AMCHITKA BIOENVIRONMENTAL PROGRAM
LIMNOLOGY OF AMCHITKA ISLAND, ALASKA

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by

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ABSTRACT

Limnological investigations on Amchitka Island, Alaska, were conducted during Fiscal Year 1971 to (1) assess the nature and magnitude of effects on chemical, physical, and biological parameters to freshwater ecosystems resulting from Milrow on October 2, 1969, and (2) study selected freshwater ecosystems in order to form a basis for predicting and evaluating the nature and magnitude of the effects of Cannikin, an underground nuclear test proposed for FY 1972.

No major alterations to lakes and ponds on Amchitka resulting from Milrow were observed during FY 1971. No significant alteration in water level occurred during the year in any of the lakes studied. The absence of significant increases in alkalinities in study lakes indicates that alkaline subsurface bedrock has not been exposed to any great degree by rupturing of the overlying peat mat in the drainage basins of these lakes.

Data collected on lakes in the Rifle Range Point area suggest that subtle shifts in chemical and biological parameters have occurred and are probably related to Milrow. These changes are expected to be of limited duration in the absence of further perturbations to their drainage basins. Data collected on Round Lake (31b) suggest that the short-term post-Milrow changes in water chemistry and zooplankton populations observed on that lake were probably seasonal and not the result of Milrow.

Observations indicate that Strange Pond (33) is rapidly recovering from increased alkalinity concentrations resulting from test-related activities. Emerald Lake (51) has been drastically altered in chemical, physical, and biological parameters as a result of drill mud entering the lake. Recovery of this lake is expected to be very slow by comparison to that for Strange Pond.

During the autumn sampling, alkalinities in the Cannikin survey lakes tended to decrease while pH values tended to increase. Zooplankton communities were dominated by rotifers and were tending to decrease in number. Population crashes during this period were observed in several lakes.

Preliminary results of studies on the effects of severe mixing of water in lake basins near SZ site by wind action suggest that these conditions may result in changes in pH and alkalinity but no drastic changes to zooplankton populations were observed.

INTRODUCTION

Since 1967, Battelle Memorial Institute, Columbus Laboratories, with assistance from scientists in several universities, the Smithsonian Institution, the U. S. Fish and Wildlife Service, and the National Marine Fisheries Services, has been responsible for bioenvironmental safety studies on Amchitka Island, Alaska, where the U. S. Atomic Energy Commission, Nevada Operations Office, has established a supplemental test site to conduct certain underground nuclear tests. Battelle's Columbus Laboratories (BCL) has the responsibility for planning and technical management of the Amchitka Bioenvironmental Program with the following broad objectives: (1) prediction and documentation of the effects of AEC operations, including underground nuclear detonations, on the Amchitka exosystems, (2) identification and evaluation of any hazard to man as a consequence of release of radionuclides and their subsequent transport to humans via food chain pathways, and (3) recommendation of courses of action that can be followed to minimize adverse effects of AEC operations on the Amchitka ecosystems. Two underground nuclear tests have been conducted at Amchitka. Long Shot was conducted in 1965 and Milrow was conducted October 2, 1969, following the initiation of the present bioenvironmental program. Another test, Cannikin, is planned for 1971.

Investigations of the effects of AEC activities on the freshwater ecosystems of the Island have been an integral component of the Amchitka Bioenvironmental Program since its inception. The limnological investigations represent a portion of this total freshwater ecology program. This report presents the limnological data collected by the author during the Fiscal Year 1971. Limnological investigations prior to this fiscal year were conducted and reported by Dr. Derry D. Koob, Utah State University, Logan, Utah.

The objectives of the limnological studies on Amchitka Island during FY 1971 were (1) to conduct follow-up analyses on physical, chemical, and biological parameters of freshwater ecosystems to assess the nature and magnitude of the effects, if any, of Milrow, and (2) to conduct studies on selected freshwater ecosystems to form a basis for predicting and evaluating the nature and magnitude of the effects of Cannikin.

METHODS AND MATERIALS

Alkalinity and pH analyses were conducted on open lake water samples with an Orion model 401 specific ion meter. Alkalinities were titrated potentiometrically to end points and chloride was determined by the mercuric nitrate method (American Public Health Association, 1965). Specific conductance was measured with a Beckman model RB3 Solu Bridge.

Phytoplankton and zooplankton were collected from about 0.25 m below the lake surface using a Kemmerer water sampler. The organisms contained in 10 liters of lake water were concentrated to 25 ml using a #20 plankton bucket. The organisms were preserved in a mixture of formalin, acetic acid, glycerine, copper sulfate, and distilled water and returned to the laboratory for counting. Zooplankton were enumerated by counting in a Sedgwick-Rafter cell at 100X magnification. Phytoplankton genera were identified at 400X.

Primary productivity analyses were by the method of Strickland and Parsons (1968) except that the samples were incubated in a controlled environmental water bath at 2,000 footcandles rather than in situ. Periphyton were collected on glass slides exposed on dental X-ray film holders 10 inches below the surface of the lake water. Groups of slides were removed from selected lakes after 2 weeks and preserved for analysis of total organic matter (Maciolek, 1962) and qualitative examination. The area of the exposed surface on the slides was used to extrapolate the total organic matter rate of accumulation to $\text{mg}/\text{m}^2/\text{day}^{-1}$. At this time this should be considered a relative unit useful in comparing lakes sampled. Concentrations of organic matter on the slides and in open lake water were analyzed using the oxidative dichromate method of Maciolek.

EFFECTS OF MILROW ON INTENSIVE-STUDY LAKES

Sixteen lakes were selected for Milrow-related studies during the fall of 1969. These lakes are shown in Figure 1 and general information on their specific location, drainage, bottom compaction, and pH is presented in Table 1.

The lakes were sampled to detect population trends of phytoplankton and zooplankton genera and to monitor any gross chemical changes that might take place during the period from 2 weeks prior to 2 weeks after Milrow (Koob, 1971). These lakes have been revisited and sampled during the same period 1 year later, and again approximately 18 months after Milrow to determine if there is any evidence of long-term effects on these systems.

In the criteria established for evaluation of seismic disturbance to the freshwater ecosystems, potential detrimental effects were considered to be (1) partial or complete drainage of a lake due to fracture of the bottom seal or to a breach of the peat retaining dam, (2) increase in alkalinity due to the rupture of the peat mat in the watershed with resulting exposure of surface drainage water to alkaline subsurface rock deposits, (3) decrease in primary productivity as detected by a reduction of pH, (4) reduction in plankton populations due to direct or indirect effects of the ground shockwave, and (5) increase in suspended silt load due to disturbance of sediments (Koob, 1971).

Chemical and Physical Data

No significant alteration in water level was observed in any of the sixteen intensive-study lakes during the autumn 1970 or spring 1971 sampling periods. The water level in Lake 31b (Round Lake) which had reportedly decreased approximately 25 cm by D+5 was typical of normal lake capacities during the sampling periods in FY 1971.

Three lakes (23, 24, and 25), all within 0.48 km of SZ, were not included in the intensive study lakes for Milrow. Lakes 25 and 24 located <0.16 and 0.32 km, respectively, from SZ were partially drained with the formation of a subsidence crater about 37 hours after the event. Water levels of these two lakes decreased further between April, 1970, and October, 1970, but did not change between October, 1970, and April, 1971. Lake 23, which is separated from Lake 24 by a narrow dike that remained intact during Milrow, appeared to be morphologically undisturbed during FY 1971.

FIGURE 1. MILROW-CANNIKIN EFFECTS STUDY LAKES

TABLE 1. MILROW EFFECTS - INTENSIVE-STUDY LAKES

Lake and Name	Map Coordinate ^(a)	Distance ^(b) (km) and Direction from Milrow SZ	Drainage	Bottom	pH
25 Heart Lake	515982	0.0 - 290	Pacific	--	Acid
24 Lower Twin Lake	517985	0.32 - 360	Pacific	--	Alkaline
23 Upper Twin Lake	518986	0.48 - 10	Pacific	Firm	Alkaline
26 Weed Lake	527994	1.61 - 37	Bering	Soft	Alkaline
28 Quonset Lake	519000	1.77 - 5	Bering	Firm	Alkaline
7 Range Pond	515965	1.77 - 192	Pacific	Firm	Acid
9 Rifle Pond	516963	1.93 - 189	Pacific	Soft	Acid
10 Duck Pond	515962	2.10 - 190	Pacific	Firm	Acid
29 Long Shot Lake	512002	2.10 - 345	Bering	Firm	Alkaline
30 Long Shot Pond	514006	2.41 - 354	Bering	Soft	Acid
31b Round Lake	521016	3.54 - 7	Bering	Hard	Alkaline
2 Clevenger Lake	556945	5.31 - 136	Pacific	Soft	Alkaline
33 Strange Pond	493030	5.31 - 334	Bering	Soft	Acid
35 Mud Pond	494034	5.80 - 338	Bering	Soft	Acid
36 Clear Pond	493034	5.80 - 336	Bering	Firm	Acid
5 Jones Lake	576965	6.44 - 108	Bering	Soft	Alkaline
1 Pumphouse Lake	585932	8.41 - 129	Pacific	Soft	Alkaline
51 Emerald Lake	431066	12.06 - 316	Pacific	Firm	Acid
58b Fault Lake	393110	18.38 - 317	Pacific	Hard	Acid

(a) Coordinates refer to approximate center of lakes.

