AMCHITKA RADIOBIOLOGICAL PROGRAM PROGRESS REPORT JULY 1970 TO APRIL 1971

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ABSTRACT

This report concerns the program designed to provide periodic documentation of radionuclides in biological and environmental samples from Amchitka Island. Samples collected in September 1970, and fish collected in September 1969, contained radionuclides that were naturally occurring, from worldwide atmospheric 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 test wells near the surface ground zero of the Long Shot nuclear detonation. The concentrations of the radionuclides found were small and within the range of values reported for similar samples from other parts of the northern hemisphere. Iron-55 was the predominant fallout radionuclide in fish. Other fallout radionuclides identified in various samples were ^{46}Sc , ^{54}Mn , ^{60}Co , ^{65}Zn , ^{95}Zr - ^{95}Nb , ^{103}Ru , ^{106}Ru - ^{106}Rh , $^{108\text{m}}\text{Ag}$, $^{110\text{m}}\text{Ag}$, ^{125}Sb , and ^{137}Cs .

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1. INTRODUCTION

The present Amchitka Radiobiological Program by the University of Washington's Laboratory of Radiation Ecology was initiated in July 1970, at the request of the U. S. Atomic Energy Commission, Nevada Operations Office (AEC/NVOO)¹. The program is designed to provide a periodic documentation of radionuclides, both naturally occurring and man-made, in biological and environmental samples from Amchitka and its environs. Seafoods and radionuclides potentially available to man through the food web are emphasized. However, organisms other than food organisms are also collected and analyzed in a search for indicator organisms (species that concentrate one or more radionuclides). Concentrations of radionuclides other than those potentially hazardous to man are measured as a means of providing clues to the origin of radionuclides at Amchitka. Unusual combinations or concentrations of radionuclides would indicate divergence from what is expected from worldwide fallout or nuclear-powered vessels, and would determine whether radionuclides from previous nuclear tests at Amchitka (Long Shot in 1965 and Milrow in 1969) remain contained underground. The program complements other Amchitka radiological surveillance studies being conducted by the U. S. Geological Survey, Teledyne Isotopes, and others primarily concerned with the measurement of tritium as the most likely indicator of seepage from the underground tests.

Another aspect of the program is the accumulation of data useful for estimating transfer coefficients and concentration factors which, in turn, can be used to predict the fate of radionuclides released from nuclear detonations or other sources. Thus, both because of the immediate practical need to identify the source of radionuclides at Amchitka and because of the opportunity to obtain basic data, specific radionuclides are being determined rather than just the gross beta or gross gamma radioactivity. Figure 1 shows collection and sampling areas discussed here.

Radionuclides, especially ^{137}Cs , ^{90}Sr , and ^{55}Fe , in current worldwide fallout result mainly from the detonation of more than 100 megatons of nuclear devices by the U.S.S.R. and the U.S. in 1961 and 1962.² In addition, worldwide fallout contains short-lived radionuclides, such as ^{95}Zr - ^{95}Nb , ^{103}Ru - ^{103}Rh , and ^{106}Ru - ^{106}Rh , from the French and Chinese tests, which started in 1964 and continue today. (The Chinese test site, at 40°N , is more important, relative to Amchitka, which lies at 51°N , generally downwind from the test site than the French test site located at 22°S .) There are well-documented seasonal changes in worldwide fallout deposition with the highest concentrations occurring in the spring in the Northern Hemisphere.³ Superimposed on these changes are seasonal differences in the abundance, feeding habits, and physiological condition of the organisms.

The radiobiological program is a small part of ecological studies being conducted by other groups at Amchitka. The latter studies are both the source of samples for obtaining radiological data and the source of basic ecological information which aids in interpreting the data. Discussion of these other programs and a description and brief history of Amchitka may be found

¹Battelle Columbus Laboratories, Columbus, Ohio, performed a radiological study beginning in 1967. (See References 4 and 13.)

²HASL-227. p. I-87 (1970)

³Radiological Health Data & Reports

AMCHITKA ISLAND ALASKA

LOCATION MAP

FIGURE 1. LOCATION MAP

SHADED AREAS ARE
SHOWN IN DETAIL IN
FIGURES 2, 3, & 4

in Reference 8. The proceedings of a symposium on Amchitka Island Bioenvironmental studies were published in June 1971 (Reference 12). Other pertinent studies are in References 4, 6, 10, and 13.

Table 1 lists the scientific and common names as well as the wet weight to dry weight ratios of some Amchitka organisms.

2. METHODS

The radiobiological program is divided into two phases. The first phase was to collect and analyze tissues of the relatively abundant species in the area. During the second phase, begun in February 1971, tissues or organs of species which appear to be the best indicators of the presence of fallout radionuclides are being analyzed. These organisms and water samples are collected quarterly from selected sites. Air samplers are operated continuously to collect airborne particulates on Whatman No. 42 filter paper. Filters are changed twice a month and analyzed.

Site selection and collections for both phases of the program are coordinated with those of the Fisheries Research Institute's (FRI) Marine Biology Program at Amchitka. Locations are given both by local names and by the 1000-meter universal grid systems or longitude and latitude where possible (Figures 2, 3, and 4).

Essentially all samples were analyzed by gamma-ray spectrometry with NaI(Tl) crystals. Selected samples were analyzed in greater detail with a Ge(Li) diode system. Chemical separation and X-ray spectrometry were used for ^{55}Fe determinations. Tritium was measured by liquid scintillation counting.

A filter-sorption bed developed by Battelle Northwest Laboratories (Reference 11) was used for large-volume (500-4000 liters) 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 an aluminum oxide sorption bed. 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 the filters 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.

3. RESULTS

The results reported here are for samples collected by the FRI and others under the Battelle Memorial Institute Amchitka Bioenvironmental Programs before the Milrow test in 1969, for samples collected in cooperation with the FRI in September 1970, and for a few samples collected in October 1970 and February 1971.

The results of gamma spectrum analyses of the large-volume water samples are given in Table 2. Quantitative results are given for the filters, or particulate fraction of all samples. For two samples the soluble fractions retained on the aluminum oxide were analyzed quantitatively. The remaining Al_2O_3 samples have been analyzed qualitatively but not quantitatively. As presently constituted, the filter-sorption bed will not retain ^{137}Cs ; a KCFC bed or cartridge, which is a specific cesium collector, will be added

for the pre-Cannikin collections in the fall of 1971. Radionuclides found in these samples by the gamma spectrum analysis were ^{46}Sc , ^{54}Mn , ^{60}Co , ^{65}Zn , ^{108}mAg , and ^{110}mAg . The highest concentrations of ^{46}Sc were at and below the thermocline at the station farthest from shore on the Pacific Ocean side of Amchitka. Scandium-46 was identified at other stations but not quantified because of the small amount present relative to ^{65}Zn .

Manganese-54 was identifiable, but at the limit of detection, which in these samples was approximately 1 to 4 pci per cubic meter, depending on the volume of water pumped and the amount and kinds of other radionuclides present.

