underground detonation in November 1971. The most frequent and extensive samples were collected prior to and immediately after that event. Analyses of the early samples indicated that radionuclides from the Cannikin detonation were not escaping to the surface (Held et al., 1973). No subsequent sampling has questioned the validity of this conclusion (Tornberg et al., 1980). Therefore, both the collection frequency and the number of samples collected were reduced in later years. Collection of some initial sample types was also discontinued.

Recent annual reports have included considerable amounts of data from earlier sampling periods. However, the data presented in those reports are not exhaustive, because (1) analytical results are presented only for those sample types that were collected during the reporting year, and (2) many of the data are reported as average values for several samples rather than the results of individual sample analyses. In order to reduce repetition among reports and consolidate the available information, Nelson and Seymour (1975) eliminated from their report a considerable amount of data that had been collected before 1973. Averaging of data started with the annual report for 1972 (Held et al., 1973) and continued in subsequent years. This final report presents the results of individual sample analyses and assembles many of the earlier data that were not included in recent reports. This will provide the most comprehensive list of the radiological data.

Amchitka Island was used for two underground detonations, Long Shot (1965) and Milrow (1969), prior to the Cannikin test. Seymour and Nelson (1977) have provided some information about these three events and appropriate references to radioecological surveys. The most important objective of these surveys was to determine the source of radioactivity at Amchitka and determine if radioactivity from the detonations was entering the Amchitka environment. Other sources of radioactivity at Amchitka include natural radiation from terrestrial and atmospheric sources and atmospheric fallout of artificial radionuclides following atmospheric weapons testing.

Natural radionuclides of terrestrial origin have long half-lives and have persisted since the formation of the earth. Potassium-40 is the most abundant terrestrial radionuclide in biological samples and generally is present in greater amounts than all other radionuclides combined (Seymour and Nelson, 1977). Other terrestrial radionuclides that may occur in detectable quantities include various isotopes of thorium and uranium, their daughter products, and ^{87}Rb. Of the natural radionuclides formed by cosmic radiation in the atmosphere, ^{3}H, ^{14}C, and ^{7}Be are most abundant. However, significant amounts of ^{3}H and ^{14}C were also introduced by the United States and the U.S.S.R. during atmospheric weapons tests (Joseph et al., 1971; Schell et al., 1974). Beryllium-7 has been detected at low concentrations in some Amchitka biological samples, especially lichens and freshwater plants (Seymour and Nelson, 1977; Tornberg. et al., 1980).

The major environmental input of artificial radionuclides resulted from atmospheric nuclear test programs (Joseph et al., 1971), especially the detonation of more than 100 megatons of nuclear devices in 1961 and 1962 (Held, 1971). Fallout included long-lived radionuclides such as ^{90}Sr, ^{137}Cs, ^{55}Fe, and plutonium isotopes and numerous short-lived radionuclides (^{46}Sc, ^{54}Mn, ^{60}Co, ^{65}Zn, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{106}Rh, ^{108m}Ag, ^{110m}Ag, and ^{125}Sb) which were detected at Amchitka in small amounts comparable to concentrations found in other parts of the Northern Hemisphere (Held, 1972).

Nuclear detonations on Amchitka were designed to retain radiation in the immediate area. It was not expected, therefore, that large amounts of radiation would be released from the detonations. Small increases in radiation would be difficult to detect or attribute to a specific cause since the radionuclides in atmospheric fallout are the same as those produced in the Amchitka tests (Seymour and Nelson, 1977). Therefore, direct radiological measurements are able to identify only large increases in environmental radiation.

In the first progress report for this project (Held, 1971), it was concluded that "the radionuclides detected were naturally occurring, from worldwide atmosphere fallout, or were carried to the area by oceanic currents, with the exception of tritium which was previously reported to be present in ponds and well water from the Long Shot ground zero site. The concentrations of the radionuclides found are within the range of values reported for similar samples from other parts of the Northern Hemisphere." This is the most important conclusion of this project and has been reiterated in each of the subsequent reports. It is presently based on considerably more data than were available for Held's original statement.

The following summary statements to justify the above conclusion are from Tornberg et al. (1980):

(a) Two natural radionuclides, ^{7}Be and ^{40}K, were the most abundant radionuclides in most samples.

(b) Some fission products, induced radionuclides, and plutonium have been detected in quantities that range from the limits of detection to a few pCi/g of dry samples.

(c) Values for ^{95}Zr and ^{95}Nb in freshwater moss and algae from Amchitka Island and the Columbia River were similar in amounts and peaks of abundance.

(d) Peaks of abundance of fission product radionuclides occurred in 1970-71, 1974 and 1977 and followed major Chinese nuclear detonations.

(e) There is no strong evidence from the gamma spectrum analysis that the radioactivity of the samples is related to the collection location on Amchitka Island.

(f) The radioactivity from fallout radionuclides, generally, was greater for freshwater than for marine organisms.

(g) There has been no significant increase in ^{3}H, ^{90}Sr, or $^{239,240}Pu$ values. Tritium is a potential radionuclide indicator of radionuclide leakage from underground sites.

(h) The background radiation survey meter readings were at or near the lower limits of detection for the instrument.

(i) The laboratory detection and measurement system for the radiobiological analyses of the samples was sensitive to small perturbations in the amounts and species of radionuclides in the environment.

METHODS

Location and Sampling Sites

Amchitka Island (51.5°N, 179°E) is one of the Rat Islands in the Aleutian Islands, Alaska. As one of the southernmost Aleutians it is also one of the southernmost points in Alaska, and is approximately 4,000 km (2,500 miles) west-northwest of Seattle, Washington. Figure 1 shows Amchitka's position between the northern Pacific Ocean and the Bering Sea. A map of Amchitka showing the general location of collection sites is provided in Figure 2. More detailed information for each of the sampling areas and the location of individual collection sites is shown in Figures 3-6.

Sample Types

One objective of this program was to identify indicator organisms which could be used to monitor long-term trends in radionuclide concentrations. In the search for indicator species, 81 types of biological samples were collected for radiological analyses (Seymour and Nelson, 1977). The samples included 37 species of vertebrates (2 mammals, 22 fish, and 13 birds), 20 invertebrates, 11 marine algae, 4 freshwater plants, and 9 land plants. Since the results of radiological analyses are presented in terms of dry weight, Held (1971, 1972) determined wet weight/dry weight ratios of numerous biological sample types. The scientific and common names and wet weight/dry weight ratios of Amchitka biological samples are given in Table 2.

Samples of air, water, and soil were collected in addition to the biological samples. These samples could indicate when new radionuclides were introduced by fallout and provide information on the concentration and variety of isotopes that were available to the biota. A filter-sorption bed developed by Battelle Northwest Laboratories (Silker et al., 1971) was used to collect large-volume (500-4,000 liter) water samples. The apparatus consists of six or more Millipore filters of 12-inch diameter and 0.3-micron porosity arranged so that water passes through the filters in parallel and then through a series of 1-3 aluminum oxide sorption beds. The Al_2O_3 sorbs both anions and cations as well

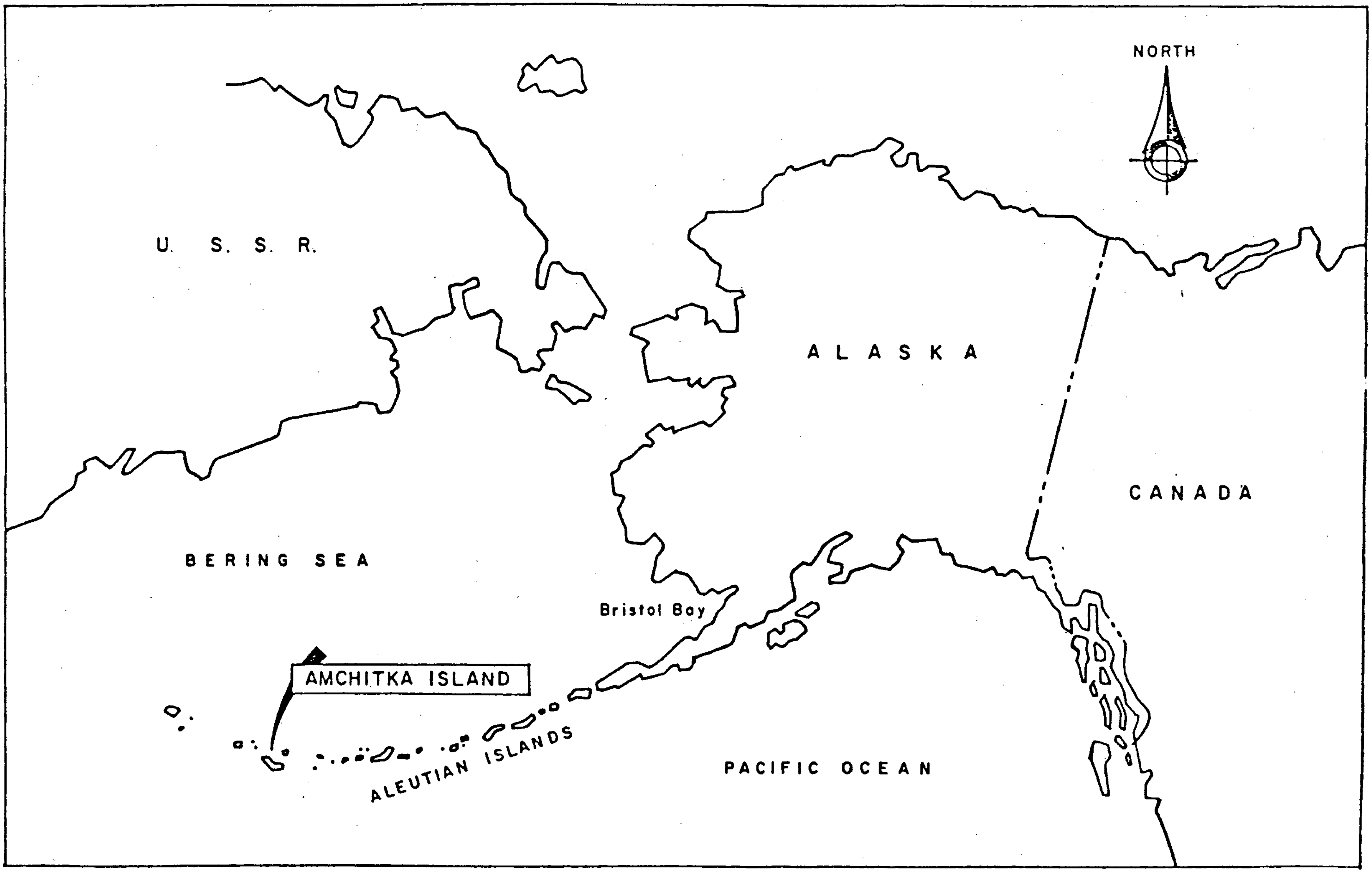

FIGURE 1. Location Map

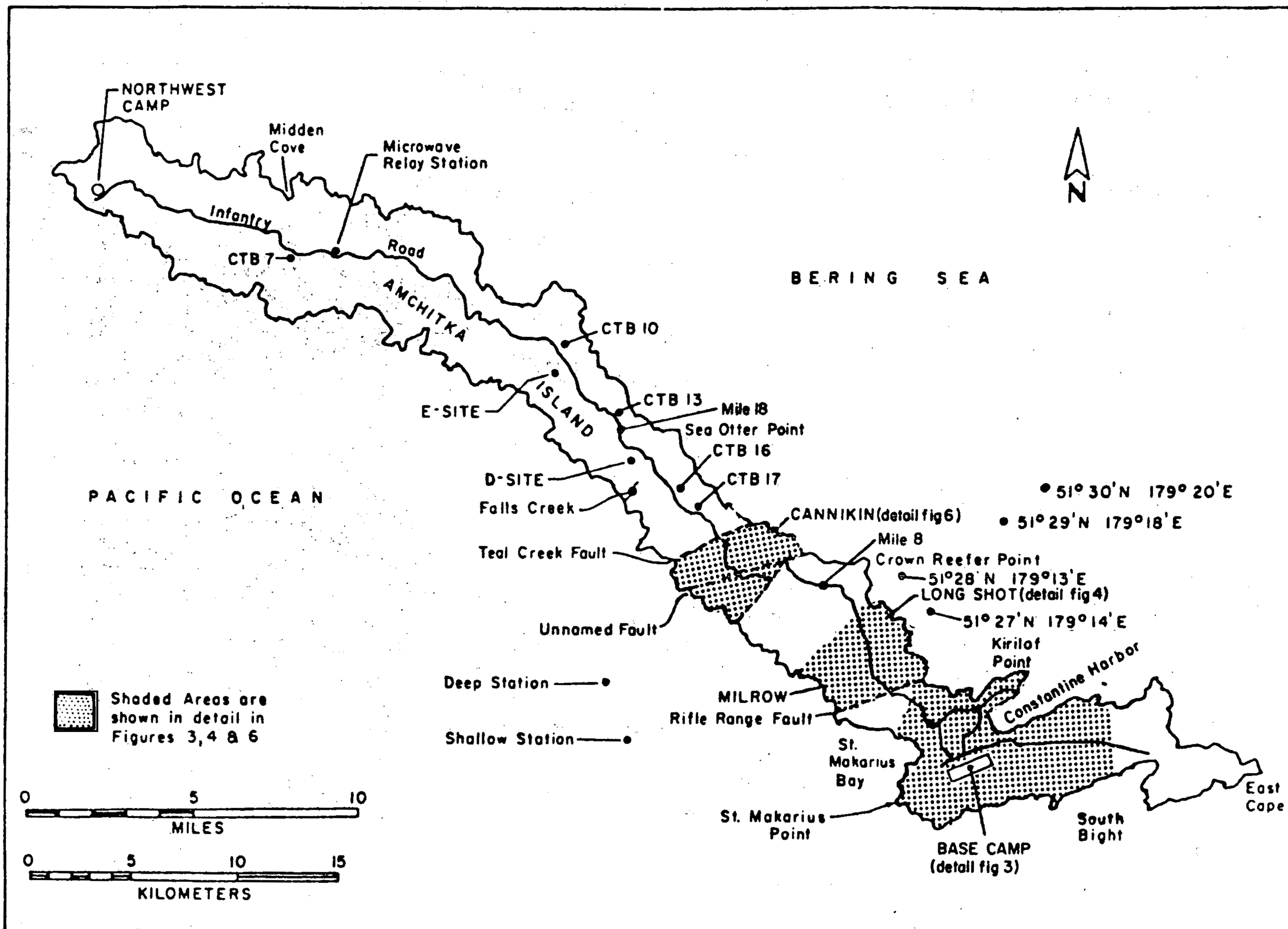

FIGURE 2. Location of Collection Sites on and near Amchitka Island, Alaska

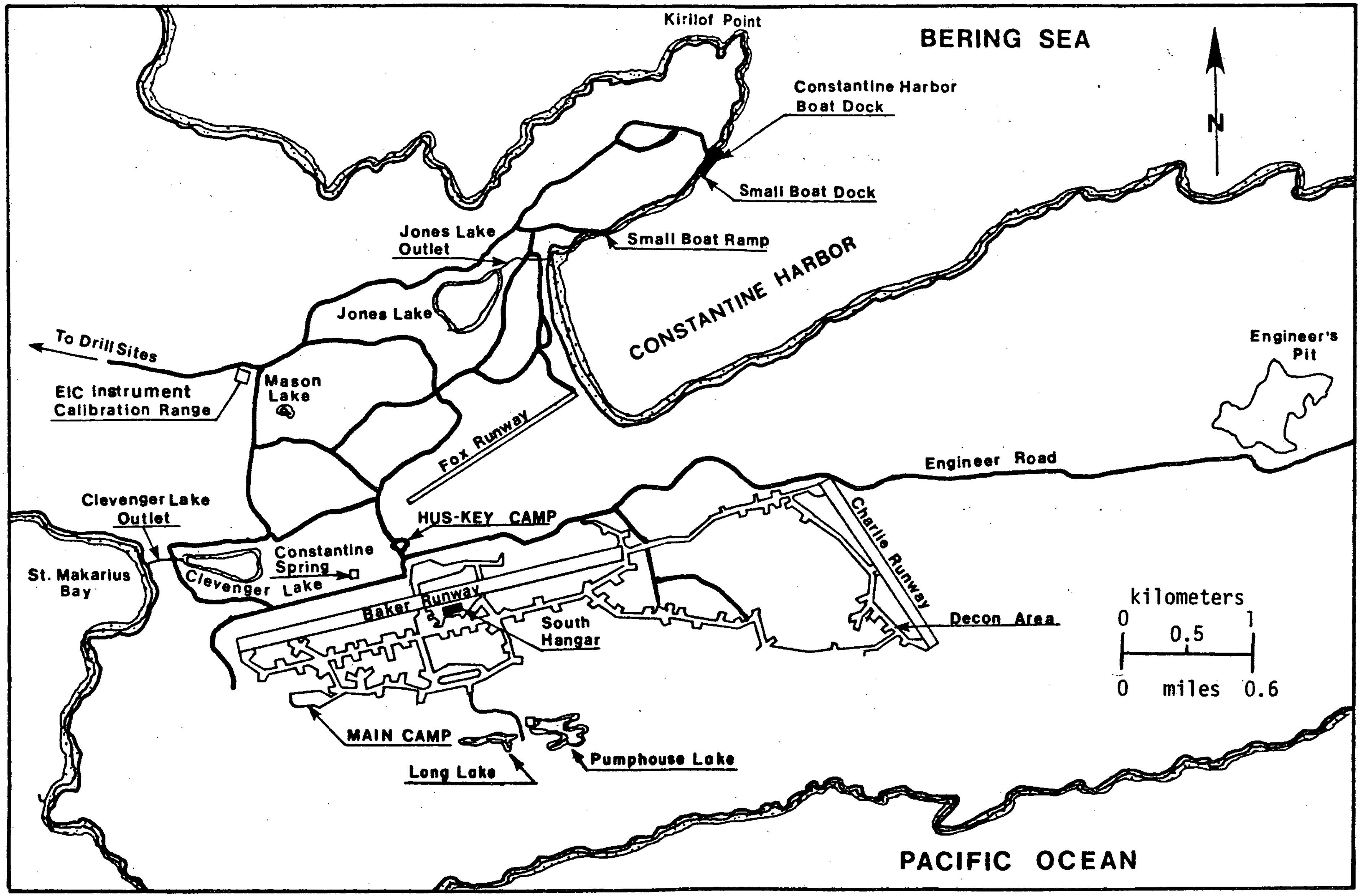

FIGURE 3. Collection Sites and Other Prominent Features in the Amchitka Island Base Camp Area

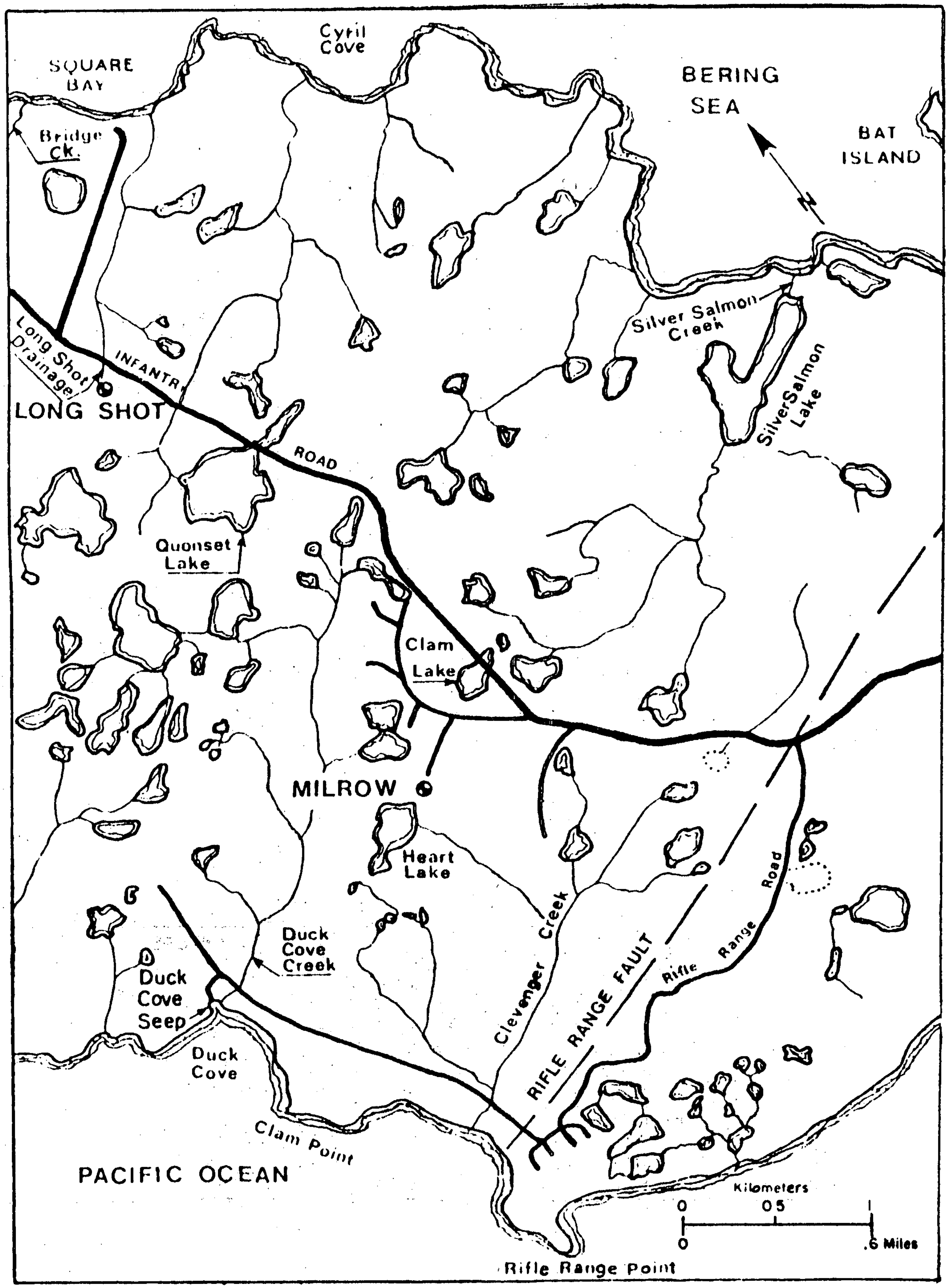

FIGURE 4. Collection Sites and Other Prominent Features in the Milrow Area.

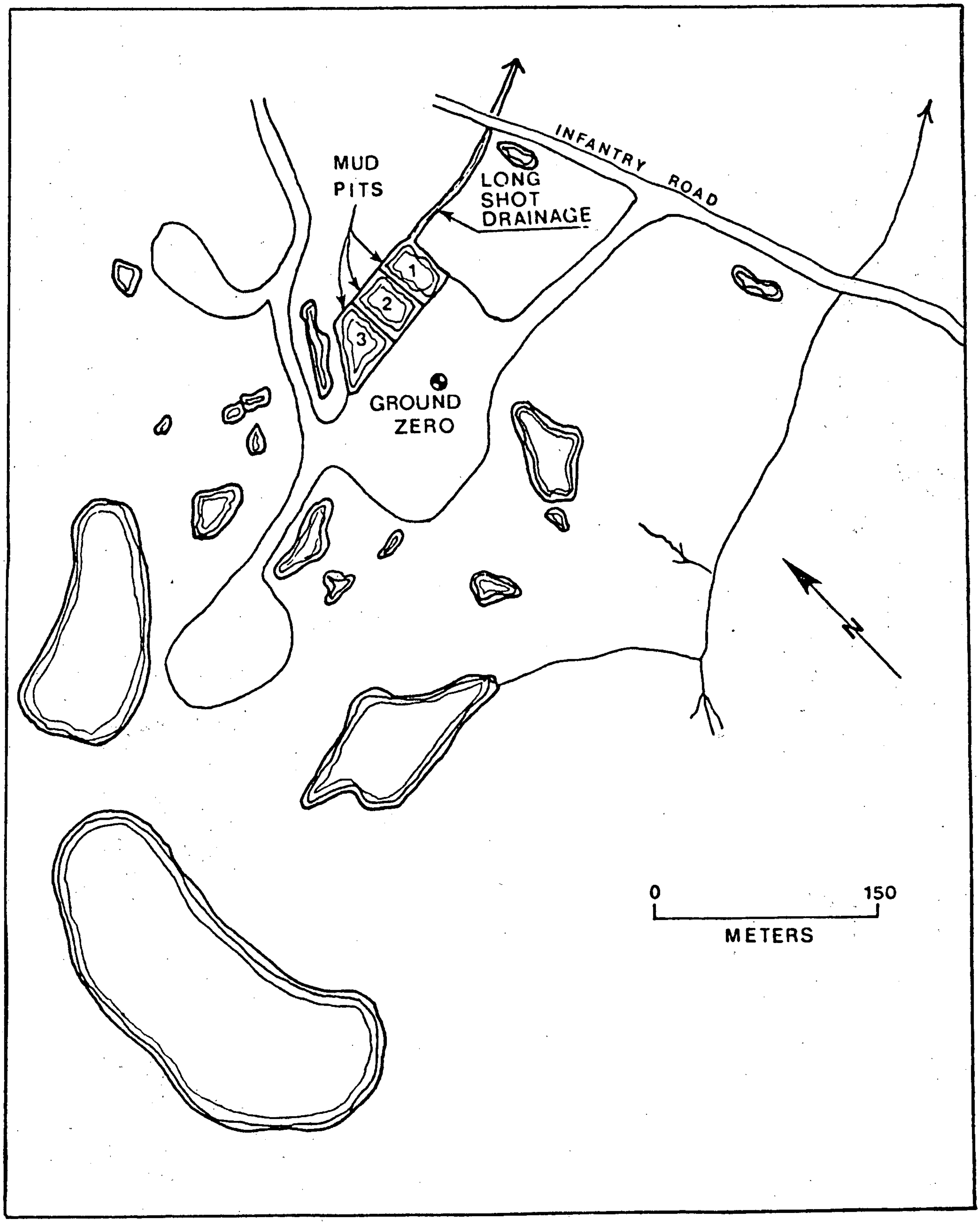

FIGURE 5. Collection Sites and Other Prominent Features in the Long Shot Ground Zero Vicinity.

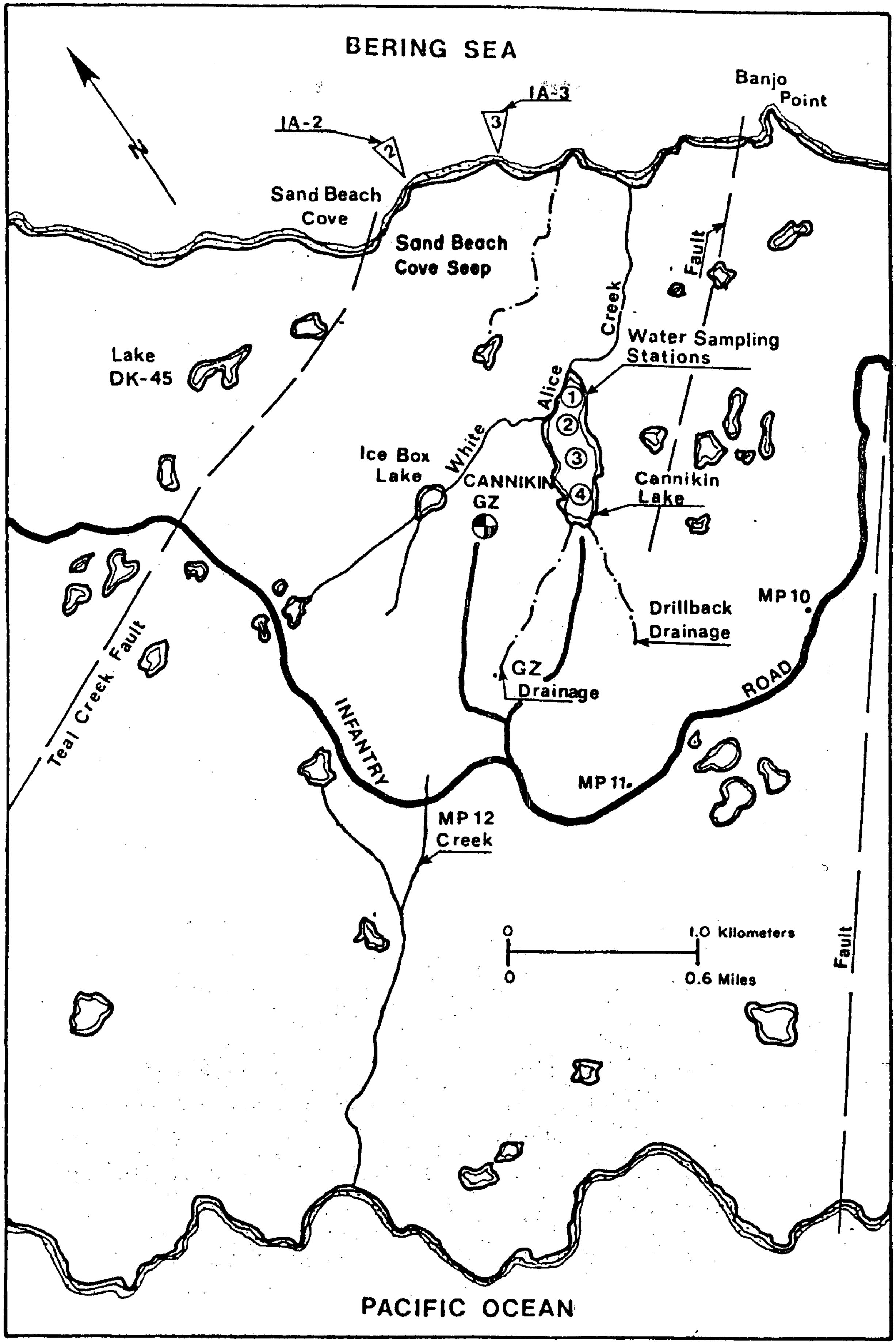

FIGURE 6. Collection Sites and Other Prominent Features in the Cannikin Area.

as colloidal species (Nevissi and Schell, 1976). Clogging of the filters by plankton and suspended matter limited the volume sampled. For example, only 500 liters of Long Shot pond water could be passed through the filters before they clogged, whereas 2,000-liter samples were easily filtered at sea. Large-volume water samples taken at sea were from three depths--above, at, and below the thermocline, or mixed layer. No samples were collected with the large-volume water sampler after 1974. From 1975 through 1979, freshwater samples (50 liters or more) for analyses of radionuclides other than ^3H were collected from four lakes or ponds. The water was evaporated and the residue counted for gamma-emitting radionuclides.

Air samples were collected with a Gast positive displacement pump calibrated at 10 ft^3/min, and a 15-cm filter head lined with No. 41 Whatman filter. Air particulates were collected on the filter paper continuously from 23 February 1972 until 28 August 1973, and for an 8-day period in August-September 1974 (Seymour and Nelson, 1977).

In addition to the radiometric analyses made of the biological and environmental samples, environmental radiation surveys of selected areas on Amchitka Island were made, starting in August 1974, with an Eberline survey meter Model E-510 and a pancake probe with a 2 mg/cm^2 window.

Radiation Measurements

Gamma-Ray Spectrometry. Most samples collected prior to July 1972, and fish, marine invertebrates, and birds collected through 1977, were analyzed by gamma spectrometry with systems using a 3x3-inch NaI (Tl) crystal and 200-channel, pulse height analyzer.

After July 1972, samples (except fish, marine invertebrates, and birds, as noted above) were analyzed with systems using Ge(Li) diode detectors and 4096-channel, pulse height analyzers. In 1979 the Ge(Li) diode detectors were interfaced with a computerized data acquisition system (Nuclear Data 6620).

The NaI system was used routinely for gamma-spectrum analyses because it is more efficient for counting gamma photons than the Ge(Li) system and requires less counting time for the same counting efficiency. If the radionuclides in the samples were not satisfactorily identified by the NaI system, the samples were then analyzed by the Ge(Li) system, which has a higher degree of resolution for different gamma energies than the NaI system. For example, the three gamma photons emitted by ^{95}Zr-^{95}Nb (724, 756, and 765 keV) appear as a single peak on the NaI spectrum.

When a sample containing ^{95}Zr and ^{95}Nb was counted by the two systems in the same day, the value for ^{95}Zr plus ^{95}Nb, as determined by the NaI system, was about the same as the sum of the values for the two radionuclides as determined by the Ge(Li) system. Hence, the composite value of ^{95}Zr plus ^{95}Nb, as determined by the NaI system, is assumed to be valid for the day it was counted. Held et al. (1973), discuss in detail the need to correct earlier data on ^{95}Zr plus ^{95}Nb. That discussion is presented below.

"In the original computation of ^{95}Zr plus ^{95}Nb values, as reported in Held (1971) and Held (1972), an error was made in the decay correction factor. This is the factor that corrects the value obtained on the day of counting to the backward extrapolated value for radioactivity in the sample on the day of collection. The radioactivity of the sample on the day of collection is the conventional method for reporting results of analyses. In the original computation it was assumed that the ratio of ^{95}Zr atoms to ^{95}Nb atoms, undergoing decay, was 1:1 as would be the ratio if the two radionuclides were in secular equilibrium; however, the radionuclides are actually in transient equilibrium and the ratio of ^{95}Zr to ^{95}Nb in dpm is 1 to 2.17, a value which was derived as follows: At transient equilibrium,

$$N_1 \lambda_1 = N_2 (\lambda_2 - \lambda_1)$$

where N_1 = number of ^{95}Zr atoms
N_2 = " " ^{95}Nb "
λ_1 = decay constant for ^{95}Zr = 0.01066/day
λ_2 = " " " ^{95}Nb = 0.0198/day

$$^{95}Nb : {}^{95}Zr,\ \text{decay rate} = \lambda_2/\lambda_1 = 1.86$$

$$^{95}Nb : {}^{95}Zr,\ \text{atoms} = N_2/N_1 = \lambda_1/\lambda_2 - \lambda_1 = 1.166$$

$$^{95}Nb : {}^{95}Zr,\ \text{in dpm} = N_2\lambda_2/N_1\lambda_1 = 2.17$$

"To correct the error in the original calculation of the ^{95}Zr + ^{95}Nb values, the composite values for ^{95}Zr + ^{95}Nb on the day of counting were used to calculate individual values for ^{95}Zr and ^{95}Nb which then were corrected for decay to the date of collection. To do this, it was assumed that ^{95}Zr and ^{95}Nb were in transient equilibrium at the time of sample counting and collection and that the equilibrium value was 1:2.17, i.e., 32% of the disintegrations were ^{95}Zr and 68% ^{95}Nb. After the values for ^{95}Zr and for ^{95}Nb, on the day of counting, had been determined, each value was corrected for decay to the date of sample collection by use of the decay correction factor for ^{95}Zr. (At equilibrium, both parent and daughter activities decrease at equal rates, the rate of decrease being dependent on the half-life of the parent.) The ^{95}Zr and ^{95}Nb values for the date of sample collection, calculated in this manner, are the ^{95}Zr and ^{95}Nb values recorded in the tables of this report.