(b) Straight-line distance between surface zero and the nearest lake shore.

Table 2 presents data on pH, alkalinity, and specific conductivity prior to and following Milrow. There appears to be little evidence to date of the increased alkalinities that would be expected in the intensive study lakes if the alkaline subsurface bed rock were exposed by event-related rupture of the peat mat in the drainage basin. The alkalinities in Rifle Range Lakes 9 and 10 during the autumn and spring FY 1971 sampling periods were slightly increased over those from similar periods in preceding years. This may be partially attributable to the activities of excavating equipment about 1 mile away, on the hilltop above the lakes, or it may be event-related.

An alkalinity about six times higher than is typical for Lake 9 (Rifle Pond) and increased specific conductivity was observed on April 20, 1970, but samples collected and analyzed 10 days later indicated normal values for these parameters in that lake. Data collected in the autumn of 1970 and the spring of 1971 also showed pH and alkalinity values in that lake generally typical of those recorded prior to Milrow. Values for pH of Lake 7 (Range Pond) were slightly elevated during the autumn of 1970 over values recorded for prior autumn sampling. Lakes with pH and alkalinity values similar to Lake 10 (Duck Pond) generally show more variation in these parameters on Amchitka than do the lakes with $\text{pH} < 6$ and alkalinity < 3 .

A large increase in alkalinity reported in Lake 33 (Strange Pond) in 1969 and 1970 was probably due to a diversion of runoff water over the berm of Infantry Road into the lake during these years. Data from autumn 1970 indicate the alkalinity in that lake decreased approximately 50 percent since autumn 1969. Values of pH in Strange Pond in autumn 1970 were also decreased from those recorded in 1969 and were comparable to data collected in autumn 1967. Spring data also indicated a trend of decreasing pH and alkalinity toward values which would be typical for that type of lake in a relatively undisturbed status.

Lake 1 (Pumphouse Lake) increased in alkalinity from 53 mg/l in 1969 to 61.8 mg/l in 1970. Alkalinities had declined in Pumphouse Lake from 65 mg/l in 1967 to 53 mg/l in 1969. Values recorded during spring 1971 were comparable to those from spring 1969. Changes in the chemistry of the water in Pumphouse Lake are probably due primarily to changes in the spring water supplying the lake. The source of this water is unknown. The decrease in pH reported in Lake 29 from 7.3 and 7.5 in the autumn of 1969 to 6.8 and 6.9 in the spring of 1970 was evident in the autumn 1970 sampling when values of 6.5 and 6.9 were obtained. A similarly decreased value for pH was observed during the spring 1971 sampling period. Similarly, slightly decreased values in pH and alkalinity were indicated in the data for Lake 26 (Weed Lake).

The alkalinities from October and April in Lake 58b (Fault Lake) were slightly increased over values from the same period in 1969. The pH of this lake also increased slightly. These increases are probably the result of new materials entering the lake as a result of increased traffic on Infantry Road.

The alkalinity in Lake 51 (Emerald Lake) increased from about 5.0 mg/l in the spring of 1970 to 27.7 mg/l in the spring of 1971 due to seepage of drill mud into the lake. The drill mud was pumped into a lake (Coordinate 437064) that ultimately drains into Emerald Lake. The lake receiving the drill mud had an alkalinity of over 400 mg/l, pH of 8.10, and specific conductivity of 1350. Both lakes were highly discolored and odoriferous. No living planktonic organisms were observed in either lake, when they were sampled in April, 1971.

TABLE 2. PRE- AND POST-MILROW CHEMICAL AND PHYSICAL
PARAMETERS OF MILROW INTENSIVE-STUDY LAKES

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C
26 Autumn Data	9-7-67 10-6-67 9-20-69 9-25-69	7.5-	<u>Before</u> 24. -	--	--
		7.4-	27. -	--	--
		7.65	25. -	--	--
		7.30	27. -	--	--
	10-7-69 10-8-69 10-3-70 10-7-70 10-16-70	7.10	<u>After</u> 22. -	--	--
		7.24	22.5	--	--
		6.76	25.3	170	11.5
		7.80	26.0	--	7.0
		6.99	12.5	180	8.0
	5-9-68 4-13-69 4-26-69 4-6-70 4-20-70 4-27-70 5-9-70 4-24-71 4-30-71	7.6-	<u>Before</u> 21. -	--	--
		7.2-	17. -	--	--
		7.4-	18. -	--	--
		7.0-	<u>After</u> 11. -	--	--
		7.00	12.9	--	--
		7.1-	11. -	--	--
		7.1-	15. -	--	--
		7.25	14.3	170	3.9
		7.09	14.3	165	5.5
28 Autumn Data	8-16-67 9-6-67 10-5-67 9-20-69 9-25-69	7.4-	<u>Before</u> 35. -	--	--
		7.7-	26. -	--	--
		7.7-	28. -	--	--
		7.65	28. -	--	--
		7.40	27.5	--	--
	10-7-69 10-8-69 10-3-70 10-7-70 10-16-70	7.39	<u>After</u> 26. -	--	--
		7.33	26. -	--	--
		6.80	29.3	178	10.0
		7.35	30.0	--	7.0
		7.30	29.0	205	8.0
	5-12-68 4-12-69 4-20-70 5-6-70 4-24-71	7.5-	<u>Before</u> 22. -	--	--
		7.1-	21. -	--	--
		7.05	<u>After</u> 13.7	260	--
		7.0-	14. -	--	--
		7.25	16.6	160	3.2

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C
7			<u>Before</u>		
Autumn	8-29-67	5.4-	<1.0	--	--
Data	9-19-69	5.50	<1.0	--	--
	9-23-69	5.70	<1.0	--	--
	9-26-69	5.46	<1.0	--	--
			<u>After</u>		
	10-7-69	5.66	<1.0	--	--
	10-11-69	5.62	<1.0	--	--
	10-3-70	5.80	<1.0	170	11.0
	10-17-70	5.70	0.7	158	7.0
			<u>Before</u>		
			(No Data Available)		
			<u>After</u>		
Spring	4-26-71	6.10	0.7	185	4.0
Data					
9			<u>Before</u>		
Autumn	8-29-67	6.2-	2.-	--	--
Data	9-19-69	6.13	1.5	--	--
	9-23-69	6.22	1.5	--	--
	9-26-69	6.05	1.5	--	--
			<u>After</u>		
	10-7-69	6.03	1.5	--	--
	10-11-69	5.80	1.0	--	--
	10-3-70	6.00	1.7	200	11.5
	10-6-70	6.25	2.0	--	--
	10-17-70	6.15	1.5	180	7.0
			<u>Before</u>		
Spring	5-10-68	6.4-	2.-	--	--
Data	4-17-69	6.0-	1.-	--	--
			<u>After</u>		
	4-20-70	6.00	9.0	340	--
	4-30-70	6.0-	1.-	--	--
	4-26-71	6.13	1.6	180	4.0
	4-30-71	6.15	1.4	195	--
			<u>Before</u>		
10	8-29-67	6.1-	2.-	--	--
Autumn	9-19-69	6.80	6.-	--	--
Data	9-23-69	6.85	6.5	--	--
	9-26-69	6.68	5.-	--	--
			<u>After</u>		
	10-7-69	6.38	6.5	--	--
	10-11-69	6.70	7.-	--	--
	10-3-70	6.65	8.1	258	13.0
	10-6-70	6.70	10.0	--	--
	10-17-70	6.75	7.5	250	7.0

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C
		<u>Before</u> (No Data Available)			
		<u>After</u>			
Spring Data	4-2-70	6.8-	3.5	450	4.3
	4-6-70	6.4-	4.-	--	--
	4-20-70	6.56	3.4	500	--
	5-1-70	6.8-	8.-	--	--
	4-26-71	7.00	6.0	295	5.0
	4-30-71	6.90	5.6	315	--
		<u>Before</u>			
29 Autumn Data	8-16-67	7.4-	13.-	--	--
	9-20-69	7.52	17.-	--	--
	9-25-69	7.38	17.-	--	--
		<u>After</u>			
	10-7-69	7.38	16.-	--	--
	10-8-69	7.11	15.-	--	--
	10-3-70	6.50	16.0	140	9.0
	10-16-70	6.90	14.0	135	8.0
		<u>Before</u>			
Spring Data	5-8-68	7.3-	11.-	--	--
	4-9-69	7.4-	8.-	--	--
		<u>After</u>			
	4-6-70	--	10.-	--	--
	4-20-70	6.95	8.4	230	--
	5-4-70	6.8-	8.-	--	--
	4-24-71	6.99	8.7	130	3.5
		<u>Before</u>			
30 Autumn Data	8-16-67	5.8-	1.-	--	--
	9-20-69	5.90	<1.-	--	--
	9-25-69	5.80	<1.-	--	--
		<u>After</u>			
	10-7-69	5.87	<1.-	--	--
	10-8-69	5.95	<1.-	--	--
	10-3-70	5.77	1.0	110	9.0
		<u>Before</u>			
Spring Data	4-23-69	5.8	1.-	--	--
		<u>After</u>			
	4-6-70	5.5-	1.-	--	--
	4-20-70	5.61	1.2	200	--
	4-28-70	5.7-	1.-	--	--
	5-3-70	5.6-	1.-	--	--
	4-24-71	6.36	1.0	110	2.9
		<u>Before</u>			
31b Autumn Data	9-20-69	7.60	23.-	--	--
	9-25-69	7.32	23.-	--	9.5