Cobalt-60, ^{65}Zn , and ^{110}mAg were present in all seawater samples. Silver-108m was identified qualitatively in the samples taken from the station farthest offshore. The maximum concentration in the particulate fraction for any of these radionuclides was 169 pCi of ^{65}Zn per cubic meter. The soluble fraction for the same sample contained 339 pCi of ^{65}Zn per cubic meter, uncorrected for collection efficiency of the aluminum oxide in seawater, which is approximately 45 percent (Reference 11). With corrected values, the average total ^{65}Zn concentration in the two samples in which both the particulate and soluble fractions were measured, is 1042 pCi per cubic meter. The particulate fraction contains 13 percent of the total zinc. Foster et al. (Reference 2) reported that 5 percent of the ^{65}Zn off the southern Washington coast was in particulate form. On the other hand, it was reported that, at the same station, 50 percent of ^{60}Co of Columbia River origin was in the particulate form, whereas in waters off Amchitka, 10 percent of the ^{60}Co was in particulate form. These differences probably reflect different origins of the radionuclides in the two areas. It is not known whether data concerning the relative amounts of soluble and particulate ^{110}mAg in seawater are available for comparison with the Amchitka data.

Large-volume water samples of the freshwater at both the Long Shot site mud pits and Jones Lake (a control station) revealed a different spectrum of radionuclides than were found in seawater. Only the filters have been analyzed quantitatively. They contain ^{95}Zr - ^{95}Nb , ^{103}Ru , and ^{137}Cs and naturally occurring ^{232}Th , not seen in the seawater samples, in addition to ^{60}Co and ^{65}Zn . The ^{137}Cs must be incorporated in biological material trapped by the filter. Analyses of filter samples taken in September 1970 and February 1971 at the Long Shot mud pits, show more than a two-fold decrease in ^{95}Zr - ^{95}Nb and ^{103}Ru - ^{103}Rh concentration and the absence of ^{60}Co , ^{65}Zn and ^{232}Th in the February collection. However, this apparent reduction is probably fortuitous, since Jones Lake, sampled only in February 1971, showed higher concentrations of ^{95}Zr - ^{95}Nb and ^{103}Ru than the Long Shot mud pits at either collection date. Also, some large-volume water samples collected in Lake Washington, Seattle, Washington in April and June 1971, contained higher concentrations of ^{95}Zr - ^{95}Nb than did the Long Shot site samples (work in progress). Jones Lake lies more than 3 miles southeast of Long Shot and Milrow sites in a separate watershed and hence could not be contaminated with seepage from either site. The detection of ^{60}Co in September 1970, but not in February 1971, cannot be explained.

The most abundant fallout radionuclide in fish samples at Amchitka is ^{55}Fe (Table 3), as it is in fish throughout the Northern Hemisphere. The distribution of ^{55}Fe in man and fish is being studied internationally but, until now, there were no data for the Amchitka area.

FIGURE 2. COLLECTION LOCATIONS. OVERLAY OF LRL CHART OF JANUARY 1971. UTM COORDINATES 49-55 AND 96-08.

FIGURE 3. COLLECTION LOCATIONS. OVERLAY OF LRL CHART OF JANUARY 1971. UTM COORDINATES 55-60 AND 93-99.

Thus far, only fish tissues from the September 1969 collection have been analyzed for ^{55}Fe . The values are within the range recently reported 8.9 to 221 pCi ^{55}Fe /mg Fe in North Atlantic cod (Reference 6). In general, the Amchitka fish with the lowest values are the Dolly Varden, whereas the chum and sockeye salmon generally have the highest concentrations of ^{55}Fe , as well as the highest specific activities. Although the ^{55}Fe concentrations in cod and perch are lower than those in chum and sockeye salmon, the specific activities are similar in some samples.

Fish from both the 1969 and 1970 collections contained only small amounts of, or no, gamma-emitting radionuclides other than naturally occurring ^{40}K . Cobalt-60, ^{65}Zn , and ^{137}Cs were found in some marine samples but at concentrations close to the limits of detection³. (See Table 4.)

Cesium-137 was found consistently in the muscle tissue of Dolly Varden. Seymour and Nakatani reported average ^{137}Cs values of 0.60 and 0.64 pCi/g dry in muscle tissue of Dolly Varden collected at Amchitka before and after the Long Shot test in 1965 (Reference 10). The average value of Dolly Varden muscle samples collected in September 1969 was 0.56 pCi/g dry with a range of 0.0 to 1.8 pCi/g dry. In September 1970, the average value was 0.32 pCi/g dry, and the range, 0.29 to 0.34 pCi/g dry. These values are within the range of values reported for muscle of salmon from Alaskan waters in 1967 (Reference 5) and are less than the ^{137}Cs values in plaice and cod from Icelandic and North Sea fishing grounds from 1963 to 1969 reported by Preston (Reference 9).

Some marine invertebrates sampled at Amchitka in September 1970, contained ^{95}Zr - ^{95}Nb in addition to naturally occurring ^{40}K , but generally at levels close to the limits of detection (see Table 5). The sponges were collected by FRI scuba divers along or close to the fault in Duck Cove, believed to have shifted at the time of the Milrow test. The source of the ^{95}Zr - ^{95}Nb is mainly from the recent Chinese nuclear tests with a possible minor contribution from French tests in the South Pacific. Although traces of ^{60}Co , ^{65}Zn and ^{137}Cs were found in a few samples, the values are not included in the table because the few significant values found were close to the limits of detection; the two sigma, propagated, counting errors for single samples were 50 percent of the values or greater. The maximum values in pCi/g dry were: ^{60}Co , 0.81 ± 0.43 ; ^{65}Zn , 1.8 ± 1.4 ; ^{137}Cs , 2.2 ± 1.3 .

Marine algae also were collected along or near the fault, as well as in other areas in September and October 1970, (see Table 6). The algae, along with the sponges, have advantages as indicator organisms. They are sessile, hence their location throughout life is known, they concentrate certain radionuclides, and large samples are usually easily obtained and processed. Thus the limits of detectability on a unit mass basis are low.

³The limits of detection depend on size of sample and the concentrations and kinds of other radionuclides present in the sample. However, if the sample counted consists of 100 g/dry weight of fish muscle tissue containing the radionuclides found in these samples, we estimate the following limits of detection in pCi/g: ^{60}Co , 0.05; ^{65}Zn , 0.1; ^{137}Cs , 0.04.

Measurable concentrations of ^{95}Zr - ^{95}Nb were found in all marine algal samples; the values ranged from 0.12 to 0.66 pCi/g dry weight with an average value of 0.31 pCi/g dry. These concentrations of ^{95}Zr - ^{95}Nb are higher than those found in other marine organisms from Amchitka, although the values for some sponges approached these levels. The ^{95}Zr - ^{95}Nb is probably absorbed on the algal surfaces rather than being metabolized and incorporated in the tissues (Reference 3). Cesium-137 was also present in most marine algal samples but in lower concentrations than ^{95}Zr - ^{95}Nb . Naturally occurring ^{40}K was by far the predominant radionuclide; in most samples the ^{40}K concentrations were more than 100 times the ^{95}Zr - ^{95}Nb concentrations.