"The question arises as to whether or not ^{95}Zr and ^{95}Nb were at equilibrium. To answer this question, the ratio of ^{95}Zr to ^{95}Nb was calculated from the data for those samples which were counted by the Ge(Li) system and compared to the theoretical ratio of 2.17. Generally, the values were similar, but not always, which suggests that an error remains in some of the recomputed values for ^{95}Zr and ^{95}Nb. ...If the ^{95}Zr in the sample was produced at various unknown times and is not in equilibrium with its daughter, ^{95}Nb, an accurate decay correction cannot be made."

A second change in previously reported data involves the naturally occurring radioisotope ^{7}Be. Beryllium-7, which is produced by the interaction of cosmic-ray particles with nuclei of gases in the atmosphere and has a 53-day half-life, is relatively abundant in some Amchitka plants. Furthermore, the 477-keV gamma photon emitted by ^{7}Be makes some contribution to the photon peaks for the 428-keV gamma from antimony-125 (^{125}Sb), the 497-keV gamma from ruthenium-103 (^{103}Ru), and the 512-keV gamma from ^{106}Ru when measured on the NaI system. By inclusion of the reference spectrum for ^{7}Be in the analyses of the total spectrum, new information for ^{7}Be and more accurate information for ^{125}Sb, ^{103}Ru, and ^{106}Ru was obtained. The data obtained with the NaI detectors have been recomputed for all samples and the corrected information is reported in the tables of this report. The small errors involved in these computations did not affect the conclusions of any progress report or this final report.

X-Ray Spectrometry. Iron-55 (^{55}Fe) decays by electron capture and is detected by the X-ray that is produced indirectly in the decay process. The measurement of ^{55}Fe requires chemical separation and deposition of the extracted iron on a planchette and the use of a thin beryllium window proportional counter and multichannel analyzer.

Tritium Analysis. Analysis for tritium in water requires distillation of either free or extracted water and measurement of ^{3}H in the distilled water by liquid scintillation detection methods (Held et al., 1973). In 1972-1974 a distillation unit to distill water samples and to extract free water from biological samples consisted of sample jars, distillate jars, capillary leak tube, manifold, vacuum pump, heater, cooler, and water and refrigerant pumps. A significant feature of the unit was the capillary leak tube joining the vacuum manifold to a tube extending from the sample jar to the distillate jar. The capillary leak tube prevented back-diffusion from distillate to sample and permitted noncondensable gases to escape. In use, the samples were placed in the sample jars and distilled from the sample into the distillate jars. The sample jars were bathed in warm water and the distillate jars were bathed in a refrigerant. The loss of water in distillation was negligible and no cross-contamination was found in the simultaneous distillation of samples with 10,000 TU and zero TU. Biota samples were processed in the same way as the water samples except that the biota samples were lyophilized rather than heated to prevent sample decomposition.

In 1974, the distillation unit was replaced by a combustion and drying unit used to extract free and bound water from tissue samples. Seawater and freshwater samples were no longer purified in the distillation unit but were azeotropically distilled with toluene and then analyzed for tritium by liquid scintillation techniques (Nelson and Seymour, 1975).

Biota samples for extraction of free and bound water were dried and then combusted in the unit diagrammed in Figure 7. Major parts of this unit are the stainless steel sample holder, combustion furnace, vacuum

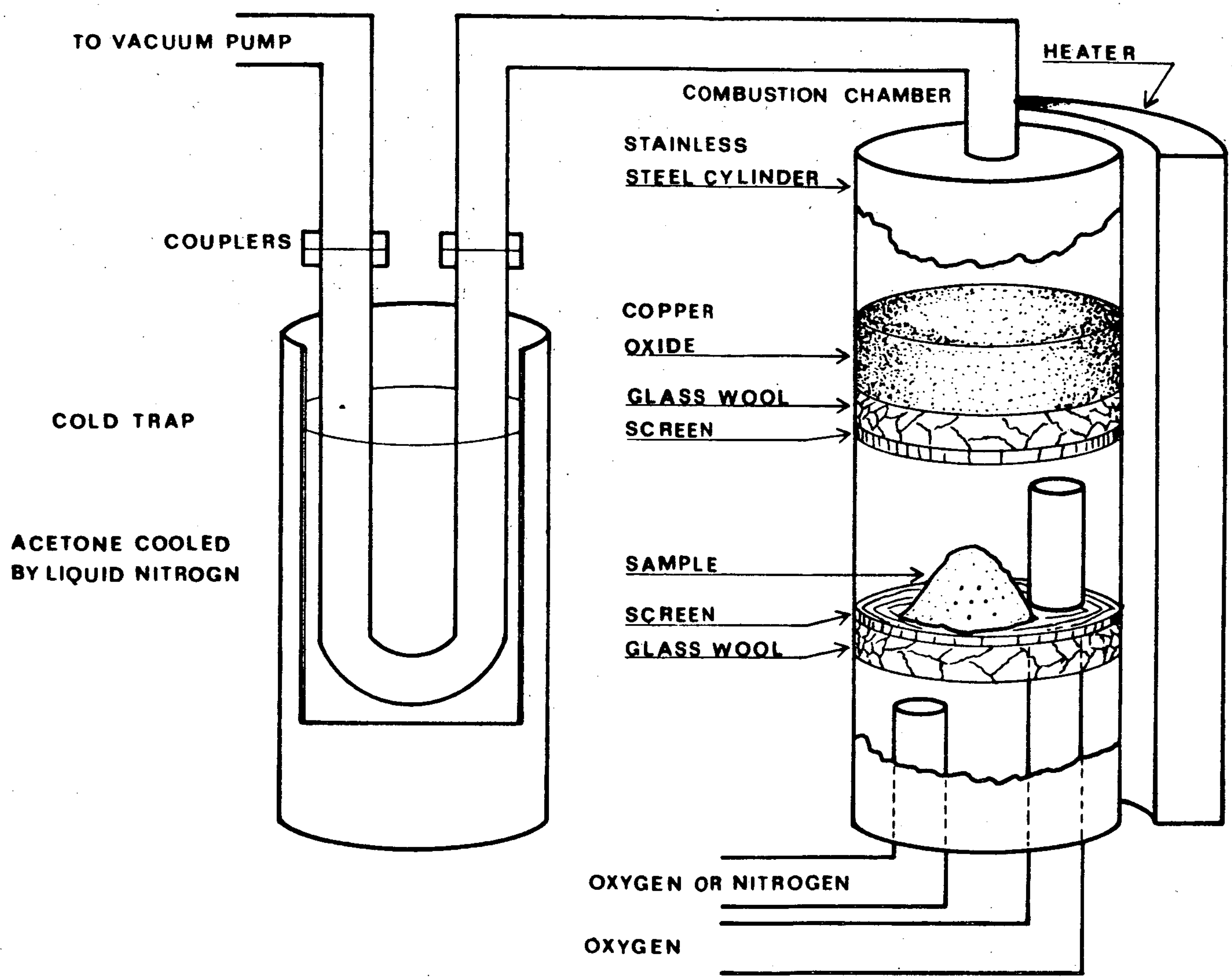

Fig. 7. Schematic drawing of the combustion chamber and cold-trap sub-units used for extracting free and bound water from tissue samples.

pump, manifold system, oxygen and nitrogen supply, cold traps, and cooling dewars containing a slush of -70°C to -100°C acetone cooled by liquid nitrogen.

To begin the drying procedure, a frozen sample of tissue was placed in the sample holder, where it remained without exposure to the atmosphere during drying and combustion. The system was evacuated and initial water distilled from the sample (about 10 ml) was collected in the cold trap and discarded, since it could contain water other than the free water of the sample, including water remaining in the system from previous use of the unit, or water from the external surface of the sample. To remove the free water, the sample was either vacuum lyophilized at ambient temperature or dried in a vacuum at 50-150°C for one to two days. When extraction of free water from the sample stopped, drying was terminated. The cold trap containing the free water was replaced with a clean, dry cold trap before combustion began. To combust a sample, the furnace temperature around the sample was raised to 500°C and oxygen was first passed over the sample and then below the sample. The products of combustion rise in the sample holder and pass through a layer of copper oxide (CuO) wire heated to 600°C. The hot CuO zone converts CO to CO_2 and promotes complete oxidation of any remaining organic molecules before combustion products pass through the cooled water trap where bound water has been collected. Combustion of a sample was usually completed in two to three hours. Water samples containing either free or bound tritium were then azeotropically distilled with toluene, and the purified water was analyzed for ^3H by the liquid scintillation method used to analyze freshwater and seawater samples.

In 1975 some changes were made in the combustion and drying unit described above. These changes included replacement of the stainless steel sample holder with a fused silica sample holder (Vycor) and replacement of the single large furnace with two smaller furnaces having separate temperature controls. These equipment changes were made to permit greater visibility and better temperature control during the drying and combustion of the samples. Also, refrigeration units were added to the system to maintain the ethylene glycol and water mixture in the cooling dewars at -45°C without adding liquid nitrogen. The system could then be operated with greater temperature control and with less staff attention.

Slight changes in the drying and combustion procedure were made after the equipment modifications were completed. Three important changes are as follows: (1) The samples were freeze-dried until extraction of free water ceased; (2) the samples were heated for one to two hours at 100-200°C, with the copper oxide at 600°C, until the volatile gases were combusted; and (3) the temperature of the sample was then raised in stages to 600°C. Previously, samples had been dried at 50 to 150°C and combusted at the same high temperature as the copper oxide, since the sample and the copper oxide were in the same furnace. These procedural changes have resulted in a better separation of free and bound water and in less contamination of the water fractions with organic material. As before, samples of free or bound water were azeotropically distilled and the purified water was analyzed for ^{3}H by the liquid scintillation method used to analyze freshwater and seawater samples.

Following distillation of samples, 8 ml of the distillate was mixed with 15 ml of Insta-gel in a 25-ml polyethylene vial. Sample vials with ^{3}H standards and background vials interspersed were counted in a Packard Model 3175 liquid scintillation spectrometer at 5°C (Sauzay and Schell, 1972). Usually, 20 sample vials and six standard and background vials were counted as a unit. For one counting sequence, the unit was cycled six times and the counting time for each sample vial was 50 minutes per cycle or a total of 300 minutes for the sequence. The background was 4.3 cpm and the efficiency of the spectrometer, in terms of ^{3}H units, was $\approx$ 1 cpm = ∿ 75 TU. The one-sigma error term for a 300-minute count of a sample was 13 TU.

<u>Strontium-90 Analyses</u>. Strontium-90 decays entirely by beta emission and can be measured most reliably by the measurement of its radioactive daughter, yttrium-90. The procedure is to chemically extract strontium from the sample, set the extracted sample aside for

two weeks to allow the radioactive decay of ^{90}Sr and ^{90}Y to reach equilibrium, and then separate and beta-count the ^{90}Y. Samples for ^{90}Sr analysis were counted with a liquid scintillation detector until 1975 when a low-level beta counting system was utilized (Seymour and Nelson, 1977).

Plutonium Analysis. Plutonium was extracted from the samples by ion exchange, electroplated on platinum disks, and analyzed by an alpha spectrometry system that includes surface-barrier detectors and a pulse height analyzer. For the determination of the chemical yield, ^{242}Pu is used as a tracer (Seymour and Nelson, 1977).

Detection Limits

The error term in radionuclide concentration values for single samples is the combined counting error for the background, standard, and sample--hence, the term "propagated error". The error limits for the gamma-emitting radionuclides in single samples are "two-sigma" or two-standard deviation counting errors, while for the ^{3}H data, error limits are one-standard deviation counting errors. Errors for ^{90}Sr and all Pu analyses are two-sigma counting errors. The error term for the mean of more than one sample is one-standard deviation of the mean. Limits of detection are important since they govern the amount of a radionuclide that can be detected if it is present in a sample. Many factors influence the limit of detection, such as the type of detector and analyzer, the presence of other radionuclides, the duration of the counting period, the size and density of the sample, and the geometry relationship of the sample and detector. Hence, the actual limits of detection can vary considerably according to radionuclide and type of sample, but can be summarized by stating that the detection limits were approximately as follows:

By gamma detection:

^{40}K	2.1 pCi/g or less
^{7}Be, ^{103}Ru, ^{106}Ru, ^{144}Ce, ^{228}Th, ^{238}U	0.41 pCi/g or less
^{95}Nb, ^{95}Zr, ^{125}Sb, ^{137}Cs, ^{155}Eu, ^{226}Ra	0.12 pCi/g or less

By beta detection:

^{3}H	48 pCi/L or less
^{90}Sr	0.2 pCi/g or less

By X-ray detection:

^{55}Fe	0.04 pCi/g or less

By alpha detection:

$^{239,240}Pu$	0.02 pCi/g or less

RESULTS AND DISCUSSION

Detailed results of radiometric analyses conducted by the Laboratory of Radiation Ecology on environmental samples from Amchitka Island have been presented in previous reports (Table 1). These results are compiled in Tables 3-30 of this report. Because of the variety of sample types (e.g., air filters, sea water, terrestrial vegetation, fish, birds, invertebrates) and the number of radionuclides (gamma-emitters, ^{3}H, ^{55}Fe, ^{90}Sr, $^{239,240}Pu$) that were considered, it is impossible to discuss thoroughly all of the available data. The following discussion will emphasize sample types that were collected during several different years and radionuclides that occurred with the highest activity. The major divisions within the discussion are for specific types of radionuclides. That is, all the data on gamma-emitting radionuclides are discussed before any of the tritium data are presented. A separate discussion of various radionuclides in individual sample types would introduce an undesirable amount of redundancy into the discussion. Therefore, readers with a primary interest in selected types of samples will find information in several sections of the discussion. The sequence of presentation is similar to recent progress reports but includes results of earlier radiological surveys.

Gamma-Emitting Radionuclides

Most samples were analyzed by gamma spectrometry for both natural and fission product radionuclides. In most samples, ^{7}Be and ^{40}K, naturally occurring gamma-emitting radionuclides, had the highest concentration. The most commonly detected gamma-emitting radionuclides from fallout were ^{95}Zr, ^{95}Nb, ^{137}Cs, and ^{144}Ce. Several other fallout radionuclides including ^{46}Sc, ^{54}Mn, ^{60}Co, ^{65}Zn, ^{103}Ru, ^{106}Ru, ^{125}Sb, and ^{155}Eu were detected less frequently, as were the naturally occurring isotopes ^{226}Ra, ^{228}Th, and ^{238}U.

From 2 October 1970 until 12 November 1971, air samples were collected biweekly at the Amchitka Island base camp. Results for samples collected prior to the Cannikin detonation are given in Table 3. The fallout radionuclides reported for those samples were ^{95}Zr-^{95}Nb, ^{103}Ru, and ^{137}Cs, the concentration of short-lived radionuclides ^{95}Zr, ^{95}Nb, and ^{103}Ru was typically less than 10 f Ci/m^3, and ^{137}Cs concentration was generally less than 1 f Ci/m^3. There was no significant increase in the concentration of these isotopes following the Cannikin detonation (Table 4).

The air sampling program was discontinued following the Cannikin detonation. However, a weekly sampling program was conducted between 23 February 1972 and 28 August 1973 (Table 4). Although the fallout radionuclides ^{95}Zr, ^{95}Nb, ^{103}Ru, and ^{137}Cs were detected in most samples, the most abundant radioisotope in all samples was naturally occurring ^{7}Be. The average concentration of the fallout radionuclides was approximately 10-70 times lower than the average concentration of ^{7}Be.

The camp on Amchitka was closed in September 1973 and the last air samples were collected between 21 and 28 August 1973. Except for ^{137}Cs the concentration of fallout radionuclides had decreased markedly to levels near or below the detection limits. During the August-September 1974 field trip, one air particulate sample was collected over an eight-day period. No radionuclides were detected by gamma-spectrum analysis of this sample. This may have resulted because a relatively small volume, approximately 4,000 m^3, of air was filtered or because the concentration of fallout radionuclides is naturally lower in late summer. No additional air samples were collected after that trip.

Marine Samples. Between May 1971 and August 1973, sea water was collected with a Battelle Large Volume Water Sampler from three intertidal areas on Amchitka Island. Gamma-emitting radionuclides that were found in those samples included ^{7}Be, ^{60}Co, ^{65}Zn, ^{95}Zr, ^{95}Nb, and ^{137}Cs (Table 5). Although some activity was found in samples collected prior to July 1972, the concentrations are always near the detection limits and have large counting errors associated with them. Therefore, it is difficult to assign much environmental significance to these results. There is no apparent increase following the Cannikin detonation.

It appears from the limited data that are presented in Table 5 that in sea water the highest concentrations of ^{7}Be and ^{65}Zn are found in the soluble phase while ^{137}Cs is detected most frequently on the particulates. The analysis of particulates (material retained on 0.3-μm porosity Millipore filters) should provide accurate results but the soluble results are only qualitative. Differences in physical and chemical form of the radionuclides will affect their sorption efficiency to the Al_2O_3 beds (Huntamer, 1976) making a quantitative calibration difficult. Furthermore, monovalent cations such as ^{3}H, ^{40}K, and ^{137}Cs are very poorly sorbed, if at all.

During 1970 several species of marine algae were analyzed to select an indicator species. Measurable concentrations of ^{95}Zr-^{95}Nb were found in all algal samples (Table 6). The average value was 0.31 pCi/g-dry weight with a range of 0.12 to 0.66 pCi/g. The ^{95}Zr-^{95}Nb was probably adsorbed on the algal surfaces rather than being metabolized and incorporated into tissues (Held, 1963). Cesium-137 was also present in most marine algal samples at lower concentrations than ^{95}Zr-^{95}Nb. The most abundant radionuclide in all samples was naturally occurring ^{40}K which was present at concentrations ranging from 32 (Porphyra) to 313 (Laminaria) times the concentration of ^{95}Zr-^{95}Nb.

The alga Fucus found high in the intertidal zone at Amchitka was selected as a marine indicator organism, because (1) it is sessile, (2) it is present throughout the year, (3) large samples could be collected on any low tide without regard to weather, and (4) it accumulates radionuclides, including short-lived fallout radionuclides. Further, it is a cosmopolitan genus and results obtained at Amchitka can be compared with results from other geographical areas. Although other seaweeds would also be good indicator organisms, they would be more difficult to obtain, especially during the frequent storms at Amchitka.

Between 1971 and 1979, Fucus samples were collected from Constantine Harbor, Duck Cove, and Sound Beach Cove; as well as from Square Bay between 1975 and 1979. The most abundant fallout radionuclides in these samples were ^{95}Zr, ^{95}Nb, ^{137}Cs, and ^{144}Ce (Table 7). The concentrations of fallout radionuclides were lower than the naturally occurring radionuclide ^{7}Be and much lower than ^{40}K concentrations. There is no indication that the Cannikin detonation released radionuclides which were accumulated by Fucus, and the concentration of fallout radionuclides decreases with time following the major atmospheric inputs. By 1979, ^{40}K is the only gamma-emitting radionuclide detected in any of the Fucus samples. There are peaks of fallout radionuclides, especially ^{144}Ce, in 1974 and 1977 following the Chinese nuclear detonations that suggest Fucus is concentrating fallout radionuclides from those tests. This corresponds to results presented previously for ^{95}Zr + ^{95}Nb in the freshwater moss Fontinalis (Seymour and Johnson, 1978).

Several marine invertebrates were analyzed for gamma-emitting radionuclides during 1971 and 1972. Fallout radionuclides were found in some of these organisms (e.g., sea urchins, false king crab), but ^{40}K was always the most abundant gamma-emitting radionuclide (Table 8). Halichondria panicea (green sponge) was selected as an indicator organism and was collected at three locations on an annual basis until October 1979. Fallout radionuclides ^{95}Zr, ^{95}Nb, and ^{144}Ce were detected in this organism but the concentrations were always lower than for ^{40}K and generally lower than for ^{7}Be (Table 8). As was noted for Fucus, there is a significant increase in the concentration of fallout radionuclides following the Chinese atmospheric tests. Figure 8 shows the concentration of ^{144}Ce in H. panicea collected at Amchitka between 1973 and 1979. There is a distinct peak in 1974 with lower concentrations in 1975 and 1976 followed by another peak in 1977 and 1978. Since there are no apparent differences in concentration among different locations on Amchitka, the most likely source of ^{144}Ce is atmospheric fallout.

Several fish species were sampled to assess the potential transfer of radionuclides from the sea to man via this pathway. The concentration of ^{40}K and ^{137}Cs found in these samples is given in Tables 9-13. For all species and all tissue types the concentration of ^{40}K is higher than ^{137}Cs, generally by at least two orders of magnitude. However, the ^{137}Cs concentration in Dolly Varden collected in DK-45 Lake in 1972 was

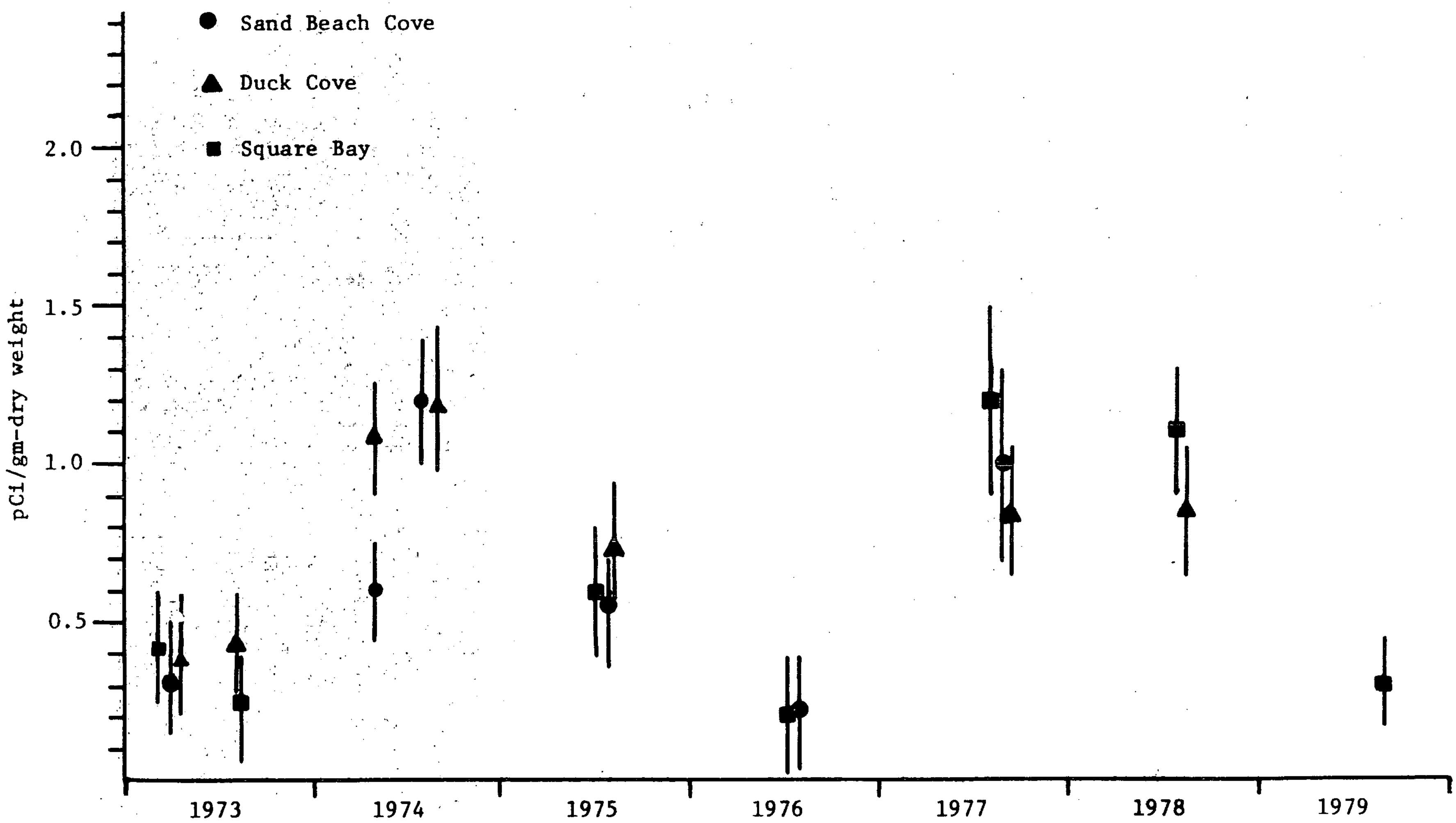

Fig. 8 Concentration of cerium-144 on _Halicondria panicea_ (green sponge) on Amchitka Island. Error bars are two-sigma propagated counting errors.

significantly higher than for other fish (Table 13) with a maximum value of 8.2 pCi/g-dry weight. All other samples were significantly less than 1 pCi/g-dry weight except the 1979 sample from Jones Lake (1.92 $\pm$ 0.08 pCi/g-dry weight). It is not certain if the landlocked races of Dolly Varden concentrate ^{137}Cs more efficiently than the anadromous fish, or if they were exposed to different concentrations. Unfortunately, the high values for the 1972 DK-45 samples were not reported until 1975 (Nelson and Seymour, 1975) and were commented upon later (Nelson and Seymour, 1976; Seymour and Nelson, 1977). Consequently, there were no additional samples collected at DK-45 Lake. Collecting more samples even at this late date (1983) might help to clarify the cause of the high concentrations. For the period 1974 until 1978, we can compare the concentration of ^{137}Cs in Dolly Varden from a marine station (Duck Cove) with samples collected at freshwater stations. Duck Cove results are not consistently higher or lower than the freshwater stations. However, samples from Duck Cove seem to concentrate ^{137}Cs following the Chinese detonation (1974 and 1977-1978) while similar increases are not apparent in the freshwater samples. Dolly Varden from Clevenger Creek and Clevenger Lake have consistently lower concentrations than fish from any other station. This indicates that there are geographic differences in the concentration of ^{137}Cs among Dolly Varden races on Amchitka, although the cause of those differences is currently unknown.

Freshwater Environment. Water samples for gamma spectrum analysis were collected from 1971 until 1979 from four freshwater sites--Jones Lake, Heart Lake, Cannikin Lake, and the Long Shot Mud Pit No. 1. Between 1977 and 1979, a rainwater sample and samples from Constantine Springs and Long Lake were also collected. A single sample was collected from Sand Beach Cove seep in 1977. Prior to 1975, samples were collected with a BLVWS collection device and the results, reported as particulate and soluble fractions, are subject to the same errors discussed above for seawater samples. Between 1975 and 1979, large volumes (34-56 liters) were evaporated on Amchitka and the residue was analyzed for gamma-emitting radionuclides. Results of gamma spectrum analysis for freshwater samples from Amchitka are given in Table 14. The radioisotopes most frequently detected included ^{7}Be, ^{95}Zr, ^{95}Nb, ^{137}Cs, and ^{144}Ce, but they were not present in all samples. The activity for ^{7}Be ranged from nondetectable to 20 $\pm$ 7.8 pCi/L and activity from fallout radionuclides was typically less than for ^{7}Be. The major fallout radionuclide is ^{144}Ce but it was not reported before 1974 because the analyses were conducted with NaI detectors. In the freshwater samples as in the seawater samples, there are marked increases in the concentration of fallout radionuclides, especially ^{95}Zr and ^{95}Nb, in 1974 and 1977 following the Chinese nuclear detonations.

Samples from Long Shot Mud Pit No. 1 frequently had higher concentrations of radionuclides than comparable lake samples. Held (1972) suggests that this may result from unusually high concentrations of suspended organic matter that may accumulate radionuclides. No studies were ever conducted to delineate the relationships between rainfall, runoff, concentration of suspended matter, and radionuclide concentration in surface waters on Amchitka.

The indicator species selected for the freshwater environment included the freshwater moss _Fontinalis neomexicana_, a vascular plant, _Ranunculus_ sp., and aufwuchs, a community of microorganisms including periphyton that attach themselves to surfaces on the bottom of streams and ponds. All of these are ideal indicator organisms since they are sessile, they are abundant enough to provide adequate samples throughout the year, and they significantly concentrate some radionuclides. Samples were collected from Clevenger Creek, Bridge Creek, Duck Cove Creek, Long Shot Pond, MP12 Creek, Ice Box Lake inlet, and the outlets of Clevenger and Cannikin lakes. The results of gamma analysis are reported in Tables 15-17. These results indicate that the values for naturally occurring ^{7}Be and ^{40}K generally are greater than the values for the fission products and that there is a distinct "year of collection" effect, with peak years in 1970-1971, 1974, and 1977. Seymour and Johnson (1978) investigated the year-of-collection effect by comparing the values for the amount of ^{95}Zr plus ^{95}Nb in _Fontinalis_ from Amchitka, with the amount of ^{95}Zr plus ^{95}Nb in freshwater moss and algal samples from Columbia River stations on the Oregon shoreline (Fig. 9). These ^{95}Zr plus ^{95}Nb values were correlated with the schedule of atmospheric detonation of nuclear devices of 20-kiloton or greater fission yields in China. The source of information about the Chinese nuclear detonations was Telegadas (1977) and Carter (1979).

The variables in Figure 9 were selected for the following reasons. Zirconium-95 and ^{95}Nb are indicators of fresh fallout radionuclides and were the most abundant fission products in the Amchitka samples. Fontinalis was selected as an excellent biological indicator species. Moss and algae from the Columbia River were selected as comparable samples to Amchitka Fontinalis samples from a location at approximately the same latitude as Amchitka. The schedule of Chinese nuclear detonations was selected for comparison with the ^{95}Zr plus ^{95}Nb values because this is the probable source of fallout radionuclides in the samples from both areas. The results of analyses of Columbia River samples (a moss, Callierogonella cuspidata, and/or an alga, Cladophora) were provided by Toombs (1978, 1979, 1980). The Columbia River samples were collected monthly and the results have been smoothed by a three-point moving average. Also, the Columbia River samples were reported in terms of wet weight, and for this reason the Amchitka samples in Figure 9 are also given in terms of wet weight. Prior to 1978 the wet weight values were calculated from the wet weight/dry weight ratio of 8.1 as determined from the measurements of 15 samples in 1977. The wet weight/dry weight ratio for samples collected in 1978 and 1979 used the measured ratio of each individual sample. The Amchitka Fontinalis data for 1979 are derived from 16 samples collected in September and October. No samples were available for other months. The concentrations of ^{95}Zr plus ^{95}Nb in Fontinalis and in Cladophora samples collected at Amchitka Island and at Goble, Rainier, and Prescott, Oregon, in 1979 were less than the minimum detectable limits of approximately 0.1 pCi/g-wet weight.

Figure 9 indicates the following: (1) The trends for the Amchitka and Columbia River values are similar; (2) the peaks in the curves occur after Chinese nuclear detonations of 20-kiloton or greater fission

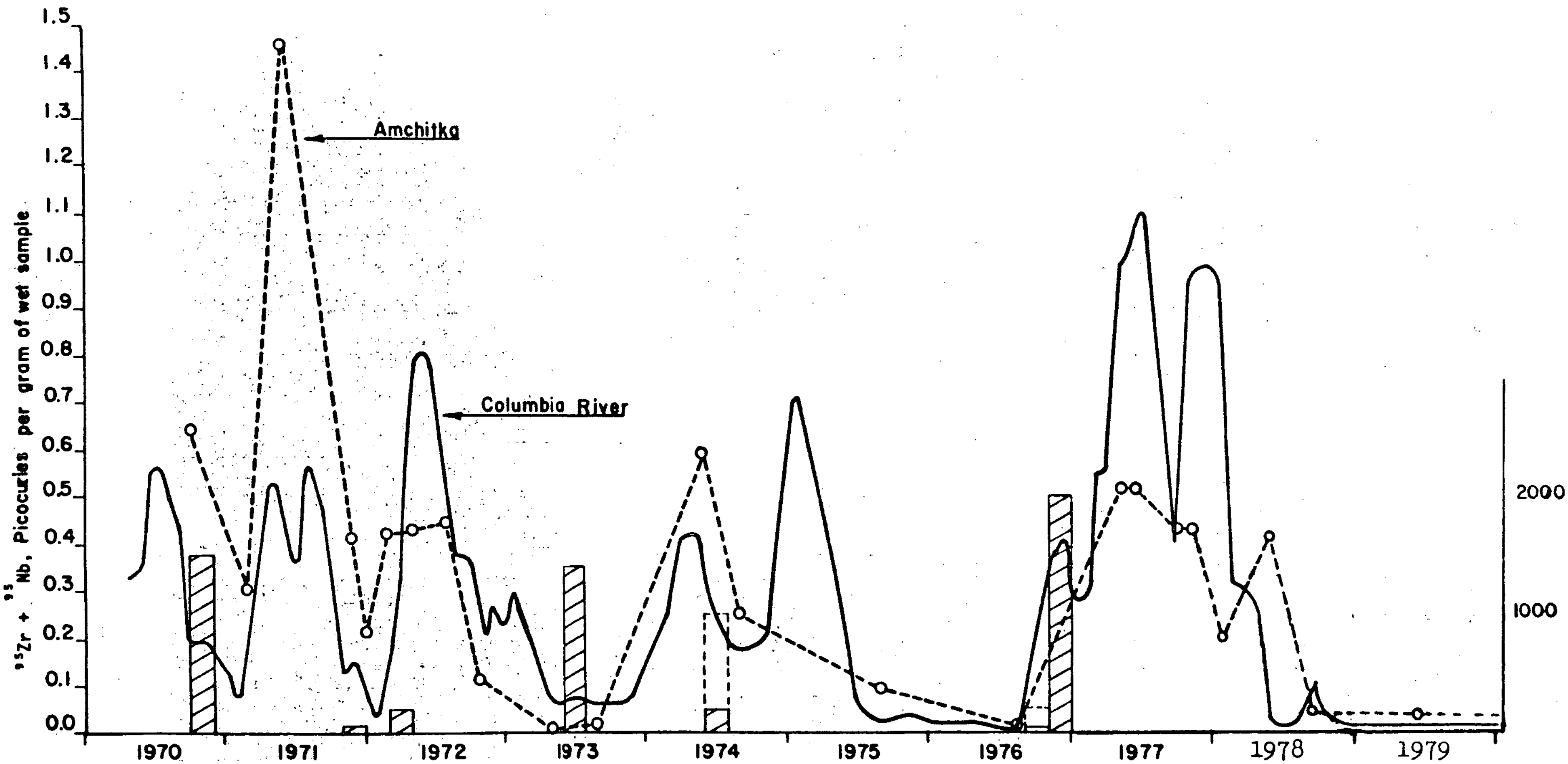

Fig. 9. Zirconium-95 plus niobium-95 in freshwater vegetation from Amchitka Island and from the Columbia River and the fission yield of Chinese atmospheric nuclear detonations, 1970-1979. The Amchitka samples were the moss Fontinalis. The Columbia River samples were the moss Calliergonella cuspidata, the algae Cladophora sp., or a combination of the two species collected at Goble, Oregon, in 1970-1971, at Rainier, Oregon, in 1972-1977, and at Goble, Rainier, and Prescott, Oregon, in 1978-1979. The three locations are ten miles apart. The Oregon samples were collected monthly and the values smoothed by a moving average of three. The fission yield of Chinese detonations greater than 20 kilotons are shown as bars (Telegadas 1977).

yield; (3) there is a year-of-collection effect with peaks in 1970-71, 1974, and 1977; and (4) the detection and measurement systems are sensitive to small perturbations in the amounts of fallout radionuclides in the environment (Seymour and Johnson 1978).