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/ℓ	Specific Conductance, micromhos/cm ²	Temperature, C
			<u>After</u>		
Autumn	10-8-69	7.39	19.5	--	6.-
Data	10-3-70	6.70	24.5	160	9.0
	10-10-70	7.32	32.0	160	9.0
	10-16-70	7.10	16.5	135	8.0
			<u>Before</u>		
Spring	4-22-68	6.9-	23.-	--	--
Data	5-7-68	7.1-	14.-	--	--
	4-16-69	7.4-	13.-	--	--
			<u>After</u>		
	4-2-70	7.10	--	280	3.5
	4-6-70	6.4-	9.-	--	--
	4-20-70	6.94	10.1	310	--
	4-26-70	7.1-	8.-	--	--
	4-24-71	7.23	11.7	160	3.8
	4-30-71	6.82	11.2	165	--
			<u>Before</u>		
2	8-21-67	8.6-	51.-	--	--
Autumn	10-3-67	8.3-	66.-	--	--
Data	9-19-69	7.70	43.-	--	9.-
	9-23-69	7.90	49.-	--	--
	9-27-69	7.79	44.-	--	--
			<u>After</u>		
	10-7-69	7.70	44.-	--	8.-
	10-11-69	7.70	46.5	--	5.-
	10-3-70	7.98	59.0	160	11.-
			<u>Before</u>		
Spring	4-20-69	7.9-	49.-	--	--
Data			<u>After</u>		
	4-6-70	7.70	38.-	400	3.0
	4-20-70	7.8-	38.5	400	--
	4-23-71	8.00	45.0	265	7.5
			<u>Before</u>		
33	8-11-67	6.8-	4.-	--	--
Autumn	10-5-67	6.6-	3.-	--	--
Data	9-17-69	7.30	14.-	--	8.-
	9-26-69	7.20	14.5	--	8.-
			<u>After</u>		
	10-7-69	7.46	14.5	--	7.-
	10-12-69	7.20	13.0	--	4.-
	10-3-70	6.40	8.3	105	9.0
	10-16-70	6.75	7.0	100	8.0
			<u>Before</u>		
Spring	5-13-68	6.6-	3.-	--	--
Data	4-21-69	6.7-	3.-	--	--

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/ℓ	Specific Conductance, micromhos/cm ²	Temperature, C
35 Autumn Data			<u>After</u>		
	5-8-70	6.8-	7.-	--	--
	4-24-71	6.73	4.3	130	2.5
			<u>Before</u>		
	8-11-67	5.6-	<1.-	--	--
	8-17-67	5.2-	<1.-	--	--
	10-5-67	4.0-	<1.-	--	--
	9-17-69	6.03	<1.-	--	9.5
	9-22-69	5.90	<1.-	--	7.5
	9-26-69	5.88	1.-	--	7.0
			<u>After</u>		
	10-12-69	5.87	1.5	--	3.5
	10-3-70	5.66	1.0	95	8.0
			<u>Before</u>		
			(No Data Available)		
36 Autumn Data			<u>After</u>		
	4-2-70	5.99	1.5	220	4.2
	4-6-70	5.3-	1.-	--	--
	4-20-70	5.38	0.0	240	--
	4-25-70	5.6	1.-	--	--
			<u>Before</u>		
	8-11-67	5.6-	<1.-	--	--
	8-17-67	5.7-	<1.-	--	--
	10-5-67	5.7-	<1.-	--	--
	9-17-69	5.50	<1.-	--	9.5
5 Autumn Data	9-22-69	5.50	<1.-	--	8.0
	9-26-69	5.65	<1.-	--	7.5
			<u>After</u>		
	10-12-69	5.77	<1.-	--	3.5
	10-3-70	5.44	0.5	100	8.0
			<u>Before</u>		
	4-18-69	5.7-	1.-	--	--
			<u>After</u>		
	4-6-70	5.4-	1.-	--	--
	4-20-70	5.42	0.3	260	--
	4-23-70	5.5-	1.-	--	--
			<u>Before</u>		
	8-21-67	9.4-	70.-	--	--
	10-5-67	8.7-	73.-	--	--
	9-19-69	8.09	66.-	--	10.-
	9-23-69	8.10	69.-	--	8.5
	9-27-69	7.80	65.5	--	--
			<u>After</u>		
	10-11-69	7.98	80.-	--	5.-
	10-3-70	8.15	81.0	300	11.0

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C
Spring Data	4-24-69	7.9-	<u>Before</u> 47. -	--	--
			<u>After</u>		
	4-3-70	7.72	58.0	410	3.0
	4-7-70	--	57. -	480	3.0
	4-8-70	8.00	58.0	475	3.0
	4-20-70	7.83	54.5	490	--
	4-29-70	8.0-	54. -	--	--
	5-9-70	8.2-	59. -	--	--
	4-23-71	7.93	54.7	290	6.5
1 Autumn Data			<u>Before</u>		
	8-21-67	7.84	65. -	--	--
	9-19-69	7.87	55. -	--	10. -
	9-23-69	8.03	56.5	--	8.5
	9-27-69	7.88	53.5	--	--
			<u>After</u>		
	10-11-69	7.77	53. -	--	5.5
	10-3-70	7.81	61.8	305	10.5
			<u>Before</u>		
	5-11-68	8.0-	61. -	--	--
Spring Data	4-11-69	7.9-	53. -	--	--
	4-25-69	8.0-	55. -	--	--
			<u>After</u>		
	4-3-70	7.60	48.3	350	1.6
	4-6-70	7.63	--	410	3.5
	4-9-70	7.6-	47. -	--	--
	4-20-70	7.82	47.3	420	--
	5-7-70	7.7-	54. -	--	--
	4-23-71	7.83	53.0	295	5.9
			<u>Before</u>		
51 Autumn Data	8-23-67	7.2-	7. -	--	--
	10-4-67	7.0-	7. -	--	--
	9-17-69	6.92	7.5	--	10. -
	9-22-69	6.37	6.5	--	8. -
	9-27-69	6.90	8.5	--	--
			<u>After</u>		
	10-12-70	6.90	7.5	--	4. -
	10-3-70	6.23	6.2	120	8.0
	10-16-70	6.69	5.5	121	7.0
			<u>* Before</u>		
Spring Data			(No Data Available)		
			<u>After</u>		
	4-6-70	6.6-	4. -	--	--
	4-20-70	6.67	5.0	220	--
	4-25-71	7.03	27.7	220	3.0

TABLE 2. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C
58b Autumn Data			<u>Before</u>		
	9-22-69	5.70	2.5	--	8.5
	10-12-69	6.63	3.0	--	5.0
			<u>After</u>		
	10-3-70	6.73	5.2	120	8.0
	10-8-70	6.60	3.5	120	7.0
	10-16-70	6.72	3.5	120	7.0
Spring Data			<u>Before</u>		
	4-30-67	6.5-	2.-	--	--
	5-6-68	6.5-	2.-	--	--
	4-19-69	6.6-	2.-	--	--
			<u>After</u>		
	4-6-70	6.4-	2.-	--	--
	4-19-70	6.70	3.7	230	2.0
	4-20-70	6.64	3.2	220	--
	5-8-70	6.4-	2.-	--	--
	4-25-71	6.73	3.8	120	4.6
	5-1-71	6.40	2.6	123	--
23 Autumn Data			<u>Before</u>		
	9-1-67	7.0-	7.-	--	--
			<u>After</u>		
	10-10-70	7.05	9.3	135	9.0
Spring Data			<u>Before</u> (No Data Available)		
			<u>After</u>		
	4-10-70	--	9.0	215	4.0
	4-27-71	6.82	6.9	135	--
24 Autumn Data			<u>Before</u>		
	9-1-67	7.0-	7.-	--	--
			<u>After</u>		
	10-10-70	7.00	9.7	160	9.0
Spring Data			<u>Before</u> (No Data Available)		
			<u>After</u>		
	4-10-70	--	7.9	215	4.0
	4-27-71	6.89	9.5	150	--
25 Autumn Data			<u>Before</u>		
	9-1-67	7.3-	11.-	--	--
			<u>After</u>		
	10-10-70	6.92	6.0	105	9.0
Spring Data			<u>Before</u> (No Data Available)		
			<u>After</u>		
	4-10-70	--	7.8	215	3.5
	4-27-71	6.80	5.4	140	--

The alkalinity of Lake 31b (Round Lake) decreased from 23 mg/ℓ on September 25, 1969, before Milrow to 19.5 mg/ℓ on October 8, 1969, immediately after. During the autumn 1970 sampling period, alkalinities in this lake decreased from 32 mg/ℓ to 16.5 mg/ℓ during a 6-day interval. The pH and specific conductance were decreased slightly. A similar phenomenon occurred in Lake 26 (Weed Lake) during the same period where alkalinity decreased from 26.0 mg/ℓ to 12.5 mg/ℓ. The reason for these changes is unresolved but they do not appear to be test related.