Freshwater plants contained markedly higher concentrations of ^{95}Zr - ^{95}Nb than the marine algae (see Table 7). The range of values was from 0.87 to 12.0 pCi/g dry weight, with the highest value in periphyton collected at the Long Shot mud pit. Freshwater plants also contained ^{60}Co , ^{103}Ru , ^{125}Sb and ^{137}Cs ; however, ^{60}Co was not detectable in the filamentous algae, Cladophora. Periphyton is obviously a good indicator of the presence of radionuclides and it would be expected that had radionuclides other than those from worldwide fallout been present in the Long Shot mud pits, they would have been detected in the periphyton. The results of the large-volume water samples discussed on page 8, which showed higher radionuclide concentrations in water at Jones Lake than at Long Shot mud pits, demonstrate that the higher radionuclide concentration in periphyton than in other freshwater plants sampled is because of species differences in the efficiency of concentration of radionuclides.

Lichens, known to be excellent fallout collectors, were collected in September and October 1970. As would be expected from the results of numerous studies of lichens in other parts of the world, ^{137}Cs was the predominant radionuclide in the lichens at concentrations of 13, 18, and 20 pCi/g in the three samples collected (see Table 8). Other fallout radionuclides measured in the lichens were ^{54}Mn , ^{60}Co , ^{95}Zr - ^{95}Nb , ^{106}Ru - ^{106}Rh , and ^{125}Sb . The results of the reduction of gamma-ray spectra taken with NaI(Tl) detectors indicate that small amounts of unidentified radionuclides might also have been present. However, unidentified gamma-emitting radionuclides in any substantial amount, relative to the radionuclides known to be present, would have been identified, at least qualitatively, with the Ge(Li) system which was also used for these samples.

Radionuclides in air filters have thus far been analyzed qualitatively. The nuclides found are consistent with those found in the biota and water samples, with the exceptions of ^{46}Sc , $^{110\text{m}}\text{Ag}$ and $^{108\text{m}}\text{Ag}$, which were detected only in the large-volume seawater samples.

Tritium was measured in seawater and freshwater samples to indicate where Long Shot-produced and Milrow-produced radionuclides were most likely to be found (see Figure 5). The maximum sensitivity of the method used is 200 ± 200 T.U. The results, given in Table 9, show that the only locations where tritium concentrations were significantly above detectable limits were in the immediate vicinity of the Long Shot ground zero site. This is in agreement with the more extensive tritium surveys by Essington (Reference 1) and Koranda (Reference 7).

The Long Shot mud pits sampled by Koranda in August 1970, and by the Laboratory of Radiation Ecology (LRE) of the University of Washington in September 1970, may exhibit an increasing tritium concentration gradient from mud pits 1 to 3 (Koranda's sample numbers 217-219).

<u>Sample No.</u>		<u>Tritium Units</u>	
<u>Koranda</u>	<u>LRE</u>	<u>Koranda</u>	<u>LRE⁴</u>
217	Mud Pit 1	1580	1680
218	" " 2	1630	2460
219	" " 3	1890	3460

Although the errors in both sampling and measurement are large, it is an interesting conjecture that there may be a tritium concentration gradient within Mud Pit 3 that would indicate the source of tritium to the mud pits.

4. RECOMMENDATIONS

Since the large-volume water samples are proving to be the most sensitive indicators of radionuclides in freshwater and seawater, they should be used more extensively in the future. It is proposed that samples be taken approximately quarterly at the FRI fault area (Duck Cove), at a lake near C-site, and at sea when possible, in addition to the samples being taken at the Long Shot mud pit, Jones Lake, and Constantine Harbor. Additional samples should be taken from any area where unusual concentrations of tritium might be reported.

Replicate samples should be collected simultaneously at one freshwater and one seawater station, at least, to estimate the variability of results due to sampling errors.

The efficiency of the sorption bed for the recovery of several radionuclides has been reported by BNL (Reference 8) but there is a need to determine the collection efficiencies for radionuclides in waters at Amchitka. It is possible that some of the radionuclides are in different chemical forms in different areas, and data for some of the radionuclides found at Amchitka were not reported by BNL.

Collection efficiencies will be determined with spiked water samples in the laboratory. A second method will be used in the field at Amchitka. Two samplers will be attached in series at both a freshwater and seawater station. If it is assumed that the collection efficiency for a given radionuclide in a given water mass is constant, the value of the constant can be calculated with the equation:

$$K = 1 - \frac{b}{a}$$

⁴Averages of two aliquots (see Table 9).

LONG SHOT GROUND ZERO VICINITY

FIGURE 5

where K = the recovery constant for a specific radionuclide

a = The amount of the radionuclide retained by the first sorption bed

b = the amount of the radionuclide retained by the second sorption bed

Filters should be used in both the first and second samplers in the series to determine if any of the radionuclides that are in ionic form adsorb on the Millipore filters.

The aquatic plants, especially periphyton, appear to be very good indicator organisms. Therefore, the collection of periphyton should be extended to other ponds if sufficient quantities can be found, and Cladophora, Fontinalis and Ranunculus should continue to be collected from representative streams when available.

Lichen samples should be taken from areas of known size in future collections so that the results can be reported on an areal as well as a weight basis. This is being done and the lichen community is taken as a sample rather than just the lichens.

The above recommendations should not be construed to indicate that other portions of the sampling program be eliminated but rather that new or added emphasis should be placed on the recommended studies.

5. SUMMARY AND CONCLUSIONS

Seawater, freshwater, air filters, marine organisms, anadromous fish, freshwater plants, and lichens collected at Amchitka in September 1970, and fish collected in September 1969, were analyzed for low concentrations of radionuclides. It was concluded that the radionuclides detected were naturally occurring, from worldwide atmospheric 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.

Seawater samples contained ^{46}Sc , $^{110\text{m}}\text{Ag}$ and $^{108\text{m}}\text{Ag}$. These radionuclides were not found in air filters or in any freshwater or terrestrial samples, hence are probably waterborne to the Amchitka area. The silver isotopes originate in worldwide fallout but the short-lived ^{46}Sc could be from a nuclear powered vessel. Other fallout nuclides detected in seawater were ^{54}Mn , ^{60}Co and ^{65}Zn .

Fallout radionuclides in water from the Long Shot site mud pits and Jones Lake were ^{60}Co , ^{65}Zn , ^{95}Zr - ^{95}Nb , ^{103}Ru , and ^{137}Cs . Tritium concentrations in water samples from the immediate vicinity of the Long Shot ground zero site were as great as 3,600 T.U. Tritium in other samples of freshwater and seawater was less than the limits of detection, 200 ± 200 T.U.

Iron-55 concentrations in fish were as great as 152 pCi/g dry weight and the specific activity as great as 254 pCi/mg Fe; these concentrations and specific activities are consistent with values from other areas reported in the literature. Fallout radionuclides other than ^{55}Fe or naturally occurring ^{40}K in fish were either not detectable or were present at concentrations of less than 5 pCi/g dry weight. There were some species differences in the kinds and concentrations of radionuclides in fish.