From comments (1) and (2) above, the obvious conclusion is that the source of radionuclides at Amchitka is world fallout, principally from the Chinese nuclear detonations. Another method of determining the source of the radionuclides is to determine the date of origin of the radionuclides and/or the presence of short half lived fallout radionuclides in the samples. The date of origin of radionuclides can be determined from the ratio of fission product radionuclides if the parent radionuclide is known, if little or no fractionation of any kind occurs, and if reliable fission product radionuclide ratios can be established. For the Amchitka data, there was insufficient information to calculate date of origin by the radionuclide ratio method. However, the presence of short half life ^{95}Zr and ^{95}Nb (65 and 35 days, respectively) as the dominant fission product radionuclides in the samples means that these radionuclides are of more recent origin than the last nuclear detonation at Amchitka (November 1971) and hence originate from world fallout following recent detonations.

There is no strong evidence from the gamma-emitting radioisotopes for a location effect on Amchitka. However, the concentration of ^{106}Ru and ^{137}Cs is consistently higher in aufwuchs samples from MP12 Creek than from other locations.

Terrestrial Samples. Of all the samples collected on Amchitka, only terrestrial vegetation had higher concentrations of fallout radionuclides than naturally occurring radioisotopes. Results from a series of pre-Cannikin and post-Cannikin samples collected along the length of the island are given in Table 18. Except for the sample from milepost 9.4, ^{137}Cs is the predominant radioisotope in all samples, and other fallout radionuclides, including ^{60}Co, ^{95}Zr, ^{95}Nb, ^{106}Ru, and ^{125}Sb, are abundant. There is, however, no indication that the concentration of these isotopes increased because of the Cannikin event.

Lichens were selected as the indicator species for the terrestrial environment because of their well-established ability to accumulate fallout radionuclides (Hanson and Eberhardt,1971). Samples collected from areas around Clam Lake, Cannikin Lake, and Ice Box Lake had a large array of fallout radionuclides including ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{125}Sb, and ^{137}Cs (Table 19). Cesium-144 and ^{155}Eu were also reported for samples that were collected after October 1972 and analyzed with a Ge(Li) detector. Cesium-137 was the most abundant radionuclide although its concentration decreased significantly during this sampling program (Table 20). By 1976 the concentration of ^{137}Cs was approximately equal to the concentration of naturally occurring ^{7}Be. The effect of the Chinese nuclear detonations in 1977 was most evident in lichens because of significantly increased concentrations of ^{95}Zr, ^{95}Nb, and ^{144}Ce. Therefore, the most abundant fallout radionuclide in the 1977 samples was ^{144}Ce. By September 1979 the most abundant gamma-emitting isotope in all lichen samples was ^{7}Be.

Between December 1970 and April 1973, several species of birds were collected and gamma spectra were obtained for muscle, liver, bone, and feathers (Table 21). The only fallout radionuclides reported were ^{60}Co and ^{137}Cs, and they were much lower than the concentration of ^{40}K in all samples. From 1973 until 1979, the only bird samples that were analyzed were muscle of rock ptarmigan collected from different sites. In general, the concentration of ^{137}Cs decreases during the sampling period, but there are higher concentrations in samples from the Cannikin area during 1975 and 1977 and a slightly higher value in the Milrow-Long Shot sample from 1978. There is no indication of a significant accumulation of gamma-emitting isotopes in any of the bird samples.

Between August 1975 and September 1979, several soil samples were collected from the Main Camp and Cannikin area, and sand was collected from Constantine Harbor and Sand Beach Cove. Potassium-40 was the most abundant gamma-emitting radionuclide in all these samples and other naturally occurring radionuclides, ^{226}Ra, ^{228}Th, and ^{238}U, were also detected in the samples (Table 22). The most commonly detected fission products were ^{137}Cs and ^{144}Ce, although ^{141}Ce was also reported for four soil samples in 1975 and 1976. Seymour and Nelson (1977) report that the concentrations of fallout radionuclides in Amchitka soils are similar to those reported for soils from western Washington State.

<u>Tritium</u>

Natural tritium produced by cosmic-ray interactions with atmospheric gases produces ^{3}H concentrations in rainwater of a few tens of tritium units (Gross et al., 1951; Perkins and Nielsen, 1965). Tritium is also produced in nuclear detonations, so a peak concentration of several thousand tritium units in precipitation occurred in 1963 and has declined since to values of less than 100.

During the Amchitka Radiobiological Program, samples for tritium analyses were collected from several marine and freshwater locations. Results of the analyses on seawater samples are presented in Table 23. Concentrations have declined steadily during the 1970's. Tritium concentrations were below detection limits for five of seven seawater samples collected in 1979 and were approximately 100 $\pm$ 40 pCi/L for single samples from Duck Cove and Square Bay.

Tritium concentrations in freshwater ponds, lakes, and streams and in precipitation samples are given in Table 24. Freshwater concentrations are always greater than seawater values, presumably because of the greater dilution in the oceans. From a maximum annual concentration of 175 tritium units (TU) in 1966 (Seymour and Nelson, 1977), the yearly mean concentration of tritium has declined steadily to values of less than 30 TU for samples collected in 1979. These concentrations result almost entirely from naturally occurring ^{3}H.

The water samples collected from the Long Shot Mud Pits for ^{3}H analysis have always been considered separately from other samples because this area was found to be slightly contaminated with ^{3}H a few months after the Long Shot nuclear detonation in 1965. The extent of the contamination has been well documented in progress reports and other publications (see Nelson, 1975; Merritt and Fuller, 1977; and Seymour and Nelson, 1977). Table 25 records the values for tritium in water samples from Long Shot Drainage for the years 1970-1979. During this period the average ^3H values for water samples from the three mud pits have declined from 11.3×10^3 to 1.7×10^3 pCi/L. These values are well below the maximum permissible concentration for ^3H in water (MPC_w) for occupational exposure. The MPC_w value as established by the International Commission on Radiological Protection (ICRP, 1959, 1964) and the U.S. National Committee on Radiation Protection (NCRP, 1959) is 3×10^7 pCi/L. For an individual member of the population in an uncontrolled area, the Radiation Protection Guide (RPG) value is one-tenth the MPC for occupational exposure, or 3×10^6 pCi/L (U.S. Energy Research and Development Administration 1975). The MPC_w for the general population is 10^6 pCi/L (ICRP, 1959). The 1.6-km course of the drainage stream has been sampled annually since 1975 for tritium analysis. Despite the high tritium values at the Mud Pit, values near the mouth of the stream are only slightly greater than the 1979 ^3H values in freshwater samples from other areas of Amchitka Island. The contribution of ^3H from Long Shot Mud Pits to the ocean is insignificant. No increase in tritium concentration was found after the Milrow or Cannikin events.

Between 1975 and 1979, some biological samples were analyzed for free and bound tritium. Tissue bound tritium was consistently higher than the free water tritium (Seymour and Nelson, 1977). However, analytical methods for providing consistently reliable results were not developed successfully (Seymour and Johnson, 1978). Therefore, bound water data are not included in this report. Table 26 presents the results of ^3H analyses of free water in biological samples from marine (Fucus and muscle from greenling and Dolly Varden), freshwater (Fontinalis and Ranunculus), and terrestrial (muscle of ptarmigan) environments. Typically, the free water concentrations of ^3H correspond to the ^3H concentrations in ambient water. This suggests that there is a free exchange of ^3H between the environment and free water in biological tissues. Similar results have been reported for other systems (Bruner, 1973; Robertson, 1973). Ranunculus and Fontinalis are the best indicators for ^{3}H, although it is probably preferable to analyze water directly. During the field trip of 1979, 12 samples of Ranunculus and Fontinalis were collected from the Long Shot Mud Pits and drainage system. The maximum tritium concentration of 3,317 pCi/L occurred in Ranunculus growing in Mud Pit #3. Tritium concentrations in the aquatic plants were consistently higher than water samples collected at the same site but decreased in concentration as distance from the mud pits increased. Tritium values in aquatic plants near the mouth of the stream were less than 50 pCi/L.

Iron-55

Following the 1961-1962 series of atmospheric nuclear detonations, ^{55}Fe, a neutron activation product, was relatively abundant in fish around the world. Several fish species were sampled for ^{55}Fe at Amchitka from 1969 to 1974 (Table 27). This radionuclide was commonly the most abundant man-made radionuclide in fish tissue, ranging from 0.04 to 6.7 pCi/g-dry weight in muscle and from 0.54 to 76.8 pCi/g-dry weight in liver. For all species and sampling times the concentration was considerably higher in liver and viscera than in muscle. During the sampling period there was a significant decline both in the concentration of ^{55}Fe and in the ratio of radioactive to stable iron. At all times the amount of naturally occurring ^{40}K was several times greater than the amount of ^{55}Fe, and that ratio steadily increased as the concentration of ^{55}Fe declined. All of the ^{55}Fe detected at Amchitka was attributed to worldwide fallout from the 1961-1962 test series rather than considered as having an Amchitka origin (Seymour and Nelson, 1977).

Strontium-90

Strontium is an alkaline earth element related to calcium, and ^{90}Sr is known to accumulate in calcium-rich tissues such as bones and crustacean exoskeletons. Surveys on Amchitka after the Long Shot event indicated that ^{90}Sr in bones of seals and greenling and in king crab exoskeletons was near or below the detection limits (Seymour and

Nakatani,1967; Isakson and Seymour,1968). Table 28 gives the ^{90}Sr activity in bones of rats and ptarmigan collected on Amchitka between 1971 and 1979 and in soil samples collected between 1975 and 1979. For ptarmigan there is a significant decrease in ^{90}Sr concentration between the samples collected in 1971 and those collected after 1973. Changes in concentration between 1973 and 1979 are not very dramatic although there appears to be a slight increase in 1976. There are no significant temporal trends in the concentration of ^{90}Sr in rat bones. The concentration of ^{90}Sr in soil is considerably lower than in bones, being near or below the minimum detection limits for most samples.

Plutonium-239,240

Samples of soil, sand, and *Fucus*, and greenling muscle were collected between 1975 and 1979 and analyzed for $^{239,240}Pu$. Results of those analyses are given in Table 29. The maximum concentration of Pu was 0.015 pCi/g-dry weight for a soil sample and there were no obvious differences related to year of collection. The $^{239,240}Pu$ values at Amchitka are similar to analyses of comparable samples from the Atlantic Coast (Noshkin et al., 1973), California (Wong et al., 1972), and Washington (Nelson and Seymour,1975). Therefore, the source of plutonium on Amchitka is believed to be worldwide fallout.

Background Radiation

A background radiation survey program with a Geiger-Muller detector (window thickness, < 2 mg/cm^2) was initiated in 1974 and continued through 1979. Results of the survey are presented in Table 30. Observations were made at 14 locations and in no instance was the average value greater than 0.04 mR per hour, although occasionally pulses of radiation would momentarily produce readings as high as 0.07 mR per hour. The survey meter readings for all years are similar, and if there were annual differences, the instrument which was operating near the lower limits of detection was insensitive to changes in background radiation.

SUMMARY AND CONCLUSIONS

The principal objective of this research program was to determine the extent of radionuclide contamination on Amchitka Island, and to evaluate the source of such contamination. These objectives were achieved by the collection and radiological analyses of biological and environmental samples from several locations on Amchitka between July 1970 and October 1979. Except for tritium in mud pits near the Long Shot test site there is no evidence of radioactive contamination from Amchitka sources. That is, the concentrations of most radionuclides found at Amchitka are comparable to the concentrations expected from world wide fallout produced by atmospheric nuclear tests. Elevated concentrations of tritium were found in surface water and freshwater plants at the Long Shot Mud Pits. Concentrations decrease dramatically within several hundred meters of the mud pits and there is no impact on the marine ecosystem. Tritium is a potential indicator of radionuclide leakage from underground sites. There was no similar increase in the concentration of strontium-90, plutonium, iron-55, or any gamma-emitting radionuclide.

Following an initial survey of nearly 90 different sample types, indicator organisms were selected for long term monitoring of marine (Fucus distichus), terrestrial (lichens), and freshwater (Ranunculus sp., Fontinalis sp., and aufwuchs) environments. The most abundant radionuclides in most samples were the two naturally occurring radionuclides, beryllium-7 and potassium-40. In lichens the most abundant radionuclide was either cerium-144 or cesium-137. In general, the concentration of fallout radionuclides was higher in freshwater organisms than in marine organisms. This was attributed to the greater dilution that occurs in the ocean. The concentrations of zirconium-95 and niobium-95 in freshwater moss and algae from Amchitka was similar to the concentration found in freshwater plants in the Columbia River. Secondary objectives of determining transfer coefficients and concentration factors in order to predict the ultimate fate of radionuclides on Amchitka were not completed very successfully during this project.

In most indicator organisms the concentration of short-lived fission product radionuclides increased significantly in 1970-1971, 1974, and 1977. These increases followed major atmospheric tests of nuclear devices by the People's Republic of China and the increased concentrations obtained on on Amchitka were attributed to worldwide fallout from those tests.

Since the release of radiation from Amchitka sources is so limited we cannot evaluate the biogeochemical cycling of radionuclides from local sources. However, the data in this report provide valuable information on the long term distribution of fallout radionuclides in freshwater, terrestrial, and marine samples from this remote oceanic site in the northern hemisphere. There are few comparable sets of long term data.

Table 1. Previous reports and publications prepared for Amchitka Radiobiological Program, 1970-1979.

	Report No.
Progress Report July 1970 to April 1971 Edward E. Held	NVO-269-11
Progress Report May 1971 to February 1972 Edward E. Held	NVO-269-17
Progress Report March 1972 to December 1972 Edward E. Held, Victor A. Nelson, William R. Schell, and Allyn H. Seymour	NVO-269-19
Progress Report January 1973 to December 1973 Victor A. Nelson and Allyn H. Seymour	NVO-269-21
Progress Report January 1974 to December 1974 Victor A. Nelson and Allyn H. Seymour	NVO-269-23
Bioenvironmental Studies Amchitka Island, Alaska 1975 Task Force Report Victor A. Nelson	NVO-269-26
Progress Report January 1975 to December 1975 Victor A. Nelson and Allyn H. Seymour	NVO-269-27
Progress Report January 1976 to December 1976 Victor A. Nelson and Allyn H. Seymour	NVO-269-31
Progress Report January 1977 to December 1977 Allyn H. Seymour and Arthur F. Johnson	NVO-269-34
Progress Report January 1978 to December 1978 Larry D. Tornberg and Roy E. Nakatani	DOE/DPO0269-37
Progress Report January 1979 to December 1979 Larry D. Tornberg, Thomas H. Sibley, and Roy E. Nakatani	DOE/DPO0269-38
Radionuclides in Air, Water, and Biota. Chapter 24 in The Environment of Amchitka Island, Alaska (M.L. Merritt and R.G. Fuller, eds.) Allyn H. Seymour and Victor A. Nelson	ERDA-TID-26712

Table 2. Scientific and common names and wet weight to dry weight ratios of some Amchitka Island organisms.

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
		VERTEBRATES		
MAMMALS				
<u>Callorhinus ursinus</u> fur seal	Liver	2	3.25	0.064
	Muscle	1	3.50	
	Bone	1	1.50	
<u>Enhydra lutris</u> sea otter	Liver	1	4.03	--
	Skin	1	3.14	--
	Kidney	1	5.00	--
	Muscle	1	4.28	--
<u>Rattus norvegicus</u> rat	Bone	*	--	--
FISH				
<u>Salvelinus malma</u> Dolly Varden	Kidney	2	4.52	0.02
	Muscle	14	3.62	0.70
	Gonad	2	2.94	0.05
	Stomach contents	1	6.58	
	Viscera	2	4.20	0.42
	Remains	5	3.51	0.63
	Bone	*		
	Liver	13	3.24	0.19
<u>Oncorhynchus keta</u> chum salmon	Muscle	9	3.28	0.19
	Bone	*		
	Viscera	1	3.90	
	Liver	10	3.48	0.37
	Remains	1	2.60	
	Whole (eviscerated)	2	2.87	0.16
<u>O. nerka</u> sockeye salmon	Liver	6	3.25	0.51
	Muscle	8	3.67	0.54
	Bone	*		
<u>O. gorbuscha</u> pink salmon	Kidney	1	5.00	
	Gonad	1	4.51	
	Bone	*		
	Muscle	1	4.33	
	Liver	2	4.49	0.69

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Vertebrates, cont'd				
Oncorhynchus kisutch	Liver	2	3.52	0.58
coho salmon	Muscle	1	3.83	
	Gonad	1	4.30	
O. tshawytscha	Muscle	2	2.94	0.20
king salmon	Liver	1	3.06	--
Lepidopsetta bilineata	Liver	5	4.08	0.56
rock sole	Muscle	5	4.62	0.34
	Bone	*		
	Remains	2	3.90	0.01
	Gonad	1	5.70	
	Kidney	1	5.30	
Hippoglossus stenolepis	Kidney	1	4.90	
Pacific halibut	Gonad	1	5.30	
	Remains	1	4.50	
	Muscle	4	4.01	0.58
	Liver	2	3.63	0.04
	Skin	1	2.47	
Theragra chalcogramma	Muscle	9	5.08	0.44
walleye pollock	Bone	*		
	Liver	5	1.51	0.11
	Skin	5	3.42	0.24
Sebastes alutus	Bone	*		
Pacific ocean perch	Muscle	3	4.37	0.05
	Liver	2	2.89	0.15
	Gonad	1	2.90	
	Skin	1	2.80	
Gadus macrocephalus	Liver	12	3.00	0.77
Pacific cod	Muscle	13	5.47	0.28
	Bone	*		
	Skin	3	3.36	0.27
Hexagrammos lagocephalus	Liver	5	3.43	0.41
rock greenling	Muscle	7	4.83	0.14
	Viscera	2	2.13	0.04
	Remains	6	4.08	0.87
	Kidney	3	5.22	0.12
	Gonad	3	5.42	0.42
	Skin	1	3.10	
	Whole (eviscerated)	1	4.40	

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Vertebrates, cont'd				
Sebastes ciliatus	Liver	1	2.62	
dusky rockfish	Muscle	2	4.42	0.08
	Remains	2	3.26	0.05
	Gonad	1	4.30	
Coryphaenoides sp. rat-tail	Liver	2	1.35	0.014
Atheresthes stomias arrowtooth flounder	Liver	1	3.28	--
Gasterosteus sp.	Evisc. whole	2	3.76	0.75
stickleback	Viscera	1	2.54	--
Bathylagus stilbius California smoothtongue	Entire	1	4.17	--
Stenobrachius leucopsaurus northern lampfish	Entire	1	3.12	--
BIRDS				
Haematopus bachmani	Liver	--	3.36	--
black oystercatcher	Muscle	--	3.96	--
Uria lomvia	Muscle	--	1.67	--
thick-billed murre	Liver	--	3.31	--
Cepphus columba	Muscle	--	4.15	0.42
pigeon guillemot	Liver	--	3.33	0.24
Lagopus mutus	Liver	--	3.52	0.32
rock ptarmigan	Muscle	--	3.54	0.08
Philacte canagica	Liver	--	3.15	0.08
emperor goose	Muscle	--	3.21	0.14
Larus glaucescens	Liver	--	3.11	--
glaucous-winged gull	Muscle	--	3.58	--
Troglodytes troglodytes wren (winterwren)	Entire**	--	3.43	--

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Vertebrates, cont'd				
Cyclorrhynchus psittacula parakeet auklet	Entire**	--	3.41	0.09
Erolia ptilocnemis rock sandpiper	Entire**	--	3.44	--
Aethia pusilla least auklet	Entire**	--	3.55	--
Sterna paradisaea arctic tern	Entire**	--	3.33	--
Anas crecca common teal	Muscle	--	3.74	--
	Liver	--	3.08	--
Lunda cirrhata tufted puffin	Muscle	--	3.41	--
	Liver	--	1.96	--
	INVERTEBRATES			
Acanthomysis mysids	Entire	2	8.41	4.7
Plankton	Entire	2	20.98	2.72
Sponge, rust	Entire	1	6.1	
yellow	Entire	1	4.5	
buff	Entire	1	4.9	
green	Entire	1	9.5	
Euphausiids krill	Entire	1	5.2	
Medusae				
Cyanea	Entire	1	26.8	
Aurellia	Entire	1	10.1	
Pecten sp. scallop	Soft parts	1	5.9	
Basket star	Soft parts	1	4.51	
	Gonads	1	4.37	
	Remains	1	2.41	
Gonatus sp. pelagic squid	Entire	1	5.41	

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Invertebrates, cont'd				
Strongylocentrotus sp.	Test	3	2.41	0.07
urchin	Gonad	2	5.87	0.38
	Soft parts	2	6.19	1.97
Octopus sp.	Viscera	1	5.25	--
octopus	Evisc. whole	1	6.42	--
Parolithodes sp.	Muscle	3	6.63	0.51
king crab	Viscera	1	7.10	--
	Exoskeleton	2	2.30	0.71
	Hepatopancreas	2	3.92	0.04
	Gonad	1	2.02	--
Littorina sp.	Entire	5	2.16	0.20
snail				
Thais sp.	Soft parts	1	4.0	
snail	Shell	1	1.2	
Mytilus sp.	Soft parts	3	6.21	0.92
mussel	Shell	4	1.08	0.05
Isopoda	Entire	2	3.04	0.07
Amphipoda	Entire	2	4.42	0.01
Gammaridae				
Lithodes aequispina	Exoskeleton	--	2.17	0.12
false king crab	Hepatopancreas	--	4.62	1.89
	Muscle	--	6.79	0.78
	Egg	--	1.94	0.099
	Remainder	--	4.57	1.12
Chionectes tanneri	Muscle	--	4.91	0.53
tanner crab	Exoskeleton	--	2.40	0.23
	Hepatopancreas	--	4.71	1.70
	Remainder	--	4.55	1.65
Erimacrus isenbecki	Exoskeleton	--	2.52	--
horse crab	Hepatopancreas	--	6.67	--
	Remainder	--	3.95	--
	MARINE ALGAE			
Hypophyllum sessile	Entire	9	7.77	2.38
marine alga				

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Marine Algae, cont'd				
Fucus distichus marine alga	Entire	12	4.94	1.4
Halosaccion glandiforme marine alga	Entire	9	7.23	1.00
Alaria sp. marine alga	Entire	17	5.95	0.99
Porphyra sp. marine alga	Entire	1	4.5	--
Corallina sp. coralline alga	Entire	1	2.1	--
Constantina sp. marine alga	Entire	--	--	--
Ulva sp. marine alga	Entire	4	8.54	0.86
Thalassophyllum sp. marine alga	Entire	--	--	--
Laminaria longipes marine alga	Entire	5	5.30	0.25
	FRESHWATER PLANTS			
Cladophora sp. filamentous alga	Entire	1	5.1	--
Fontinalis sp. moss	Entire	4	4.83	0.89
Ranunculus sp. freshwater plant	Entire	3	12.2	4.10
Periphyton and others	Entire	2	7.27	2.40
	LAND PLANTS			
Cladonia sp. lichens	Entire	6	3.75	0.87

Table 2, cont'd

Species	Tissue	No. of samples	Wet/dry ratio	Standard deviation
Land Plants, cont'd				
<u>Calomagrastis</u> sp. grass	--	--	--	--
<u>Empetra</u> sp. crowberry	--	--	--	--
<u>Agiostis</u> sp. grass	--	--	--	--

*Wet/dry not available, only dry/ash.
**Less head, feathers, and skin.

Table 3. Some gamma-emitting radionuclides on ground level air filters at the Amchitka Island base camp prior to the Cannikin detonation.

Date	Volume filtered ($10^3 m^3$)	Gamma-emitting radionuclides (pCi/thousand cubic meters)[a] $^{95}Zr-^{95}Nb$	^{103}Ru	^{137}Cs
1970				
Oct 2-16	25.7	3 ± 1.80	3.60 ± 0.46	0.99 ± 0.24
Oct 16-30	26.2	3.10 ± 0.24	5 ± 0.64	1.10 ± 0.34
Oct 30-Nov 13	25.8	0.73 ± 0.06	1.60 ± 0.18	0.36 ± 0.11
Nov 13-27	25.5	1.50 ± 0.08	3.20 ± 0.34	0.38 ± 0.10
Nov 27-Dec 11	25.7	2.70 ± 0.11	3.80 ± 0.38	0.73 ± 0.15
Dec 11-25	21.8	0.79 ± 0.05	1.50 ± 0.17	0.63 ± 0.08
1971				
Dec 25-Jan 8	26.6	1.40 ± 0.07	2.60 ± 0.28	1.10 ± 0.11
Jan 8-22	26.0	0.92 ± 0.05	2.60 ± 0.09	0.32 ± 0.07
Jan 22-Feb 6	28.0	0.92 ± 0.14	2.40 ± 1.10	0.30 ± 0.07
Feb 6-20	26.2	0.92 ± 0.12	1.60 ± 0.41	0.21 ± 0.14
Feb 20-Mar 6	26.4	3 ± 0.11	3.60 ± 0.40	0.55 ± 0.12
Mar 6-19	24.1	7.30 ± 0.20	7.90 ± 0.86	0.86 ± 0.14
Mar 19-Apr 2	26.3	6.50 ± 0.23	4.40 ± 0.64	0.61 ± 0.24
Apr 2-16	26.4	11 ± 0.22	5.60 ± 0.66	0.92 ± 0.24
Apr 16-30	26.3	10.70 ± 0.44	4.20 ± 0.99	2.20 ± 0.56
Apr 30-May 15	27.5	10.90 ± 0.33	6.10 ± 0.79	1.10 ± 0.30
May 15-28	25.1	9.20 ± 0.26	4.30 ± 0.55	0.92 ± 0.29
May 28-Jun 11	26.0	9.90 ± 0.35	4.30 ± 0.61	1.10 ± 0.34
Jun 11-25	26.3	9.20 ± 0.23	3.20 ± 0.47	0.79 ± 0.26
Jun 25-Jul 11	30.0	5.20 ± 0.12	1.60 ± 0.27	0.54 ± 0.13
Jul 11-24	24.5	2.80 ± 0.07	1.10 ± 0.18	0.34 ± 0.09
Jul 24-Aug 7	26.1	2.80 ± 0.07	1.10 ± 0.18	0.32 ± 0.10
Aug 7-21	26.9	1.90 ± 0.06	0.79 ± 0.15	0.25 ± 0.09
Aug 21-Sep 4	17.2	4 ± 0.14	1.90 ± 0.35	0.58 ± 0.20
Sep 4-17	16.3	6.60 ± 0.26	3.40 ± 0.60	1.20 ± 0.37
Sep 17-Oct 2	19.2	3.80 ± 0.21	3.20 ± 0.57	0.88 ± 0.31
Oct 2-16	17.2	2 ± 0.16	2.70 ± 0.48	0.76 ± 0.27
Oct 16-29	16.5	1.90 ± 0.19	3.10 ± 0.54	0.85 ± 0.38

[a]Error terms are two-sigma, propagated counting errors.

Table 4. Some gamma-emitting radionuclides on ground level air filters at the Amchitka Island base camp after the Cannikin detonation.

Collection date	$10^3 m^3$	Gamma-emitting radionuclides (pCi/thousand cubic meters)[a]				
		^{7}Be	^{95}Zr[b]	^{95}Nb[b]	^{103}Ru	^{137}Cs
1971						
Oct 29-Nov 12	17.8	23 ± 2.6	1.1 ±0.1	2.1 ±0.3	--	0.56±0.13
1972						
Feb 23-28	5.3	29 ±15	0.5 ±0.2	1.1 ±0.4	--	0.70±0.47
Feb 28-Mar 6	8.9	16 ± 3.4	0.2 ±0.1	0.5 ±0.2	--	--
Mar 6-13	9.9	47 ± 3.0	0.4 ±0.1	0.8 ±0.2	--	0.86±0.25
Mar 13-20	13.2	22 ± 1.5	0.2 ±0.1	0.3 ±0.1	--	0.45±0.15
Mar 20-27	13.2	17 ± 3.2	0.1 ±0.03	0.2 ±0.05	--	0.38±0.15
Mar 27-Apr 3	13.2	19 ± 1.5	--	--	--	--
Apr 3-10	13.1	42 ± 2.3	0.6 ±0.1	1.2 ±0.2	0.46±0.15	0.69±0.14
Apr 10-17	12.1	32 ± 2.5	0.4 ±0.1	0.8 ±0.2	--	0.60±0.20
Apr 17-24	11.1	36 ± 2.2	2.1 ±0.2	4.3 ±0.4	1.1 ±0.2	0.72±0.18
Apr 24-May 1	11.1	19 ± 1.8	0.5 ±0.1	1.0 ±0.3	--	0.45±0.18
May 1-9	13.0	12 ± 1.5	0.3 ±0.1	0.6 ±0.2	0.38±0.08	0.38±0.08
May 9-15	9.3	10 ± 1.6	2.4 ±0.2	5.2 ±0.4	0.75±0.22	--
May 15-22	11.1	20 ± 0.9	1.5 ±0.1	3.2 ±0.2	1.6 ±0.2	0.54±0.09
May 22-29	11.1	36 ± 5.3	2.7 ±0.3	5.8 ±0.7	0.82±0.76	0.54±0.17
May 29-Jun 5	11.1	31 ± 1.1	6.2 ±0.3	7.0 ±0.3	3.3 ±0.2	--
Jun 5-12	11.2	13 ± 1.4	2.1 ±0.4	3.0 ±0.3	1.5 ±0.2	0.36±0.18
Jun 12-19	10.9	19 ± 1.8	3.9 ±0.5	4.6 ±0.1	--	0.56±0.17
Jun 19-26	11.2	6.2± 0.6	2.1 ±0.2	1.3 ±0.1	0.93±0.07	0.11±0.05
Jun 26-Jul 3	11.2	10 ± 1.2	1.9 ±0.4	1.6 ±0.2	--	0.21±0.11
Jul 3-10	11.1	Data missing				
Jul 10-17	11.1	3.3± 1.0	0.40±0.27	1.3 ±0.2	0.49±0.12	--
Jul 17-24	11.2	3.8± 0.9	--	0.85±0.17	0.57±0.14	--
Jul 24-31	11.2	--	--	0.23±0.11	0.25±0.11	--
Jul 31-Aug 7	11.0	4.2± 0.9	--	0.46±0.11	0.44±0.11	--
Aug 7-14	11.2	5.3± 0.9	0.61±0.24	0.85±0.17	0.57±0.11	--
Aug 14-21	11.2	5.3± 0.9	--	0.73±0.17	0.36±0.14	--
Aug 21-28	11.1	7.5± 1.2	0.49±0.24	1.2 ±0.2	0.79±0.14	0.16±0.11
Aug 28-Sep 4	11.2	7.4± 1.2	--	0.79±0.17	--	0.11±0.05
Sep 4-11	11.0	15 ± 1.5	--	1.1 ±0.1	0.58±0.07	--
Sep 11-18	11.2	7.6± 1.2	--	0.62±0.12	0.33±0.11	--
Sep 18-25	11.1	6.1± 1.1	--	0.99±0.15	0.29±0.10	--
Sep 25-Oct 2	11.2	16 ± 1.6	0.55±0.26	0.91±0.26	0.42±0.12	0.29±0.13
Oct 2-9	11.0	11 ± 1.4	--	0.39±0.14	--	--
Oct 9-16	11.2	9.8± 1.3	--	0.33±0.12	--	0.18±0.12
Oct 16-23	11.1	12 ± 1.4	0.36±0.18	0.28±0.13	--	0.11±0.10
Oct 23-30	11.3	21 ± 1.4	0.39±0.15	0.34±0.11	0.18±0.08	0.22±0.09
Oct 30-Nov 6	11.0	12 ± 1.0	--	0.21±0.08	0.09±0.07	0.09±0.08
Nov 6-13	11.2	14 ± 1.2	0.22±0.19	0.48±0.12	0.18±0.09	0.24±0.09
Nov 13-20	10.4	5.0± 0.9	--	--	--	0.13±0.08

Table 4, cont'd

Collection date	$10^3 m^3$	Gamma-emitting radionuclides (pCi/thousand cubic meters)[a] ^{7}Be	^{95}Zr[b]	^{95}Nb[b]	^{103}Ru	^{137}Cs
1972, cont'd						
Nov 20-27	11.5	25 ± 1.5	--	0.86±0.14	0.20±0.08	0.41±0.10
Nov 27-Dec 4	11.1	19 ± 1.4	--	0.31±0.10	0.08±0.07	0.18±0.09
Dec 4-11	11.1	15 ± 1.5	--	0.55±0.15	--	0.14±0.10
Dec 11-19	12.6	22 ± 1.5	--	0.23±0.12	--	0.15±0.09
Dec 19-26	11.4	17 ± 1.7	--	0.12±0.11	--	0.15±0.11
1973						
Jan 3-10	11.1	14 ± 1.4	--	--	0.13±0.09	--
Jan 10-17	11.2	16 ± 1.5	--	--	0.14±0.10	0.63±0.46
Jan 17-24	11.1	22 ± 1.8	--	--	0.20±0.10	0.94±0.28
Jan 24-31	11.1	36 ± 2.4	0.43±0.17	0.16±0.13	0.37±0.15	--
Jan 31-Feb 7	11.1	17 ± 1.7	0.19±0.12	--	0.30±0.12	2.0 ±0.49
Feb 7-14	11.1	26 ± 2.0	0.21±0.15	--	--	0.55±0.50
Feb 14-21	11.2	14 ± 1.3	--	--	0.30±0.09	0.53±0.42
Feb 21-28	11.1	21 ± 1.8	--	--	0.24±0.11	0.88±0.48
Feb 29-Mar 7	11.1	15 ± 1.6	--	--	--	0.64±0.48
Mar 7-14	10.7	17 ± 1.7	--	--	0.20±0.14	--
Mar 14-21	10.9	9.8± 1.3	--	--	0.12±0.10	0.52±0.43
Mar 21-26	8.4	6.3± 1.4	--	--	--	--
Mar 26-Apr 2	7.4	36 ± 2.9	--	--	0.48±0.19	1.7 ±0.73
Apr 2-9	11.8	26 ± 1.7	--	--	0.41±0.12	1.2 ±0.45
Apr 9-17	12.3	18 ± 1.6	--	--	0.11±0.11	--
Apr 17-23	9.5	34 ± 2.4	--	--	0.17±0.16	0.80±0.59
Apr 23-30	11.1	37 ± 2.3	--	--	0.42±0.12	1.3 ±0.52
Apr 30-May 7	11.6	20 ± 1.4	--	--	0.20±0.09	0.57±0.41
May 7-14	11.1	18 ± 1.7	--	0.18±0.08	0.16±0.10	0.62±0.46
May 14-21	11.4	7.7± 1.2	--	0.12±0.09	--	--
May 21-29	12.4	20 ± 1.0	--	--	0.24±0.07	0.41±0.27
May 29-Jun 5	11.1	10 ± 1.1	--	--	0.11±0.08	--
Jun 5-12	11.2	12 ± 1.2	--	--	0.13±0.09	--
Jun 12-19	11.1	16 ± 1.3	--	--	0.21±0.08	--
Jun 19-26	11.1	11 ± 1.3	--	--	0.22±0.12	--
Jun 26-Jul 3	11.1	3.0± 1.1	--	--	--	--
Jul 3-10	11.1	3.8± 1.0	--	0.16±0.10	--	--
Jul 10-17	11.2	12 ± 1.5	--	0.25±0.11	--	--
Jul 17-24	11.0	3.2± 1.0	--	--	--	--
Jul 24-31	11.1	6.0± 0.9	--	--	0.10±0.07	0.56±0.33
Jul 31-Aug 8	12.7	4.4± 0.9	--	--	--	--
Aug 8-14	9.6	11 ± 0.9	--	0.08±0.06	0.07±0.06	--
Aug 14-21	11.0	4.7± 1.1	--	0.14±0.10	0.11±0.09	--
Aug 21-28	16.4	13 ± 1.2	0.12±0.07	0.14±0.07	0.14±0.07	--

[a]Error terms are two-sigma, propagated counting errors. Dashes indicate that the sample count is less than the counting error.