Increased alkalinities were observed in Lakes 23 and 24, and the water remaining in Lake 25 had decreased alkalinity. Alkalinity and pH remained essentially unchanged from previous sampling periods in all of the intensive study lakes not specifically cited in this discussion.

Biological Data

Zooplankton communities during late September and October, 1970, were again dominated by rotifers in all of the intensive study lakes. Cladocerans were absent from most lakes and copepods were generally present in very low concentrations. There were fewer zooplankters in most lakes than were recorded for prior years but this was probably due to natural variability in the zooplankton population densities. Table 3 presents the data collected on these populations during FY 1971 and comparative data from similar seasons during previous years.

Comparing the data from autumn 1969 with that from 1970 shows decreased numbers of rotifers in 7 of the 15 lakes of the series that were resampled during the 1970 season. Seven lakes had slightly increased numbers of rotifers and one was essentially unchanged. There were increased numbers of adult copepods in 6 lakes and comparable numbers in 9. Cladocerans were either absent or present in very small numbers during the autumn 1970 sampling period.

Lakes 1, 10, 29, and 58b contained very low numbers of total zooplankton relative to other intensive-study lakes. Lake 10 had unusually low concentrations of rotifers and rotifer eggs during autumn 1970 compared with 1969 samples. Rotifer adults that numbered 21/ℓ and eggs 13/ℓ October 3, 1970, were totally absent in samples from October 17, 1970. Concentrations on October 11, 1969, were 4655 adults/ℓ and 2405 eggs/ℓ. Cladocerans and copepod nauplii were present in 1970 in small numbers but were absent in 1969. The spring samples from 1971 indicated large numbers of rotifer adults and eggs present in Lake 10.

The trend of the zooplankton communities in the Milrow intensive-study lakes was to decrease in total numbers during October, 1970. This was particularly apparent in rotifer populations. By comparison, numbers of copepods were more stable throughout the sampling period. These trends are significant to the interpretation of short-term event-related effects on zooplankton populations; Milrow was detonated during the autumn and Cannikin is proposed for an autumn detonation. Multiple effects were observed in Lake 31b (Round Lake) after Milrow among which was a drastic decrease in the concentration of zooplankton populations between September 25, 1969 (preevent), and October 8, 1969 (postevent). Between October 3, 1970, and October 16, 1970, a similar drastic reduction was observed in the zooplankton populations in Round Lake in the absence of a test. Similar population crashes occurred in zooplankton in Lakes 10, 26, 33, and 58b during the same period. These data will be useful information to contribute to the interpretation of effects of possible future events during the autumn season.

TABLE 3. ZOOPLANKTON POPULATION CONCENTRATIONS IN MILROW
INTENSIVE-STUDY LAKES IMMEDIATELY BEFORE AND
AFTER AND ONE YEAR AFTER THE EVENT^(a)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
1	9/19/69	265	120	8	--	--
	9/23/69	527	135	--	--	--
	10/11/69	212	80	2	--	--
	10/3/70	24	2	--	2	2
	4/23/71	2	--	f	--	--
2	9/19/69	50	49	8	--	--
	9/23/69	109	66	2	--	--
	10/11/69	340	228	--	--	--
	10/3/70	63	25	--	13	38
	4/23/71	--	--	--	--	--
7	9/19/69	78	21	--	--	21
	9/23/69	149	36	--	--	24
	10/11/69	107	52	--	7	27
	10/3/70	42	29	--	8	42
	10/17/70	95	43	--	--	13
	4/25/71	8	8	--	--	10
9	9/19/69	652	146	--	--	8
	9/23/69	584	144	--	--	2
	10/11/69	367	135	--	--	--
	10/3/70	129	13	--	--	--
	10/10/70	435	75	--	3	--
	10/17/70	276	68	--	--	--
	4/25/71	58	8	--	--	3
10	9/19/69	764	232	--	--	--
	9/23/69	1530	525	--	--	--
	10/11/69	4655	2405	--	--	--
	10/3/70	21	13	4	--	21
	10/10/70	65	45	--	3	3
	10/17/70	--	--	--	--	5
	4/30/71	3160	1200	--	20	--
26	9/20/69	79	20	--	--	2
	9/25/69	59	18	--	--	2
	10/8/69	48	24	--	--	--
	10/3/70	96	42	--	--	--
	10/7/70	80	33	3	--	3
	10/16/70	3	--	--	--	3

TABLE 3. (Continued)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
28	9/20/69	3	--	--	--	--
	9/25/69	77	57	--	--	3
	10/8/69	24	80	--	--	3
	10/3/70	17	8	--	4	8
	10/7/70	13	3	--	3	--
	10/16/70	3	3	--	--	--
	4/24/71	8	--	--	--	8
29	9/20/69	10	--	--	--	2
	9/25/69	39	8	--	--	--
	10/8/69	11	10	--	--	2
	10/3/70	8	21	--	--	--
	10/16/70	8	8	--	--	3
	4/24/71	--	--	--	--	--
30	9/20/69	400	21	--	--	14
	9/25/69	426	81	--	--	6
	10/8/69	180	64	--	--	3
	10/3/70	63	29	--	6	17
	4/24/71	5	5	--	--	13
31b	9/20/69	14	--	--	2	10
	9/25/69	107	33	--	3	12
	10/8/69	10	--	--	--	3
	10/3/70	79	29	--	4	21
	10/10/70	13	--	--	13	10
	10/16/70	--	--	--	--	--
	4/24/71	--	--	--	3	3
	4/30/71	25	--	--	5/f	--
33	9/17/69	28	--	--	8	2
	9/22/69	62	16	--	4	4
	9/26/69	51	16	--	2	--
	10/12/69	21	14	--	--	--
	10/3/70	92	33	--	--	--
	10/16/70	25	3	--	--	--
	4/24/71	8	--	--	--	--
35	9/17/69	290	42	--	5	40
	9/22/69	187	34	--	12	82
	9/26/69	104	22	--	6	63
	10/12/69	64	33	--	2	36
	10/3/70	142	13	--	8	46

TABLE 3. (Continued)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
36	9/17/69	81	21	--	2	36
	9/22/69	35	10	--	8	27
	10/12/69	88	46	--	4	44
	10/12/69	42	45	2	--	6
	10/3/70	246	100	--	--	--
51	9/17/69	74	51	--	--	--
	9/22/69	235	68	--	--	--
	10/12/69	38	5	--	--	3
	10/3/70	92	25	0	0	4
	10/16/70	60	18	0	0	3
	4/25/71	--	--	--	--	--
58a	9/22/69	10	--	3	--	6
	10/12/69	2	3	--	--	--
	10/3/70	35	51	0	0	16
	10/8/70	--	--	--	--	--
	10/16/70	3	--	--	--	--
	5/1/71	20	5	--	--	--
	4/25/71	--	--	--	--	--
23	10/10/70	50	65	--	3	5
	4/27/71	13	5	--	--	15
24	10/10/70	38	28	--	3	3
	4/27/71	8	--	--	3	--
25	10/10/70	13	5	73	8	5
	4/27/71	--	--	--	--	--

(a) -- Organisms not observed.

f Fragments of organisms observed.

During the autumn sampling period the phytoplankton populations were declining in most of the intensive-study lakes. Species of Mougeotia, Pediastrum, Zygonema, Tabellaria, and Anabaena were common in the lakes during this period. General observations on phytoplankton suggested that concentrations of these organisms decreased sharply as water temperatures decreased. Since this decrease was expected and since it was considered more important to concentrate the studies on zooplankton, no attempt was made to quantify precisely the decrease in phytoplankton.

The limnetic organic matter concentrations on selected Milrow intensive-study lakes compared favorably with values reported prior to the event (Table 4). Lake 9 had concentrations of 7.6 mg/l and 5.2 mg/l in autumn 1970 and spring 1969. Values of 8.3 mg/l and 4.9 mg/l were reported for similar periods during 1968 and 1969, respectively. A spring value of 12.6 mg/l on Lake 9 in 1970 may indicate the flushing of organic matter which had been torn loose during Milrow into the lake. High alkalinity and specific conductance values were also observed in the lake during that period. Values of 12.4 mg/l, 9.9 mg/l, and 5.3 mg/l for Lakes 26, 28, and 31b, respectively, during autumn 1970 compare favorably with values of 10.0-25.6 mg/l, 7.3-14.4 mg/l, and 6.9-34.9 mg/l reported for autumn 1968. Spring data for Lake 26 show slightly decreased values from prior years and for Lake 58b are slightly higher than for the prior spring. There was no indication of large amounts of organic material entering the intensive-study lakes. Such a result would be expected if peat mats in the drainage basins were ruptured as a result of Milrow.