Marine invertebrates and algae contained primarily ^{95}Zr - ^{95}Nb , among the fallout radionuclides, in concentrations of less than 1 pCi/g dry weight. Since no unusual kinds or amounts of radionuclides were detected in the sponges collected along the FRI fault, it is extremely unlikely that Milrow-produced radionuclides are being released in the area.

Concentrations of ^{95}Zr - ^{95}Nb in freshwater plants were as high as 12 pCi/g dry weight. Cobalt-60, ^{103}Ru , ^{125}Sb , and ^{137}Cs also were found but in lower concentrations.

Cesium-137 concentrations in lichens were 20 pCi/g dry weight. Other fallout radionuclides in lichens were ^{54}Mn , ^{60}Co , ^{95}Zr - ^{95}Nb , ^{106}Ru - ^{106}Rh , and ^{125}Sb .

TABLE 1

SCIENTIFIC AND COMMON NAMES AND WET WEIGHT
TO DRY WEIGHT RATIOS OF SOME AMCHITKA ISLAND ORGANISMS

<u>Species</u>	<u>Tissue</u>	<u>No. of Samples</u>	<u>Wet/Dry Ratio</u>	<u>Standard Deviation</u>
<u>Vertebrates</u>				
<u>Callorhinus ursinus</u> Fur Seal	Liver	2	3.25	0.064
	Muscle	1	3.50	
	Bone	1	1.50	
<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>Oncorhynchus nerka</u> Sockeye Salmon	Liver	6	3.25	0.51
	Muscle	8	3.67	0.54
	Bone	*		
<u>Oncorhynchus gorbuscha</u> Pink Salmon	Kidney	1	5.00	
	Gonad	1	4.51	
	Bone	*		
	Muscle	1	4.33	
	Liver	2	4.49	0.69
<u>Oncorhynchus kisutch</u> Coho Salmon	Liver	2	3.52	0.58
	Muscle	1	3.83	
	Gonad	1	4.30	

*Wet/dry not available, only dry/ash.

TABLE 1 (Cont'd)

SCIENTIFIC AND COMMON NAMES AND WET WEIGHT
TO DRY WEIGHT RATIOS OF SOME AMCHITKA ISLAND ORGANISMS

<u>Species</u>	<u>Tissue</u>	<u>No. of Samples</u>	<u>Wet/Dry Ratio</u>	<u>Standard Deviation</u>
<u>Vertebrates</u>				
<u>Lepidopsetta bilineata</u> Rock Sole	Liver	5	4.08	0.56
	Muscle	5	4.62	0.34
	Bone	*		
	Remains	2	3.90	0.01
	Gonad	1	5.70	
	Kidney	1	5.30	
<u>Hippoglossus stenolepis</u> Halibut	Kidney	1	4.90	
	Gonad	1	5.30	
	Remains	1	4.50	
	Muscle	4	4.01	0.58
	Liver	2	3.63	0.04
	Skin	1	2.47	
<u>Thelegra chalcogramus</u> Alaskan Pollack	Muscle	9	5.08	0.44
	Bone	*		
	Liver	5	1.51	0.11
	Skin	5	3.42	0.24
<u>Sebastes alutus</u> Ocean Perch	Bone	*		
	Muscle	3	4.37	0.05
	Liver	2	2.89	0.15
	Gonad	1	2.90	
	Skin	1	2.80	
<u>Gadus macrocephalus</u> Pacific Cod	Liver	12	3.00	0.77
	Muscle	13	5.47	0.28
	Bone	*		
	Skin	3	3.36	0.27
<u>Hexagrammos lagocephalus</u> Greenling	Liver	5	3.43	0.41
	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 1 (Cont'd)

SCIENTIFIC AND COMMON NAMES AND WET WEIGHT
TO DRY WEIGHT RATIOS OF SOME AMCHITKA ISLAND ORGANISMS

<u>Species</u>	<u>Tissue</u>	<u>No. of Samples</u>	<u>Wet/Dry Ratio</u>	<u>Standard Deviation</u>
<u>Vertebrates</u>				
<u>Sebastes melanops</u> Black Rockfish	Liver	1	2.62	
	Muscle	2	4.42	0.08
	Remains	2	3.26	0.05
	Gonad	1	4.30	
<u>Invertebrates</u>				
<u>Acanthomysis</u> Mysids	Entire	2	8.41	4.7
Plankton	Entire	2	20.98	2.72
Sponge (rust)	"	1	6.1	
(yellow)	"	1	4.5	
(buff)	"	1	4.9	
(green)	"	1	9.5	
Enphausids	Entire	1	5.2	
Krill				
Medusae				
(Cyanea)	"	1	26.8	
(Aurellia)	"	1	10.1	
<u>Pecten</u> sp. scallop	Soft parts	1	5.9	
Basket star	Soft parts	1	4.51	
" "	Gonads	1	4.37	
" "	Remains	1	2.41	
<u>Gonatus</u> Pelagic squid	Entire	1	5.41	
<u>Stronglocentrotus</u> sp. Urchin	Test	3	2.41	0.07
	Gonad	2	5.87	0.38
	Soft parts	2	6.19	1.97

TABLE 1 (Cont'd)

SCIENTIFIC AND COMMON NAMES AND WET WEIGHT
TO DRY WEIGHT RATIOS OF SOME AMCHITKA ISLAND ORGANISMS

<u>Species</u>	<u>Tissues</u>	<u>No. of Samples</u>	<u>Wet/Dry Ratio</u>	<u>Standard Deviation</u>
<u>Invertebrates</u>				
<u>Parolithodes</u> sp. King crab	Muscle	3	6.63	0.51
	Viscera	1	7.10	
	Exoskeleton	2	2.30	0.71
	Hepatopancreas	2	3.92	0.04
	Gonad	1	2.02	
<u>Littorina</u> sp. Snail	Entire	5	2.16	0.20
<u>Thais</u> sp. Snail	Soft parts	1	4.0	
	Shell	1	1.2	
<u>Mytilus</u> sp. Mussel	Soft parts	3	6.21	0.92
	Shell	4	1.08	0.05
Isopoda	Entire	2	3.04	0.07
Amphipoda (Gammaridae)	Entire	2	4.42	0.01
<u>Marine Algae</u>				
<u>Hypophyllum</u> sp. Marine algae	Entire	9	7.77	2.38
<u>Fucus</u> sp. Marine algae	"	12	4.94	1.4
<u>Halosaccion</u> sp. Marine algae	"	9	7.23	1.00
<u>Alaria</u> sp. Marine algae	"	17	5.95	0.99
<u>Porphyra</u> sp. Marine algae	"	1	4.5	
<u>Corallina</u> sp. Coralline algae	"	1	2.1	

TABLE 1 (Cont'd)