[b]Air filters collected before May 29, 1972, were counted on NaI detectors; ^{95}Zr and ^{95}Nb values were calculated as discussed in the text. Filters collected after May 29, 1972, were counted on a Ge(Li) detector.

Table 5. Gamma-emitting radionuclides in water samples collected with a filter and sorption bed system from intertidal areas of Amchitka Island.

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a]					
			^{7}Be	^{60}Co	^{65}Zn	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs
Pre-Cannikin								
Constantine Harbor[d]	950–	Part.	0.009±0.011	0.013±0.030	0.019±0.040	0.002±0.008	0.006±0.007	0.001±0.001
	5,974	Sol.	0.38 ±0.81	0.018±0.037	0.20 ±0.47	0.003±0.017	0.012±0.015	0.002±0.035
Duck Cove								
May 71	931	Part.	0.035±0.022	--	--	0.007±0.002	0.016±0.004	--
May 71	931	Sol.	--	--	--	--	--	--
Nov 71	391	Part.	--	--	--	--	--	--
Nov 71	391	Sol.	--	--	0.008±0.007	0.003±0.002	0.006±0.005	--
Post Cannikin								
Constantine Harbor								
Dec 71	524	Part.	--	--	--	0.005±0.004	0.013±0.009	--
Dec 71	524	Sol.	0.49 ±0.48	--	--	--	--	0.09 ±0.03
Feb 72	1,190	Part.	--	--	--	0.002±0.001	0.004±0.003	0.004±0.002
Feb 72	1,190	Sol.	0.19 ±0.16	--	0.036±0.032	--	--	--
Apr 72	1,520	Part.	--	--	0.006±0.004	--	--	--
Apr 72	1,520	Sol.	--	--	0.035±0.028	0.009±0.008	0.021±0.020	--
Jul 72	341	Part.	--	--	--	--	--	--
Jul 72	341	Sol.	--	--	--	--	--	--
Sep 72	83	Part.	--	--	--	--	--	--
Sep 72	83	Sol.	--	--	--	--	--	--
Apr 73	1,332	Part.	--	--	--	--	--	--
Apr 73	1,332	Sol.	--	--	--	--	--	--
Aug 73	1,223	Part.	--	--	--	--	--	--
Aug 73	1,223	Sol.	--	--	--	--	--	--

Table 5, cont'd

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a]					
			^{7}Be	^{60}Co	^{65}Zn	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs
Duck Cove								
Nov 71	420	Part.	--	--	--	--	--	0.021±0.020
Nov 71	420	Sol.	--	--	--	--	--	--
Dec 71	380	Part.	--	--	--	--	--	0.007±0.006
Dec 71	380	Sol.	--	--	0.035±0.027	0.013±0.012	0.027±0.024	--
Feb 72	353	Part.	0.19 ±0.09	--	--	0.006±0.002	0.013±0.005	--
Feb 72	353	Sol.	--	--	--	--	--	--
Apr 72	513	Part.	--	--	0.018±0.013	--	--	--
Apr 72	513	Sol.	--	--	--	--	--	--
Jul 72	44	Part.	--	--	--	--	--	--
Jul 72	44	Sol.	--	--	--	--	--	--
Sep 72	121	Part.	--	--	--	--	--	--
Sep 72	121	Sol.	--	--	--	--	--	--
Apr 73	937	Part.	--	--	--	--	--	--
Apr 73	937	Sol.	--	--	--	--	--	--
Aug 73	150	Part.	--	--	--	--	--	--
Aug 73	150	Sol.	--	--	--	--	--	--
Sand Beach Cove								
Nov 71	566	Part.	--	--	--	--	--	0.008±0.003
Nov 71	566	Sol.	--	--	--	--	--	--
Dec 71	479	Part.	--	0.007±0.003	--	--	--	--
Dec 71	479	Sol.	--	--	0.11 ±0.09	--	--	--
Feb 72	832	Part.	--	--	--	--	--	0.008±0.003
Feb 72	832	Sol.	0.43 ±0.22	0.013±0.010	--	--	--	--
Apr 72	589	Part.	--	--	--	0.013±0.005	0.028±0.008	--
Apr 72	589	Sol.	--	--	0.12 ±0.08	--	--	0.017±0.007
Jul 72	352	Part.	--	--	--	0.01 ±0.01	0.02 ±0.01	--
Jul 72	352	Sol.	--	--	--	--	--	--
Sep 72	145	Part.	--	--	--	--	--	--
Sep 72	145	Sol.	--	--	--	--	--	--

Table 5, cont'd

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a]					
			^{7}Be	^{60}Co	^{65}Zn	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs
Apr 73	242	Part.	--	--	--	--	--	--
Apr 73	242	Sol.	--	--	--	--	--	--
Aug 73	681	Part.	--	--	--	--	--	--
Aug 73	681	Sol.	--	--	--	--	--	--

[a]Error values are two-sigma, propagated, counting errors. Dashes in the body of the table indicate that the sample count is less than the two-sigma, propagated counting error.

[b]Part. (particulate)--that portion retained by the 0.3-micron porosity filter. Sol. (soluble)--that portion which passes through the 0.3-micron filter and is absorbed by the Al_2O_3. Traces of ^{60}Co, ^{103}Ru, ^{106}Ru-^{106}Rh, and ^{144}Ce-^{144}Pr were also identified in some samples, but quantitative determinations were not made.

[c]Samples collected before July 1972 were counted on a NaI detector. After July 1972, samples were counted on a Ge(Li) detector. For samples counted on NaI detectors, ^{95}Zr and ^{95}Nb values were calculated as discussed in the text.

[d]Pre-Cannikin results for Constantine Harbor are mean and standard deviation of 10 samples collected between September 1970 and November 1971.

Table 6. Gamma-emitting radionuclides in marine algae collected at Amchitka in 1970 prior to Cannikin detonation.

Collection site	Genus	Radionuclides (pCi/g, dry)[a]		
		^{40}K	$^{95}Zr-^{95}Nb$	^{137}Cs
September 1970				
Constantine Harbor	*Fucus*	32 ± 0.7	0.23 ± 0.03	0.12 ± 0.04
Duck Cove	"	25 ± 0.4	0.16 ± 0.01	0.08 ± 0.02
Sand Beach Cove	"	23 ± 0.4	0.19 ± 0.01	0.07 ± 0.02
Constantine Harbor	*Alaria*	66 ± 0.6	0.22 ± 0.01	0.05 ± 0.03
Duck Cove	"	60 ± 0.3	0.27 ± 0.01	
"	*Halosaccion*	15 ± 0.4	0.34 ± 0.01	0.07 ± 0.02
Sand Beach Cove	"	14 ± 0.4	0.32 ± 0.03	0.08 ± 0.03
"	*Porphyra*	18 ± 0.4	0.55 ± 0.01	
"	*Corallina*	49 ± 0.4	0.33 ± 0.02	0.04 ± 0.04
Duck Cove	*Constantina*	32 ± 0.6	0.43 ± 0.03	0.11 ± 0.03
"	*Thalasiophyllum*	18 ± 0.5	0.32 ± 0.03	0.08 ± 0.03
"	*Laminaria*	69 ± 1.4	0.22 ± 0.04	0.12 ± 0.06
"	*Hypophyllum*	41 ± 0.9	0.12 ± 0.02	0.08 ± 0.05
"	"	15 ± 0.2	0.21 ± 0.01	0.03 ± 0.01
October 1970				
Duck Cove	*Alaria*	38 ± 0.4	0.19 ± 0.02	
Sand Beach Cove	"	60 ± 0.9	0.66 ± 0.05	
Duck Cove	*Hedophyllum*	37 ± 0.6	0.16 ± 0.02	0.05 ± 0.03
"	*Laminaria*	69 ± 1.2	0.62 ± 0.12	0.11 ± 0.06

[a]The error values are the two-sigma, propagated counting errors for single samples.

Table 7. Some gamma-emitting radionuclides in the marine alga Fucus distichus collected at Amchitka Island after the Cannikin detonation, 1971-1979.

	Radionuclides (pCi/g, dry)[a]					
Location and date	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Constantine Harbor						
Feb 72	5.0 ± 1.8	33 ± 1.0	--	--	--	--
Apr 72	2.3 ± 1.2	36 ± 0.7	0.07 ± 0.05	0.16 ± 0.10		
Jun 72	--	32 ± 0.6	0.07 ± 0.04	0.13 ± 0.07	--	--
Oct 72	2.7 ± 2.6	36 ± 0.8	--	--	--	--
Apr 73	--	34 ± 2.1	--	--	--	--
Aug 73	--	33 ± 3.0	--	--	0.05 ± 0.03	--
May 74	1.0 ± 0.04	32 ± 2.0	0.36 ± 0.04	0.73 ± 0.09	0.05 ± 0.03	1.5 ± 0.2
Aug 75	1.7 ± 1.3	32 ± 2.3	--	--	0.04 ± 0.04	--
Aug 76	--	28 ± 2.2	--	--	0.05 ± 0.04	--
Sep 77	--	23 ± 3.2	--	--	--	0.38 ± 0.26
Aug 78	0.66 ± 0.47	28 ± 2.3	--	--	--	0.38 ± 0.18
Sep 79	--	33 ± 1.2	--	--	--	--
Duck Cove						
Dec 71	2.0 ± 1.4	30 ± 0.8	0.06 ± 0.06	0.14 ± 0.11	--	--
Feb 72	2.5 ± 1.1	33 ± 1.0	0.03 ± 0.03	0.07 ± 0.06	--	--
Apr 72	--	41 ± 0.7	0.07 ± 0.04	0.14 ± 0.08	--	--
Jun 72	1.1 ± 0.1	34 ± 0.5	0.08 ± 0.02	0.16 ± 0.04	0.06 ± 0.02	--
Sep 72	4.1 ± 3.7	39 ± 0.9	--	--	--	--
Apr 73	--	40 ± 2.1	--	--	--	0.24 ± 0.17
Jul 73	0.77 ± 0.25	24 ± 1.8	--	--	--	--
Aug 73	0.65 ± 0.43	42 ± 2.6	--	--	0.09 ± 0.04	--
May 74	--	38 ± 1.2	0.08 ± 0.06	0.22 ± 0.05	0.07 ± 0.02	0.91 ± 0.10
Aug 74	--	36 ± 2.3	--	--	0.07 ± 0.04	0.35 ± 0.21
Aug 75	--	33 ± 2.3	--	--	--	--
Aug 76	--	30 ± 2.2	--	0.13 ± 0.10	--	--
Sep 77	--	32 ± 3.4	--	0.24 ± 0.11	--	--
Aug 78	--	30 ± 2.2	--	--	--	--
Sep 79	--	38 ± 2.2	--	--	--	--

Table 7, cont'd

Location and date	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
	Radionuclides (pCi/g, dry)[a]					
Sand Beach Cove						
Nov 71	--	28 ± 0.6	0.06 ± 0.06	0.12 ± 0.12	--	--
Dec 71	1.8 ± 1.2	29 ± 1.0	0.07 ± 0.03	0.15 ± 0.06	--	--
Feb 72	4.7 ± 1.4	30 ± 0.9	0.18 ± 0.03	0.36 ± 0.06	--	--
Apr 72	7.7 ± 2.3	28 ± 0.5	0.45 ± 0.08	0.98 ± 0.16	0.05 ± 0.03	--
Jun 72	7.1 ± 1.9	18 ± 0.6	0.49 ± 0.08	1.0 ± 0.2	--	--
Sep 72	1.4 ± 0.9	23 ± 0.6	0.04 ± 0.03	0.06 ± 0.06	--	--
Apr 73	--	36 ± 2.0	--	--	--	0.32 ± 0.16
Aug 73	--	33 ± 2.3	--	--	--	--
May 74	0.61 ± 0.45	39 ± 2.3	0.23 ± 0.09	0.34 ± 0.08	--	0.92 ± 0.19
Aug 74	--	27 ± 1.4	--	--	--	0.25 ± 0.19
Aug 75	--	34 ± 2.2	--	0.16 ± 0.12	0.04 ± 0.04	--
Aug 76	--	24 ± 2.1	--	--	--	--
Sep 77	0.95 ± 0.79	25 ± 3.2	0.20 ± 0.19	--	--	0.66 ± 0.27
Aug 78	--	23 ± 2.9	--	--	0.07 ± 0.04	0.21 ± 0.18
Sep 79	--	39 ± 1.2	--	--	--	--
Square Bay						
Aug 75	--	38 ± 2.4	--	--	--	--
Aug 76	--	22 ± 2.0	--	--	--	--
Sep 77	--	31 ± 3.4	--	0.34 ± 0.12	--	0.69 ± 0.27
Aug 78	0.90 ± 0.45	19 ± 1.7	--	--	0.08 ± 0.04	0.27 ± 0.14
Sep 79	--	31 ± 1.2	--	--	--	--

[a]The error values are the two-sigma, propagated counting errors for single samples.

Table 8. Some gamma-emitting radionuclides in invertebrates collected at Amchitka Island.

Organism & collection date	Collection site	Tissue	Gamma-emitting radionuclides (pCi/g, dry)[a]			
			^{7}Be	^{40}K	^{95}Zr	^{95}Nb
Octopus						
Nov 71	Off St. Makarius Pt.	Viscera	--	13 ±1.5	0.27±0.21	0.54±0.48
Nov 71	"	Remainder	--	7.8±0.4	--	--
Plankton						
Sep 71	Off East Cape	Entire	3.1 ±2.9	9.9±0.6	--	--
Sep 71	IA-3	Entire	--	11 ±1.1	--	--
Sep 71	IA-3	Entire	--	15 ±0.8	--	--
Aug 72	Off Kiriloff Pt.	Entire	--	9 ±0.5	--	--
Sep 72	"	Entire	--	17 ±0.7	--	--
Sep 72	"	Entire	0.7 ±0.6	10 ±0.6	--	--
Sep 72	"	Entire	0.6 ±0.5	10 ±0.5	--	--
Sep 72	"	Entire	2.1 ±1.9	11 ±0.6	--	--
Sep 72	Off C-site	Entire	--	12 ±0.4	--	--
Sep 72	Off Kiriloff Pt.	Entire	--	10 ±0.8	--	--
Littorina						
May 71	IA-3	Entire	0.25±0.22	2.1±0.2	0.03±0.02	0.05±0.04
Sea Urchin						
Sep 71	Off Bat Island	Soft parts	--	13 ±1.4	--	--
Sep 71	Crown Reefer Pt.	Soft parts	--	11 ±0.7	--	--
Sep 71	Crown Reefer Pt.	Gonad	--	11 ±1.5	0.45±0.30	1.0 ±0.6
Sep 71	Off C-site	Soft parts	--	10 ±0.8	0.16±0.05	0.35±0.14
Sep 71	St. Makarius Bay	Soft parts	--	11 ±1.2	0.63±0.23	1.3 ±0.6
Sep 71	Off C-site	Soft parts	--	12 ±1.4	0.63±0.34	1.3 ±0.8
Oct 71	Off Bat Island	Soft parts	--	64 ±5	0.46±0.27	1.0 ±0.6
Oct 71	"	Soft parts	1.6 ±1.1	11 ±1	0.09±0.07	0.22±0.13
Oct 71	"	Test	--	2 ±0.4	0.04±0.02	0.08±0.04
Oct 71	"	Test	--	3 ±0.5	0.04±0.03	0.08±0.06
Oct 71	"	Gonad	--	6 ±1.3	--	--

Table 8, cont'd

Organism & collection date	Collection site	Tissue	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{7}Be	^{40}K	^{95}Zr	^{95}Nb
Mussel						
Jun 72	Sand Beach Cove	Shell	--	--	--	--
Apr 73	Constantine Harbor	Soft parts	--	13 ±0.6	--	--
Aug 73	Rifle Range Pt.	Soft parts	--	9.3±0.7	--	--
Aug 73	Rifle Range Pt.	Shell	--	2.4±0.7	--	--
Scallop						
Sep 71	Off Sea Otter Pt.	Soft parts	--	13 ±1.2	--	--
Sep 71	Off Sea Otter Pt.	Shell	--	0.3±0.3	--	--
Oct 71	Off Kiriloff Pt.	Soft parts	32 ±5	11 ±4.9	0.5 ±0.4	1.0 ±0.8
Oct 71	Kiriloff Point	Soft parts	--	8.8±2.2	--	--
Tanner Crab						
Oct 71	Off Bat Island	Skeleton	--	5.2±1.2	0.22±0.11	0.44±0.22
Oct 71	"	Remainder	--	6.2±0.9	--	--
Oct 71	"	Skeleton	--	5.8±1.2	--	--
Horse Crab						
Oct 71	Off Bat Island	Muscle	--	15 ±0.8	--	--
Oct 71	"	Skeleton	--	6.6±0.9	--	--
Oct 71	"	Remainder	--	--	1.1 ±0.8	2.3 ±1.7

Table 8, cont'd

Organism and collection date	Tissue	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{60}Co	^{65}Zn	^{95}Zr-^{95}Nb	^{137}Cs
False King Crab					
Oct 71	Muscle	0.4 ± 0.09	--	2.6 ± 0.6	2.4 ± 0.4
Oct 71	Eggs	--	--	--	0.2 ± 0.1
Oct 71	Muscle	0.3 ± 0.1	0.4 ± 0.30	0.3 ± 0.1	0.2 ± 0.1
Oct 71	Hepatopancreas	--	--	0.4 ± 0.2	0.3 ± 0.1
Oct 71	Muscle	0.28 ± 0.08	0.5 ± 0.30	0.3 ± 0.1	0.2 ± 0.1
Oct 71	Hepatopancreas	--	0.4 ± 0.2	0.1 ± 0.1	--
Oct 71	Eggs	--	--	--	--
Oct 71	Remainder	--	--	--	--
Oct 71	Muscle	0.3 ± 0.1	--	0.3 ± 0.1	0.2 ± 0.1
Oct 71	Skeleton	0.31 ± 0.09	0.5 ± 0.3	0.4 ± 0.1	0.2 ± 0.1
Oct 71	Remainder	--	--	--	--
Oct 71	Muscle	--	--	--	--
Oct 71	Eggs	--	--	--	0.08 ± 0.07
Oct 71	Skeleton	0.21 ± 0.07	0.5 ± 0.3	0.2 ± 0.1	0.16 ± 0.09
Oct 71	Skeleton	--	--	--	--
Oct 71	Muscle	--	--	--	--
Oct 71	Hepatopancreas	--	--	--	--
Oct 71	Eggs	0.18 ± 0.07	--	--	--
Oct 71	Remainder	--	--	--	--
Oct 71	Muscle	--	--	0.3 ± 0.1	--
Oct 71	Remainder	0.06 ± 0.05	--	--	--
Oct 71	Skeleton	0.13 ± 0.04	--	0.14 ± 0.08	--
Nov 71	Hepatopancreas	0.11 ± 0.09	0.6 ± 0.3	0.4 ± 0.2	--
Nov 71	Hepatopancreas	0.12 ± 0.06	--	0.2 ± 0.1	--

Table 8, cont'd

Organism & collection date	Collection site	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{144}Ce
		Gamma-emitting radionuclides (pCi/g, dry)[a]				
Green Sponge						
Jun 72	Sand Beach Cove	--	6.8 ± 1.7	0.24 ± 0.13	0.54 ± 0.28	NA
Apr 73	"	--	12 ± 1.7	--	--	0.31 ± 0.17
May 74	"	1.1 ± 0.4	9.0 ± 1.5	0.10 ± 0.07	0.26 ± 0.07	0.60 ± 0.16
Aug 74	"	--	9.6 ± 1.4	--	--	1.2 ± 0.2
Aug 75	"	--	10.0 ± 1.6	--	--	0.56 ± 0.2
Aug 76	"	1.0 ± 0.7	8.5 ± 1.4	--	--	0.22 ± 0.16
Sep 77	"	--	7.4 ± 2.3	--	0.40 ± 0.26	1.0 ± 0.3
Aug 78	"	1.1 ± 0.58	11 ± 1.5	--	--	1.1 ± 0.19
Oct 79	"	--	13 ± 1.0	--	--	--
Apr 73	Square Bay	--	10 ± 1.7	--	--	0.43 ± 0.18
Aug 73	"	1.3 ± 0.5	9.3 ± 1.5	--	--	0.26 ± 0.15
Aug 75	"	1.2 ± 0.9	9.5 ± 1.7	--	0.11 ± 0.09	0.61 ± 0.20
Aug 76	"	--	10 ± 1.7	--	--	0.21 ± 0.18
Sep 77	"	--	7.8 ± 2.3	--	0.48 ± 0.25	1.2 ± 0.3
Oct 79	"	--	10 ± 0.8	--	--	0.31 ± 0.14
Dec 71	Duck Cove	2.4 ± 0.6	8.4 ± 0.6	0.07 ± 0.05	0.15 ± 0.10	NA
Feb 72	"	6.4 ± 5.9	9.5 ± 0.7	--	--	NA
Apr 72	"	--	15 ± 0.7	--	--	NA
Jun 72	"	2.0 ± 0.4	9.7 ± 0.3	0.14 ± 0.04	0.28 ± 0.06	NA
Apr 73	"	1.9 ± 0.9	9.8 ± 1.7		--	0.39 ± 0.19
Aug 73	"	1.1 ± 0.6	9.7 ± 1.6		--	0.44 ± 0.15
May 74	"	1.0 ± 0.4	10 ± 1.5	0.16 ± 0.07	0.36 ± 0.07	1.1 ± 0.17
Aug 74	"	--	7.2 ± 1.3	--	--	1.2 ± 0.23
Aug 75	"	--	7.7 ± 1.4	--	--	0.73 ± 0.20
Aug 76	"	4.3 ± 4.2	20 ± 1.3	--	--	--
Sep 77	"	--	8.2 ± 1.5	0.41 ± 0.34	0.45 ± 0.16	1.1 ± 0.2
Aug 78	"	0.9 ± 0.6	10 ± 1.5	--	--	1.1 ± 0.20
Oct 79	"	--	9.5 ± 2.0	--	--	--

[a]Radionuclide values for a single sample (n=1) are a single count of the sample plus or minus the two-sigma, propagated counting error. The radionuclide value shown for more than one sample is the mean plus or minus one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

Table 9. Specific activity of potassium-40 and cesium-137 in selected marine fish collected off Amchitka Island.

Collection Date	Collection Site	Common Name (size cm)	No. of Fish	Tissue	Gamma-Emitting Radionuclides[a] (pCi/g, dry) ^{40}K	^{137}Cs
Oct 1971	Bering Sea (51°30'N 179°20'E)	Rattail (91)	3	Liver	1.3 ± 1.1	---
"	Pacific Ocean[b]	Ocean Perch (19-29)	5	Liver	9.5 ± 1.1	0.05 ± 0.05
"	"	"	4	Muscle	14 ± 0.5	0.06 ± 0.04
"	"	"	2	Viscera	8.8 ± 1.2	0.06 ± 0.01
"	"	Pacific Cod (47-70)	3	Liver	3.8 ± 0.1	---
"	"	"	2	Muscle	16 ± 0.6	0.04 ± 0.06
Aug 1972	Bering Sea (Off C-site)	"	4	Muscle	18 ± 0.9	0.07 ± 0.05
"	"	"	"	Liver	12 ± 1.0	0.08 ± 0.07
"	"	"	"	Bone	11 ± 0.7	0.07 ± 0.05
"	Off St. Makarius Point	Pacific Cod (44)	1	Muscle	17 ± 1.8	---
"	"	"	1	Muscle	17 ± 1.8	---

Table 9, cont'd

Collection Date	Collection Site	Common Name (size cm)	No. of Fish	Tissue	Gamma-Emitting Radionuclides (pCi/g, dry)	
					^{40}K	^{137}Cs
Aug 1972	Off St. Makarius Point	Pacific Cod (44)	1	Liver	8.1 ± 2.7	---
"	"	"	1	Muscle	17 ± 0.5	0.10 ± 0.03
"	"	"	1	Liver	13 ± 1.8	---
"	"	"	4	Muscle	17 ± 0.9	---
"	"	"	"	Liver	9.2 ± 1.5	---
Oct 1971	Pacific Ocean[b]	Pollack (42-44)	3	Liver	3.1 ± 0.5	---
Oct 1971	"	"	"	Muscle	15 ± 0.5	0.10 ± 0.03
Aug 1972	Off Kirilof Pt.	Walleye Pollock (37)	1	Muscle	16 ± 0.5	0.06 ± 0.03
"	"	"	"	Viscera	16 ± 3.9	---
"	"	"	"	Remainder	10 ± 0.4	0.08 ± 0.03
"	"	"	10	Muscle	12 ± 0.04	0.04 ± 0.02
Nov 1971	Bering Sea	Lantern Fish (4-10)	35	Entire	6.3 ± 0.5	0.06 ± 0.04
Ang 1972	Off Kirilof Pt.	Lantern Fish (7-10)	40	Eviscerated Whole	6.3 ± 0.4	---
"	"	"	"	Viscera	4.8 ± 0.4	---

Table 9, cont'd

Collection Date	Collection Site	Common Name (size cm)	No. of Fish	Tissue	Gamma-Emitting Radionuclides (pCi/g, dry)	
					^{40}K	^{137}Cs
Nov 1971	Bering Sea	Smelt (12-14)	5	Entire	11 ± 1.8	---
Aug 1972	Off Kirilof Pt.	"	"	Eviscerated whole	7.7 ± 0.7	0.10 ± 0.05
Nov 1971	Pacific Ocean[c]	Rock Sole (30)	1	Muscle	18 ± 0.9	---
"	"	Rock Sole (29)	1	"	15 ± 0.7	---
"	"	"	"	"	18 ± 0.8	---
"	"	"	"	"	17 ± 0.7	0.11 ± 0.05
"	"	"	5	"	15 ± 0.8	0.09 ± 0.05
Aug 1972	Bering Sea (Off C-site)	Rock Sole (15-25)	10	Muscle	13 ± 0.6	---
"	"	"	"	Liver	15 ± 3.6	---
"	"	"	"	Bone	9.1 ± 1.0	---
Sept 1972	Bering Sea (Off Bat Island)	Rock Sole (19-31)	5	Muscle	15 ± 0.3	0.06 ± 0.02

Table 9, cont'd

Collection Date	Collection Site	Common Name (size cm)	No. of Fish	Tissue	Gamma-Emitting Radionuclides (pCi/g, dry)	
					^{40}K	^{137}Cs
Sept 1972	Bering Sea (Off Bat Island)	Rock Sole (19-31)	5	Liver	20 ± 3.0	0.24 ± 0.21
"	"	"	"	Bone	8.0 ± 0.8	---

a. Error values are two-sigma propagated, counting errors for single sample counts. The dashes in the body of the table indicate that the net sample count is less than the two-sigma, propagated counting error.

b. These fish were caught within the area bounded by 179°9'E to 179°21'E longitude and 51°14'N to 51°15.5'N latitude in the Pacific Ocean off Amchitka.

c. These fish were caught within the are bounded by 179°9'E to 179°21'E longitude and 51°14'N to 51"15.5'N latitude in the Pacific Ocean off Amchitka.

Table 10. Specific activity of potassium-40 and cesium-137 in salmon collected in the Bering Sea off Amchitka Island.[a]

Species and collection date	Tissue	pCi/g, dry[b]	
		^{40}K	^{137}Cs
Chinook salmon			
Aug 71	Liver	10 ± 1.0	0.11 ± 0.07
"	Muscle	11 ± 0.8	0.05 ± 0.05
"	"a	7.6 ± 0.7	--
Chum salmon			
Sept 71	Liver	7.2 ± 1.2	--
"	Muscle	12 ± 0.9	0.07 ± 0.06
"	Liver	12 ± 1.6	0.16 ± 0.12
"	Muscle	9.2 ± 0.6	0.08 ± 0.04
"	Muscle	13 ± 0.8	--
"	"	13 ± 0.7	0.08 ± 0.04
"	"	9 ± 0.7	--
"	"	11 ± 0.6	--
"	"	10 ± 0.8	--
"	Liver	11 ± 1.8	--
"	Muscle	13 ± 0.8	0.09 ± 0.05
"	"	14 ± 0.6	--
"	"	13 ± 1.4	--
"	"	11 ± 0.7	0.07 ± 0.05
"	"	9.6 ± 0.5	0.12 ± 0.05
"	"	11 ± 0.7	--
"	Liver	12 ± 1.1	0.13 ± 0.08
"	Muscle	12 ± 0.7	--
"	"	13 ± 0.8	0.08 ± 0.05
"	"	12 ± 0.8	--
"	"	12 ± 0.9	--
"	"	9.5 ± 0.7	--
"	Liver	11 ± 1.3	0.17 ± 0.10
"	Muscle	9.2 ± 0.6	--
Aug 72	"	11 ± 0.9	--
"	"	12 ± 0.9	--

Table 10, cont'd

Species and collection date	Tissue	pCi/g, dry[b]	
		^{40}K	^{137}Cs
Pink salmon			
Sept 71	Muscle[a]	15 ± 0.8	0.10 ± 0.04
Aug 72	"	14 ± 1.0	--
"	"	13 ± 1.1	--
"	"	11 ± 1.0	--
"	"	12 ± 1.0	--
"	"	21 ± 2.2	--
"	"	13 ± 1.0	--
"	"	15 ± 1.0	--
"	"	13 ± 1.2	--
Aug 78	"	13 ± 1.6	--
"	"	15 ± 1.7	--
Sockeye salmon			
Nov 71	Muscle	15 ± 0.8	0.07 ± 0.05
"	"	14 ± 0.6	--
"	"	12 ± 0.6	--
"	"	12 ± 0.8	--
"	"	13 ± 0.5	0.04 ± 0.03
"	"	13 ± 0.6	0.08 ± 0.04
Coho salmon			
Oct 79	Muscle[a]	17 ± 1.0	--

[a]With the exception of one chinook (Pacific Ocean, 51°15.5'N, 178° 59.5'E) and of one pink (Kiriloff Bay) and of one coho (Clevenger Lake Outlet), these fish were caught in the area bounded by 179°22.5'E to 179°9.5'E longitude and 51°30.4'N to 51°35.2'N latitude in the Bering Sea.

[b]Error values are two-sigma, propagated, counting errors. Dashes in the body of the table indicate the sample count is not detectable, i.e., the net sample count is less than the two-sigma, propagated counting error.

Table 11. Specific activity of potassium-40 and cesium-137 in Pacific halibut collected off Amchitka Island, 1971-1979.

Location and collection date	n[b]	Tissue	pCi/g, dry[a]	
			^{40}K	^{137}Cs
Bering Sea off C-Site				
Aug 71	1	Muscle	20 ± 0.8	--
"	1	Liver	21 ± 4.2	0.68 ± 0.30
"	1	Muscle	18 ± 0.7	0.06 ± 0.05
"	1	Liver	8.1 ± 0.5	0.08 ± 0.03
"	1	Muscle	16 ± 0.8	--
"	1	Liver	15 ± 1.9	0.24 ± 0.14
"	1	Muscle	19 ± 0.8	0.19 ± 0.05
"	1	Liver	9.3 ± 0.5	0.08 ± 0.03
Nov 71	1	Muscle	19 ± 1.1	--
"	1	"	19 ± 0.7	0.08 ± 0.04
"	1	Liver	5.8 ± 1.0	--
"	1	Muscle	19 ± 0.9	0.18 ± 0.06
Sep 72	1	"	16 ± 1.0	--
"	1	Testes	28 ± 1.1	0.09 ± 0.06
"	1	Liver	4.1 ± 1.6	--
"	1	Bone	3.5 ± 0.5	--
"	1	Muscle	16 ± 1.0	0.06 ± 0.05
"	1	Testes	28 ± 1.0	--
"	1	Liver	4.8 ± 1.0	--
"	1	Bone	7.9 ± 1.3	--
"	1	Muscle	15 ± 0.9	--
"	1	Liver	7.9 ± 1.7	--
"	1	Ovary	6.4 ± 0.9	--
"	1	Bone	7.2 ± 1.5	--
"	1	Muscle	18 ± 0.9	--
"	1	Ovary	26 ± 1.2	0.17 ± 0.09

Table 11, cont'd

Location and collection date	n[b]	Tissue	pCi/g, dry[a] ^{40}K	pCi/g, dry[a] ^{137}Cs
Bering Sea off C-Site, cont'd				
Sep 72	1	Liver	9.5 ± 0.4	--
"	1	Bone	7.4 ± 1.2	--
"	1	Muscle	15 ± 1.1	--
"	1	Liver	8.6 ± 0.8	--
"	1	Bone	8.7 ± 1.5	--
"	1	Muscle	18 ± 1.2	--
"	1	Liver	8.4 ± 0.5	--
"	1	Ovary	33 ± 3.2	0.36 ± 0.25
"	1	Bone	12 ± 2.3	--
"	1	Muscle	15 ± 0.8	--
"	1	Liver	4.4 ± 2.3	--
"	1	Ovary	30 ± 8.4	--
"	1	Bone	12 ± 2.3	--
Aug 73	1	Muscle	20 ± 0.6	0.09 ± 0.03
"	1	Liver	4.7 ± 0.6	--
"	1	Muscle	18 ± 0.5	0.12 ± 0.03
"	1	Liver	8.1 ± 0.6	0.08 ± 0.05
"	1	Muscle	18 ± 0.7	0.08 ± 0.04
"	1	Liver	7.1 ± 0.4	0.04 ± 0.02
"	1	Muscle	17 ± 0.5	0.10 ± 0.03
"	1	Liver	7.3 ± 0.7	0.10 ± 0.05
"	1	Gonad	8.7 ± 0.5	0.07 ± 0.03
"	1	Muscle	18 ± 0.6	0.14 ± 0.04
"	1	Liver	7.3 ± 0.7	--
"	1	Gonad	24 ± 1.0	0.17 ± 0.07
Aug 75	1	Muscle	18 ± 1.6	0.06 ± 0.04
"	1	Liver	11 ± 1.5	0.05 ± 0.03

Table 11, cont'd

Location and collection date	n[b]	Tissue	pCi/g, dry[a] ^{40}K	^{137}Cs
Constantine Harbor				
Aug 74	1	Liver	6.1 ± 0.7	0.17 ± 0.05
"	1	"	5.8 ± 0.4	--
"	1	"	5.1 ± 0.3	--
"	1	"	10 ± 0.3	0.02 ± 0.02
"	1	"	11 ± 0.4	0.10 ± 0.02
Sep 77	1	"	--	--
Aug 78	1	"	7.7 ± 2.7	--
Oct 79	6	"	6.8 ± 0.40	--
Sep 77	1	Muscle	18 ± 2.8	0.07 ± 0.06
Aug 78	1	"	12 ± 1.6	0.08 ± 0.04
Oct 79	6	"	20 ± 2.2	--
Midden Cove				
Aug 75	2	Muscle	19 ± 1.9	0.05 ± 0.04
"	4	Liver	10 ± 1.5	--
Sand Beach Cove				
Aug 75	1	Muscle	18 ± 1.6	0.06 ± 0.03
"	8	Liver	11 ± 1.5	0.05 ± 0.03
Square Bay				
Aug 76	1	Muscle	18 ± 0.5	0.05 ± 0.03

[a]Error values are two-sigma propagated counting errors.