Rates of production of total organic matter by periphyton organisms was estimated on nine lakes during September and October, 1970. Six of those lakes were Milrow intensive-study lakes (1, 26, 28, 31b, 51, and 58b). These data are presented in Table 5. Production ranges from a high of 27.6 mg/m²/day in Lake 1 (Pumphouse Lake) to a low of 1.3 mg/m²/day in an acid lake near Cannikin SZ site. Lakes 28 and 31b were also very productive during this period with rates of 16.2 and 18.0 mg/m²/day, respectively. Weed Lake (58a) was considerably less productive at 2.2 mg/m²/day as was Emerald Lake. Fault Lake (58b) was the least productive of the intensive-study lakes investigated (1.4 mg/m²/day). Carbon fixation rates during autumn sampling periods are available for five of these lakes. Ranked from highest to lowest in terms of carbon fixation, these lakes are 28, 31b, 1, 26, and 58b. In total organic matter production during autumn 1970 they ranked 1, 31b, 28, 26, and 58b. Except for Lakes 1 and 28 being reversed, the ranking is similar. The rates of periphyton production and phytoplankton production may be comparable on a relative basis for Amchitka lakes but such a suggestion requires much more investigation. Periphyton and associated organisms may represent a considerable portion of the autochthonous production of organic matter in some of the lakes. This source of organic matter may exceed that produced by phytoplankton in several Amchitka lakes.

Rates of primary productivity of phytoplankton by carbon fixation were investigated in 11 lakes during April and May, 1971; of these, 5 were Milrow intensive-study lakes. The data from these analyses are presented in Table 6. The highest rates of carbon fixation were in Rifle and Duck Ponds in the Rifle Range area with rates of 31.5 and 11.5 mg C/m³/hr x 10⁻³, respectively. The lowest value recorded was from Lake 58b at 0.4 mg C/m³/hr x 10⁻³. Lakes 31b and 26 were intermediate between those lakes at 5.4 and 3.8 mg C/m³/hr x 10⁻³. The rank of relative productivities of the five intensive-study lakes compared favorably with those from previous spring sampling programs. The fact that the Rifle Range lakes were several times more productive than most other lakes analyzed and the presence of other minor changes cited may be an indication of a subtle change in these lakes as a result of Milrow.

TABLE 4. TOTAL ORGANIC MATTER CONCENTRATIONS
IN OPEN LAKE WATER

Lake	Total Limnetic Organic Matter, mg/l			
	Autumn 1970		Spring 1971	
	Date	Data	Date	Data
9	10-6	7.6	4-30	5.2
10	10-6	13.1	4-30	5.4
19b	10-9	9.7	--	--
26	10-7	12.4	4-30	3.9
28	10-7	9.9	--	--
31b	10-10	5.3	4-30	4.7
42c	10-9	5.0	5-2	2.6
42d	10-9	15.1	5-2	5.1
42f	10-9	9.1	5-2	8.0
43b	10-10	8.8	5-1	6.1
43c	10-10	7.6	5-1	4.0
49	10-8	8.5	5-1	4.6
58b	10-8	5.5	5-1	3.4

TABLE 5. RATES OF PRODUCTION OF TOTAL ORGANIC MATTER
BY PERIPHYTON ORGANISMS SEPTEMBER
AND OCTOBER, 1970

Lake	Date		Total Exposure, days	Total Organic Matter Production	
	In	Out		Total Exposure Period, mg/m ²	Daily, mg/m ² /day
1	9-28	10-13	15	415.4	27.6
19b	9-28	10-12	14	60.3	4.5
26	9-28	10-13	15	34.1	2.3
28	9-28	10-13	15	243.3	16.2
31b	9-28	10-12	14	252.6	18.0
42d	9-28	10-13	15	102.3	6.8
42f	9-28	10-13	15	20.2	1.3
51	9-28	10-13	15	32.6	2.2
58b	9-28	10-13	15	20.9	1.4

TABLE 6. RATES OF CARBON FIXATION BY PHYTOPLANKTON
APRIL AND MAY, 1971

Lake	Date	pH	Alkalinity, mg/ℓ	Carbon Fixation mg C/m ³ /hr		
				Total	Dark	Net
9	4-30	6.15	1.4	32.3	0.8	31.5
10	4-30	6.90	5.6	12.3	0.8	11.5
26	4-30	7.09	14.3	5.9	2.1	3.8
31b	4-30	6.82	11.2	7.2	1.8	5.4
42c	5-2	5.93	<1.0	3.1	0.6	2.5
42d	5-2	7.40	21.0	2.4	1.8	0.6
42f	5-2	5.65	<1.0	2.6	0.3	2.3
43b	5-1	6.13	1.0	0.9	0.3	0.6
43c	5-1	6.95	5.8	3.0	0.5	2.5
49	5-1	6.22	1.3	1.6	0.2	1.4
58b	5-1	6.40	2.6	0.8	0.4	0.4

CANNIKIN-EFFECTS BASELINE-STUDY LAKES

A total of 39 lakes were sampled during the autumn 1970 and spring 1971 field program to acquire baseline information in preparation for Cannikin. Some of these lakes were also intensive-study lakes for the Milrow event. From these 39 lakes a smaller number of study lakes will be selected for intensive event-time investigation. The lakes were selected on the basis of (1) morphology and relative permanence, (2) location with respect to SZ, (3) accessibility, (4) the existence of prior sampling data, and (5) coordination of limnology sampling with the freshwater fisheries investigations. All of the lakes sampled are shown on Figure 1 and those within 3,218 m of Cannikin SZ are shown on Figure 2.

Chemical and Physical Data

The lakes range in distance from Cannikin SZ from 740 to 11,000 m as described in Table 7. Most of these lakes are less than 2 m deep and they vary considerably in type of bottom substrate and bottom compaction. Data on pH, alkalinity, dissolved chloride, and specific conductance collected from the lakes during the autumn and spring sampling programs are presented in Table 8.

Alkalinities in these lakes varied from 0.0 mg/ℓ to 34.5 mg/ℓ, and pH values between 5.04 and 7.80. Of 23 lakes sampled within 3,200 m of SZ, 5 had pH values which were usually below 6.0, 11 were acidic (between 6.0 and 7.0), and 7 were near neutral to slightly alkaline in nature. Alkalinities ranged between 0.0 and 3.7 mg/ℓ in lakes sampled having pH values below 6.0 during the autumn. Alkalinities ranged between 1.0 mg/ℓ and 29.3 mg/ℓ in lakes with pH's between 6.0 and 7.0. Lakes with pH's above 7.0 had alkalinity values between 26.0 and 34.5 mg/ℓ. During the autumn sampling period, the pH values of most Cannikin survey lakes were either stable or tending to increase, but overall decreases in pH were observed in five lakes. Values

FIGURE 2. CANNIKIN-EFFECTS EVALUATION LAKES WITHIN 3,200 M OF SZ
(DISTANCES ARE FROM SURFACE ZERO TO THE NEAREST LAKE SHORE)

TABLE 7. CANNIKIN-EFFECTS BASELINE-STUDY LAKES

Lake	Coordinate ^(a)	Distance ^(b) , km, and Direction from Cannikin SZ	Drainage	pH	Bottom Characterization ^(c)				Approx. Maximum Depth, m
					Compaction		Substrate		
					NS	OLW	NS	OLW	
42f ^(d)	467048	0.74 - 40	Bering	Acid	Soft	Soft	Peat	Peat	0.66
42d	471041	0.82 - 102	Bering	Alkaline	Firm	--	Gravel	Silt	0.66
42e	471036	0.92 - 124	Bering	Acid	Soft	Soft	Peat	Peat	0.66
42h	472039	0.92 - 112	Bering	Acid	Firm	--	--	--	0.66
42c	473039	0.98 - 112	Bering	Acid	Soft	v/Soft	--	--	0.98
42i	474038	1.17 - 106	Bering	Acid	Firm	Soft	--	--	0.98
44a	451037	1.22 - 245	Pacific	Acid	Firm	Firm	Sand	Sand	0.98
45	457054	1.27 - 340	Bering	Alkaline	Soft	Soft	--	--	--
43a	465029	1.32 - 171	Bering	Acid	v/Soft	v/Soft	Silt	Silt	0.98
46	453051	1.43 - 315	Bering	Alkaline	Soft	Soft	Floc	Floc	0.66
43b	466027	1.43 - 168	Bering	Acid	Firm	Soft	Cobble	Peat	0.98
48	451052	1.53 - 313	Bering	Acid	Soft	Soft	Floc	Floc	0.98
49	449049	1.56 - 298	Bering	Acid	Firm	Soft	Mud	--	--
43c	465025	1.58 - 174	Bering	Acid	Firm	Firm	Sand	Sand	0.98
42g	481045	1.80 - 83	Bering	Alkaline	Hard	--	Cobble	--	--
41c	481036	1.87 - 111	Bering	Acid	v/Soft	v/Soft	Mud	Mud	0.66
50a	445053	2.11 - 304	Bering	Acid	Hard	--	Gravel	--	0.66
41b	484033	2.17 - 114	Bering	Acid	Soft	Soft	Mud	Mud	0.98
43f	461016	2.49 - 184	Pacific	Alkaline	Firm	--	--	--	--
43e	472016	2.59 - 161	Pacific	Acid	Soft	--	--	--	--
44b	437033	2.70 - 254	Pacific	Akaline	Firm	--	--	--	--
43h	447018	2.88 - 215	Pacific	Alkaline	Firm	--	--	--	--
33	493030	3.19 - 113	Bering	Acid	Hard	Soft	Cobble	Silt	1.31
50c	424047	3.81 - 279	Pacific	Alkaline	Firm	--	--	--	--
51	431066	3.97 - 309	Pacific	Acid	Hard	Soft	Cobble	Silt	1.64
29	512002	6.26 - 130	Bering	Alkaline	Firm	--	Sand	--	3.28
30	514006	6.26 - 127	Bering	Acid	Hard	Soft	Cobble	Peat	0.98
31b	521016	6.39 - 116	Bering	Alkaline	Hard	--	Cobble	--	1.97
52a	415086	6.39 - 315	Bering	Acid	Soft	Soft	Silt	--	3.28
28	519000	6.92 - 128	Bering	Alkaline	Gravel	--	Firm	--	2.62