SCIENTIFIC AND COMMON NAMES AND WET WEIGHT
TO DRY WEIGHT RATIOS OF SOME AMCHITKA ISLAND ORGANISMS

<u>Species</u>	<u>Tissues</u>	<u>No. of Samples</u>	<u>Wet/Dry Ratio</u>	<u>Standard Deviation</u>
<u>Marine Algae</u>				
<u>Constantina</u> sp. Marine algae	Entire	*		
<u>Ulva</u> sp. Marine algae	"	4	8.54	0.86
<u>Thalassophyllum</u> sp. Marine algae	"	*		
<u>Laminaria</u> sp. Marine algae	"	5	5.30	0.25
<u>Freshwater Plants</u>				
Periphyton Pond algae	Entire	2	7.27	2.40
<u>Cladophora</u> sp. Filamentous algae	"	1	5.1	
<u>Fontinalis</u> sp. Moss	"	4	4.83	0.89
<u>Ranunculus</u> sp. Freshwater plant	"	3	12.2	4.10
<u>Land Plants</u>				
<u>Cladonia</u> sp. lichens	Entire	6	3.75	0.87

TABLE 2

GAMMA-EMITTING RADIONUCLIDES IN LARGE-VOLUME WATER SAMPLES
COLLECTED AT AMCHITKA, SEPTEMBER 1970 AND FEBRUARY 1971

Location and date	Sample no.	Fraction	Depth sampled (meters)	Cubic meters sampled	pCi per cubic meter (1)					
					⁴⁶ Sc	⁵⁴ Mn	⁶⁰ Co (2)	⁶⁵ Zn (2)	^{110m} Ag	²³² Th
Constantine Harbor										
596976 Sept. 1970	147	Part. (3)	Surface	2.002			93± 3	128±15	106± 4	
596971	149	"	"	"		1.2± 1.1	24± 1	41± 5	30± 2	4.3± 1.7
Shallow Station (50 fm)	151	"	10	1.810			16± 1.4	50± 8	101± 3	
51°23'N 178°59'E(4)	153	"	40	2.002			13± 1.4	23± 7	16± 2.1	
Sept. 1970	155	"	80	"		1.5± 0.9	11± 0.8	23± 4	12± 1.2	3.4± 1.3
Deep Station (150 fm)	157	"	10	1.617			28± 1.7	74± 9	98± 2.8	
51°25'N 178°59'E(4)	159	"	40	1.925	16 ± 9.4		95± 3.9	169±18	46± 4.8	12 ± 5.2
Sept. 1970	161	"	80	"	7.3± 4.1		38± 1.5	70±8	42± 2.2	6.1± 2.4
	201	Sol. (3)	40	.482			460±48	753±71	27± 8.2	20 ± 8.5
	200	Sol.	80	.464	43 ±35		410±64	1088±91	22±10	
					⁶⁰ Co	⁶⁵ Zn	⁹⁵ Zr- ⁹⁵ Nb	¹⁰³ Ru	¹³⁷ Cs	²³² Th
Long Shot mud pit #1										
517007 Sept. 1970	145	Part.	Surface	0.477	41±4	67±17	54±7	51±36	18 ± 5	48± 7
Feb. 1971	177	"	"	0.832			22±2	20± 9	4.4± 3.4	
Jones Lake Feb. 1971	183	"	"	0.152		60±32	148±9	142±31	62 ±12	33±17
578967										

(1) The error values are the two sigma, propagated, counting errors for single samples.

(2) The values for ⁶⁰Co and ⁶⁵Zn in the soluble fraction have been corrected for retention efficiencies of 10 percent and 45 percent retention on the sorption bed (Silker, W. B., R. W. Perkins, and H. G. Rieck. A sampler for concentrating radionuclides from natural waters. 1970. Ocean Engineering. (In press))

(3) Part. = Particulate: That portion which remains on the 0.3 micron porosity filter. Sol. = Soluble: That portion which passes through the filter.

(4) Approximate locations.

TABLE 3

IRON-55 IN FISH COLLECTED AT AMCHITKA SEPTEMBER, OCTOBER 1969

Deck No.	Species	Location ¹	<u>pCi/g dry</u>		<u>mg Fe</u> <u>g Dry</u>		<u>pCi/mg Fe</u>	
			Muscle	Liver	Muscle	Liver	Muscle	Liver
827	Dolly Varden	Bridge Creek	0.10		0.021		4.76	
810	" "	Ultra Stream	0.11		0.036		3.06	
*838-39	" "	Clevenger Creek	0.024	3.18	0.019	0.46	1.26	7.36
867-68	" "	Outlet Silver Salmon Stream	0.65	43.3	0.020	0.94	32.9	62.0
*832-33	" "	Silver Salmon Str.	0.08	2.68	0.018	0.33	4.71	8.18
*844-45	" "	Silver Salmon Lk.	0.078	5.89	0.019	0.42	4.14	13.6
*835-36	" "	Clam Lake	0.22	4.87	0.026	0.82	8.41	7.24
841-42	" "	Pratfall Lake	0.11	4.84	0.021	0.90	5.54	5.88
*806-07	" "	" "	0.32	10.8	0.032	1.08	9.90	10.1
804	" "	Quonset Lake	0.37		0.033		11.4	
*830	" "	" "	0.0		0.032		0	
853-54	Chum Salmon	Pacific Ocean	1.50	82.4	0.017	0.76	87.8	110
875-76	" "	Bering Sea	1.62	107	0.026	0.93	63.6	115
878-79	" "	" "	4.14	152	0.036	1.01	106	160
881-82	" "	" "	0.58	40.1	0.016	0.53	36.2	75.6
884-85	" "	" "	0.81	40.7	0.023	0.50	35.2	86.4
905,910	" "	" "	0.82	24.1	0.026	0.34	31.8	72.0
912-13	" "	" "	2.04	56.4	0.036	0.68	58.0	83.0
800-01	Sockeye Salmon	Pratfall Lake	1.60	89.7	0.027	1.19	60.2	75.4
864-65	" "	Bering Sea	0.62	63.1	0.018	1.02	34.4	62.2
890	" "	" "		106		1.36		78.5
893-94	" "	" "	1.80	95.3	0.019	0.62	94.4	157
896-97	" "	" "	1.16	35.5	0.023	0.28	51.2	126
899-900	" "	" "	1.38	70.9	0.028	0.62	49.6	115
861-62	Pink Salmon	Clevenger Creek Outlet	9.73	53.1	0.11	0.57	88.4	93.2
847-48	" "	Silver Salmon Str.	3.66	64.4	0.038	0.61	97.7	106

TABLE 3

IRON-55 IN FISH COLLECTED AT AMCHITKA SEPTEMBER, OCTOBER 1969
(Cont'd)