[b]Number of fish that were pooled to make sample.

Table 12. Specific activity of potassium-40 and cesium-137 in greenling collected off Amchitka Island.

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Constantine Harbor				
Pre-Cannikin				
May 71	19	Muscle	16 ± 0.7	0.37 ± 0.42
"	"	Liver	10 ± 1.4	0.03 ± 0.04
"	"	Bone	8.6 ± 1.3	---
"	"	Stomach content	15 ± 2.1	0.17 ± 0.23
"	"	Viscera	13 ± 0.7	0.15 ± 0.05
"	"	Gonad	9.8 ± 1.7	0.04 ± 0.05
"	"	Remainder	7.5 ± 0.4	0.06 ± 0.01
Post-Cannikin				
Dec 71	10	Muscle	14 ± 0.4	0.06 ± 0.02
"	"	Liver	13 ± 1.6	0.21 ± 0.12
Feb 72	1	Muscle	14 ± 0.5	---
"	"	"	15 ± 0.6	0.06 ± 0.04
"	"	"	14 ± 0.5	0.05 ± 0.03
"	"	"	16 ± 0.9	0.11 ± 0.06
Apr 72	"	"	14 ± 0.8	---
"	"	"	15 ± 1.2	---
"	"	"	15 ± 0.6	---
"	"	"	14 ± 0.6	0.11 ± 0.04
"	"	"	15 ± 0.5	0.05 ± 0.04
July 72	"	"	12 ± 0.5	---
"	"	"	15 ± 0.7	---

Table 12, cont'd

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
July 72	1	Muscle	17 ± 0.8	---
"	"	"	14 ± 0.8	---
Oct 72	6	"	17 ± 0.6	0.09 ± 0.04
Apr 73	5	"	19 ± 0.6	0.09 ± 0.03
"	"	Liver	---	---
Aug 73	4	Muscle	15 ± 0.3	---
"	"	Viscera	9.1 ± 0.6	---
May 74	5	Muscle	18 ± 1.5	0.06 ± 0.03
Aug 74	"	"	16 ± 0.8	0.07 ± 0.05
Aug 75	4	"	21 ± 2.5	0.49 ± 0.07
Aug 76	"	"	9.8 ± 0.8	---
Sept 77	6	"	15 ± 2.7	0.08 ± 0.06
Aug 78	4	"	18 ± 2.8	0.07 ± 0.06
Sept 79	"	"	16 ± 1.0	---
May 74	5	Viscera	15 ± 1.0	0.03 ± 0.02
Aug 74	"	"	9.2 ± 0.8	---
Aug 75	4	"	11 ± 2.2	0.06 ± 0.05
Aug 76	"	"	10 ± 0.9	0.20 ± 0.06
Sept 77	6	"	7.9 ± 3.5	---
Aug 78	4	"	17 ± 2.6	---
Sept 79	"	"	17 ± 1.1	0.07 ± 0.03
Sand Beach Cove				
Pre-Cannikin				
May 71	27	Muscle	15 ± 1.2	0.07 ± 0.02
"	"	Liver	12 ± 3.5	0.05 ± 0.09

Table 12, cont'd

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
May 71	27	Bone	8 ± 1.2	0.04 ± 0.06
"	"	Stomach Content	13 ± 1.5	0.19 ± 0.17
"	"	Viscera	13 ± 0.6	0.02 ± 0.02
"	"	Gonad	9.7 ± 1.2	0.02 ± 0.03
"	"	Remainder	8.7 ± 0.3	0.05 ± 0.04
Post-Cannikin				
Nov 71	1	Muscle	12 ± 1.4	---
"	"	"	13 ± 1.1	---
"	"	"	16 ± 0.9	0.09 ± 0.06
"	"	"	14 ± 0.8	---
Feb 72	"	"	14 ± 0.7	0.08 ± 0.05
"	"	"	17 ± 1.1	---
"	"	"	15 ± 0.7	---
"	"	"	13 ± 0.7	---
Apr 72	"	"	15 ± 0.7	---
"	"	"	14 ± 0.5	0.07 ± 0.03
"	"	"	16 ± 0.6	---
"	"	"	14 ± 0.8	---
"	"	"	15 ± 0.8	---
July 72	6	"	18 ± 0.5	0.09 ± 0.03
"	"	Liver	21 ± 2.9	---
Oct 72	7	Muscle	16 ± 0.5	0.12 ± 0.03

Table 12, cont'd

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Apr 73	6	Muscle	18 ± 0.5	0.09 ± 0.03
"	"	Liver	13 ± 0.6	---
Aug 73	"	Muscle	16 ± 0.3	---
"	"	Viscera	11 ± 0.4	---
May 74	5	Muscle	21 ± 1.9	0.05 ± 0.04
Aug 74	4	"	15 ± 0.7	---
Aug 75	8	"	25 ± 2.7	0.08 ± 0.06
Aug 76	"	"	18 ± 0.8	---
Sept 77	7	"	15 ± 2.5	---
Aug 78	4	"	18 ± 2.8	---
Sept 79	"	"	19 ± 2.2	---
May 74	5	Viscera	9.1 ± 1.1	---
Aug 74	4	"	8.1 ± 2.1	---
Aug 75	8	"	6.3 ± 1.4	0.06 ± 0.04
Aug 76	8	"	9.6 ± 0.4	---
Sept 77	7	"	9.0 ± 2.4	---
Aug 78	4	"	15 ± 4.2	---
Sept 79	4	"	13 ± 0.9	---
Dick Cove				
Post-Cannikin				
Feb 72	1	Muscle	17 ± 0.7	---
"	"	"	14 ± 0.6	0.13 ± 0.04
Apr 72	"	"	15 ± 0.5	---

Table 12, cont'd

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Apr 72	1	Muscle	15 ± 0.6	0.05 ± 0.04
"	"	"	15 ± 0.6	---
"	"	"	16 ± 0.5	0.11 ± 0.03
"	"	"	16 ± 0.5	0.05 ± 0.03
Oct 72	7	"	17 ± 1.0	0.13 ± 0.06
Apr 73	4	"	17 ± 0.4	0.07 ± 0.02
"	"	Liver	---	---
Aug 73	"	Muscle	13 ± 0.5	0.08 ± 0.03
"	"	Viscera	12 ± 0.5	0.13 ± 0.03
May 74	3	Muscle	18 ± 1.6	0.06 ± 0.03
Aug 74	6	"	15 ± 1.8	0.07 ± 0.02
Aug 75	"	"	17 ± 1.8	0.09 ± 0.04
Aug 76	8	"	18 ± 0.4	0.07 ± 0.02
Sept 77	6	"	13 ± 2.7	---
Aug 78	4	"	19 ± 2.9	0.09 ± 0.06
May 74	3	Viscera	7.7 ± 0.8	0.04 ± 0.02
Aug 74	6	"	9.5 ± 0.1	0.15 ± 0.05
Aug 75	"	"	9.5 ± 1.2	0.04 ± 0.03
Aug 76	8	"	9.6 ± 0.4	---
Sept 77	6	"	11 ± 2.5	0.08 ± 0.06
Aug 78	4	"	9 ± 2.0	0.09 ± 0.05
Square Bay				
Post - Cannikin				
Aug 75	5	Muscle	16 ± 1.6	---

Table 12, cont'd

Location and Date	No. of Fish	Tissue	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Aug 76	6	Muscle	18 ± 0.9	---
Sept 77	5	"	16 ± 2.8	---
Aug 78	"	"	14 ± 2.1	0.04 ± 0.04
Sept 79	4	"	15 ± 2.2	---
Aug 75	5	Viscera	7.8 ± 1.4	0.07 ± 0.04
Aug 76	6	"	11 ± 0.8	0.10 ± 0.05
Sept 77	5	"	9.1 ± 2.6	---
Aug 78	"	"	10 ± 2.4	0.10 ± 0.06
Sept 79	4	"	13 ± 1.9	---

[a]Pre-Cannikin radionuclide values are given as mean ± one standard deviation. Post-Cannikin error values are two-sigma propagated counting errors for single samples. Dashes in the table indicated that the net sample count is less than the two-sigma propagated counting error.

Table 13. Specific activity of potassium-40 and cesium-137 in Dolly Varden muscle collected at Amchitka Island, 1971-1979.

Collection date	Location	n[b]	pCi/g, dry[a]	
			^{40}K	^{137}Cs
Oct 71	Jones Lake	1	15 ± 0.8	0.35 ± 0.05
Oct 72	DK-45 Lake	1	17 ± 1.3	8.20 ± 0.15
"	"	2	16 ± 1.0	1.13 ± 0.07
"	"	5	15 ± 1.3	7.85 ± 0.16
Apr 73	Jones Lake	2	16 ± 0.5	0.28 ± 0.03
"	Bridge Cr	1	15 ± 0.9	0.13 ± 0.06
"	Silver Salmon Lk	4	16 ± 0.4	0.13 ± 0.02
May 74	Jones Lake	5	14 ± 1.7	0.28 ± 0.05
Aug 74	"	6	12 ± 1.4	0.23 ± 0.04
"	"	1	14 ± 0.6	0.06 ± 0.04
"	"	3	14 ± 0.4	0.23 ± 0.02
"	Duck Cove	4	17 ± 0.5	0.35 ± 0.03
"	Cannikin Lk	9	14 ± 0.5	0.31 ± 0.03
Aug 75	Jones Lk	5	4.4 ± 0.9	0.10 ± 0.03
"	Cannikin Lk	6	12 ± 1.6	0.25 ± 0.05
"	Bridge Cr	1	16 ± 2.2	0.33 ± 0.07
"	Duck Cove Cr	3	14 ± 1.7	0.10 ± 0.04
"	Clevenger Cr	4	13 ± 1.7	0.05 ± 0.04
Aug 76	Cannikin Lk	2	14 ± 0.5	0.19 ± 0.03
"	Jones Lk	9	15 ± 0.4	0.22 ± 0.02
"	Duck Cove	6	15 ± 1.8	0.10 ± 0.04
Sept 77	Clevenger Lk	2	15 ± 2.6	0.08 ± 0.05
"	Jones Lk	3	12 ± 3.1	0.41 ± 0.13
"	Duck Cove	1	16 ± 4.9	0.32 ± 0.15
Aug 78	Jones Lk	3	13 ± 2.5	0.16 ± 0.07
"	Cannikin Lk	5	13 ± 2.5	0.21 ± 0.07
"	Duck Cove	3	15 ± 1.8	0.51 ± 0.04
"	Clevenger Cr	4	14 ± 1.8	0.04 ± 0.04

Table 13, cont'd

Collection date	Location	n[b]	pCi/g, dry[a] ^{40}K	^{137}Cs
Oct 79	Jones Lk	4	17 ± 1.2	1.92 ± 0.08
"	Cannikin Lk	5	15 ± 2.6	0.35 ± 0.09
"	Clevenger Lk	3	15 ± 2.6	0.06 ± 0.09

[a]Error values are two-sigma propagated counting errors.

[b]Number of fish that were pooled to form sample.

Table 14. Gamma-emitting radionuclides in freshwater samples collected on Amchitka Island following the Cannikin detonation.

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a]				
			^{7}Be	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs	^{144}Ce
Jones Lake							
Dec 71	277	Part.	0.4 ±0.1	--	--	0.02 ±0.01	NA
Dec 71	277	Sol.	6.4 ±3.6	0.34 ±0.16	0.75±0.34	0.23 ±0.20	NA
Feb 72	109	Part.	0.7 ±0.4	0.02 ±0.01	0.04±0.02	--	NA
Feb 72	109	Sol.	--	0.02 ±0.01	0.03±0.01	--	NA
Apr 72	251	Part.	--	0.02 ±0.01	0.05±0.03	--	NA
Apr 72	251	Sol.	--	--	--	--	NA
Jul 72	79	Part.	--	--	--	--	NA
Jul 72	79	Sol.	--	--	--	--	NA
Sep 72	53	Part.	--	--	--	--	NA
Sep 72	53	Sol.	--	--	--	--	NA
Apr 73	151	Part.	--	--	--	0.052±0.017	NA
Apr 73	151	Sol.	--	--	--	--	NA
Aug 73	193	Part.	--	--	--	0.031±0.008	NA
Aug 73	193	Sol.	--	--	--	--	NA
May 74	53	Part.	--	0.084±0.062	0.19±0.06	0.039±0.029	0.44±0.14
May 74	53	Sol.	--	--	--	--	--
Aug 74	413	Part.	--	--	--	--	--
Aug 74	413	Sol.	--	--	--	--	--
Aug 75	56	Entire	1.1 ±0.3	--	0.05±0.03	0.12 ±0.03	--
Aug 76	50	Entire	1.9 ±0.5	--	--	0.08 ±0.04	--
Sep 77	50	Entire	1.6 ±0.6	0.29 ±0.09	0.42±0.09	0.13 ±0.04	0.44±0.17
Aug 78	50	Entire	--	--	--	0.11 ±0.05	0.23±0.22
Sep 79	50	Entire	--	--	--	0.09 ±0.02	--
Lake DK-45							
Dec 71	98	Part.	0.43±0.35	0.01 ±0.01	0.02±0.01	--	NA
Dec 71	98	Sol.	--	--	--	--	NA
Feb 72	375	Part.	0.36±0.14	0.02 ±0.01	0.05±0.01	0.02 ±0.01	NA
Feb 72	375	Sol.	20 ±7.8	--	--	--	NA

Table 14, cont'd

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a]				
			^{7}Be	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs	^{144}Ce
Apr 72	152	Part.	--	0.11 ±0.03	0.23±0.07	0.35 ±0.02	NA
Apr 72	152	Sol.	--	--	--	--	NA
Jul 72	79	Part.	--	0.22 ±0.05	0.47±0.13	--	NA
Jul 72	79	Sol.	--	--	--	--	NA
Oct 72	38	Part.	--	--	--	--	NA
Oct 72	38	Sol.	--	--	--	--	NA
Apr 73	114	Part.	--	--	--	0.11 ±0.025	NA
Apr 73	114	Sol.	--	--	--	--	NA
Aug 73	106	Part.	--	--	--	0.038±0.015	NA
Aug 73	106	Sol.	--	--	--	--	NA
Aug 79	174	Part.	--	--	--	--	NA
Aug 79	174	Sol.	--	--	--	--	NA
Cannikin Lake							
Feb 72	8	Part.	--	0.33 ±0.14	0.68±0.29	--	NA
Apr 72	10	Part.	--	--	--	--	NA
Apr 73	72	Part.	--	--	--	0.080±0.022	NA
Apr 73	72	Sol.	--	--	--	--	NA
Aug 73	95	Part.	--	--	--	--	NA
Aug 73	95	Sol.	--	--	--	0.16 ±0.09	NA
May 74	314	Part.	--	0.20 ±0.04	0.25±0.03	0.019±0.013	0.41±0.07
May 74	314	Sol.	--	--	--	--	--
Aug 74	99	Part.	--	--	--	--	--
Aug 74	99	Sol.	--	--	--	--	--
Aug 75	53	Entire	--	--	--	0.21 ±0.04	--
Aug 76	50	Entire	--	--	--	0.10 ±0.04	0.24±0.15
Sep 77	50	Entire	0.93±0.78	--	0.46±0.13	0.10 ±0.06	0.35±0.25
Aug 78	50	Entire	--	--	--	0.05 ±0.03	--
Sep 79	50	Entire	--	--	--	0.05 ±0.02	--

Table 14, cont'd

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a] ^{7}Be	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs	^{144}Ce
Heart Lake							
Aug 75	52	Entire	2.3 ±0.4	0.09 ±0.05	0.15±0.04	0.25 ±0.04	0.24±0.11
Aug 76	48	Entire	1.9 ±0.5	--	--	0.13 ±0.05	--
Sep 77	50	Entire	--	--	--	--	0.90±0.30
Aug 78	50	Entire	1.8 ±1.3	--	--	0.10 ±0.04	--
Sep 79	50	Entire	2.6 ±1.0	--	--	0.14 ±0.02	--
Long Shot Mud Pit No. 1							
Dec 71	66	Part.	3.2 ±1.0	0.06 ±0.03	0.13±0.008	--	NA
Dec 71	66	Sol.	--	--	--	--	NA
Feb 72	125	Part.	1.2 ±0.1	0.06 ±0.03	0.14±0.04	--	NA
Feb 72	125	Sol.	2.2 ±1.5	--	--	--	NA
Apr 72	29	Part.	--	0.58 ±0.14	1.2 ±0.3	0.16 ±0.14	NA
Apr 72	29	Sol.	--	--	--	--	NA
Jul 72	34	Part.	1.4 ±0.5	0.55 ±0.16	0.93±0.15	--	NA
Jul 72	34	Sol.	--	--	--	--	NA
Sep 72	28	Part.	--	--	--	--	NA
Sep 72	28	Sol.	--	--	--	--	NA
Apr 73	31	Part.	2.7 ±1.9	--	--	0.08 ±0.03	NA
Apr 73	31	Sol.	--	--	--	--	NA
Aug 73	38	Part.	1.3 ±0.7	--	--	--	NA
Aug 73	38	Sol.	--	--	--	--	NA
May 74	48	Part.	4.0 ±0.7	1.3 ±0.1	2.7 ±0.2	0.034±0.028	4.9 ±0.3
May 74	48	Sol.	--	--	--	--	--
Aug 74	189	Part.	0.7 ±0.2	0.06 ±0.03	0.14±0.02	--	--
Aug 74	189	Sol.	--	--	0.21±0.10	--	--
Aug 75	50	Entire	1.2 ±0.3	--	--	0.08 ±0.03	--
Aug 76	52	Entire	1.3 ±0.4	--	--	0.05 ±0.03	--
Sep 77	50	Entire	1.7 ±0.8	0.44 ±0.14	0.91±0.19	0.14 ±0.06	0.31±0.24
Aug 78	50	Entire	1.3 ±1.2	--	--	0.12 ±0.05	--
Sep 79	50	Entire	--	--	--	0.03 ±0.02	--

Table 14, cont'd

Location and date	Liters sampled	Fraction[b]	Gamma-emitting radionuclides (pCi/liter)[a] ^{7}Be	^{95}Zr[c]	^{95}Nb[c]	^{137}Cs	^{144}Ce
Constantine Springs							
Sep 77	50	Entire	--	--	--	--	--
Aug 78	50	Entire	0.75±0.62	--	--	0.05 ±0.03	--
Sep 79	50	Entire	--	--	--	--	--
Long Lake							
Sep 77	50	Entire	1.1 ±0.7	0.55 ±0.15	0.61±0.14	0.11 ±0.06	0.41±0.24
Aug 78	50	Entire	--	--	--	0.10 ±0.05	0.30±0.20
Sep 79	50	Entire	--	--	--	0.05 ±0.02	--
Sand Beach Cove Seepage							
Sep 77	34	Entire	1.1 ±1.0	0.30 ±0.29	0.33±0.14	--	--
Rainwater							
Sep 77	50	Entire	28.0 ±1.5	4.9 ±0.2	9.4 ±0.3	0.40 ±0.06	2.8 ±0.3
Aug 78	50	Entire	3.3 ±2.2	0.24 ±0.23	0.28±0.23	0.41 ±0.06	3.7 ±0.26
Sep 79	50	Entire	14.0 ±1.4	--	--	0.12 ±0.02	0.27±0.06

[a]Error values are two-sigma, propagated counting errors. Dashes in the table indicate that the sample counts are less than the counting error; NA = not analyzed.

[b]Part. (particulate) refers to material retained on a 0.3-micron filter; Sol. (soluble) is what passes through the filter and is adsorbed on Al_2O_3. Entire means the sample was reduced by evaporation and not filtered.

[c]Samples collected prior to July 1972 were counted on NaI detectors and ^{95}Zr and ^{95}Nb values were calculated as discussed in text. Samples collected after July 1972 were counted on Ge(Li) detectors.

Table 15. Gamma-emitting radionuclides in the freshwater moss *Fontinalis* collected at Amchitka Island.

Location and Date	Gamma-Emitting Radionuclides (pCi/g,dry)[a]						
	^{40}K	^{60}Co	$^{95}Zr-^{95}Nb$	^{103}Ru	$^{106}Ru-^{106}Rh$	^{125}Sb	^{137}Cs
Pre-Cannikin							
Clevenger Creek							
September 1970	9.2 ± 1.4	0.11 ± 0.08	5.2 ± 0.3	1.7 ± 0.3	------	2.4 ± 0.6	8.3 ± 0.3
February 1971	1.3 ± 0.7	0.06 ± 0.04	1.5 ± 0.1	1.1 ± 0.2	1.4 ± 0.5	0.9 ± 0.2	2.2 ± 0.1
May 1971	8.6 ± 1.6	0.15 ± 0.09	11.5 ± 0.5	3.3 ± 0.9	3.8 ± 1.2	2.9 ± 0.6	4.1 ± 0.2
November 1971	6.7 ± 1.1	0.14 ± 0.06	4.4 ± 0.2	2 ± 0.4	2 ± 0.7	2.1 ± 0.4	4 ± 0.2
Bridge Creek							
February 1971	4.9 ± 1.3	0.19 ± 0.07	3.4 ± 0.2	1.6 ± 0.3	2.2 ± 0.8	1.1 ± 0.4	2.8 ± 0.1
May 1971	11 ± 0.2	0.15 ± 0.09	13.8 ± 0.5	3.7 ± 1	6.1 ± 1.4	3.2 ± 0.7	7.4 ± 0.3
November 1971	5.5 ± 0.6	0.91 ± 0.04	3.2 ± 0.1	1.1 ± 0.3	1.8 ± 0.4	1.1 ± 0.2	2.1 ± 0.1
Duck Cove Creek							
February 1971	3.3 ± 0.7	0.06 ± 0.04	2.2 ± 0.1	1.9 ± 0.3	0.6 ± 0.5	1.3 ± 0.3	1.3 ± 0.1
May 1971	7.6 ± 1.3	0.14 ± 0.07	10.2 ± 0.4	3.1 ± 0.5	2.9 ± 1.1	2.5 ± 0.5	3.2 ± 0.2
November 1971	8.4 ± 0.7	0.05 ± 0.04	2.5 ± 0.1	1.2 ± 0.3	1.5 ± 0.5	2 ± 0.2	3.1 ± 0.1

Table 15, cont'd

Location and Date	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Post-Cannikin										
Clevenger Creek										
December 1971	3.8 ± 1.1	6.6 ± 0.5	0.3 ± 0.1	0.6 ± 0.1	---	1.5 ± 0.3	0.9 ± 0.2	3.6 ± 0.1	---	---
February 1972	9.9 ± 2.1	5.1 ± 0.8	0.5 ± 0.1	1.2 ± 0.2	0.81 ± 0.4	1.2 ± 0.6	---	1.7 ± 0.1	---	---
April 1972	---	9.3 ± 0.3	1.0 ± 0.4	5.3 ± 1.0	---	---	---	1.3 ± 0.2	3.5 ± 0.5	---
July 1972	---	3.7 ± 1.7	0.9 ± 0.3	2.4 ± 0.4	0.46 ± 0.2	---	---	0.6 ± 0.1	2.0 ± 0.3	---
October 1972	---	6.2 ± 0.9	0.3 ± 0.1	0.7 ± 0.2	2.1 ± 1.5	---	---	2.5 ± 0.1	---	---
April 1973	5.2 ± 1.1	5.5 ± 1.0	---	---	---	0.87 ± 0.33	0.25 ± 0.08	3.0 ± 0.1	1.1 ± 0.02	0.22 ± 0.07
August 1973	3.7 ± 0.7	5.2 ± 1.1	---	0.29 ± 0.07	0.14 ± 0.09	0.61 ± 0.38	0.21 ± 0.09	1.5 ± 0.1	0.58 ± 0.15	0.22 ± 0.07
May 1974	17 ±11	3.9 ± 1.8	2.4 ± 1.2	3.4 ± 0.8	---	3.1 ± 0.9	0.55 ± .16	1.2 ± 0.1	2.8 ± 0.3	0.26 ± .10
August 1974	4.3 ± 1.9	5.7 ± 1.4	0.7 ± 0.3	1.5 ± 0.2	---	2.5 ± 0.5	0.31 ± .10	1.5 ± 0.1	3.9 ± 0.3	0.27 ± .06
August 1975	4.2 ± 2.0	6.3 ± 1.4	---	0.44 ± 0.18	---	0.88 ± 0.47	0.17 ± .09	0.7 ± 0.1	2.3 ± 0.3	0.08 ± .06
August 1976	6.8 ± 2.2	11.0 ± 1.6	---	---	0.62 ± 0.38	---	0.11 ± 0.11	0.7 ± 0.09	0.75 ± 0.25	0.14 ± 0.06
August 1976	2.3 ± 1.5	5.4 ± 1.5	---	---	---	0.46 ± 0.36	---	0.8 ± 0.07	0.33 ± 0.2	---
August 1976	3.0 ± 2.3	11.0 ± 1.7	---	---	---	---	---	2.1 ± 0.12	0.47 ± 0.22	---
April 1977	20.1 ± 1.3	5.5 ± 1.4	1.5 ± 0.15	3.0 ± 0.19	1.2 ± 0.15	0.78 ± 0.43	0.23 ± 0.12	2.9 ± 0.13	1.5 ± 0.21	0.28 ± 0.09
May 1977	12.0 ± 7.7	4.6 ± 1.6	2.3 ± 0.94	3.7 ± 0.91	---	1.4 ± 0.83	---	1.7 ± 0.17	1.1 ± 0.44	---
August 1977	---	4.8 ± 2.3	0.8 ± 0.37	1.6 ± 0.40	---	---	0.28 ± 0.15	0.8 ± 0.12	2.2 ± 0.40	0.18 ± 0.14
September 1977	---	3.6 ± 2.7	---	1.2 ± 0.36	---	---	0.28 ± 0.19	0.8 ± 0.14	2.1 ± 0.48	---
September 1977	---	3.9 ± 2.3	---	1.6 ± 0.47	---	0.92 ± 0.84	---	0.4 ± 0.13	2.5 ± 0.56	---
September 1977	3.9 ± 1.8	7.7 ± 2.7	---	1.3 ± 0.28	---	---	---	1.0 ± 0.14	1.4 ± 0.37	---
February 1978	7.0 ± 5.8	4.4 ± 1.4	---	1.2 ± 0.42	---	1.6 ± 0.58	0.18 ± 0.11	1.8 ± 0.11	2.9 ± 0.32	---
May 1978	3.2 ± 2.4	6.2 ± 1.5	0.5 ± 0.26	0.6 ± 0.22	---	2.2 ± 0.51	0.27 ± 0.10	2.8 ± 0.13	3.4 ± 0.28	---
August 1978	---	6.4 2.0	---	---	---	1.2 ± 0.65	0.17 ± 0.14	0.92 ± 0.15	1.2 ± 0.36	---
August 1978	3.2 ± 1.1	6.2 ± 2.4	0.2 ± 0.22	0.2 ± 0.12	---	2.6 ± 0.83	---	0.93 ± 0.14	2.3 ± 0.39	0.22 ± 0.16
August 1978	3.0 ± 1.0	4.9 ± 2.5	---	0.1 ± 0.11	---	1.5 ± 0.74	---	1.3 ± 0.16	2.0 ± 0.37	0.18 ± 0.15
November 1978	4.7 ± 1.3	4.4 ± 2.0	---	---	---	1.4 ± 0.58	---	1.7 ± 0.13	1.2 ± 0.33	0.13 ± 0.12
September 1979	4.0 ± 0.34	7.2 ± 0.36	---	---	---	0.7 ± 0.13	---	1.4 ± 0.03	0.76 ± 0.08	---
September 1979	1.8 ± 0.23	7.2 ± 0.32	---	---	---	---	---	1.8 ± 0.03	0.15 ± 0.06	---
September 1979	5.0 ± 0.29	5.7 ± 0.31	---	---	---	0.54 ± 0.14	---	1.4 ± 0.03	0.95 ± 0.08	---

Table 15, cont'd

Location and Date	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{45}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{135}Eu
Post-Cannikin										
Bridge Creek										
December 1971	5.6 ± 1.5	7.50 ± 0.4[f]	0.7 ± 0.1	1.4 ± 0.2	0.6 ± 0.3	2.9 ± 0.4	1.3 ± 0.2	5.5 ± 0.1	---	---
February 1972	9.0 ± 1.2	5.2 ± 1.2	2.0 ± 0.3	4.4 ± 0.3	1.9 ± 0.2	---	---	3.5 ± 0.2	---	---
April 1972	9.2 ± 1.7	6.6 ± 0.9	0.7 ± 0.1	1.6 ± 0.2	---	2.0 ± 0.7	0.7 ± 0.3	2.8 ± 0.1	---	---
July 1972	2.8 ± 1.2	6.8 ± 0.9	1.1 ± 0.3	2.9 ± 0.4	0.3 ± 0.2	0.5 ± 0.3	---	2.2 ± 0.2	2.6 ±0.4	---
October 1972	4.6 ± 4.3	7.7 ± 0.7	0.3 ± 0.1	0.7 ± 0.1	---	---	---	2.7 ± 0.1	---	---
April 1973	6.1 ± 1.7	5.5 ± 1.4	---	---	---	---	0.27± 0.14	3.6 ± 0.2	1.4 ±0.2	0.21 ±0.10
August 1973	4.1 ± 1.0	6.0 ± 1.3	---	0.15± 0.11	---	---	---	0.97± 0.09	0.72±0.18	---
May 1974	5.2 ± 0.9	7.9 ± 1.6	2.1 ± 0.2	4.4 ± 0.2	0.24± 0.10	3.5 ± 0.6	0.33± .11	1.9 ± 0.1	4.5 ±0.3	0.18 ± .06
August 1974	3.6 ± 2.5	5.2 ± 1.8	1.0 ± 0.3	2.1 ± 0.3	---	2.3 ± 0.7	0.20± .15	1.0 ± 0.1	4.6 ±0.4	0.23 ± .09
August 1975	3.3 ± 2.2	5.8 ± 1.7	0.3 ± 0.3	0.6 ± 0.23	---	1.7 ± 0.7	0.25± .14	1.1 ± 0.1	3.1 ±0.4	0.10 ± .08
August 1976	5.6 ± 2.4	5.8 ± 1.2	---	0.19± 0.15	0.48± 0.45	0.78± 0.46	0.16± 0.08	1.4 ± 0.06	1.3 ±0.26	0.16± 0.06
August 1976	4.7 ± 2.1	6.2 ± 1.2	---	---	---	---	---	1.1 ± 0.10	0.49±0.23	---
April 1977	2.0 ± 1.6	5.5 ± 1.2	1.2 ± 0.16	2.6 ± 0.20	1.1 ± 0.16	0.71± 0.42	0.24± 0.12	5.1 ± 0.20	1.30±0.24	0.14± 0.07
May 1977	11.9 ± 9.3	5.7 ± 1.8	---	2.3 ± 0.82	---	0.92± 0.78	0.33± 0.16	2.3 ± 0.20	1.50±0.46	0.16± 0.10
August 1977	3.9 ± 3.3	2.3 ± 1.7	1.5 ± 0.43	3.0 ± 0.50	0.53± 0.49	2.0 ± 0.77	0.38± 0.18	2.7 ± 0.22	3.0 ±0.47	0.14± 0.1
September 1977	---	5.9 ± 2.9	---	1.6 ± 0.40	---	2.2 ± 0.93	---	1.3 ± 0.16	2.2 ±0.46	---
September 1977	3.3 ± 2.7	---	1.4 ± 0.37	3.9 ± 0.46	---	2.2 ± 0.83	0.26± 0.16	1.9 ± 0.17	3.1 ±0.41	0.24± 0.20
September 1977	3.7 ± 1.9	7.9 ± 2.0	---	1.4 ± 0.29	---	0.8 ± 0.69	---	1.7 ± 0.18	1.6 ±0.38	---
February 1978	---	3.0 ± 1.1	---	1.3 ± 0.50	---	2.6 ± 0.65	0.28± 0.14	3.2 ± 0.17	4.2 ±0.43	0.19± 0.07
May 1978	11.2 ± 2.7	6.1 ± 1.6	0.9 ± 0.29	1.4 ± 0.27	0.65± 0.53	4.7 ± 0.72	0.44± 0.11	1.4 ± 0.10	5.0 ±0.34	0.14± 0.11
August 1978	2.6 ± 1.2	7.2 ± 2.2	---	0.3 ± 0.12	---	2.0 ± 0.86	---	1.3 ± 0.18	2.5 ±0.44	---
August 1978	1.5 ± 0.7	4.7 ± 1.4	---	0.3 ± 0.09	---	1.8 ± 0.52	0.21± 0.10	1.1 ± 0.11	4.0 ±0.33	0.13± 0.06
August 1978	3.0 ± 0.9	4.6 ± 1.8	---	0.3 ± 0.10	---	2.0 ± 0.68	0.28± 0.14	1.0 ± 0.13	3.3 ±0.39	---
November 1978	3.7 ± 1.3	5.6 ± 1.6	---	---	---	1.4 ± 0.58	---	1.7 ± 0.16	1.9 ±0.33	0.11± 0.07
September 1979	4.6 ± 0.54	5.9 ± 0.73	---	---	---	---	---	1.0 ± 0.04	0.76±0.13	---
September 1979	4.2 ± 0.52	6.8 ± 0.74	---	0.08± 0.09	---	---	---	1.8 ± 0.06	0.55±0.13	---
September 1979	3.7 ± 1.4	7.7 ± 1.5	---	---	---	---	---	1.9 ± 0.07	---	---