TABLE 7. (Continued)

Lake	Coordinate ^(a)	Distance ^(b) , km, and Direction from Cannikin SZ	Drainage	pH	Bottom Characterization ^(c)				Approx. Maximum Depth, m
					Compaction		Substrate		
					NS	OLW	NS	OLW	
53	409091	7.42 - 314	Bering	Acid	Hard	Firm	Cobble	Mud	1.31
52c	396078	7.56 - 300	Pacific	Alkaline	--	--	--	--	--
26	527994	7.93 - 128	Bering	Alkaline	Firm	Soft	Sand	--	3.28
58a	401095	8.25 - 312	Pacific	Acid	Soft	--	Peat	--	--
7	515965	9.35 - 148	Pacific	Acid	Firm	Firm	Peat	Peat	0.80
19b	541990	9.38 - 126	Bering	Alkaline	Firm	--	Gravel	--	--
9	516963	9.56 - 148	Pacific	Acid	v/Soft	v/Soft	Mud	Mud	0.98
10	515962	9.65 - 149	Pacific	Acid	Hard	Firm	Cobble	Peat	1.64
58b	393110	9.98 - 316	Pacific	Acid	Hard	Firm	Cobble	Cobble	4.92

(a) Coordinates refer to the approximate center of lakes.

(b) Straight-line distance between surface zero and the nearest lake shore.

(c) NS = near shore; OLW = open lake water; v/Soft = very soft.

(d) Lake 42f in this report = Lake 43 in Koob, 1968.

TABLE 8. CHEMICAL AND PHYSICAL PARAMETERS OF CANNIKIN-EFFECTS BASELINE-STUDY LAKES

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Chloride, mg/l	Temperature, C
42f	9-29-70	5.80	1.0	70	16.0	7.0
	10-13-70	5.58	0.5	80	--	8.0
	4-28-71	5.25	0.0	120	29.3	--
	5-2-71	5.65	0.4	138	--	--
42d	9-29-70	7.15	34.0	170	27.5	7.0
	10-9-70	7.72	32.0	170	28.7	6.0
	10-13-70	7.20	32.5	180	--	8.0
	4-28-71	7.59	34.2	235	33.4	--
	5-2-71	7.40	21.0	200	--	--
42e	9-29-70	5.92	3.7	82	17.5	8.5
	10-13-70	6.69	4.8	95	--	8.0
	4-28-71	6.43	2.5	130	24.0	--
42h	9-29-70	5.45	0.5	105	23.5	8.0
	10-13-70	5.04	0.0	105	--	7.0
	4-28-71	6.17	1.3	115	25.0	--
42c	9-29-70	5.59	1.0	100	24.5	8.0
	10-13-70	5.95	<1.0	102	--	7.0
	4-28-71	6.13	1.1	115	25.5	--
	5-2-71	5.93	<1.0	119	--	--
42i	9-29-70	5.71	<1.0	99	23.8	8.0
	10-13-70	6.05	<1.0	101	--	7.0
	4-28-71	5.52	0.5	120	23.5	--
44a	9-30-70	6.50	12.0	130	27.2	10.0
	10-2-70	6.45	11.5	130	26.7	7.0
	10-16-70	6.85	10.5	138	--	7.0
	4-25-71	6.52	9.7	155	32.2	4.2
45	10-15-70	7.00	15.7	170	33.8	6.0
43a	9-30-70	6.55	10.0	123	26.8	10.0
	10-2-70	6.20	9.2	125	26.2	7.0
	10-16-70	6.75	7.0	220	--	7.0
	4-26-71	6.82	4.4	115	26.1	3.9
46	9-30-70	6.68	17.7	170	34.0	10.0
	10-2-70	7.15	19.5	170	34.0	9.0
43b	9-30-70	6.49	<2.0	99	23.0	8.0
	10-2-70	5.88	1.0	100	23.0	7.0
	10-10-70	5.70	0.5	100	22.7	9.0
	10-16-70	5.79	0.5	105	--	7.0
	4-26-71	6.16	1.2	110	25.0	3.1
	5-1-71	6.13	1.0	117	--	--
48	9-30-70	6.42	9.3	120	25.3	11.0
	10-2-70	6.40	9.5	120	25.7	11.0

TABLE 8. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Chloride, mg/l	Temperature, C
49	9-30-70	6.15	<3.5	95	21.5	9.0
	10-2-70	6.11	<3.0	96	21.2	9.5
	10-8-70	6.53	2.5	100	20.7	7.0
	10-16-70	6.45	2.5	100	--	7.0
	4-25-71	6.15	1.5	105	24.7	4.9
	5-1-71	6.22	1.3	118	--	--
43c	9-30-70	6.35	10.5	120	20.3	9.0
	10-2-70	6.15	10.5	128	25.0	7.0
	10-16-70	6.75	7.0	182	--	7.0
	4-26-71	6.90	6.5	130	26.2	3.1
	5-1-71	6.95	5.8	120	--	--
42g	9-29-70	6.71	26.0	165	31.3	8.0
	10-15-70	7.35	25.7	180	34.7	7.0
41c	9-30-70	6.40	8.0	96	24.8	9.0
	10-2-70	6.39	8.0	102	21.0	7.0
	10-16-70	6.80	7.0	120	--	8.0
	4-24-71	6.62	3.0	150	34.0	2.5
50a	9-30-70	6.75	16.5	150	28.8	8.0
	10-2-70	6.65	16.5	145	28.8	9.5
	10-16-70	6.95	16.5	150	--	7.0
	4-25-71	6.55	10.0	145	27.7	4.5
41b	9-30-70	6.70	<3.0	80	18.3	9.0
	10-2-70	6.25	1.5	83	18.3	7.0
	10-16-70	6.11	1.5	92	--	8.0
	4-24-71	6.10	1.0	120	25.7	2.5
43f	10-15-70	7.10	11.8	135	26.0	7.0
43e	10-15-70	6.70	5.3	110	23.8	7.0
44b	10-15-70	7.20	26.0	180	33.3	7.0
43h	10-15-70	7.07	15.3	165	34.5	7.0
33	10-3-70	6.40	8.3	105	--	9.0
	10-16-70	6.75	7.0	100	--	8.0
	4-24-71	6.73	4.3	130	28.6	2.5
50c	10-15-70	7.30	32.8	200	32.5	7.0
51	10-3-70	6.23	6.2	120	--	8.0
	10-16-70	6.69	5.5	121	--	7.0
	4-25-71	7.03	27.7	220	34.2	3.0
29	10-3-70	6.50	16.0	140	--	9.0
	10-16-70	6.90	14.0	135	--	8.0
	4-24-71	6.99	8.7	130	27.0	3.5

TABLE 8. (Continued)

Lake	Date	pH	Alkalinity, mg/l	Specific Conductance, micromhos/cm ²	Chloride, mg/l	Temperature, C
30	10-3-70	5.77	1.0	110	--	9.0
	4-24-71	6.36	1.0	110	29.7	2.9
31b	10-3-70	6.70	24.5	160	--	9.0
	10-10-70	7.32	32.0	160	29.0	9.0
	10-16-70	7.10	16.5	135	--	8.0
	4-24-71	7.23	11.7	160	32.7	3.8
	4-30-71	6.82	11.2	165	--	--
52a	10-16-70	6.77	8.5	138	--	7.0
	4-25-71	6.45	7.1	140	28.6	3.2
28	10-3-70	6.80	29.3	178	--	10.0
	10-7-70	7.35	30.0	--	31.7	7.0
	10-16-70	7.30	29.0	205	--	8.0
	4-24-71	7.25	16.6	160	29.9	3.2
53	10-16-70	6.52	4.5	118	--	7.0
	4-25-71	6.40	3.2	115	25.0	3.7
52c	10-15-70	7.10	22.5	195	37.2	7.0
26	10-3-70	6.76	25.3	170	--	11.5
	10-7-70	7.80	26.0	--	30.7	7.0
	10-16-70	6.99	12.5	180	--	8.0
	4-24-71	7.25	14.3	170	33.2	3.9
	4-30-71	7.09	14.3	165	--	5.5
58a	10-16-70	6.90	13.5	160	--	7.0
	4-25-71	6.59	8.7	150	32.3	4.0
7	10-3-70	5.80	<1.1	170	--	11.0
	10-17-70	5.70	0.7	158	--	7.0
	4-26-71	6.10	0.7	185	43.0	4.0
19b	10-9-70	7.60	34.5	195	32.5	6.0
9	10-3-70	6.00	1.7	200	--	11.5
	10-6-70	6.25	2.0	--	43.7	--
	10-17-70	6.15	1.5	180	--	7.0
	4-26-71	6.13	1.6	180	43.7	4.0
	4-30-71	6.15	1.4	195	--	--
10	10-3-70	6.65	8.1	258	--	13.0
	10-6-70	6.70	10.0	--	58.0	--
	10-17-70	6.75	7.5	250	--	7.0
	4-26-71	7.00	6.0	295	70.2	5.0
	4-30-71	6.90	5.6	315	--	--
58b	10-3-70	6.73	5.2	120	--	8.0
	10-8-70	6.60	3.5	120	27.2	7.0
	10-16-70	6.72	3.5	120	--	7.0
	4-25-71	6.73	3.8	120	26.6	4.6
	5-1-71	6.40	2.6	123	--	--

of pH in the survey lakes during spring were generally stable or tending to increase. The spring 1971 pH values were about equal to those recorded from the lakes during autumn 1970 in 48 percent of the lakes; 30 percent had pH values higher, and 22 percent were lower. Alkalinities were generally decreasing or stable in the survey lakes during the autumn sampling period. During spring sampling, alkalinities were decreased from autumn values in 73 percent of the lakes, 23 percent were about the same, and 4 percent were higher.