Deck No.	Species	Location ¹	<u>pCi/g dry</u>		<u>mg Fe</u> <u>g Dry</u>		<u>pCi/mg Fe</u>	
			Muscle	Liver	Muscle	Liver	Muscle	Liver
*872-73	Coho Salmon	Silver Salmon Lk.	1.60	18.1	0.048	0.19	33.5	95.1
887-88	Rock Sole	Bering Sea	0.14	8.50	0.015	0.24	10.3	32.8
823-24	" "	" "	0.10	4.52	0.022	0.19	4.83	23.8
858-59	" "	" "	0.11	8.12	0.008	0.18	14.0	44.3
856	Halibut	Constantine Harbor	0.31		0.031		10.1	
851	Alaska Pollack	Pacific Ocean	0.72		0.013			56.4
903	" "	" "	1.08		0.013			87.2
821A-21B	Pacific Ocean Perch	" "	3.55	66.8	0.014	0.31	254	216
812-13	Pacific Cod	" "	0.95	3.28	0.010	0.06	101	54.8
816	" "	" "	0.64		0.025		33.2	
818-19	" "	" "	1.70	15.8	0.010	0.065	170	245
915-16	" "	Bering Sea	0.22	1.12	0.010	0.13	22.9	8.71
918-19	" "	" "	0.20	1.42	0.007	0.07	29.0	22.5
921-22	" "	" "	0.46	9.38	0.014	0.20	32.6	49.3
924-25	" "	" "	0.58	2.86	0.006	0.055	97.5	50.5

¹Universal thousand meter grid coordinates:

Bridge Creek	522021	Quonset Lake	520000
Clam Lake	511968	Silver Salmon Lake	544990
Clevenger Creek	523985	Silver Salmon Stream	547993
Pratfall Lake	530979	Ultra Stream	470008

*Collected October 4, 1969; all other samples collected in September 1969.

TABLE 4A

GAMMA-EMITTING RADIONUCLIDES IN FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER, OCTOBER 1969

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry**			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
856	Constantine Harbor 596976***	Halibut (430mm)	Muscle	100	18± .5			0.11±.04
888	51°27'N 179°15'E	Sole (231mm)	Muscle	50	14± .6			
889			Bone	6.8	7±4			
824			Muscle	50	11± .6			
825		(187mm)	Bone	7.2	10±2			
859			Muscle	50	13± .6			
860			Bone	6.9	5±2			0.40±.32
851	51°15'N 179°11'E	Pollack (368mm)	Muscle	100	17± .4			
903		(379mm)	"	100	17± .5			0.09±.04
904			Bone	6.6	13±3	1.4 ±.30		
821	51°15'N 179°11'E	Perch (244mm)	Muscle	100	14± .5			0.07±.03
822			Bone	7.0	7±2			
959			Liver	11.7	0.2± .04			

TABLE 4A

GAMMA-EMITTING RADIONUCLIDES IN FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER, OCTOBER 1969 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry**			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
813	51°22'N 179°14'E	Cod (675mm)	Muscle	50	15±0.7			0.18±.04
814			Bone	6.6	7±3			
816			Muscle	100	16±0.5			0.06±.04
817		(545mm)	Bone	6.7	9±2			
819			Muscle	50	15±0.7			0.20±.05
820		(605mm)	Bone	6.6	5±3			
916			Muscle	25	17±0.7			0.11±.05
917		(485mm)	Bone	6.8	8±4			
919			Muscle	50	19±0.5			
920		(520mm)	Bone	6.8	8±2			
922			Muscle	15	16±0.8			0.15±.06
923		(520mm)	Bone	6.7	7±3			
925			Muscle	50	18±0.6			0.13±.04
926		(615mm)	Bone	6.8	7±3			
954		(pooled)	Liver	40	6±0.6			
956		(pooled)	Liver	40	5±0.4			0.06±.03
854	51°19'N 179°01'E	Chum Sal. (390mm)	Muscle	66	12±0.5			
855			Bone	5.9	16±2	0.21±.17	4.5±.17	
876	59°29'N 179°20'E	Chum Sal. (450mm)	Muscle	60	10±0.5			0.04±0.03
877			Bone	5.3	6±2			
879			Muscle	185	10±0.2			0.05±0.01
880		(520mm)	Bone	8.1	10±2	0.33±.18		

TABLE 4A

GAMMA-EMITTING RADIONUCLIDES IN FISH COLLECTED AT AMGHITKA ISLAND
SEPTEMBER, OCTOBER 1969 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry**			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
882			Muscle	45	12±0.5	0.04±03		0.07±0.03
883		(165mm)	Bone	5.3	10±3	0.51±.30		
885			Muscle	241	12±0.1			0.07±0.01
886		(575mm)	Bone	8.3	14±2			
910			Muscle	244	13±0.1			0.07±0.01
911		(610mm)	Bone	8.1	11±2	0.64±.20		
913			Muscle	164	13±0.1			0.05±0.01
914		(590mm)	Bone	9.2	6±2	0.27±.18		
955		(pooled)	Liver	40	9±0.6	0.05±.04		
865	51°20'N 179°20'E	Sockeye Salmon	Muscle	20	14±0.6	0.28±.06		0.14±0.08
866		(375mm)	Bone	4.4	11±3	0.23±.21	2.9±1.6	
891	59°29'N 179°20'E		Muscle	38	12±0.4	0.14±.03		0.07±0.05
892		(400mm)	Bone	3.0	14±4		3.5±2.1	
894			Muscle	31	15±0.5	0.11±.04		0.08±0.06
895		(400mm)	Bone	3.3	20±9			
900	59°29'N 179°20'E	Sockeye Salmon	Muscle	147	11±0.2			0.04±.01
901		(470mm)	Bone	6.6	9±2	.43±.20		
897			Muscle	57	10±0.7			
898		(445mm)	Bone	6.2	5±2			
962		(pooled)	Liver	7.7	13±2			

TABLE 4A

GAMMA-EMITTING RADIONUCLIDES IN FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER, OCTOBER 1969 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry**			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
848	Silver Salmon Cr.	Pink Salmon	Muscle	43	13±0.5	.05±.03		0.04±.03
849	547993	(460mm)	Bone	6.8	14±2	.29±.17		
873	Silver Salmon Lk.	Silver Salmon	Muscle	44	15±.05			0.07±.03
*874	544990	(550mm)	Bone	8.2	2±2			
*872			Liver	20	12±1			0.15±.07
868	Silver Salmon Cr.	Dolly Varden	Muscle	94	11±0.5	.05±.03		0.12±.04
869	547993	(315mm)	Bone	7.2	9±2			
*845			Muscle	50	10±0.5			0.10±.04
*846		(355mm)	Bone	2.9	13±5			
*833		(217mm)	Muscle	5.9	11±2			0.53±.14
*961		(pooled)	Liver	8.1	10±2			
*836	Clam Lk.		Muscle	50	16±2			
*837	523985	(212mm)	Bone	4.6	10±5			
*839	Clevenger Cr.							
	508964	(165mm)	Muscle	21	2.8±.78			.09±.06
*840			Bone	1.1				1.6±±1.1
*807	Pratfall Lk.		Muscle	17	13±1.5			
*808	530979	(184mm)	Bone	3.0	21±5	1.7 ±.47		.81±.65
842			Muscle	50	14± .6			.25±.04
843		(316mm)	Bone	6.3	6±2			.17±.16
804	Quonset Lk.		Muscle	99	13± .5			1.6 ±.05

TABLE 4A

GAMMA-EMITTING RADIONUCLIDES IN FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER, OCTOBER 1969 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry**			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
805	520000	(306mm)	Bone	6.4	8±3			1.2 ±.27
*830			Muscle	25	13± .5			1.8 ±.04
*831		(315mm)	Bone	5.7	9±3			.65±.18

* Collected October 4, 1969; all other samples collected in September 1969.