Table 15, cont'd

Location and Date	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Post-Cannikin										
Duck Cove Creek										
December 1971	7.3 ± 1.3	6.8 ± 0.5	0.4 ± 0.1	0.9 ± 0.1	---	2.4 ± 0.4	1.7 ± 0.2	2.9 ± 0.1	---	---
February 1972	14 ± 4	6.0 ± 1.0	0.7 ± 0.1	1.4 ± 0.3	1.9 ±0.7	1.4 ± 0.8	1.2 ± 0.4	0.8 ± 0.1	---	---
April 1972	7.9 ± 2.1	4.8 ± 0.9	0.6 ± 0.1	1.3 ± 0.2	---	1.9 ± 0.3	0.9 ± 0.3	1.4 ± 0.1	---	---
July 1972	2.6 ± 1.0	6.3 ± 0.8	0.8 ± 0.3	2.6 ± 0.4	0.2 ±0.2	0.5 ± 0.1	0.4 ± 0.1	1.0 ± 0.1	1.6 ± 0.1	---
October 1972	---	6.4 ± 0.9	0.2 ± 0.1	0.5 ± 0.1	2.4 ±1.2	---	1.4 ± 0.4	2.4 ± 0.1	---	---
April 1973	12 ± 1.5	6.6 ± 1.2	---	---	---	1.3 ± 0.4	0.48± 0.09	1.6 ± 0.1	1.8 ± 0.2	0.18 ± 0.09
August 1973	2.1 ± 0.7	6.1 ± 1.5	---	---	---	---	0.15± 0.13	0.89± 0.11	---	---
May 1974	7.4 ± 1.0	5.4 ± 1.2	1.6 ± 0.2	3.5 ± 0.2	0.36±0.11	3.4 ± 0.6	0.53± .13	2.2 ± 0.1	5.7 ± 0.3	1.16 ± .05
August 1974	1.4 ± 0.8	6	---	0.21± 0.08	---	0.29± 0.19	---	0.8 ± 0.1	0.34± 0.1	---
August 1975	1.9 ± 1.2	5.4 ± 1.1	0.2 ± 0.2	0.65± 0.15	---	0.69± 0.44	0.26± .09	0.8 ± 0.1	2.4 ± 0.26	0.09 ± .05
August 1976	4.7 ± 2.2	7.0 ± 1.3	---	---	---	---	0.18± 0.08	1.4 ± 0.11	---	---
September 1977	---	3.6 ± 2.1	---	1.1 ± 0.42	---	---	---	1.0 ± 0.16	1.5 ± 0.44	---
August 1978	2.9 ± 0.9	4.1 ± 2.0	---	0.14± 0.09	---	0.9 ± 0.6	---	0.86± 0.11	1.1 ± 0.28	---
September 1979	1.8 ± 0.7	7.6 ± 0.8	---	---	---	0.5 ± 0.25	---	0.66± 0.05	---	---
Long Shot Drainage										
August 1975	4.4 ± 1.2	4.0 ± 1.3	0.2 ± 0.1	0.61± 0.13	---	2.3 ± 0.4	0.27± 0.1	1.2 ± 0.1	3.2 ± 0.2	0.2 ± .08
August 1976	4.7 ± 1.6	5.3 ± 1.2	---	---	---	---	0.12± .09	0.7 ± 0.1	0.26± 0.21	0.10 ± .05
September 1977	4.2 ± 2.9	4.8 ± 2.7	---	0.58± 0.30	---	---	---	0.7 ± 0.14	0.60± 0.39	---
September 1977	4.1 ± 1.8	4.8 ± 2.4	0.8 ± 0.26	1.6 ± 0.29	---	1.3 ± 0.7	---	0.7 ± 0.12	2.2 ± 0.38	---
August 1978	2.3 ± 1.0	7.0 ± 2.6	---	0.21± 0.11	---	2.1 ± 0.77	0.4 ± 0.16	0.93± 0.14	2.6 ± 0.39	---
August 1978	2.2 ± 0.63	4.4 ± 1.3	---	0.14± 0.07	0.11±0.07	0.60± 0.40	0.14± 0.09	1.6 ± 0.12	1.3 ± 0.23	0.10 ± 0.05
October 1979	5.3 ± 1.4	8.1 ± 1.5	---	---	---	---	---	0.87± 0.06	1.3 ± 0.26	---
October 1979	16.9 ± 1.1	4.9 ± 0.9	---	---	---	---	---	0.11± 0.04	1.0 ± 0.19	---
September 1979	---	9.7 ± 1.5	---	---	---	---	---	0.76± 0.05	---	---

Table 15, cont'd

Location and Date	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{70}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Post-Cannikin										
MP 12 Creek										
April 1973	15 ± 1.9	6.1 ± 1.6	---	0.33 ± 0.13	---	1.3 ±0.4	0.24 ± 0.10	2.8 ± 0.1	1.9 ± 0.2	0.17 ± 0.06
August 1973	2.9± 1.0	3.3 ± 1.3	---	---	---		---	1.1 ± 0.1	0.83± 0.20	---
May 1974	13 ± 1.0	6.0 ± 1.1	1.4± 0.13	3.4 ± 0.18	0.20± 0.05	4.1 ±0.6	0.23 ± .10	2.1 ± 0.1	6.0 ± 0.3	0.16 ± .04
August 1974	4.5± 2.0	5.8 ± 1.2	0.8± 0.3	1.3 ± 0.3	---	1.9 ±0.6	---	0.7 ± 0.1	3.9 ± 0.3	0.13 ± .06
August 1975	6.5± 1.8	4.5 ± 1.7	0.3± 0.2	0.67 ± 0.18	---	2.7 ±0.7	---	0.5 ± 0.1	5.2 ± 0.3	0.21 ± .11
August 1976	8.7± 1.9	5.3 ± 1.5	0.3± 0.28	---	---	1.6 ±0.47	0.14 ± 0.10	0.9 ± 0.08	1.7 ± 0.24	0.16 ± 0.09
September 1977	5.9± 4.1	6.4 ± 2.6	1.2± 0.53	3.4 ± 0.62	---	2.8 ±1.0	---	1.0 ± 0.15	4.4 ± 0.52	---
August 1978	6.6± 1.4	5.6 ± 2.0	---	0.32 ± 0.14	0.12± 0.11	4.3 ±1.1	---	1.1 ± 0.16	7.1 ± 0.61	---
Ice Box Lake Inlet										
April 1973	4.7± 1.3	6.4 ± 1.4	---	---	---	0.50±0.34	0.24 ± 0.07	1.1 ± 0.1	0.95± 0.17	0.11 ± 0.05
August 1973	3.5± 0.7	5.0 ± 1.4	---	0.15 ± 0.06	---	0.50±0.32	0.32 ± 0.07	1.9 ± 0.1	0.78± 0.16	0.23 ± 0.05
May 1974	3.7± 0.6	5.0 ± 1.0	0.70± .09	1.2 ± 0.11	---	1.0 ±0.4	0.20 ± .09	3.1 ± 0.1	2.4 ± .21	0.13 ± .04
August 1974	2.3± 0.8	5.9 ± 0.5	0.17± .14	0.6 ± 0.1	---	0.0 ±0.3	0.23 ± .08	1.0 ± 0.1	1.6 ± .2	---
August 1975	---	4.7 ± 1.3	---	0.27 ± 0.16	---	0.7 ±0.5	0.20 ± .11	1.3 ± 0.1	1.8 ± .3	0.09 ± .07
August 1976	6.2± 2.3	4.7 ± 1.4	---	---	---	---	0.16 ± .09	1.1 ± 0.09	0.75± .23	0.18 ± 0.09
August 1976	5.2± 2.0	4.2 ± 1.2	---	---	---	0.6 ±0.43	0.17 ± .08	1.1 ± 0.1	0.88± .25	0.08 ± 0.06
August 1976	2.8± 1.8	3.2 ± 1.4	0.45± .29	---	---	---	0.30 ± .09	1.9 ± 0.1	0.63± .21	0.12 ± .09
September 1977	3.0± 2.9	4.0 ± 2.0	---	1.13 ± 0.30	---	0.64±0.57	---	1.9 ± 0.1	1.24± .30	---
September 1977	---	6.7 ± 2.9	---	2.7 ± 0.78	1.4 ± 0.97	1.9 ±1.3	---	1.6 ± 0.24	4.3 ± 0.74	---
September 1977	---	3.7 ± 2.7	---	1.9 ± 0.41	---	---	---	0.63 ± 0.13	2.1 ± 0.46	---
August 1978	1.7± 0.66	6.8 ± 1.8	---	---	---	1.1 ±0.45	0.14 ± 0.10	0.93 ± 0.09	2.1 ± 0.24	0.13 ± 0.10
August 1978	2.7± 1.4	5.6 ± 2.7	---	1.4 ± 1.2	---	1.5 ±0.84	---	0.60 ± 0.12	2.6 ± 0.42	---
August 1978	1.5± 1.0	---	---	---	---	---	---	0.92 ± 0.14	1.2 ± 0.27	---
September 1979	---	8.8 ± 1.6	---	---	---	---	---	0.73 ± 0.06	0.95± 0.26	---
September 1979	2.5± 0.28	7.4 ± 0.03	---	---	---	---	---	0.60 ± 0.02	0.42± 0.05	---
September 1979	2.0± 0.8	3.7 ± 0.9	---	---	---	---	---	0.70 ± 0.05	---	---

Table 15, cont'd

Location and Date	Gamma-Emitting Radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Post-Cannikin										
Cannikin Lake Outlet										
April 1973	6.9 ± 1.4	6.7 ± 1.6	---	---	---	---	0.17 ± 0.10	0.67 ± 0.07	0.89 ± 0.21	---
August 1973[b]	7.6 ± 1.0	5.7 ± 1.4	0.32 ± .15	0.17 ± 0.06	0.13 ± 0.12	1.1 ± 0.4	0.42 ± 0.09	7.2 ± 0.2	1.4 ± 0.2	0.29 ± 0.05
May 1974	10 ± 1.0	2.4 ± 0.6	1.2 ± .12	2.7 ± 0.15	0.24 ± .13	2.2 ± 0.3	0.29 ± .05	1.1 ± 0.1	6.3 ± .2	0.13 ± .03
August 1974	---	4.2 ± 0.6	1.2 ± .15	2.3 ± 0.17	0.21 ± .11	2.6 ± 0.5	0.33 ± .12	1.6 ± 0.1	6.4 ± .3	---
August 1975	7.9 ± 1.9	5.1 ± 1.1	---	0.52 ± 0.16	---	1.8 ± 0.5	0.24 ± .09	2.0 ± 0.1	2.1 ± .3	---
August 1976	3.3 ± 1.9	3.5 ± 1.4	---	---	---	0.4 ± 0.4	0.16 ± 0.09	0.6 ± 0.07	---	0.09 ± 0.08
August 1976	4.5 ± 2.1	3.3 ± 1.4	---	---	---	---	---	1.4 ± 0.1	---	---
August 1976	3.6 ± 1.8	3.9 ± 1.4	---	---	0.46 ± 0.31	0.5 ± 0.4	---	1.0 ± 0.1	---	0.09 ± 0.09
September 1977	1.9 ± 4.5	3.6 ± 2.8	3.0 ± 0.55	6.5 ± 0.68	---	5.4 ± 1.3	---	0.90 ± 0.15	9.0 ± 0.70	0.37 ± 0.21
September 1977	19.7 ± 4.8	5.2 ± 2.4	3.0 ± 6.2	5.5 ± 0.78	---	2.1 ± 1.3	---	0.87 ± 0.17	9.7 ± 0.88	---
September 1977	19.8 ± 2.8	7.2 ± 2.3	3.4 ± 0.39	7.8 ± 0.55	0.66 ± 0.35	4.4 ± 0.94	2.3 ± 0.20	1.3 ± 0.14	8.3 ± 0.53	---
August 1978	10.5 ± 1.1	3.9 ± 1.2	---	0.17 ± 0.07	---	1.4 ± 0.46	0.21 ± 0.09	1.8 ± 0.13	3.5 ± 0.30	0.08 ± 0.06
August 1978	17.4 ± 2.3	3.0 ± 1.8	---	0.18 ± 0.15	---	2.3 ± 0.88	0.35 ± 0.15	0.89 ± 0.16	5.1 ± 0.56	---
August 1978	9.6 ± 2.0	2.7 ± 1.9	---	0.23 ± 0.16	---	1.4 ± 0.53	0.18 ± 0.12	1.2 ± 0.10	2.2 ± 0.28	0.18 ± 0.11
September 1979	14.0 ± 1.3	7.4 ± 0.9	---	---	---	---	---	0.5 ± 0.05	---	---
September 1979	14.1 ± 0.7	2.3 ± 0.7	---	---	---	0.42 ± 0.27	---	0.76 ± 0.04	0.55 ± 0.13	---
September 1979	13.5 ± 1.0	3.7 ± 0.4	---	---	---	0.38 ± 0.15	---	0.67 ± 0.03	0.35 ± 0.09	---
Falls Creek										
April 1973	3.4 ± 1.4	4.8 ± 1.0	---	0.19 ± 0.11	---	0.65 ± 0.34	0.23 ± 0.08	1.6 ± 0.1	1.0 ± 0.2	0.22 ± 0.08
August 1973	5.3 ± 0.8	6.0 ± 1.4	---	0.16 ± 0.07	0.15 ± 0.10	0.44 ± 0.30	0.20 ± 0.07	0.64 ± 0.05	0.90 ± 0.16	0.14 ± 0.05

a. Single sample error values are two-sigma, propagated, counting errors. Dashes in the body of the table indicate the sample count is less than the two-sigma, propagated counting error.

b. This sample was not completely washed and contained sediment which was not present in other <u>Fontinalis</u> samples. This sediment may have contributed to the higher than normal ^{137}Cs concentration in the sample.

Table 16. Gamma-emitting radionuclides in the freshwater plant Ranunculus collected at Amchitka Island.

	Gamma-emitting radionuclides (pCi/g, dry)[a]						
Location and date	^{40}K	^{60}Co	^{95}Zr-^{95}Nb	^{103}Ru	^{106}Ru-^{106}Rh	^{125}Sb	^{137}Cs
Pre-Cannikin							
Clevenger Creek							
Sep 70	22 ± 1	0.06 ± 0.04	2 ± 0.1	0.35 ± 0.08	--	0.2 ± 0.2	0.56 ± 0.05
Feb 71	24 ± 1	0.19 ± 0.08	1.6 ± 0.2	0.5 ± 0.4	2.4 ± 0.8	0.6 ± 0.4	1.4 ± 0.1
May 71	15 ± 0.2	0.19 ± 0.07	5.9 ± 0.3	1.2 ± 0.6	2.7 ± 0.8	2 ± 0.5	3.1 ± 0.2
Nov 71	24 ± 4	neg.	1.1 ± 0.6	1.9 ± 1.5	neg.	ns	1.7 ± 0.4
Bridge Creek							
Feb 71	13 ± 2	--	3.9 ± 0.3	2.6 ± 0.6	--	1.4 ± 0.7	3.2 ± 0.2
May 71	18 ± 2	--	5.8 ± 0.3	1.4 ± 0.6	1.7 ± 0.9	0.9 ± 0.4	3.2 ± 0.2
Nov 71	19 ± 1	--	2.6 ± 0.2	1.2 ± 0.5	1.1 ± 0.07	1.3 ± 0.4	2.9 ± 0.1
Clevenger Lake Outlet							
Sep 70	28 ± 1	--	2.4 ± 0.06	0.7 ± 0.08	--	0.5 ± 0.1	--
Nov 71	6.7 ± 1	--	1.4 ± 0.1	0.8 ± 0.3	--	0.4 ± 0.3	1.1 ± 0.1
Duck Cove Creek							
Feb 71	7.1 ± 0.8	--	1 ± 0.1	1.1 ± 0.2	--	0.6 ± 0.2	0.92 ± 0.06
May 71	15 ± 1	--	2.1 ± 0.2	--	0.9 ± 0.7	0.4 ± 0.3	1.3 ± 0.1
Nov 71	22 ± 1	--	1.7 ± 0.2	0.5 ± 0.4	1.1 ± 0.60	1.5 ± 0.3	1.7 ± 1

Table 16, cont'd

Location and date	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{7}Be	^{40}K	^{54}Mn	^{60}Co	^{95}Zr[c]	^{95}Nb[c]	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
Post-Cannikin											
Clevenger Creek											
Dec 71	—	16 ±0.8	—	0.06±0.05	0.1 ±0.1	0.3 ±0.1	0.7 ±0.5	—	0.6 ±0.2	1.8 ±0.1	NA
Feb 72	20 ±3	19 ±1.0	0.2 ±0.1	—	1.2 ±0.1	2.6 ±0.2	1.2 ±0.6	1.8 ±0.7	0.6 ±0.3	1.5 ±0.1	NA
Apr 72	4.9±1.4	16 ±0.7	0.09±0.04	0.04±0.04	0.4 ±0.1	0.9 ±0.2	0.8 ±0.3	—	1.3 ±0.2	2.7 ±0.1	NA
Jul 72	—	15 ±0.6	—	—	—	0.95±0.33	—	1.0 ±0.5	—	0.90±0.15	NA
Oct 72	—	15 ±3.4	—	—	0.12±0.06	0.20±0.15	—	—	—	1.2 ±0.1	—
Apr 73	3.8±1.4	24 ±2.3	—	—	—	—	—	—	—	1.1 ±0.1	—
Aug 73	—	19 ±1.9	—	—	—	—	—	—	—	0.43±0.07	—
May 74	3.1±0.6	24 ±1.6	0.80±0.10	1.8 ±0.1	0.12±0.08	1.0 ±0.4	0.14±0.09	0.87±0.07	2.3 ±0.2	—	—
Aug 74	1.4±1.4	15 ±1.3	—	—	—	—	—	0.24±0.07	0.5 ±0.3	—	—
Aug 75	—	19 ±2.3	—	—	—	—	—	0.52±0.09	0.34±0.3	—	—
Aug 76	2.0±1.3	20 ±1.9	—	—	—	—	0.3 ±0.3	—	—	0.38±0.06	—
Aug 76	1.5±1.3	16.0±1.7	—	—	—	—	—	—	—	0.54±0.07	—
Aug 76	—	16.0±1.8	—	—	—	—	—	—	—	0.25±0.05	—
Sep 77	—	19.0±3.0	—	—	—	0.42±0.23	—	—	—	0.19±0.07	0.45±0.31
Sep 77	—	20.0±3.0	—	—	—	0.58±0.28	—	—	—	0.40±0.10	0.51±0.32
Sep 77	—	26.0±4.7	—	—	—	—	—	—	—	0.42±0.14	0.11±0.54
Aug 78	—	17.0±4.3	—	—	—	—	—	—	—	0.77±0.17	0.55±0.45
Aug 78	—	16.0±3.7	—	—	—	—	—	—	—	0.57±0.16	—
Aug 78	—	14.0±2.7	—	—	—	—	—	—	—	0.58±0.12	0.98±0.30
Sep 79	—	21.0±1.3	—	—	—	—	—	—	—	0.54±0.04	—
Sep 79	—	15.0±1.6	—	—	—	—	—	—	—	0.21±0.06	—
Sep 79	—	14.0±0.5	—	—	—	—	—	—	—	0.53±0.02	—
Clevenger Lake Outlet											
Dec 71	2.8±1.1	11 ±0.5	0.1 ±0.03	0.06±0.03	0.32±0.06	0.69±0.13	—	1.7 ±0.4	0.3 ±0.2	1.2 ±0.1	NA
Feb 72	37 ±7	15 ±2	0.2 ±0.1	0.1 ±0.09	0.9 ±0.2	1.9 ±0.4	3.1 ±1.0	1.6 ±1.4	—	0.9 ±0.2	NA
Apr 72	9.4±1.6	14 ±0.8	0.07±0.05	—	0.5 ±0.1	1.0 ±0.2	—	1.1 ±0.6	0.4 ±0.3	1.2 ±0.1	NA
Jul 72	5.8±1.8	19 ±0.6	—	—	2.2 ±0.5	6.6 ±0.6	1.2 ±0.3	0.7 ±0.4	—	1.2 ±0.2	NA
Oct 72	6.1±1.7	34 ±3.1	—	—	—	2.4 ±0.5	0.3 ±0.2	1.0 ±0.6	—	1.1 ±0.1	NA
Aug 73	3.4±1.0	20 ±2.1	—	—	—	—	—	—	—	0.32±0.06	—
Aug 74	—	24 ±1.1	0.45±0.20	0.80±0.19	—	—	—	0.7 ±0.1	1.4 ±0.3	—	1.4 ±0.3
Aug 75	1.9±0.7	18 ±1.5	—	0.07±0.07	—	0.5 ±0.3	—	0.8 ±0.1	0.6 ±0.2	—	0.6 ±0.2

Table 16, cont'd

Location and date	Gamma-emitting radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Bridge Creek										
Dec 71	--	22 ±1	--	0.09±0.08	0.2 ±0.1	0.5 ±0.3	--	--	--	1.8 ±0.1
Feb 72	10 ±2	14 ±0.9	0.1±0.06	0.07±0.05	0.6 ±0.1	1.3 ±0.2	0.7 ±0.4	2.0 ±0.6	0.9 ±0.3	4.1 ±0.1
Apr 72	8.2±1.4	14 ±1	--	--	0.6 ±0.1	1.3 ±0.2	--	1.1 ±0.6	0.7 ±0.3	3.0 ±0.1
Jul 72	--	24 ±1.5	--	--	0.15±0.03	0.32±0.06	0.24±0.19	--	--	0.43±0.04
Oct 72	--	32 ±1.3	--	--	0.25±0.15	0.49±0.31	--	--	--	1.8 ±0.1
Apr 73	4.7±1.5	29 ±2.3	--	--	--	--	--	--	--	1.2 ±0.1
May 74	3.8±0.8	19 ±2.5	1.1±0.2	2.4 ±0.2	0.15±0.09	1.5 ±0.6	0.23±0.12	1.6 ±0.1	3.4 ±0.3	--
Aug 74	2.0±0.8	19 ±0.8	0.4±0.1	0.7 ±0.1	--	0.94±0.32	0.16±0.08	0.85±0.06	1.7 ±0.2	--
Aug 75	2.5±1.2	21 ±2.2	--	0.35±0.13	--	0.67±0.46	--	1.2 ±0.1	1.0 ±0.23	--
Aug 76	--	19.0±1.9	--	--	0.36±0.35	--	--	1.4 ±0.1	--	--
Aug 76	2.8±1.8	19.0±2.4	--	--	--	--	--	2.5 ±0.2	0.3 ±0.3	--
Aug 76	--	20.0±2.0	--	--	--	--	0.13±0.09	1.5 ±0.10	0.4 ±0.21	0.1 ±0.09
Sep 77	--	25.0±3.3	--	0.95±0.34	--	0.71±0.58	--	0.41±0.10	1.1 ±0.36	--
Sep 77	--	24.0±3.3	--	0.53±0.30	--	--	--	0.15±0.08	0.9 ±0.33	--
Aug 78	1.4±0.8	18.0±2.8	02 ±0.12	--	--	--	--	0.54±0.11	1.1 ±0.31	--
Aug 78	--	20.0±4.5	--	--	--	--	--	0.26±0.13	1.0 ±0.45	--
Sep 79	--	18.0±1.5	--	--	--	--	--	1.59±0.07	--	--
Sep 79	--	22.0±0.9	--	--	--	--	--	1.37±0.06	0.64±0.15	--
Sep 79	--	18.0±0.9	--	--	--	--	--	0.96±0.05	--	--
Duck Cove Creek										
Dec 72	2.0±1.1	26 ±0.5	--	--	0.25±0.06	0.52±0.13	0.4 ±0.3	0.7 ±0.3	0.7 ±0.1	1.7 ±0.1
Feb 72	21 ±3	17 ±0.8	0.1 ±0.06	0.1 ±0.05	0.8 ±0.1	1.8 ±0.2	1.6 ±0.5	2.0 ±0.7	1.1 ±0.3	2.5 ±0.1
Apr 72	8.1±1.6	18 ±0.8	0.1 ±0.05	--	0.4 ±0.1	0.8 ±0.2	0.6 ±0.3	1.3 ±0.5	0.9 ±0.2	1.0 ±0.1
Jul 72	--	23 ±0.5	--	--	0.45±0.24	1.2 ±0.3	--	0.33±0.19	--	0.4 ±0.1
Oct 72	--	14 ±0.7	--	--	0.19±0.05	0.4 ±0.1	--	--	0.5 ±0.3	2.2 ±0.1
Apr 73	6.0±1.5	20 ±1.5	--	--	--	--	--	--	0.26±0.09	2.9 ±0.1
May 74	3.1±0.7	14 ±1.5	0.46±0.09	1.2 ±0.01	0.16±0.08	0.81±0.36	--	4.0 ±0.02	1.8 ±0.2	--
Aug 74	--	21 ±2	--	0.47±0.19	--	--	--	0.67±0.08	0.78±0.22	--
Aug 75	--	13 ±1.8	--	--	--	0.63±0.43	--	1.6 ±0.13	0.85±0.24	--
Aug 76	3.5±2.9	18 ±2.3	--	--	--	--	--	1.5 ±0.1	0.25±0.24	--
Aug 78	--	12.0±2.4	--	--	--	--	0.2 ±0.1	0.11±0.12	0.61±0.25	--
Sep 79	--	21.0±1.0	--	--	--	--	--	0.43±0.04	--	--

Table 16, cont'd

Location and date	^{7}Be	^{40}K	^{95}Zr	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Long Shot Drainage										
Aug 75	5.3±2.4	19 ±3.0	--	0.42±0.26	--	1.3±0.8	--	1.0 ±0.1	1.4 ±0.4	--
Aug 76	3.5±2.0	29.0±2.3	--	--	--	--	--	0.82±0.09	0.4 ±0.2	--
Aug 76	--	22.0±2.0	--	--	--	--	--	0.43±0.02	--	--
Sep 77	--	18.0±2.8	0.72±0.50	0.91±0.31	--	--	--	0.69±0.11	0.87±0.3	--
Aug 78	9.8±1.0	15.0±1.9	--	0.20±0.07	--	2.0±0.5	0.29±0.1	0.29±0.05	2.6 ±0.2	--
Aug 78	2.0±0.7	20.0±2.1	--	0.12±0.08	--	2.0±0.5	--	0.80±0.09	1.9 ±0.3	--
Aug 78	1.1±0.9	15.0±2.7	--	--	--	--	--	0.62±0.10	1.1 ±0.3	--
Oct 79	9.9±0.62	13.0±0.5	--	--	--	--	--	0.26±0.02	0.91±0.09	--
Oct 79	--	25.0±0.8	--	--	--	--	--	0.61±0.04	--	--
Oct 79	--	24.0±0.62	--	--	--	--	--	0.73±0.03	--	--
Cannikin Lake Outlet										
May 74	13 ±1.2	17 ±1.8	1.6 ±0.2	3.9 ±0.2	0.45±0.13	3.4±0.6	--	1.3 ±0.1	6.4 ±0.3	0.20±0.06
Aug 74	3.5±1.3	28 ±3.3	0.31±0.19	0.60±0.16	--	1.2±0.8	--	1.4 ±0.1	2.0 ±0.3	--
Aug 75	2.3±0.9	10 ±1.5	--	0.18±0.09	--	--	0.22±0.1	2.9 ±0.2	1.5 ±0.2	0.14±0.06
Aug 76	--	11 ±1.9	--	--	--	--	--	1.8 ±0.1	--	--

[a]Single sample error values are two-sigma, propagated counting errors. Dashes in the body of the table indicate the sample count is not significant, i.e., the net sample count is less than the two-sigma, propagated counting error.

Table 17. Some gamma-emitting radionuclides in freshwater aufwuchs and filamentous algae collected at Amchitka Island.[a]

Location and date	Radionuclides (pCi/g, dry)[b]								
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
Long Shot Pond									
Dec 71	--	12 ±0.2	--	--	--	--	0.4 ±0.2	0.6 ±0.2	2.2 ±0.5
Feb 72	7.4±1.1	8.4 ±1.5	1.4 ±0.2	3.7 ±0.4	1.2 ±0.2	--	0.2 ±0.1	0.5 ±0.1	3.4 ±0.4
Apr 72	2.5±2.0	9.9 ±0.9	0.2 ±0.1	0.4 ±0.3	--	--	0.5 ±0.3	0.5 ±0.1	--
Jul 72	6.0±1.5	11 ±0.5[f]	2.3 ±0.5	6.6 ±0.7	0.76±0.23	--	--	0.3 ±0.1	--
Sep 72	--	11 ±0.5	0.1 ±0.1	0.3 ±0.1	--	0.9 ±0.4	0.8 ±0.2	0.4 ±0.1	--
Apr 73	2.2±1.0	9.5 ±1.2	--	--	--	--	--	0.28±0.05	0.60±0.17
Aug 73	5.2±0.9	10 ±1.6	--	0.17±0.09	--	--	--	0.25±0.06	0.23±0.17
May 74	26 ±9	4.9 ±1.4	--	4.6 ±1.0	--	2.5 ±0.8	0.39±0.13	0.40±0.07	7.7 ±0.6
Aug 74	3.4±1.0	9.4 ±0.8	0.55±0.15	0.92±0.14	--	1.3 ±0.4	0.24±0.09	0.34±0.05	1.2 ±0.2
Aug 75	2.8±1.8	9.8 ±1.6	--	0.28±0.19	--	--	0.21±0.09	0.19±0.05	1.4 ±0.3
Aug 76	1.8±1.4	8.6 ±1.6	--	--	--	--	0.16±0.08	0.25±0.05	--
Sep 77	--	10 ±2.7	--	0.72±0.37	0.54±0.51	0.69±0.63	--	--	1.5 ±0.4
Aug 78	--	7.5 ±2.5	--	--	--	--	--	0.09±0.07	0.31±0.29
Oct 79	--	13 ±2.2	--	--	--	--	--	0.12±0.08	--
MP 12 Creek									
Jul 72	7.8±1.7	5.2 ±0.5[f]	3.5 ±0.4	6.4 ±0.5	1.7 ±0.3	0.76±0.28	--	2.0 ±0.2	3.8 ±0.4
Aug 73	8.3±0.9	9.6 ±1.6	0.29±0.11	0.34±0.08	0.24±0.09	--	--	2.7 ±0.1	0.36±0.17
May 74	9.1±1.1	8.9 ±1.6	4.0 ±0.2	7.6 ±0.3	0.28±0.13	2.9 ±0.7	0.79±0.13	2.5 ±0.2	12 ±0.5
Aug 75	13 ±1.2	6.2 ±1.5	0.36±0.11	0.97±0.12	--	2.3 ±0.5	0.26±0.10	2.3 ±0.1	3.2 ±0.2
Sep 77	7.8±2.8	5.1 ±2.3	2.5 ±0.4	5.3 ±0.5	--	2.4 ±1.0	--	1.7 ±0.2	3.0 ±0.4
Aug 78	8.9±1.5	6.1 ±2.2	--	0.21±0.11	--	2.2 ±0.72	0.30±0.15	1.8 ±0.16	2.7 ±0.35
Sep 79	10 ±2.0	13 ±1.0	--	--	--	--	--	0.89±0.06	--
White Alice Inlet to Cannikin Lake									
Aug 73	23 ±1.5	6.1 ±1.4	0.59±0.13	1.1 ±0.14	0.91±0.15	--	--	0.72±0.09	1.4 ±0.2
Aug 74	12 ±1.2	9.8 ±0.6	0.99±0.14	2.0 ±0.15	0.43±0.08	1.7 ±0.4	--	1.1 ±0.08	4.3 ±0.2
Aug 75	3.8±0.9	5.1 ±1.3	--	0.2 ±0.08	--	0.89±0.4	0.16±0.09	0.75±0.09	2.0 ±0.3
Aug 76	3.3±1.9	10 ±1.7	--	--	--	--	--	0.17±0.04	0.23±0.20

Table 17, cont'd

Location and date	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
	Radionuclides (pCi/g, dry)[b]								
Aug 78	--	21 ±20	--	--	--	--	--	1.6 ±0.69	--
Sep 79	--	8.5 ±6.9	--	--	--	--	--	2.3 ±0.28	--
Drillback Drainage to Cannikin Lake									
Sep 77	36 ±5.1	4.8 ±3.0	4.1 ±0.62	8.7 ±0.80	--	5.0 ±1.3	--	1.0 ±0.17	9.1 ±0.7
Aug 78	10 ±1.4	3.3 ±2.4	--	0.17±0.11	--	--	0.30±0.13	0.83±0.10	--
Sep 79	6.2±1.5	2.1 ±0.72	--	--	--	--	--	0.35±0.05	0.47±0.16
Duck Cove Seepage									
Aug 78	1.7±0.67	16 ±2.2	--	--	0.09±0.08	0.44±0.39	--	0.06±0.05	1.2 ±0.23
Sep 79	--	5.0 ±1.3	--	--	--	--	--	0.14±0.04	--
Cannikin GZ Creek									
Apr 73	6.2±1.7	8.6 ±1.6	--	--	--	--	--	0.68±0.09	0.65±0.23
Aug 73	4.3±1.0	10 ±1.8	--	--	--	--	--	0.41±0.08	0.19±0.18

[a]Aufwuchs samples were collected from Long Shot Pond, MP-12 Creek, and Drillback Drainage to Cannikin Lake, and the algal samples were collected from White Alice Inlet to Cannikin Lake and from Cliff Seepage at Duck Cove.

[b]Radionuclide values for a single sample (n=1) are a single count of the sample plus or minus the two-sigma, propagated counting error. Dashes in the table indicate the sample count is not significant.