Measured chloride concentrations ranged between 16.0 and 58.0 mg/l during autumn 1970 and appeared to be influenced by the size of the drainage area for a particular lake and its proximity to the ocean. Specific conductance varied from 70 to 258 micromhos/cm² during the same period and appeared to be influenced by some of the same factors affecting chlorides. Spring chloride concentrations ranged from 23.5 to 70.2 mg/l and specific conductivity varied from 105 to 315 micromhos/cm². Chloride concentrations were higher in the spring in 68 percent of the survey lakes, about equal to autumn values in 16 percent, and were decreased from autumn values in 16 percent of the lakes. Fifty percent of the lakes sampled had higher specific conductivities during the spring field program while 19 percent were lower. The others were approximately equal during the two sampling periods.

Biological Data

Zooplankton communities in the Cannikin baseline-data survey lakes were dominated numerically by rotifers in the autumn and spring samples except in Lake 42e where cladocerans were the dominant form. Table 9 presents the results of the analyses on the zooplankton communities. Population trends during the autumn sampling period (September 29-October 17) were to decreasing numbers of all organisms. Rotifer populations in several lakes decreased drastically in a matter of a few days during this period.

The zooplankton distribution in the lakes sampled indicates that cladocerans were essentially limited to the lakes in the area of SZ at the time of sampling. The reason for this apparent limited distribution of cladocerans to these lakes (with a few exceptions) is unresolved. Rotifers were widely distributed and present in all of the lakes sampled. Copepods were more or less sporadic in distribution by comparison to rotifers.

Table 5 presents rates of production of total organic matter by periphyton and associated organisms in some of the baseline-data survey lakes. Lakes 42d and 42f* are both near SZ but they differ considerably in chemical and physical characteristics (Tables 7 and 8). Lake 42d, which had alkaline pH values and high alkalinity concentrations, had a rate of production of about five times that of acidic Lake 42f with a peat substrate and low alkalinity. Both lakes are characteristic of the SZ-site lakes, but rates of production in both lakes are only fractions of those of highly productive lakes like 31b, 28, and 1. These SZ-site lake values are similar to values from other relatively undisturbed lakes away from the main camp area.

Table 6 presents data on rates of carbon fixation by phytoplankton organisms. The same pattern is demonstrated as with the periphyton in that the SZ-site lakes appear to be unproductive relative to lakes like 31b, 9, and 10. At the time of these

* Lake 42f in the present report is Lake 43 in Koob (1968).

TABLE 9. ZOOPLANKTON POPULATION CONCENTRATIONS OF CANNIKIN-EFFECTS
BASELINE-STUDY LAKES (ORGANISMS/LITER)^(a)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
42f	9-29-70	13	25	25	--	--
	10-13-70	33	5	8	--	5
	4-27-71	5	--	f	--	25
	5- 2-71	5	--	--	--	46
42d	9-29-70	113	38	25	--	50
	10- 9-70	263	28	--	3	--
	10-13-70	185	25	--	--	--
	4-27-71	--	--	f	--	--
	4-28-71	35	8	3	--	--
	5- 2-71	--	--	--	--	--
42e	9-29-70	25	50	225	--	25
	4-27-71	3	--	3	--	--
42h	9-29-70	938	225	75	38	--
	10-13-70	168	68	13	10	13
	4-27-71	180	45	--	--	30
42c	9-29-70	250	50	13	--	13
	10-13-70	85	33	--	--	--
	4-27-71	5	--	3	--	25
	4-28-71	5	10	5	f	40
	5- 2-71	--	--	--	--	5
42i	9-29-70	313	100	13	50	--
	10-13-70	25	8	35	--	3
	4-27-71	5	3	f	--	--
44a	9-30-70	19	69	--	--	6
	10- 7-70	6	31	6	--	--
	10-16-70	23	23	--	--	--
	4-25-71	5	--	--	3	3
45	10-15-70	8	5	3	--	--
43a	9-30-70	25	--	--	--	--
	10- 2-70	19	6	--	--	--
	10-16-70	--	--	f	--	5
	4-25-71	3	--	--	--	--
	9-30-70	31	6	--	--	--

TABLE 9. (Continued)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
46	10- 2-70	100	44	--	13	--
43b	9-30-70	31	6	6	19	--
	10- 2-70	88	25	19	38	6
	10-10-70	40	8	30	18	10
	10-16-70	25	4	54/f	13	--
	4-25-71	--	--	--	--	5
	9-30-70	88	31	--	--	6
48	10- 2-70	13	13	--	--	--
	9-30-70	112	19	--	--	--
49	10- 2-70	38	6	--	6	--
	10- 8-70	23	3	--	--	--
	10-16-70	48	13	--	3	--
	4-25-71	--	--	--	--	--
	5- 1-71	--	--	--	--	5
43c	9-30-70	100	19	6	--	--
	10- 2-70	50	--	--	6	--
	10-16-70	43	93	--	--	3
	4-25-71	3	--	--	--	8
	5- 1-71	10	--	--	--	5
42g	9-29-70	75	25	f	13	--
	10-15-70	30	3	--	--	--
41c	9-30-70	63	25	--	13	--
	10- 2-70	19	--	--	--	--
	10-16-70	23	18	--	--	8
	4-24-71	8	13	--	--	8
	9-30-70	31	6	--	--	6
50a	10- 2-70	31	25	--	--	--
	10-16-70	40	18	--	--	8
41b	9-30-70	150	50	13	--	--
	10- 2-70	75	50	--	6	6
	10-16-70	48	18	--	--	--
	4-24-71	5	--	--	--	--
43f	10-15-70	130	45	--	--	3
43e	10-15-70	193	118	3	3	--

TABLE 9. (Continued)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
44b	10-15-70	33	13	--	8	--
43h	10-15-70	108	70	--	--	3
33	10- 3-70	92	33	--	--	--
	10-16-70	25	3	--	--	--
	4-24-71	8	--	--	--	--
50c	10-15-70	50	28	--	5	8
51	10- 3-70	92	25	--	--	4
	10-16-70	60	18	--	--	3
	4-25-71	--	--	--	--	--
29	10- 3-70	8	21	--	--	--
	10-16-70	8	8	--	--	3
	4-24-71	--	--	--	--	--
30	10- 3-70	63	29	--	6	17
	4-24-71	5	5	--	--	13
31b	10- 3-70	79	29	--	4	21
	10-10-70	13	--	--	13	10
	10-16-70	--	--	--	--	--
	4-24-71	--	--	--	3	3
	4-30-71	25	--	--	5/f	--
52a	10-16-70	25	5	--	--	--
	4-25-71	--	--	--	--	3
28	10- 3-70	17	8	--	4	8
	10- 7-70	13	3	--	3	--
	10-16-70	3	3	--	--	--
	4-24-71	8	--	--	--	8
53	10-16-70	15	3	--	--	--
	4-25-71	--	--	f	--	--
52c	10-15-70	5	5	--	--	--
58a	10-16-70	33	5	--	--	--
	4-25-71	--	--	--	--	--
7	10- 3-70	42	29	--	8	42
	10-17-70	95	43	--	--	13
	4-25-71	8	8	--	--	10

TABLE 9. (Continued)

Lake	Date	Adult Rotifers	Rotifer Eggs	Cladocerans	Adult Copepods	Copepod Nauplii
19b	10- 9-70	3	--	--	--	--
9	10- 3-70	129	13	--	--	--
	10-10-70	435	75	--	3	--
	10-17-70	276	68	--	--	--
	4-25-71	58	8	--	--	3
10	10- 3-70	21	13	4	--	21
	10-10-70	65	45	--	3	3
	10-17-70	--	--	--	--	5
	4-30-71	3, 160	1, 200	--	20	--
58b	10- 3-70	35	51	--	--	16
	10- 8-70	8	10	--	--	3
	10-16-70	3	--	--	--	--
	4-25-71	--	--	--	--	--
	5- 1-71	20	5	--	--	--

(a) -- Organisms not observed.

f Fragments of organisms observed.

analyses Lake 42f was about four times as productive as Lakes 42d and 43b. Lakes 42c, 42f, and 43c were very similar in their rates of productivity.