** The error values are the two sigma, propagated, counting errors for single samples.

*** Universal thousand meter grid system.

TABLE 4B

GAMMA-EMITTING RADIONUCLIDES IN MARINE FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER 1970

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry*			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
001	Off C-Site 51°29'N 179°08'E	Halibut (220-465mm)	Muscle	99.7	20±0.7	0.09±.04		0.1 ±.05
			Bone	49.7	10±0.7		.28±.14	
			Liver	18.0	12±1.3	0.1 ±.09		
			Kidney	9.0	19±2.1		.6 ±.4	
			Gonad	3.2	34±6.5	0.7 ±.4		
			Remainder	100	13±0.5			0.05±.03
046			Liver	20.2	10±0.9			0.1 ±.07
064	Duck Cove 503979**	Greenling (166-205mm)	Muscle	88.5	17±0.9			0.15±.06
			Bone	6.2	13±1.8			
			Remainder	100	9± .6			0.09±.04
069		(220-260mm)	Muscle	100	16±0.6			0.06±.04
			Bone	18.0	13±0.7	0.4 ±.07	.3 ±.2	
			Liver	13.4	9±1.7			
			Remainder	100	8±0.5			0.06±.03
075		(260-300mm)	Muscle	100	15±0.6			0.16±.04
			Bone	24.9	9±0.9	0.08±.06		
			Liver	9.6	9±3			
			Kidney	5.0	21±5			
			Gonad	2.2	29±8	0.85±.56		0.95±.66
			Remainder	100	10±.35		.12±.07	.03±.02

TABLE 4B

GAMMA-EMITTING RADIONUCLIDES IN MARINE FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER 1970 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry*			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
081		(305-365mm)	Muscle	100	16±0.8			0.15±.05
			Bone	37.3	9±0.4	0.21±.04		
			Liver	12.0	8±1.3			
			Kidney	5.2	11±3.8			
			Gonad	3.7	35±4.5			0.5 ±.4
			Remainder	100	9±0.6			0.09±.04
099	Near mouth of Silver Salmon Creek 547993	(285-345mm)	Muscle	100	17±0.6			0.20±.04
			Bone	12.4	7±1.1			
			Liver	6.9	11±3.4			0.66±.20
			Remainder	100	9±0.6			0.15±.04
082	Duck Cove 503979	Rockfish	Muscle	100	17±0.6			0.08±.04
			Bone	6.8	14±4.4			0.50±.33
			Remainder	100	8±0.4			0.07±.03
090	Constantine Harbor 596976	(215-280mm)	Muscle	100	15±0.4			0.07±.03
			Bone	17.8	7±1	0.11±.06	.34±.24	
			Liver	50	5±0.7			
			Gonad	7.1	17±3			
			Remainder	100	8±0.4			0.05±.03

TABLE 4B

GAMMA-EMITTING RADIONUCLIDES IN MARINE FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER 1970 (Cont'd)

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry*			
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs
135	Off C-Site 51°29'N 179°08'E	(165-220)	Muscle	100	14±0.4			
			Bone	13.1	4±1			
			Liver	4.6				
			Remainder	100	9±0.5		0.12±.09	
		(230-390)	Muscle	100	14±0.6			
			Bone	23.9	8±0.9			
			Liver	11.0	7±1			
			Kidney	5.2	19±5			
			Gonad	10.9	22±1			
			Remainder	100	8±0.5	0.03±.02		0.04±.03

* The error values are the two sigma, propagated, counting errors for single samples.

** Universal thousand meter grid system.

TABLE 4C

GAMMA-EMITTING RADIONUCLIDES IN ANADROMOUS FISH COLLECTED AT AMCHITKA ISLAND
SEPTEMBER 1970

Specimen No.	Collection Site	Common Name (size)	Tissue	Grams dry Sample	pCi/g, dry*										
					⁴⁰ K	⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs							
107	Square Bay 523221**	Dolly Varden (295-330 mm)	Muscle	100.4	14±0.7	0.05±.03		0.34±.05							
108			Liver	14.0	5±4										
109			Kidney	5.2	10±4.8				0.34±.31						
110			Gonad	25.0	9±0.4					0.18±.04					
112			Bone	12.8	9±0.9										
111			Remainder	100.0	7±0.6						0.10±.04	0.16±.05			
113	Duck Cove 503979	Dolly Varden (215-360 mm)	Muscle	100.0	13±0.4	0.02±.02		0.29±.03							
114			Liver	50.0	8±0.9				0.10±.05						
115			Kidney	15.7	12±2.6										
116			Gonad	25.0	6±0.6										
118			Bone	30.1	10±0.5										
117			Remainder	103.9	6±0.6					0.04±.03		0.16±.04			
119			Stomach content	11.5	16±1.6								0.48±.36		0.28±.12
123	Duck Cove 503979	Silver Salmon	Liver	17.3	15±2.2	0.15±.07									
124			Gonad	55.0	18±1.3										
121		Pink Salmon	Liver	4.9	19±3.3		1.4 ±.75								
120			Kidney	2.8	16±4.4			0.74±.42							
125			Gonad	11.1	14±1				0.28±.09						

*The error values are the two sigma, propagated, counting errors
for single samples.

**Universal thousand meter grid system.

TABLE 5

 ^{95}Zr - ^{95}Nb IN MARINE INVERTEBRATES COLLECTED AT AMCHITKA, SEPTEMBER 1970

Sample Number	Collection site	Organism	Tissue	Grams dry sample	pCi/g dry* ⁹⁵ Zr- ⁹⁵ Nb	
044	Duck Cove	503979**	Urchin	Gonad	2.5	0.5 ± .4
043			Soft parts	19.4	0.4 ± .08	
042			Test	100	0.03 ± .03	
025	Off IA-3	51°30'N 179°07'E	Urchin	Gonad	9.1	0.1 ± .09
024			Soft parts	22.5	0.3 ± .05	
026			Test	100	0.09 ± .02	
053	Off IA-3	51°30'N 179°11'E	Basket Star	Gonad	6.0	
054			Soft parts	4.2		
055			Remainder	100		
047	Duck Cove	503979	Littorina	Entire	100	0.06 ± .03
094	Constantine Harbor	596976	"	"	17.7	
030	Rifle Range Point	508964	"	"	100	0.08 ± .03
027	IA-3	473055	"	"	97.5	0.04 ± .01
029	"	"	Thais	Soft parts	3.8	
032			Shell	17		
038	Constantine Harbor	596976	Mytilus	Soft parts	100	
037			Shell	197		
095	"	"	Isopods	Entire	2.9	
028	IA-3	473055	"	"	12.5	0.07 ± .06
031	"	"	"	"	9.4	
033	"	"	Amphipods	"	1.2	
049	Constantine Harbor	596976	Mysids	"	19.5	
051	51°16'N 179°07'E		"	"	25.1	
052	51°23'N 179°59'E		Plankton	"	25.0	
056	51°25'N 178°58'E		"	"	25.0	0.08 ± .04
106	51°25'N 178°49'E		Euphausiids	"	100	0.07 ± .02
058	"	"	Medusa	"	100	
048	51°25'N 178°49'E		Squid	"	25.0	0.04 ± .03
045	Duck Cove	503979	Sponge, rust	"	8.2	0.6 ± .1
034	"	"	" , yellow	"	100	0.11 ± .03
035	"	"	" , buff	"	100	0.10 ± .03
036	"	"	" , green	"	46.5	0.12 ± .01

*The error values are the two sigma, propagated, counting errors for single samples.