Table 18. Gamma-emitting radionuclides in vegetation collected at Amchitka Island, 1971-1972.[a]

Location & Miles from C-Site	Dominant Vegetation	Time of Collection	Gamma-Emitting Radionuclides (pCi/g, dry)[b]							
			^{7}Be	^{40}K	^{60}Co	^{95}Zr[c]	^{95}Nb[c]	^{106}Ru	^{125}Sb	^{137}Cs
Engineer Rd. (13.7)	Grass, *Calomagrastis* sp.	Pre	---	3.9±1.1	0.17±.08	---	---	1.6 ±1.4	3.7 ±0.6	24 ±.3
		Post	---	5.1±0.9	0.17±.06	0.54± .44	1.2±0.9	1.7 ±1.0	2.8 ±0.4	23 ±.2
White house (9.4)	Grass, *Calomagrastis* sp.	Pre	---	11 ±1.0	---	0.51± .28	1.0±0.6	2.3 ±0.9	0.74±0.3	6.9±.2
		Post	---	11 ±0.7	0.06±.04	0.34± .04	0.7±0.4	0.84±0.5	0.84±0.2	3.4±.1
Kirilof Pt. (9.3)	Moss	Pre	---	7.4±1.3	---	---	---	---	2.8 ±0.6	19 ±.3
		Post	14 ± 9.6	6.6±1.2	0.14±.08	0.98± .33	2.0 ±0.7	2.4 ±1.2	1.9 ±0.5	18 ±.3
Jones Lake Outlet (8.7)	Moss	Pre	27 ±13	4.7±1.2	---	1.2 ± .4	2.4 ±0.9	3.9 ±1.3	2.7 ±0.5	12 ±.3
		Post	---	3.5±1.0	0.12±.06	0.79± .48	1.7 ±1.0	2.2 ±1.0	3.6 ±0.4	13 ±.2
St. Makarius Pt. (8.9)	Crowberry, *Empetra* sp.	Pre	---	2.4±0.9	---	0.71±0.54	1.5 ±1.1	2.3 ±1.1	2.5 ±0.4	8.6±.2
		Post	---	2.9±0.8	0.11±.05	---	---	1.6 ±0.9	1.9 ±0.3	5.7±.1
Square Bay (4.2)	Crowberry, *Empetra* sp. & Moss	Pre	20 ±14	3.7±1.2	---	1.1 ±0.4	2.3 ±0.9	3.4 ±1.3	2.7 ±0.6	17 ±.3
		Post	---	4.6±0.8	0.11±.05	0.79±0.42	1.6 ±1.0	1.0 ±0.9	2.7 ±0.4	23 ±.2
Milrow (5.0)	Grass, *Agiostis* sp.	Pre	---	5.8±0.8	0.06±.05	1.0 ±0.38	2.1 ±0.8	1.7 ±0.9	2.4 ±0.4	9.9±.2
		Post	---	3.9±0.6	0.08±.04	0.28±0.23	0.7 ±0.6	1.7 ±0.7	1.7 ±0.3	8.7±.1
Long Shot SGZ (4.0)	Grass, *Calomagrastis* sp.	Pre	---	4.6±0.9	0.15±.06	0.88±0.52	1.9 ±1.0	2.1 ±1.1	3.1 ±0.4	21 ±.2
		Post	---	3.0±0.8	0.09±.05	0.44±0.34	1.0 ±0.8	2.5 ±0.9	2.3 ±0.4	10 ±.2
CTB No. 21 (1.1)	Crowberry, *Empetra* sp. & Grass, *Calomagrastis* sp.	Pre	---	5.9±0.9	0.06±.06	---	---	1.2 ±1.0	2.2 ±0.4	14 ±.2
		Post	---	7.7±1.1	0.15±.07	0.59±0.29	1.2 ±0.6	1.2 ±1.0	2.2 ±0.4	13 ±.2

Table 18, cont'd

Location & Miles from C-Site	Dominant Vegetation	Time of Collection	Gamma-Emitting Radionuclides (pCi/g, dry)[b]							
			^{7}Be	^{40}K	^{60}Co	^{95}Zr[c]	^{95}Nb[c]	^{106}Ru	^{125}Sb	^{137}Cs
CTB No. 20 (0.7)	Moss, Crowberry, <u>Empetra</u> sp.	Pre	---	3.4±1.0	---	---	---	1.3 ±1.1	1.0 ±0.4	7.1±.2
		Post	---	3.5±1.2	---	0.63±0.32	1.3±0.7	---	1.8 ±0.4	11 ±.2
Sandia Trailer Park (1.2)	Moss, Crowberry, <u>Empetra</u> sp.	Pre	13 ± 8.2	2.0±1.0	0.08±.06	0.40±0.27	0.9±0.5	1.9 ±1.0	2.0 ±0.4	16 ±.2
		Post	---	3.1±1.1	0.08±.07	0.60±0.33	1.3±0.7	---	1.7 ±0.4	10 ±.2
CTB No. 16 (3.4)	Moss, Crowberry, <u>Empetra</u> sp.	Pre	---	3.8±1.1	0.10±.07	---	---	---	2.3 ±0.5	13 ±.3
		Post	12 ± 9.8	5.2±0.9	0.12±.06	0.71±0.30	1.4±0.7	---	2.5 ±0.4	14 ±.2
CTB No. 10 (9.0)	Moss	Pre	---	5.7±0.9	0.08±.06	---	---	---	2.5 ±0.4	13 ±.2
		Post	---	5.8±0.8	0.22±.05	0.79±0.39	1.7±0.8	2.1 ±0.9	1.6 ±0.4	9.7±.2
Microwave Relay Station (16.0)	Moss, Crowberry, <u>Empetra</u> sp.	Pre	15 ± 9.6	3.5±1.0	0.14±.06	0.66±0.31	1.5±0.6	2.1 ±1.1	2.8 ±0.5	18 ±.2
		Post	3.4± 1.6	2.7±0.8	0.08±.05	0.68±0.26	1.5±0.6	1.2 ±0.7	1.9 ±0.4	20 ±.2
Northwest Camp (22.6)	Moss, Crowberry, <u>Empetra</u> sp.	Pre	9.6± 6.6	2.1±0.8	---	0.65±0.19	1.5±0.5	1.8 ±0.8	1.9 ±0.4	11 ±.2
		Post	1.5± 1.0	2.6±0.8	---	0.32±0.13	0.7±0.3	---	1.2 ±0.3	6.7±.1
S-8 near Generator House (4.8)	Moss	Pre	11 ± 9.4	3.0±1.2	---	0.81±0.32	1.8±0.7	2.7 ±1.2	2.3 ±0.5	11 ±.2
		Post	26 ±14	3.6±1.4	0.09±.09	1.1 ±0.4	2.2±0.9	2.5 ±1.4	2.4 ±0.6	11 ±.2

[a]Pre-Cannikin collections were made on 4 Nov 1971; post-Cannikin collections were made on 7 Dec 1971, except stations 14 and 15, which were made on 21 Apr 1972.

[b]The error values are two-sigma, propagated, counting errors for single samples.

[c]The ^{95}Zr and ^{95}Nb values were calculated as discussed in the text.

Table 19. Fallout radionuclides in lichens collected at Clam Lake, Amchitka Island, in 1970-71.

Collection date	Fallout radionuclides (pCi/g, dry)[a]						
	^{54}Mn	^{60}Co	^{95}Zr-^{95}Nb	^{103}Ru	^{106}Ru-^{106}Rh	^{125}Sb	^{137}Cs
Sep 70	0.11 ± 0.07	0.05 ± 0.04	4.8 ± 0.4	--	5.7 ± 0.5	3.8 ± 0.5	18 ± 0.3
Oct 70	0.14 ± 0.05	0.07 ± 0.04	2.9 ± 0.2	--	3.6 ± 0.4	2.4 ± 0.4	13.5 ± 0.3
Oct 70	0.16 ± 0.08	0.10 ± 0.06	4.4 ± 0.4	--	5.8 ± 0.6	4.1 ± 0.6	20 ± 0.4
Feb 71	--	0.10 ± 0.09	1.4 ± 0.2	--	4.0 ± 0.7	4.3 ± 0.7	27 ± 0.5
May 71	--	0.10 ± 0.06	3.9 ± 0.2	2.2 ± 0.7	1.1 ± 0.9	3.8 ± 0.5	26 ± 0.4
Nov 71	0.16 ± 0.03	0.10 ± 0.03	2.0 ± 0.1	0.85 ± 0.28	1.6 ± 0.5	3.8 ± 0.3	20 ± 0.2
Dec 71	0.09 ± 0.02	0.05 ± 0.02	0.90 ± 0.05	0.64 ± 0.12	0.74 ± 0.25	1.4 ± 0.1	8 ± 0.09

[a]The error values are two sigma, propagated counting errors for single samples. Dashes in the body of the table indicate the sample count is not significant, i.e., the net sample count is less than the two sigma, propagated counting error.

Table 20. Gamma-emitting radionuclides in lichens collected at Amchitka Island, 1971-79 (post-Cannikin).

Location and date	Gamma-emitting radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Post-Cannikin										
Clam Lake										
Dec 71	24 ±6.4	16 ±1.5	1.9 ±0.3	4.0 ±0.8	1.6 ±1.2	10 ±1.8	9.6 ±0.1	67 ±0.5		
Feb 72	8.1±5.2	4.9±1.4	0.6 ±0.2	1.4 ±0.4	--	2.0 ±1.3	2.2 ±0.6	20 ±0.3		
Apr 72	6.4±2.4	3.5±0.8	0.3 ±0.1	0.6 ±0.2	--	2.9 ±0.8	2.1 ±0.4	19 ±0.2		
Jul 72	3.2±2.2	4.2±0.7	0.8 ±0.1	1.7 ±0.2	0.8 ±0.4	--	1.8 ±0.4	14 ±0.2		
Oct 72	7.0±2.2	2.6±0.9	--	0.8 ±0.2	--	3.0 ±0.5	1.1 ±0.2	15 ±0.3	9.0±0.4	1.5 ±0.14
Apr 73	4.7±2.0	3.8±0.9	--	0.21±0.10	--	0.96±0.44	0.69±0.11	15 ±0.3	5.2±0.3	0.87±0.09
Jul 73	5.6±0.6	3.5±1.5	0.08±0.06	0.12±0.04	0.10±0.04	1.3 ±0.4	0.45±0.10	5.4±0.2	2.7±0.2	0.24±0.06
Aug 73	5.6±0.9	3.3±0.8	--	--	--	0.91±0.37	0.65±0.10	1.5±0.3	3.3±0.3	0.56±0.06
May 74	4.5±0.9	2.4±0.9	0.48±0.09	1.2 ±0.1	--	1.4 ±0.5	0.56±0.11	12 ±0.3	4.0±0.3	0.38±0.05
Aug 74	5.2±1.2	3.7±0.4	0.23±0.18	0.9 ±0.1	--	1.3 ±0.4	0.33±0.09	9 ±0.2	4.1±0.2	0.33±0.09
Aug 75	4.6±1.7	2.5±1.1	--	0.5 ±0.1	--	1.0 ±0.6	0.28±0.14	6 ±0.2	5.5±0.4	0.23±0.08
Aug 76	8.0±1.5	2.0±1.5	--	--	--	0.6 ±0.4	0.41±0.11	7 ±0.2	2.0±0.3	0.11±0.10
Sep 77	8.1±3.3	1.9±1.4	1.1 ±0.4	2.4 ±0.5	--	2.1 ±0.8	0.36±0.19	2.8±0.2	6.2±0.6	0.18±0.10
Aug 78	6.5±1.5	--	0.28±0.18	0.17±0.11	--	1.9 ±0.69	0.35±0.14	3.9±0.25	10 ±0.63	0.24±0.10
Sep 79	6.0±2.6	2.6±2.6	--	--	--	--	--	2.0±0.14	2.7±0.48	--
Icebox Lake										
Oct 72	--	2.8±1.2	0.7 ±0.1	1.4 ±0.3	3.8 ±2.0	--	2.6 ±0.7	14 ±0.2		
Apr 73	5.9±1.8	1.1±0.7	--	--	--	1.2 ±0.4	0.94±0.11	16 ±0.3	5.0±0.3	0.75±0.11
Aug 73	5.5±1.0	--	--	--	--	1.4 ±0.4	0.77±0.10	15 ±0.3	3.5±0.2	0.50±0.06
May 74	8.6±1.1	1.4±0.9	0.80±0.12	2.1 ±0.2	--	2.1 ±0.5	0.59±0.13	13 ±0.3	8.1±0.4	0.40±0.06
Aug 74	5.7±1.5	1.3±0.5	0.49±0.19	0.8 ±0.1	--	2.2 ±0.5	0.64±0.13	9 ±0.2	6.0±0.3	0.43±0.07
Aug 75	5.2±1.5	1.9±1.6	--	0.4 ±0.1	--	1.5 ±0.6	0.48±0.14	11 ±0.3	5.4±0.3	0.38±0.13
Aug 76	8.1±3.7	--	--	0.2 ±0.2	--	0.87±0.55	0.56±0.13	11 ±0.3	2.1±0.3	0.48±0.12
Sep 77	14 ±3.8	1.7±1.3	1.5 ±0.4	3.8 ±0.6	--	2.0 ±0.9	0.37±0.17	3.6±0.3	10 ±0.7	--
Aug 78	8.3±2.0	--	0.32±0.14	0.39±0.14	--	2.2 ±0.80	--	9.5±4.2	9.0±0.66	0.18±0.12
Sep 79	8.9±0.7	0.5±0.4	--	--	--	0.72±0.26	--	3.0±0.08	2.8±0.09	--

Table 20, cont'd

Location and date	Gamma-emitting radionuclides (pCi/g, dry)[a]									
	^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Cannikin Lake										
Jul 72	5.3±1.7	2.0±0.7	0.7 ±0.1	1.6 ±0.1	0.6 ±0.3	--	0.2 ±0.4	21 ±0.2		
Apr 73	4.4±2.0	2.2±0.8	--	--	--	1.3 ±0.5	0.86±0.12	15 ±0.3	5.2±0.4	0.85±0.13
Aug 73	6.2±0.9	2.3±1.3	--	--	0.13±0.10	1.2 ±0.4	0.94±0.09	16 ±0.2	3.0±0.2	0.61±0.06
May 74	6.7±0.6	1.6±0.6	0.62±0.07	1.6 ±0.1	0.09±0.06	1.6 ±0.3	0.65±0.08	11 ±0.2	5.8±0.2	0.39±0.03
Aug 74	5.1±1.3	2.5±0.6	0.30±0.15	0.7 ±0.1	--	1.7 ±0.5	0.34±0.12	8 ±0.2	4.3±0.3	0.30±0.06
Aug 75	6.1±2.1	--	--	0.4 ±0.2	--	1.4 ±0.5	0.40±0.10	7 ±0.2	4.6±0.3	0.26±0.11
Aug 76	6.4±1.6	1.4±1.0	--	--	--	0.52±0.45	0.40±0.11	5 ±0.2	2.4±0.3	0.19±0.07
Sep 77	13 ±3.6	--	1.3 ±0.4	3.6 ±0.5	--	2.0 ±0.7	0.38±0.15	3.5±0.2	7.6±0.5	--
Aug 78	7.3±1.4	--	--	0.32±0.12	--	1.6 ±0.65	0.52±0.14	4.0±0.23	7.5±0.46	0.23±0.14
Sep 79	9.6±1.7	1.6±1.3	--	--	--	0.8 ±0.48	--	2.5±0.12	2.6±0.36	--

[a]Radionuclide values for a single sample (n=1) are a single count of the sample plus or minus the two-sigma, propagated counting error. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

Table 21. Some gamma-emitting radionuclides in birds collected at Amchitka Island.

Collection location and date	Common name	Tissue	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{40}K	^{60}Co	^{137}Cs
Cannikin Area					
Dec 70	Black oystercatcher	Muscle	11 ±1.1	--	--
		Liver	13 ±4	--	--
		Bone	2.5±0.6	--	--
Feb 73	"	Muscle	13 ±0.5		
Dec 70	Emperor goose	Muscle	8.8±0.6	0.08±0.03	--
		Liver	7.3±2.5	--	--
		Bone	3 ±0.3	0.05±0.02	--
"	"	Muscle	9.5±0.6	0.04±0.03	--
		Liver	7.5±1.1	--	--
		Bone	1.9±0.6	--	--
		Feathers	1.7±0.2	--	0.04±0.01
Jan 73	"	Muscle	13 ±0.6	--	0.04±0.03
"	"	Liver	9.0±0.9	--	--
Apr 73	"	Muscle	13 ±0.4	--	--
"	"	Liver	10 ±0.8	--	--
"	"	Muscle	12 ±0.4	--	--
"	"	Liver	8.3±0.7	0.07±0.05	--
Jun 71	Herring gull	Liver	7.7±1.1	--	--
"	"	Muscle	8.3±0.6	--	0.09±0.05
Feb 72	"	Feathers	0.5±0.2	--	0.02±0.01
"	"	Muscle	10 ±0.7	--	0.06±0.05
"	"	Liver	8.1±0.9	--	--
"	"	Feathers	0.3±0.2	--	2.1 ±0.03
"	"	Muscle	9.9±0.7	--	0.08±0.06
"	"	Liver	7.8±0.7	--	0.09±0.04
Jun 71	Tufted puffin	Liver	7.2±1.8	--	--
"	"	Muscle	11 ±0.7	0.10±0.05	--
"	Murre	Liver	7.6±1.4	--	--
"	"	Muscle	11 ±0.5	0.03±0.03	--
Jul 71	Pigeon guillemot	Muscle	12 ±0.8	--	0.06±0.06
		Liver	10 ±1.5	0.2 ±0.1	--
		Feathers	2 ±1	--	--
Jan 73	Goldeneye	Muscle	11 ±0.3	--	0.38±0.02
"	"	Liver	7.7±0.6	--	1.2 ±0.04
Dec 70	Rock ptarmigan	Muscle	11 ±1.2	--	0.25±0.08
		Liver	--	--	--
		Bone	2.7±1.2	0.09±0.08	0.19±0.09
		Feathers	2.1±1.5	0.30±0.10	0.24±0.13
Apr 71	"	Muscle	11 ±0.7	--	1.20±0.05
		Feathers	1.2±0.7	0.10±0.05	0.13±0.06
"	"	Muscle	12 ±0.6	--	1.70±0.05
		Feathers	--	--	0.15±0.05

Table 21, cont'd

Collection location and data	Common name	Tissue	Gamma-emitting radionuclides (pCi/g, dry)[a] ^{40}K	^{60}Co	^{137}Cs
Dec 71	Rock ptarmigan	Muscle	9.9±0.8	--	0.65±0.05
Feb 72	"	"	13 ±0.5	--	0.73±0.03
"	"	"	11 ±0.7	--	0.72±0.05
"	"	Feathers	0.6±0.5	--	0.14±0.04
Feb 73	"	Muscle	12 ±0.7	--	0.38±0.05
"	"	"	11 ±0.8	--	0.64±0.06
Apr 73	"	"	12 ±0.7	--	0.76±0.05
Aug 73	"	"	10 ±0.7	--	0.18±0.04
Sep 73	"	"	11 ±0.8	--	0.21±0.06
May 74	"	"	11 ±1.2	--	0.42±0.05
Aug 74	"	"	11 ±1.5	--	0.90±0.35
Aug 75	"	"	14 ±2	--	3.4 ±0.2
Aug 76	"	"	12 ±0.5	--	1.7 ±0.1
Sep 77	"	"	11 ±2.5	--	2.1 ±0.18
Aug 78	"	"	9.1±2.3	--	0.39±0.08
Sep 79	"	"	12 ±1.6	--	0.32±0.07
Milrow/Long Shot					
Aug 75	Rock ptarmigan	Muscle	12 ±2	--	1.8 ±0.6
Aug 76	"	"	10 ±4.5	--	< 0.3
Sep 77	"	"	8.8±1.0	--	0.37±0.08
Aug 78	"	"	9.6±1.8	--	0.90±0.08
Sep 79	"	"	11 ±1.6	--	0.53±0.07
Camp Area					
Aug 76	"	"	10 ±0.6		1.5 ±0.1
Sep 77	"	"	12 ±2.5		0.55±0.10
Aug 78	"	"	9.4±1.5		0.30±0.04
Sep 79	"	"	11 ±2.8		0.15±0.10
Mile 8					
Aug 75	"	"	11 ±2		1.4 ±0.1
Mile 18					
Aug 76	"	"	9.4±0.6		0.75±0.04

[a]Error values are two-sigma propagated counting errors. Dashes indicate the sample counts are less than the counting error.

Table 22. Some gamma-emitting radionuclides in sand and soil collected at Amchitka Island.

Location and date	Sample type	Radionuclides (pCi/g, dry)[a] ^{40}K	^{137}Cs	^{141}Ce	^{144}Ce	^{226}Ra	^{228}Th	^{238}U
Main Camp								
Aug 75	Soil	8.0±1.2	--	0.2 ±0.13	0.14±0.13	0.18±0.04	0.14±0.05	--
Aug 76	"	10.1±1.4	1.4 ±0.08	--	--	0.32±0.04	0.14±0.05	--
Aug 76	"	10.6±1.2	0.58±0.06	0.45±0.31	--	0.21±0.04	0.07±0.04	0.52±0.25
Aug 76	"	11.8±1.3	0.37±0.05	0.35±0.31	--	0.26±0.04	0.13±0.04	0.05±0.02
Sep 77	"	15 ±2.2	0.24±0.07	--	0.29±0.21	0.29±0.07	0.27±0.08	0.85±0.69
Sep 78	"	21 ±1.6	0.38±0.05	--	0.22±0.13	0.39±0.04	--	0.67±0.42
Sep 79	"	14 ±0.7	0.15±0.02	--	--	0.40±0.05	0.41±0.04	0.13±0.26
Cannikin Area								
Aug 75	Soil	11 ±1.3	0.32±0.05	0.22±0.15	0.97±0.18	0.11±0.05	0.08±0.04	--
Aug 76	"	12.9±1.7	0.11±0.04	--	--	0.24±0.05	0.09±0.07	0.80±0.56
Aug 76	"	10.0±1.7	0.39±0.06	--	0.27±0.19	0.22±0.05	0.13±0.07	0.66±0.56
Aug 76	"	8.0±1.5	0.52±0.08	--	--	0.18±0.05	0.12±0.05	0.45±0.30
Sep 77	"	11.9±2.0	0.17±0.06	--	0.40±0.20	--	0.13±0.05	--
Sep 77	"	11.4±2.4	0.09±0.06	--	--	0.21±0.07	0.12±0.09	0.06±0.05
Sep 77	"	9.5±2.3	0.06±0.06	--	--	0.22±0.09	--	--
Sep 77	"	4.9±2.1	0.38±0.08	--	0.43±0.26	0.24±0.12	0.29±0.09	--
Sep 77	"	6.7±1.7	--	--	--	0.13±0.67	0.20±0.08	--
Aug 78	"	4.6±1.3	0.50±0.08	--	0.56±0.20	0.21±0.07	--	--
Aug 78	"	10.6±1.7	0.38±0.06	--	0.77±0.17	0.16±0.06	--	--
Aug 78	"	11.7±1.3	0.54±0.06	--	0.47±0.14	0.10±0.05	--	--
Sep 79	"	11.7±0.40	0.04±0.02	--	--	0.13±0.03	0.20±0.02	0.26±0.19
Sep 79	"	13.3±0.25	0.14±0.01	--	0.12±0.04	--	0.13±0.01	--
Constantine Harbor								
Aug 75	Sand	13 ±1.2	0.07±0.03	--	--	0.18±0.04	0.09±0.04	0.44±0.36
Aug 76	"	16 ±1.6	0.22±0.04	--	--	0.28±0.05	0.11±0.05	0.88±0.47
Sep 77	"	15 ±2.1	0.05±0.04	--	--	0.19±0.06	0.09±0.07	--
Aug 78	"	15 ±2.2	--	--	--	0.20±0.05	--	--
Sep 79	"	8.3±0.4	0.03±0.01	--	--	0.13±0.03	0.08±0.02	0.05±0.10

Table 22, cont'd

Location and date	Sample type	^{40}K	^{137}Cs	^{141}Ce	^{144}Ce	^{226}Ra	^{228}Th	^{238}U
		Radionuclides (pCi/g, dry)[a]						
Sand Beach Cove								
Aug 75	Sand	9.8±1.1	0.06±0.03	--	0.2 ±0.1	0.22±0.04	0.11±0.03	0.48±0.20
Aug 76	"	8.6±1.1	--	--	--	0.28±0.04	0.13±0.04	0.64±0.33
Sep 77	"	4.7±1.1	--	--	--	0.08±0.05	0.07±0.04	--
Aug 78	"	7.8±1.8	--	--	--	0.28±0.06	--	0.71±0.62
Sep 79	"	9.8±0.4	0.01±0.01	--	--	0.24±0.03	0.22±0.03	--

[a]Radionuclide values for a single sample (n=1) are a single count of the sample plus or minus the two-sigma, propagated counting error. Dashes in the table indicate the sample count is not significant.

Table 23. Tritium concentration in seawater samples collected near Amchitka Island, 1970-1979.

Collection date	Collection location	Tritium units	pCi/liter
Sep 70[c]	51°23'N 179°59'E 10 m depth	19 ± 12	61 ± 39
Sep 70[c]	" 40 m depth	18 ± 12	58 ± 39
Sep 70[c]	" 80 m depth	40 ± 13	129 ± 42
Sep 70[c]	51°25'N 178°58'E 10 m depth	43 ± 13	138 ± 42
Sep 70[c]	" 40 m depth	23 ± 12	74 ± 39
Sep 70[c]	" 80 m depth	30 ± 13	97 ± 42
Feb 72	Constantine Harbor	99 ± 14	319 ± 45
Apr 72	"	28 ± 13	90 ± 42
May 72	"	75 ± 14	241 ± 45
Jul 72	"	16 ± 13	51 ± 42
Sep 72	"	< 13	< 42
Apr 73	"	< 13	< 42
May 74	"	< 13	< 42
Aug 74	"	< 12	< 39
Aug 75	"	18 ± 12	57 ± 40
Aug 76	"	< 14	< 45
Sep 77	"	< 13	< 42
Aug 78	"	< 9	< 29
Sep 79	"	< 9	< 29
Sep 70[c]	St. Makarius Bay	< 200	< 644
Jul 72	"	< 13	< 42
Aug 75	"	< 13	< 42
Aug 76	"	< 14	< 45
Aug 78	"	34 ± 10	110 ± 32
Sep 79	"	< 9	< 29
Sep 70[c]	Duck Cove Fault Line	21 ± 13	68 ± 42
Sep 70[c]	Duck Cove	36 ± 13	116 ± 42
May 71[c]	Duck Cove at IA-1	< 16	< 52
Apr 72	Duck Cove	33 ± 14	106 ± 45
Jul 72	"	26 ± 14	84 ± 45
Sep 72	"	< 13	< 42
Apr 73	"	16 ± 13	51 ± 42
Aug 73	"	< 13	< 42
May 74	"	< 13	< 42
Aug 74	"	< 12	< 39
Aug 75	"	< 13	< 42
Aug 76	"	20 ± 11	65 ± 36
Sep 77	"	13 ± 11	42 ± 36
Aug 78	"	10 ± 10	32 ± 32
Sep 79	"	37 ± 11	120 ± 36
Dec 71	Square Bay	54 ± 13	174 ± 42
Feb 72	Square Bay Point	33 ± 13	106 ± 42

Table 23, cont'd

Collection date	Collection location	Tritium units	pCi/liter
Aug 75	Square Bay	17 ± 12	56 ± 40
Aug 76	"	< 14	< 45
Sep 77	"	< 15	< 49
Aug 78	"	< 9	< 29
Aug 78	Square Bay near mouth of Long Shot Cr.	23 ± 7	74 ± 23
Aug 78	Square Bay near mouth of Bridge Cr.	20 ± 9	65 ± 29
Sep 79	Square Bay	< 10	< 32
Sep 79	Square Bay near mouth of Long Shot Cr.	< 10	< 32
Sep 79	Square Bay near mouth of Bridge Cr.	29 ± 11	94 ± 36
Feb 72	Sand Beach Cove	27 ± 13	98 ± 47
Apr 72	"	< 13	< 42
Apr 72	"	< 13	< 42
Apr 72	"	< 13	< 42
Jul 72	"	< 13	< 42
Sep 72	"	< 13	< 42
Apr 73	"	41 ± 14	149 ± 51
Aug 73	"	< 13	< 42
May 74	"	15 ± 13	48 ± 42
Aug 74	"	12 ± 10	39 ± 32
Aug 75	"	< 13	< 42
Aug 76	"	< 14	< 45
Sep 77	"	< 13	< 49
Aug 78	"	< 9	< 29
Sep 79	"	< 8	< 26

[a]Radionuclide values are means of replicate counts ± one-sigma propagated counting error.

[b]One T.U. equals 3.23 pCi/liter.

[c]Pre-Cannikin.

Table 24. Tritium concentration in freshwater samples (excluding the Long Shot drainage) collected at Amchitka Island, 1970-79.

Collection Location and Date	Tritium Units	pCi/liter
Precipitation samples		
Aug 75	33 ± 13	106 ± 42
Aug 76	23 ± 14	74 ± 45
Mar 77	34 ± 11	109 ± 35
Mar 77	34 ± 10	109 ± 32
June 77	≤ 24	≤ 77
June 77	< 24	< 77
July 77	33 ± 11	106 ± 35
July 77	34 ± 11	109 ± 35
Aug 77	66 ± 12	212 ± 39
Aug 77	26 ± 10	84 ± 32
Sept 77	32 ± 10	103 ± 32
Sept 77	34 ± 10	109 ± 32
Sept 77	36 ± 10	116 ± 32
Oct 77	≤ 13	≤ 42
Oct 77	12 ± 9	39 ± 29
Nov 77	≤ 13	≤ 42
Nov 77	< 12	< 39
Dec 77	< 14	< 45
Dec 77	< 12	< 39
Jan 78	< 15	< 48
Jan 78	< 14	< 45
Feb 78	151 ± 13	486 ± 42
Feb 78	63 ± 12	203 ± 39
Apr 78	≤ 14	≤ 45
May 78	< 14	< 45
Sept 78	21 ± 10	68 ± 32
Oct 78	≤ 9	≤ 29
Nov 78	< 9	< 29
Nov 78	10 ± 9	32 ± 29
Dec 78	≤ 9	≤ 29
Dec 78	19 ± 10	61 ± 32
Jan 79	≤ 9	≤ 29
Jan 79	15 ± 10	48 ± 32
Feb 79	12 ± 9	39 ± 29
Feb 79	≤ 9	≤ 29
Apr 79	72 ± 10	232 ± 32
Apr 79	67 ± 10	216 ± 32
May 79	23 ± 10	74 ± 32
May 79	26 ± 10	84 ± 32
June 79	21 ± 11	68 ± 35
June 79	20 ± 9	64 ± 29
July 79	≤ 9	≤ 29
July 79	13 ± 9	42 ± 29
Sept 79	40 ± 9	129 ± 29

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Clevenger Creek		
Sept 70	110 ± 13	354 ± 42
Sept 70	73 ± 13	235 ± 42
Feb 71	85 ± 13	274 ± 42
May 71	87 ± 14	280 ± 45
July 72	57 ± 13	183 ± 42
Apr 73	48 ± 13	154 ± 42
Sept 73	68 ± 14	219 ± 45
May 74	34 ± 13	110 ± 42
Aug 74	41 ± 10	132 ± 32
Aug 75	30 ± 12	98 ± 40
Aug 75	26 ± 12	84 ± 40
Aug 76	36 ± 11	116 ± 36
Aug 76	36 ± 11	116 ± 36
May 77	17 ± 11	55 ± 36
Aug 77	33 ± 11	107 ± 36
Sept 77	23 ± 11	74 ± 36
May 78	≤ 8	≤ 26
May 78	< 8	< 26
Aug 78	15 ± 9	48 ± 29
Aug 78	34 ± 9	109 ± 29
Nov 78	≤ 9	≤ 29
Nov 78	10 ± 9	< 29
Feb 79	≤ 11	< 35
Feb 79	< 10	< 32
May 79	10 ± 9	32 ± 29
May 79	16 ± 10	51 ± 32
Sept 79	23 ± 9	74 ± 29
Sept 79	21 ± 9	68 ± 29
Bridge Creek		
Feb 71	78 ± 14	251 ± 45
May 71	100 ± 14	322 ± 45
July 72	67 ± 14	216 ± 45
Apr 73	72 ± 13	232 ± 42
Aug 73	74 ± 14	238 ± 45
May 74	61 ± 12	197 ± 39
Aug 74	45 ± 10	145 ± 32
Aug 75	55 ± 13	177 ± 41
Aug 76	29 ± 11	94 ± 36
May 77	32 ± 21	103 ± 68
Aug 77	18 ± 11	58 ± 36

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Bridge Creek		
Sept 77	41 ± 11	132 ± 36
Aug 78	36 ± 9	116 ± 29
Aug 78	29 ± 9	93 ± 29
Nov 78	< 9	< 29
Nov 78	14 ± 9	45 ± 29
Feb 79	26 ± 11	84 ± 35
Feb 79	< 10	< 32
May 79	31 ± 10	100 ± 32
May 79	35 ± 12	113 ± 39
Sept 79	< 10	< 32
Sept 79	21 ± 10	68 ± 32
Jones Lake		
Dec 71	62 ± 13	200 ± 42
Feb 72	36 ± 13	116 ± 42
July 72	40 ± 13	129 ± 42
Sept 72	54 ± 13	174 ± 42
Apr 73	46 ± 13	148 ± 42
Aug 73	41 ± 14	132 ± 45
May 74	14 ± 13	45 ± 42
Aug 74	39 ± 12	126 ± 39
Aug 75	28 ± 12	89 ± 40
Aug 76	12 ± 11	39 ± 31
Sept 77	13 ± 11	42 ± 36
Aug 78	11 ± 9	36 ± 29
Sept 79	< 10	< 32
Clevenger Lake		
Apr 73	46 ± 13	148 ± 42
Aug 73	62 ± 14	200 ± 45
May 74	34 ± 13	110 ± 42
Aug 74	51 ± 10	165 ± 32
Aug 75	51 ± 13	165 ± 41
Aug 76	20 ± 14	65 ± 45
Sept 77	21 ± 12	68 ± 39
Aug 78	27 ± 9	87 ± 29
Oct 79	9 ± 8	29 ± 26
Clam Lake		
Sept 70	180 ± 14	579 ± 45
Feb 71	78 ± 14	251 ± 45
May 71	< 13	< 42
Apr 73	51 ± 13	164 ± 42

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Clam Lake		
Aug 73	60 ± 14	193 ± 45
May 74	21 ± 13	68 ± 42
Aug 74	≤ 12	≤ 39
Aug 75	24 ± 12	78 ± 38
Aug 76	30 ± 11	97 ± 36
Sept 77	39 ± 11	126 ± 36
Aug 78	33 ± 10	107 ± 32
Sept 79	18 ± 9	58 ± 29
Duck Cove Creek		
Sept 70	130 ± 13	418 ± 42
Feb 71	24 ± 13	77 ± 42
May 71	140 ± 14	451 ± 45
Dec 71	81 ± 13	261 ± 42
Feb 72	50 ± 13	161 ± 42
July 72	52 ± 14	167 ± 45
Apr 73	72 ± 13	232 ± 42
Aug 73	70 ± 14	238 ± 45
May 74	27 ± 13	87 ± 42
Aug 74	34 ± 10	110 ± 32
Aug 75	41 ± 13	132 ± 38
Aug 76	25 ± 11	81 ± 36
Sept 77	28 ± 11	90 ± 36
Aug 78	≤ 9	≤ 29
Sept 79	27 ± 9	87 ± 29
Duck Cove Seep Water		
Aug 75	47 ± 13	151 ± 41
Aug 76	38 ± 11	123 ± 36
Sept 77	20 ± 11	65 ± 36
Aug 78	49 ± 11	158 ± 36
Sept 79	20 ± 9	65 ± 29
MP-12 Creek		
July 72	82 ± 14	264 ± 45
Apr 73	98 ± 13	315 ± 42
May 74	59 ± 13	191 ± 42
Aug 74	55 ± 10	178 ± 32
Aug 75	40 ± 12	129 ± 38
Aug 76	39 ± 11	126 ± 36
Sept 77	29 ± 11	94 ± 36
Aug 78	12 ± 9	39 ± 29

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Cannikin Lake Inlet from Ground Zero		
Feb 72	< 13	< 42
Apr 73	71 ± 13	228 ± 42
Aug 73	36 ± 13	116 ± 42
May 74	50 ± 13	162 ± 42
Aug 74	< 12	< 39
Aug 75	< 13	< 42
Aug 76	50 ± 23	162 ± 74
Sept 77	14 ± 11	45 ± 36
Aug 78	18 ± 10	58 ± 32
Sept 79	< 10	< 32
Cannikin Lake Inlet from Drillback		
Apr 73	40 ± 13	129 ± 42
Aug 73	53 ± 13	171 ± 42
Aug 73	67 ± 13	216 ± 42
May 74	25 ± 13	81 ± 42
Aug 74	< 12	< 39
Aug 75	53 ± 13	173 ± 41
Aug 76	40 ± 11	129 ± 36
Sept 77	42 ± 12	136 ± 39
Aug 78	15 ± 10	48 ± 32
Sept 79	< 10	< 32
Cannikin Lake White Alice Inlet		
Apr 73	44 ± 13	142 ± 42
Aug 73	39 ± 13	126 ± 42
May 74	40 ± 13	129 ± 42
Aug 74	28 ± 10	90 ± 32
Aug 75	41 ± 13	133 ± 41
Aug 76	29 ± 13	94 ± 42
Sept 77	20 ± 11	65 ± 36
Aug 78	73 ± 10	236 ± 32
Sept 79	30 ± 11	97 ± 36
Cannikin Lake		
Apr 73	54 ± 13	174 ± 42
Apr 73	51 ± 13	164 ± 42
Apr 73	53 ± 13	171 ± 42
Apr 73	40 ± 13	129 ± 42
Apr 73	49 ± 13	158 ± 42

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Cannikin Lake		
Apr 73	40 ± 13	129 ± 42
Apr 73	53 ± 13	171 ± 42
Apr 73	37 ± 13	119 ± 42
Aug 73	32 ± 13	103 ± 42
Aug 73	27 ± 13	87 ± 42
Aug 73	56 ± 14	180 ± 45
Aug 73	30 ± 13	97 ± 42
Aug 73	26 ± 13	84 ± 42
Aug 73	18 ± 13	58 ± 42
Aug 73	37 ± 13	119 ± 42
Aug 73	16 ± 13	51 ± 42
May 74	45 ± 12	145 ± 39
May 74	51 ± 12	165 ± 39
May 74	51 ± 12	165 ± 39
May 74	60 ± 12	194 ± 39
Aug 74	< 12	< 39
Aug 74	13 ± 11	42 ± 36
Aug 74	< 12	< 39
Aug 74	< 12	< 39
Aug 75	21 ± 10	67 ± 33
Aug 75	27 ± 10	87 ± 34
Aug 75	< 13	< 42
Aug 75	38 ± 12	124 ± 38
Aug 75	47 ± 11	151 ± 34
Aug 75	36 ± 10	115 ± 34
Aug 75	46 ± 11	148 ± 34
Aug 75	33 ± 10	108 ± 34
Aug 76	< 14	< 45
Aug 76	26 ± 12	84 ± 39
Aug 76	< 15	< 48
Aug 76	20 ± 16	65 ± 52
Aug 76	23 ± 13	74 ± 42
Aug 76	33 ± 11	107 ± 36
Aug 76	< 15	< 48
Aug 76	27 ± 13	87 ± 42
Sept 77	< 15	< 48
Sept 77	< 15	< 48
Sept 77	46 ± 12	149 ± 39
Sept 77	28 ± 12	90 ± 39
Sept 77	36 ± 12	116 ± 39
Sept 77	31 ± 12	100 ± 39
Sept 77	18 ± 12	58 ± 39
Sept 77	20 ± 12	65 ± 39
Aug 78	19 ± 10	61 ± 32

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Cannikin Lake		
Aug 78	16 ± 9	51 ± 29
Aug 78	24 ± 9	77 ± 29
Aug 78	11 ± 9	35 ± 29
Aug 78	32 ± 10	103 ± 32
Aug 78	27 ± 10	87 ± 32
Aug 78	17 ± 9	55 ± 29
Sept 79	< 10	< 32
Sept 79	< 10	< 32
Sept 79	< 10	< 32
Sept 79	< 10	< 32
Sept 79	15 ± 11	48 ± 35
Sept 79	< 10	< 32
Sept 79	19 ± 9	61 ± 29
Sept 79	15 ± 9	48 ± 29
Sept 79	28 ± 10	90 ± 32
White Alice Creek Gauge Station		
Apr 73	57 ± 13	183 ± 42
Aug 73	42 ± 13	135 ± 42
Cannikin Lake White Alice Outlet		
Apr 73	71 ± 13	228 ± 42
Aug 73	20 ± 13	64 ± 42
May 74	18 ± 13	58 ± 42
Aug 74	< 12	< 39
Aug 75	19 ± 12	63 ± 40
Aug 76	29 ± 19	94 ± 61
Sept 77	41 ± 11	132 ± 35
Sept 77	16 ± 11	51 ± 35
Aug 78	12 ± 9	39 ± 29
Aug 78	19 ± 9	61 ± 29
Aug 78	13 ± 9	42 ± 29
Sept 79	23 ± 9	74 ± 29
Sept 79	31 ± 10	100 ± 32
Sept 79	< 9	< 29
Ice Box Lake		
Oct 72	43 ± 14	138 ± 45
Sept 72	52 ± 13	167 ± 42
Sept 72	58 ± 13	187 ± 42

Table 24, cont'd

Collection Location and Date	Tritium Units	pCi/liter
Ice Box Lake		
Sept 72	44 ± 13	142 ± 42
Sept 72	56 ± 13	180 ± 42
Apr 73	60 ± 14	193 ± 45
Apr 73	66 ± 13	212 ± 42
Aug 73	52 ± 13	167 ± 42
Aug 73	61 ± 13	196 ± 42
May 74	74 ± 12	239 ± 39
May 74	46 ± 13	149 ± 42
Aug 74	23 ± 11	74 ± 36
Aug 74	20 ± 11	65 ± 36
Aug 75	31 ± 12	102 ± 40
Aug 75	57 ± 13	183 ± 41
Aug 76	49 ± 11	158 ± 36
Aug 76	43 ± 14	139 ± 45
Sept 77	23 ± 11	74 ± 36
Sept 77	< 14	< 45
Aug 78	40 ± 10	129 ± 32
Aug 78	12 ± 9	39 ± 29
Sept 79	54 ± 10	174 ± 32
Sept 79	18 ± 10	58 ± 32
DK-45 Lake		
July 72	49 ± 14	158 ± 45
Feb 72	54 ± 13	174 ± 42
Oct 72	33 ± 14	106 ± 45
Apr 72	46 ± 14	148 ± 45
Apr 73	37 ± 13	119 ± 42
Aug 73	70 ± 14	225 ± 45
May 74	36 ± 13	116 ± 42
Aug 74	26 ± 11	84 ± 36
Aug 75	< 13	< 42
Aug 76	17 ± 11	55 ± 36
Sept 77	27 ± 11	87 ± 36
Aug 78	31 ± 9	100 ± 29
Sept 79	24 ± 9	78 ± 29
Sand Beach Cove Seep Water		
Aug 75	45 ± 13	144 ± 41
Aug 76	21 ± 12	68 ± 39
Sept 77	26 ± 12	84 ± 39
Sept 77	38 ± 11	122 ± 36
Aug 78	49 ± 10	158 ± 32
Aug 78	26 ± 9	84 ± 29
Sept 79	25 ± 9	80 ± 29
Sept 79	20 ± 9	64 ± 29

Table 25. Tritium concentration in water samples collected at Long Shot drainage system, 1970-1979.

Collection location	Collection date	Tritium[a] units	pCi/liter[b]
Spring Draining into Mud Pit #3	Aug 78	792 ± 23	2558 ± 74
	Sep 79	54 ± 9	174 ± 29
Long Shot Mud Pit #3	Sep 70[c]	3100 ± 52	10,000 ± 170
	May 71[c]	4000 ± 68	12,920 ± 220
	Aug 71[c]	3400 ± 55	10,980 ± 180
	Aug 74	2900 ± 50	9400 ± 160
	Aug 75	867 ± 19	2802 ± 61
	Aug 76	1150 ± 23	3710 ± 74
	Sep 77	915 ± 23	2956 ± 74
	Aug 78	704 ± 21	2274 ± 68
	Sep 79	654 ± 20	2112 ± 65
Long Shot Mud Pit #2	Sep 70[c]	2300 ± 35	7429 ± 113
	May 71[c]	3000 ± 49	9690 ± 158
	Aug 71[c]	2500 ± 42	8075 ± 136
	Aug 76	1140 ± 23	3680 ± 74
	Sep 77	731 ± 20	2361 ± 65
	Aug 78	623 ± 20	2012 ± 65
	Sep 79	501 ± 20	1618 ± 65
Long Shot Mud Pit #1	Sep 70[c]	1600 ± 33	5168 ± 107
	May 71[c]	2100 ± 38	6783 ± 123
	Aug 71[c]	1700 ± 31	5491 ± 100
	Dec 71	480 ± 17	1550 ± 55
	Feb 72	2100 ± 38	6783 ± 123
	Apr 72	2200 ± 35	7080 ± 113
	Jul 72	2200 ± 33	7080 ± 106
	Sep 72	1700 ± 31	5471 ± 100
	Apr 73	2200 ± 41	7080 ± 132
	Aug 73	1600 ± 32	5149 ± 103
	May 74	1450 ± 29	4666 ± 93
	Aug 74	1103 ± 23	3549 ± 74
	Aug 75	122 ± 11	395 ± 36
	Aug 76	716 ± 12	2310 ± 39
	Sep 77	662 ± 18	2130 ± 58
	Sep 77	700 ± 20	225 ± 64
	Aug 78	492 ± 18	1589 ± 58
	Sep 79	383 ± 15	1237 ± 48
Long Shot Mud Pit Drainage 3 meters below Mud Pit #1	1975	872 ± 19	2820 ± 61
	1976	739 ± 18	2390 ± 58
	1978	529 ± 18	1709 ± 58
	1979	404 ± 15	1300 ± 48

Table 25, cont'd

Collection location	Collection date	Tritium[a] units	pCi/liter[b]
Infantry Road	1975	666 ± 16	2150 ± 52
	1976	342 ± 14	1100 ± 45
	1977	454 ± 16	1466 ± 52
	1978	394 ± 15	1273 ± 48
	1979	329 ± 14	1063 ± 45
100 meters below road	1975	424 ± 15	1370 ± 48
	1976	278 ± 14	898 ± 45
	1977	148 ± 13	478 ± 42
	1978	279 ± 13	901 ± 42
	1979	229 ± 12	740 ± 39
200 meters below road	1976	252 ± 13	814 ± 42
	1977	84 ± 12	271 ± 39
	1978	273 ± 14	879 ± 45
	1979	214 ± 12	691 ± 39
400 meters below road	1976	103 ± 12	333 ± 39
	1977	57 ± 12	184 ± 39
	1978	168 ± 11	543 ± 35
	1979	78 ± 10	252 ± 32
500 meters below road	1975	82 ± 13	264 ± 42
	1976	53 ± 11	171 ± 36
	1978	70 ± 10	226 ± 32
	1979	45 ± 9	145 ± 29
200 meters above Square Bay	1975	121 ± 13	390 ± 47
	1976	48 ± 11	155 ± 36
	1977	41 ± 12	132 ± 39
	1978	92 ± 10	297 ± 32
	1979	64 ± 9	207 ± 29
100 meters above Square Bay	1979	54 ± 9	174 ± 29
20 meters above Square Bay	1975	107 ± 13	347 ± 42
	1976	27 ± 11	87 ± 36
	1977	16 ± 12	52 ± 39
	1978	62 ± 10	200 ± 32
	1979	37 ± 10	120 ± 32

[a]Radionuclide values are means of replicate sample counts ± one-sigma propagated counting error.

[b]One TU equals 3.23 pCi/liter.

[c]Pre-Cannikin.

Table 26. Tritium in free water from biological samples collected at Amchitka Island

Sample Type and Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[c]
Fucus, entire				
Constantine Harbor	Aug 75	2	<35 ± 18	<110 ± 58
	Aug 76	1	35 ± 11	110 ± 36
	Sep 77	1	23 ± 10	74 ± 32
	Aug 78	1	15 ± 9	48 ± 29
	Sep 79	1	<8	<26
Square Bay	Aug 75	3	<26 ± 12	<84 ± 39
	Aug 76	2	25 ± 3	81 ± 10
	Sep 77	1	38 ± 11	122 ± 36
	Aug 78	1	53 ± 19	171 ± 61
	Sep 79	1	15 ± 9	48 ± 29
Sand Beach Cove	Aug 75	2	<21 ± 1	<68 ± 3
	Aug 76	3	31 ± 4	100 ± 13
	Sep 77	1	38 ± 11	90 ± 36
	Aug 78	1	<9	<29
	Sep 79	1	13 ± 9	42 ± 29
Duck Cove	Aug 76	3	23 ± 3	74 ± 10
	Sep 77	4	<13	<42
	Aug 78	1	<9	<29
Greenling, muscle				
Constantine Harbor	May 74	2	48 ± 4	155 ± 13
	Aug 75	1	<14	<45
	Aug 76	1	<21	<68
	Sep 77	2	<13	<42
	Aug 78	1	< 9	<29
	Sep 79	1	14 ± 9	45 ± 29
Square Bay	Aug 75	4	<20 ± 2	<65 ± 6
	Aug 76	1	<19	<62
	Sep 77	1	17 ± 10	55 ± 32
	Aug 78	1	< 9	<29
	Sep 79	1	<10	<32
Sand Beach Cove	May 74	3	94 ± 39	304 ± 126
	Aug 75	2	<20 ± 1	65 ± 3
	Aug 76	3	20 ± 7	65 ± 23
	Sep 77	1	<12	<39
	Aug 78	1	<10	<32
	Sep 79	1	28 ± 9	90 ± 29
Duck Cove	Aug 76	1	<46	<150
	Sep 77	1	<13	<42
	Aug 78	1	16 ± 9	52 ± 29

Table 26, cont'd

Sample Type and Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[c]
Dolly Varden, muscle				
Ice Box Lake	Oct 72	3	45 ± 9	145 ± 29
White Alice Creek	Aug 73	2	162 ± 52	523 ± 168
Bridge Creek (Intertidal area of Creek)	Aug 73	4	64 ± 3	207 ± 10
	Aug 75	2	16 ± 2	51 ± 6
Duck Cove	Aug 76	2	43 ± 9	140 ± 29
	Sep 77	1	<11	<36
	Aug 78	1	<9	<29
Jones Lake	May 74	3	68 ± 54	220 ± 174
	Aug 75	4	26 ± 16	85 ± 52
	Aug 76	1	58 ± 13	190 ± 42
	Sep 77	1	38 ± 11	123 ± 36
	Aug 78	1	<9	<29
	Oct 79	1	25 ± 11	81 ± 26
Cannikin Lake	Aug 75	1	39 ± 12	130 ± 39
	Aug 76	1	72 ± 17	230 ± 55
	Aug 78	1	22 ± 9	71 ± 29
	Oct 79	1	<10	<32
<u>Ranunculus</u>, entire				
Duck Cove Creek	Aug 73	2	68 ± 35	220 ± 113
White Alice Creek	Aug 73	2	89 ± 28	228 ± 90
Bridge Creek	Aug 76	2	<67	<220
	Aug 78	3	24 ± 4	81 ± 13
	Sep 79	1	13 ± 9	42 ± 29
Clevenger Creek	Aug 78	2	31 ± 1	100 ± 3
Long Shot Mud Pit #3	Aug 78	2	787 ± 7	2542 ± 23
	Oct 79	1	1027 ± 30	3317 ± 97
Long Shot Mud Pit #1	Oct 79	1	413 ± 17	1334 ± 55
Long Shot, Infantry Road	Oct 79	1	383 ± 18	1237 ± 58
Long Shot-200 m below Infantry Road	Oct 79	1	270 ± 15	872 ± 48
Long Shot-250 m below Infantry Road	Aug 78	1	143 ± 11	462 ± 36
Long Shot-400 m below Infantry Road	Aug 78	1	72 ± 10	233 ± 32
	Oct 79	1	105 ± 12	339 ± 39
Long Shot-500 m below Square Bay	Oct 79	1	53 ± 10	171 ± 32
Long Shot-100 m above Square Bay	Oct 79	1	309 ± 15	998 ± 48

Table 26, cont'd

Sample Type and Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[c]
Fontinalis, entire				
Clevenger Creek	Aug 76	4	102 ± 6	329 ± 19
	Sep 77	1	27 ± 16	87 ± 52
	Aug 78	3	38 ± 6	123 ± 19
	Nov 78	1	37 ± 9	120 ± 29
	Sep 79	1	46 ± 11	149 ± 36
Ice Box Lake Inlet	Aug 76	3	37 ± 16	120 ± 52
	Sep 77	2	54 ± 9	174 ± 29
	Aug 78	3	32 ± 1	103 ± 3
White Alice Creek (Cannikin Lake Drainage)	Aug 75	2	39 ± 28	126 ± 91
	Aug 76	5	71 ± 15	229 ± 48
	Sep 77	3	32 ± 9	103 ± 29
	Aug 78	3	32 ± 4	103 ± 13
	Sep 79	1	35 ± 11	113 ± 36
Bridge Creek	Feb 78	1	<10	<32
	Aug 78	1	<9	<29
	Sep 79	1	44 ± 11	142 ± 36
Long Shot Mud Pit #2	Oct 79	1	721 ± 24	2329 ± 78
Long Shot-200 m above Square Bay	Aug 75	2	85 ± 14	275 ± 45
	Sep 77	1	107 ± 12	346 ± 39
	Aug 78	1	95 ± 10	307 ± 32
	Oct 79	1	87 ± 12	281 ± 39
Long Shot-20 m above Square Bay	Aug 76	1	150 ± 15	480 ± 48
	Sep 77	1	62 ± 11	200 ± 36
	Aug 78	1	97 ± 11	313 ± 36
	Oct 79	1	49 ± 9	158 ± 29
Ptarmigan, muscle				
Camp Area	Aug 76	2	<21	<68
	Sep 77	1	21 ± 10	68 ± 32
	Aug 78	1	17 ± 9	55 ± 29
	Sep 79	1	<10	<32
Milrow/Long Shot	Aug 76	2	40 ± 17	130 ± 55
	Sep 77	2	35 ± 5	113 ± 16
	Aug 78	1	<9	<29
	Sep 79	1	15 ± 10	48 ± 32
Cannikin Area	Aug 76	1	36 ± 18	120 ± 58
	Aug 78	1	10 ± 10	32 ± 32
	Sep 79	1	16 ± 10	52 ± 32

[a] n equals the number of free water samples from a single tissue sample.

[b] Radionuclide values for single samples (n=1) are a mean of a repeated count of the sample ± a one-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of these individual sample values.

[c] One TU equals 3.23 pCi/liter.

Table 27. Iron-55 in fish collected at Amchitka Island, 1969-1974.

Species and collection location	Collection date	N[a]	Tissue	^{55}Fe (pCi) / g, dry	Fe (mg) / g, dry	^{55}Fe (pCi) / mg Fe
Halibut						
	Sep-Oct 69	1/1	Muscle	0.31	0.031	10.1
C-Site Bering Sea	Sep-Oct 70	1/26	"	0.117	0.009	12.7
"	"	2/27	Liver	2.48	0.185	13.4
Sand Beach Cove	Aug-Oct 72		Muscle	0.35 ±0.02	0.051	6.86
"	"		Liver	3.07 ±0.08	0.099	31.0
Kirilof Pt.	"		Muscle	0.36 ±0.02	0.034	10.6
"	"		Liver	3.07 ±0.06	0.146	21.0
Sand Beach Cove	Apr-Aug 73		Muscle	0.014±0.008	0.014	1.0
"	"		Liver	0.28 ±0.04	0.073	3.8
"	"		Muscle	0.16 ±0.01	0.037	4.3
"	"		Liver	0.80 ±0.02	0.12	6.7
"	"		Ovary	0.66 ±0.01	0.075	8.8
Constantine Harbor	Aug 74		Liver	1.960±0.063	0.39	5.0
"	"		"	2.435±0.065	0.29	8.4
Greenling						
S-8	Sep-Oct 70	5/60	Muscle	0.559	0.04	13.2
"	"	5/60	Liver	8.33	0.58	14.3
"	"	4/45	Kidney	13.2	0.47	28.1
"	"	4/55	Gonad	12.5	0.28	45.4
Constantine Harbor	Aug-Sep 72		Muscle	0.05 ±0.02	0.029	1.72
Sand Beach Cove	"		"	0.17 ±0.02	0.018	0.94
Duck Cove	"		"	0.04 ±0.01	0.053	0.75
Sand Beach Cove	Apr-Aug 73		"	0.051±0.008	0.018	2.8
"	"		Liver	0.51 ±0.06	0.83	0.61
Constantine Harbor	"		Muscle	0.049±0.007	0.029	1.7
"	"		Liver	3.1 ±0.22	2.7	1.1
Duck Cove	"		Muscle	0.022±0.007	0.029	0.76
"	"		Liver	0.62 ±0.09	1.3	0.48

Table 27, cont'd

Species and collection location	Collection date	N[a]	Tissue	^{55}Fe (pCi) / g, dry	Fe (mg) / g, dry	^{55}Fe (pCi) / mg Fe
Greenling, cont'd						
Constantine Harbor	May 74	5	Muscle	0.035±0.008	0.005	7.0
"	"	5	Viscera	0.569±0.194	2.4	0.24
Duck Cove	May 74	3	Muscle	0.055±0.009	0.019	2.9
"	"	3	Viscera	0.215±0.102	1.3	0.17
Sand Beach Cove	"	5	Muscle	0.083±0.014	0.022	3.8
"	"	5	Viscera	0.225±0.069	0.97	0.23
"	Aug 74	4	Muscle	0.183±0.018	0.042	4.4
"	"		Viscera	0.464±0.091	3.6	0.13
Dolly Varden						
	Sep-Oct 69	11	Muscle	0.19 ±0.19	0.025±0.007	7.82± 9.01
	"	7	Liver	10.8 ±14.6	0.71 ±0.30	16.3 ±20.3
Square Bay, S-8	Sep-Oct 70	2/22	Muscle	1.63	0.02	91.3
"	"	2/22	Liver	3.70	0.05	78.4
DE-45 Lake	Aug-Oct 72		Muscle	0.23 ±0.02	0.042	5.5
"	"		"	0.49 ±0.10	0.039	12.6
Silver Salmon Outlet	Apr-Aug 73		"	0.049±0.011	0.031	1.6
"	"		Liver	2.1 ±0.1	1.1	1.9
Jones Lake	May 74		Muscle	N.S.	0.023	--
"	"		Viscera	N.S.	3.04	--
"	Aug 74		Muscle	0.036±0.014	0.016	2.3
"	"		Viscera	0.143±0.041	0.53	0.27
"	"		Muscle	0.093±0.017	0.031	3.0
"	"		Viscera	0.573±0.044	0.78	0.73
"	"		Muscle	0.080±0.020	0.039	2.1
"	"		Viscera	0.504±0.107	1.05	0.48
"	"		Bone	0.164±0.044	0.019	8.6
Cannikin Lake	"		Muscle	0.043±0.014	0.024	1.8
"	"		Viscera	0.191±0.071	0.85	0.22

Table 27, cont'd

Species and collection location	Collection date	N[a]	Tissue	^{55}Fe (pCi) / g, dry	Fe (mg) / g, dry	^{55}Fe (pCi) / mg Fe
Silver Salmon						
	Sep-Oct 69	1	Muscle	1.60	0.048	33.5
	"	1	Liver	18.1	0.19	95.1
S-8	Sep-Oct 70	1/1	"	21.1	0.25	83.8
Pink Salmon						
	Sep-Oct 69	2	Muscle	6.70 ±4.29	0.074±0.051	93.1 ± 6.6
	"	2	Liver	58.8 ±8.0	0.59 ±0.03	99.6 ± 9.1
S-8	Sep-Oct 70	1/1	"	55	0.84	65.1
Midden Cove	Aug-Oct 72		Muscle	0.54 ±0.02	0.029	18.6
"	"		"	1.06 ±0.02	0.051	20.8
"	"		"	0.39 ±0.02	0.024	16.2
"	"		"	0.46 ±0.04	0.032	14.4
"	"		Liver	14.5 ±0.1	0.678	21.4
Signal Cove	Aug 74		Eggs	1.036±0.031	0.088	11.8
"	"		Muscle	0.418±0.016	0.035	11.9
Chapel Cove St.	"		Muscle	0.361±0.015	0.037	9.8
"	"		Viscera	12.732±0.118	0.96	13.2
Chum Salmon						
	Sep-Oct 69	7	Muscle	1.64 ±1.22	0.026±0.008	59.8 ±28.5
	"	7	Liver	71.8 ±45.2	0.68 ±0.24	100 ±31
Kirilof Pt	Aug-Oct 72		Muscle	0.45 ±0.02	0.025	18.0
"	"		"	0.56 ±0.03	0.026	21.5
"	"		Liver	7.1	0.31	22.9
Sockeye Salmon						
	Sep-Oct 69	5	Muscle	1.31 ±0.45	0.023±0.004	58.0 ±22.4
	"	6	Liver	76.8 ±25.6	0.85 ±0.41	102 ±36

Table 27, cont'd

Species and collection location	Collection date	N[a]	Tissue	^{55}Fe (pCi) / g, dry	Fe (mg) / g, dry	^{55}Fe (pCi) / mg Fe
Pacific Cod						
	Sep-Oct 69	7	Muscle	0.69 ±0.52	0.012±0.006	69.5 ±55.3
	"	6	Liver	5.64 ±5.81	0.10 ±0.06	71.8 ±86.8
St. Makarius Pt.	Aug-Oct 72		Muscle	0.055	0.06	0.91
"	"		Muscle	0.021	0.004	5.24
True Cod						
St. Makarius Pt.	May 74		Muscle	0.09 ±0.03	0.019	4.7
Alaska Pollock						
	Sep-Oct 69	2	Muscle	0.90 ±0.25	0.013±0.000	71.8 ±21.8
Pacific Ocean Perch						
	Sep-Oct 69	1	Muscle	3.55	0.014	254
	"	1	Liver	66.8	0.31	216
Rockfish						
S-8, Constantine Harbor	Sep-Oct 70	2/11	Muscle	1.84	0.01	173
"	"	2/11	Liver	16.9	0.41	41.4
"	"	2/11	Kidney	21.0	0.03	65.5
Rock Sole						
	Sep-Oct 69	3	Muscle	0.12 ±0.02	0.015±0.007	9.71± 4.61
	"	3	Liver	7.04 ±2.20	0.20 ±0.003	33.6 ±10.3
C-Site	Sep-Oct 70	2/46	Muscle	1.76	0.010	185
		1/26	Liver	1.41	0.28	4.95
		1/26	Kidney	16.1	0.35	45.7
		1/26	Gonad	23.2	0.04	516

Table 28. Strontium-90 in bone samples from rats and ptarmigan and in soil samples collected at Amchitka Island.

Collection Date	n[a]	Collection Location	Sample Type	pCi ^{90}Sr/g, dry[b]
1971[c]	2	Sand Beach Cove	Rat, bone	1.6 ± 1.3
1971	2	"	"	5.8 ± 5.9
1973	1	"	"	1.9 ± 2.0
1975	1	"	"	0.5 ± 0.2
1976	1	"	"	<1.3
1977	1	"	"	<0.78
1978	1	"	"	0.63 ± 0.04
1979	1	"	"	<0.11
1973	1	Other Sites[d]	Rat, Bone	1.8 ± 0.4
1974	2	"	"	1.6 ± 1.1
1975	2	"	"	1.4 ± 0.3
1976	5	"	"	<1.3
1977	3	"	"	<0.80
1978	3	"	"	2.1 ± 5.2
1979	3	"	"	1.1 ± 1.1
1971	1	Cannikin Area	Ptarmigan, bone	31.0 ± 3.6
1975	1	"	"	13.0 ± 1.0
1976	1	"	"	14.0 ± 2.6
1977	1	"	"	17.0 ± 1.4
1978	1	"	"	13.0 ± 1.0
1979	1	"	"	13.0 ± 1.0
1971[c]	1	Milrow/Long Shot	Ptarmigan, bone	27.0 ± 3.2
1973	1	"	"	11.0 ± 0.8
1975	1	"	"	14.0 ± 1.4
1976	1	"	"	19.0 ± 2.4
1977	1	"	"	16.0 ± 1.2
1978	1	"	"	9.6 ± 0.6
1979	1	"	"	9.7 ± 1.2

Table 28, cont'd

Collection Date	n[a]	Collection Location	Sample Type	pCi ^{90}Sr/g, dry[b]
1971	2	Other Sites[e]	Ptarmigan, bone	27.0 ± 12.0
1973	1	"	"	14.0 ± 0.8
1974	1	"	"	16.0 ± 9.2
1975	1	"	"	19.0 ± 2.8
1976	2	"	"	26.0 ± 0.4
1977	1	"	"	15.0 ± 1.4
1978	1	"	"	10.0 ± 0.8
1979	1	"	"	9.6 ± 1.2
1975	1	Main Camp	Soil	0.03 ± 0.02
1976	3	"	"	<0.03
1977	1	"	"	<0.14
1978	1	"	"	0.06 ± 0.10
1979	1	"	"	0.13 ± 0.12
1975	1	Cannikin Area	Soil	<0.16
1976	3	"	"	<0.04
1977	3	"	"	<0.14
1978	3	"	"	0.21 ± 0.26
1979	1	"	"	0.11 ± 0.08

[a] Each bone sample obtained from 2 to 4 individuals.

[b] Radionuclide values for single samples (n=1) are a mean of a repeated count of the sample ± two sigma, propagated, counting error. The radionuclide values for more than one sample is the mean ± one standard deviation of those individual sample values. Since 1976 a correction was made for reagent contaminants and, in 1977, an additional correction for residual sample contaminants. The maximum net effect of these correction on sample values, in terms of pCi per gram of sample, is about 0.5 for rat samples (3 g) 0.3 for ptarmigan (5 g) and 0.03 for soils (50 g).

[c] Pre-Cannikin.

[d] Main dump, Duck Cove, Constantine Harbor, Camp Area, Bridge Creek and Clevenger Creek (mouth).

[e] Main camp, mile post 8, Silver Salmon Lake, mile 18.

Table 29. Plutonium-239,240 in *Fucus*, greenling, and sand and soil samples collected at Amchitka Island.

Sample type and collection location	Collection date	$^{239,240}Pu$ pCi/g, dry[a]
Fucus, entire		
Sand Beach Cove	Aug 75	0.006 ± 0.002
	Aug 76	0.003 ± 0.002
	Sep 77	0.002 ± 0.002
	Aug 78	0.003 ± 0.0008
	Sep 79	0.004 ± 0.001
Constantine Harbor	Aug 75	0.002 ± 0.002
	Aug 76	< 0.002
	Sep 77	0.002 ± 0.0006
	Aug 78	0.003 ± 0.0006
	Sep 79	0.001 ± 0.0004
Square Bay	Aug 76	0.003 ± 0.002
	Sep 77	0.005 ± 0.002
	Aug 78	0.003 ± 0.001
	Oct 79	0.002 ± 0.001
Duck Cove	Sep 77	0.002 ± 0.0008
	Aug 78	0.003 ± 0.001
	Sep 79	0.003 ± 0.0008
Greenling, muscle		
Sand Beach Cove	Aug 75	< 0.002
	Aug 76	< 0.002
	Sep 77	0.001 ± 0.0004
	Aug 78	< 0.001
	Sep 79	< 0.0005
Constantine Harbor	Aug 75	< 0.003
	Aug 76	< 0.002
	Sep 77	< 0.0001
	Aug 78	< 0.001
Sand, surface[b]		
Sand Beach Cove	Aug 75	0.004 ± 0.002
	Aug 76	< 0.001
	Sep 77	0.001 ± 0.0006
	Aug 78	< 0.001
	Sep 79	0.004 ± 0.001
Constantine Harbor	Aug 75	< 0.002
	Aug 76	0.003 ± 0.002
	Sep 77	0.005 ± 0.002
	Sep 79	0.003 ± 0.001

Table 29, cont'd

Sample and collection location	Collection date	$^{239,240}Pu$ pCi/g, dry[a]
Soil surface		
Cannikin Area Drillback #1	Aug 75	0.015 ± 0.004
	Aug 76	0.008 ± 0.002
	Sep 77	0.005 ± 0.006
	Aug 78	0.003 ± 0.002
	Sep 79	0.007 ± 0.004
Cannikin Area Drillback #2	Aug 76	< 0.002
	Sep 77	0.002 ± 0.0008
	Aug 78	0.005 ± 0.001
	Sep 79	0.001 ± 0.001
Cannikin Area Drillback #3	Aug 76	0.009 ± 0.005
	Sep 77	0.001 ± 0.0001
	Aug 78	0.004 ± 0.001
Camp Area	Aug 75	0.001 ± 0.001
	Aug 76	< 0.002
	Aug 76	0.005 ± 0.003
	Aug 76	0.006 ± 0.004
	Sep 77	0.004 ± 0.002
	Aug 78	0.004 ± 0.001

[a]The radionuclide value for these single samples is a single count of the sample ± the two sigma, propagated counting error.

[b]Surface samples were the 0 to 2.5 cm layer.

Table 30. Background radiation at selected sites on Amchitka Island.

	Average reading, mR/hr[a]						Maximum reading, mR/hr[a]					
Location	1974	1975	1976	1977	1978	1979	1974	1975	1976	1977	1978	1979
Decon Facility	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.04	0.03	0.04	0.03	0.06
Inside "D" Barracks	0.01	<0.01	0.01	0.01	0.01	0.03	0.04	0.04	0.04	0.05	0.03	0.06
Husky Camp	<0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.04	0.05	0.05	0.06
Jones Creek Effluence	<0.01	<0.01	0.01	0.01	0.01	0.03	0.04	0.04	0.03	0.04	0.03	0.06
EIC Calibration Range	<0.01	0.01	0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.05	0.03	0.05
Rifle Range Target Area	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.04	0.06	0.03	0.06
Duck Cove	<0.01	<0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.05	0.03	0.06
Milrow SGZ & Vicinity	<0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.04	0.06	0.05	0.02	0.06
Long Shot SGZ & Vicinity	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.05	0.05	0.04	0.04	0.06
Cannikin SGZ & Vicinity	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.06
Cannikin Drillback	0.01	0.01	0.01	0.01	0.01	0.04	0.05	0.04	0.05	0.05	0.04	0.07
Sand Beach Cove	<0.01	<0.01	0.01	0.01	0.02	0.03	0.04	0.04	0.04	0.06	0.03	0.06
D-Site	0.01	<0.01	0.01	0.01	0.02	0.03	0.05	0.03	0.04	0.05	0.03	0.05
E-Site	0.01	<0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.03	0.03	0.06

[a]Eberline G-M detector, Model E-150, probe window thickness less than 2 mg/cm^2.

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