**Universal thousand meter grid coordinates.

TABLE 6

GAMMA-EMITTING RADIONUCLIDES IN MARINE ALGAE COLLECTED AT AMCHITKA, 1970

Sample number	Collection site		Genus	Grams dry sample	⁴⁰ K	pCi/g dry* ⁹⁵ Zr- ⁹⁵ Nb	¹³⁷ Cs
September, 1970							
013	Constantine Harbor	596976**	Fucus	100	32 ± 0.7	0.23 ±0.03	0.12 ±0.04
020	Duck Cove	503979	"	235	25 ± 0.4	0.16 ±0.01	0.08 ±0.02
018	IA-3	473055	"	350	23 ± 0.4	0.19 ±0.01	0.07 ±0.02
011	Constantine Harvor	596976	Alaria	71	66 ± 0.6	0.22 ±0.01	0.05 ±0.03
023	Duck Cove	503979	"	190	60 ± 0.3	0.27 ±0.01	
019	" "	"	Halosaccion	181	15 ± 0.4	0.34 ±0.01	0.07 ±0.02
016	IA-3	473055	"	211	14 ± 0.4	0.32 ±0.03	0.08 ±0.03
015	"	"	Porphyra	156	18 ± 0.4	0.55 ±0.01	
014	"	"	Corallina	100	49 ± 0.4	0.33 ±0.02	0.04 ±0.04
007	Duck Cove	503979	Constantina	273	32 ± 0.6	0.43 ±0.03	0.11 ±0.03
008	" "	"	Thalasiophyllum	100	18 ± 0.5	0.32 ±0.03	0.08 ±0.03
010	" "	"	Laminaria	348	69 ± 1.4	0.22 ±0.04	0.12 ±0.06
017	" "	"	Hypophyllum	146	41 ± 0.9	0.12 ±0.02	0.08 ±0.05
039	" "	"	"	350	15 ± 0.2	0.21 ±0.01	0.03 ±0.01
October, 1970							
142	Duck Cove	503979	Alaria	158	38 ± 0.4	0.19 ±0.02	
139	IA-2	468056	"	349	60 ± 0.9	0.66 ±0.05	
141	Duck Cove	503979	Hedophyllum	441	37 ± 0.6	0.16 ±0.02	0.05 ±0.03
140	" "	"	Laminaria	100	69 ± 1.2	0.62 ±0.12	0.11 ±0.06

*The error values are the two sigma, propagated, counting errors for single samples.

**Universal thousand meter grid coordinates.

TABLE 7

GAMMA-EMITTING RADIONUCLIDES IN FRESHWATER PLANTS
COLLECTED AT AMCHITKA, SEPTEMBER 1970

pCi/g dry*

Sample no.	Species	Location	^{40}K	^{60}Co	^{95}Zr - ^{95}Nb	^{103}Ru	^{125}Sb	^{137}Cs
000	Periphyton	Long Shot mud pit 1 517007	17 ±3.5	0.65±.21	12.0 ±.75	7.8 ±1.2	6.5 ±1.4	2.9 ±.41
021	"	Long Shot mud pit 2 517007	17 ±1.7	0.17±.01	4.5 ±.13	2.1 ±0.26	2.4 ±0.48	1.8 ±.15
041	Algae (Cladophora)	Clevenger Creek 511968	17 ±0.96		1.3 ±.05	0.28±0.13	0.55±0.25	5.1 ±.11
009	"	Duck Cove 504979	08.1±0.19		0.87±.01	0.43±0.03	0.75±0.06	1.1 ±0.2
022	Moss (Fontinalis)	Clevenger Creek 511968	09.2±1.4	0.11±.08	2.6 ±.14	1.7 ±0.28	2.4 ±0.57	8.3 ±.27
040	Higher plant (Ranunculus)	Clevenger Creed 511968	22 ±0.71	0.06±.04	0.98±.06	0.35±0.08	0.22±0.15	0.56±.05
012	"	Clevenger Lake outlet 522945	28 ±0.59		1.2 ±.03	0.73±0.08	0.47±0.14	

*The error values are the two sigma, propagated, counting errors for single samples.

Table 8

FALLOUT RADIONUCLIDES IN LICHENS COLLECTED AT CLAM LAKE, AMCHITKA ISLAND
SEPTEMBER 1970

Collection Date	Grams dry Sample	pCi/g dry*					
		^{54}Mn	^{60}Co	^{95}Zr - ^{95}Nb	^{106}Ru - ^{106}Rh	^{125}Sb	^{137}Cs
Sept. 1970	308	.11±.07	.05±.04	2.4±.19	5.7±.51	3.8±.52	18±.30
Oct. 1970	650	.14±.05	.07±.04	1.4±.10	3.6±.42	2.4±.42	13±.27
Oct. 1970	248	.16±.08	.10±.06	2.2±.19	5.8±.60	4.1±.63	20±.40

*The error values are the two sigma, propagated, counting errors for single samples.

Table 9

TRITIUM IN WATER SAMPLES COLLECTED AT AMCHITKA
SEPTEMBER 1970

Location	Tritium Units*	
	Aliquot a	Aliquot b
Long Shot 517007		
Mud pit 1	1660±240	1710±260
" " 2	2250±240	2670±260
" " 3	3300±290	3630±300
Pond A	<200	<200
" B	"	"
" C	"	"
" D	"	"
" E	"	"
Well 1	"	"
Well 2	610±200	590±100
Well west of well 2	2590±280	2610±280
Well nearest Infantry Road	<200	<200
Milrow 518982		
Pond	"	"
Pond at well 2	"	"
" " " 3	"	"
" " " 17	"	"
Seep near G.Z.	"	"
Emerald Lake 431066	"	"
Clam Lake 523985	"	"
Clevenger Lake outlet 552945	"	"
Clevenger Creek 511968	"	"
Duck Cove Creek 504979	"	"
Husky Camp tap water	"	"
Spring at Cyril Cove 534013	"	"
Saint McKarius Bay 552945	"	"
Duck Cove, FRI fault 503977	"	"
Duck Cove 504979	"	"
51°23'N 179°59'E 10 meter depth	"	"
" " 40 " "	"	"
" " 80 " "	"	"
51°25'N 178°58'E 10 " "	"	"
" " 40 " "	"	"
" " 80 " "	"	"

*The error values are the two sigma counting errors for single samples.

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