Concentrations of total organic matter in selected survey lakes are presented in Table 4. The autumn concentrations, without exception higher than the spring values, probably reflect increased production of planktonic biomass. Lake 42d has a higher autumn value than Lake 42f, and the reverse is true for the spring samples. Lakes 10, 26, and 42d had the highest autumn values of the lakes sampled, and Lakes 31b, 42c, and 58b were all low. Less difference in total organic matter concentrations for the lakes was observed in spring 1971 than in autumn 1970.

Effects of Storm Conditions on Selected Amchitka Lakes

Storms accompanied by high winds are typical of Amchitka weather and they occur frequently during most of the year. The readily observable effects of these storms on most Amchitka lakes are dramatic. The typical shallow lake may be vigorously stirred by wind action for periods of several hours. The considerable quantities of suspended matter that becomes visible in the water is, no doubt, the surface sediments of the bottom substrates. When unidirectional winds prevail for short periods, quantities of water are splashed from the lake basins. These wind effects are similar to those expected to result to some lakes from ground motion during an underground test when varying amounts of water may be splashed from lakes, and surface sediments may become stirred into the lake water. The duration of such conditions would be expected to be much less than that from a typical storm condition.

Ten Amchitka lakes in the area of SZ were sampled prior to and immediately following a storm with high winds to acquire some preliminary information on the effects of these conditions on the freshwater lake ecosystems. The results of the analyses of selected parameters of these lakes are presented in Table 10.

On September 30, 1970, the 10 lakes were sampled for pH, alkalinity, dissolved chloride, specific conductance, temperature, suspended sediment, and plankton. The sky was clear and winds were calm. A storm with high winds prevailed for several hours October 1, 1970, to the extent that it was impossible to collect samples. The storm subsided during the following night and post-storm samples were collected from the lakes October 2, 1970, under clear skies and in low wind.

Temperature decreases of 1 or 2 C were recorded for seven of the ten lakes. No change was observed in two lakes and temperature increased 1 degree in one lake (Table 11). Temperatures probably decreased slightly in all of the lakes during the storm. There were no differences in the amount of suspended particulate matter prior to and on the day after the storm that were detectable by Millipore filter gravimetric analysis. This suggests that surface sediments in the lakes sampled settled out rapidly when the wind subsided. Specific conductance was essentially unchanged in nine of the ten lakes and was increased very slightly in Lake 43c. Dissolved chloride concentrations remained unchanged in seven of the ten lakes, slightly decreased in two, and increased some 4.7 mg/l in Lake 43c. The reason for chloride concentrations to increase in this lake and not in others is undetermined. Decreases in pH values were noted in eight of ten lakes, an increase was recorded in Lake 46, and no change was observed in 41c. Alkalinities remained unchanged in six lakes, while slight decreases were found in three and a slight increase in Lake 46. Alterations in pH and alkalinity were undoubtedly the result of a shift in the carbon dioxide-bicarbonate equilibrium due to changes in the

TABLE 10. PRE- AND POST-STORM ANALYSES ON TEN AMCHITKA LAKES

	Date 1970	pH	Alkalinity, mg/l	Chloride, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C	Rotifers		Copepods		Cladocerans
							Adults	Eggs	Adults	Nauplii	
41b	9-30	6.70	<3.0	18.3	80	9	150	50	--	--	13
	10-2	6.25	1.5	18.3	83	7	75	50	6	6	--
41c	9-30	6.40	8.0	24.8	96	9	63	25	13	--	--
	10-2	6.39	8.0	21.0	102	7	19	--	--	--	--
43a	9-30	6.55	10.0	26.8	123	10	25	--	--	--	--
	10-2	6.20	9.2	26.2	125	7	19	6	--	--	--
43b	9-30	6.49	<2.0	23.0	99	8	31	6	19	--	6
	10-2	5.88	1.0	23.0	100	7	88	25	38	6	19
43c	9-30	6.35	10.5	20.3	120	9	100	19	--	--	6
	10-2	6.15	10.5	25.0	128	7	50	0	6	--	--
44	9-30	6.50	12.0	27.2	130	10	19	69	--	6	--
	10-2	6.45	11.5	26.7	130	7	6	31	--	--	6
46	9-30	6.68	17.7	34.0	170	10	31	6	--	--	--
	10-2	7.15	19.5	34.0	170	9	100	44	13	--	--
48	9-30	6.42	9.3	25.3	120	11	88	31	--	6	--
	10-2	6.40	9.5	25.7	120	11	13	13	--	--	--
49	9-30	6.15	<3.5	21.5	95	9	112	19	--	--	--
	10-2	6.11	<3.0	21.2	96	9	38	6	6	--	--
50a	9-50	6.75	16.5	28.8	150	8	31	6	--	6	--
	10-2	6.65	16.5	28.8	145	9	31	25	--	--	--

TABLE 11. SUMMARY OF RESULTS OF PRE- AND POST-STORM ANALYSES
ON TEN AMCHITKA LAKES

	pH	Alkalinity, mg/l	Chloride, mg/l	Specific Conductance, micromhos/cm ²	Temperature, C	Rotifers		Copepods		Cladocerans
						Adults	Eggs	Adults	Nauplii	
41b	-	-	0	0	-	-	0	+	+	-
41c	0	0	-	0	-	-	-	-	*	*
43a	-	-	-	0	-	-	+	*	*	*
43b	-	-	0	0	-	+	+	+	+	+
43c	-	0	+	+	-	-	-	+	*	-
44a	-	0	0	0	-	-	-	*	-	+
46	+	+	0	0	-	+	+	+	*	*
48	-	0	0	0	0	-	-	*	-	*
49	-	0	0	0	0	-	-	+	*	*
50a	-	0	0	0	+	0	+	*	-	*

- = Decrease, 0 = No change, + = Increase, * = not observed in pre- or post-storm samples.

concentration of dissolved carbon dioxide. Changes in carbon dioxide concentrations could have resulted from increased exposure to atmospheric carbon dioxide due to the mixing action of the wind or to change (decreases) in rates of primary productivity. Lake 46 is sheltered from the wind and probably was not agitated as violently as were the other lakes. The increase in pH in this lake is probably the result of an increase in primary productivity or the flushing of high-alkaline-content water into the lake from the surrounding exposed piles of excavated earth. The greatest changes in pH were observed in low-alkalinity Lakes 41b and 43b.

The effects of these conditions on zooplankton populations were not clearly defined. Decreases in numbers of adult rotifers were observed in seven lakes following the storm while numbers increased in two lakes and one was unchanged. Numbers of rotifer eggs decreased in five lakes, increased in four, and remained unchanged in one. Adult copepods increased in five lakes and decreased in one. Copepod nauplii were more abundant in two lakes and less in three; Cladoceran concentrations increased in two lakes and decreased in two others.

Preliminary results of these observations suggest that severe mixing of water in these lake basins from storm action or as a result of wind action may be expected to cause changes in pH and alkalinity in water, but are less likely to cause changes in dissolved chloride and specific conductivity. Reasons for changes in abundance of zooplankton are unclear. The decreased adult rotifer population may be related to the decreased water temperatures resulting from the storm.

DISCUSSION AND CONCLUSIONS

The observation that no significant alteration in water level occurred in any of the intensive-study lakes during FY 1971 verifies the short-term observations that no major fracture of the bottom seal or breach of the peat-retaining dam went unnoticed in the post-event investigation. The leak in the peat dam of Lake 31b has sealed and the lake level was normal during FY 1971. Partial drainage of two lakes (24 and 25) near SZ has apparently ceased, thus establishing the new normal water levels in these lakes in the absence of further disturbance.

The absence of significant increases in alkalinities in intensive-study lakes indicates that highly alkaline subsurface bedrock has not been exposed to any great degree by rupturing of the overlying peat mat in the drainage basins of these lakes. Slightly increased alkalinities in Lakes 9 and 10 during FY 1971 sampling periods may be an exception to this generalization. An increase of several times the typical preevent alkalinity concentrations and increased specific conductivity were recorded on one sampling date in spring 1970 for Lake 9. These values had returned to more typical values for the lake about 10 days later. Values for pH of a third Rifle Range lake (7) were slightly elevated during autumn 1970 sampling over values recorded prior to Milrow. Total organic matter concentration in open lake water was increased in Lake 9 during spring 1970, and rates of carbon fixation of Lakes 9 and 10 were higher than rates in any of the other lakes sampled during spring 1971. Lake 9 was considerably more productive during spring 1970 analyses also. Total organic matter concentrations in Lake 9 during autumn 1970 and spring 1971 were similar to values from similar periods prior to the Milrow event. Lake 10 had unusually low concentrations of rotifers and rotifer eggs during autumn 1970 compared to the same period in 1969. Spring samples from 1971 indicated the presence of large numbers of rotifer adult and eggs in Lake 10. These data

suggest that subtle changes that have occurred in lakes in the Rifle Range area are probably test related. They have been changes in degree not in kind. The changes have not been drastic chemical, physical, or biological changes and would be expected to be of limited duration in the absence of further perturbations in their drainage basins. The changes observed to date have probably resulted from the introduction of new materials to these lakes from subsurface lake sediments and from materials flushed into them from disturbed areas in their drainage basins.

Increases in alkalinity as a result of Milrow or of event-related activities were observed in Upper and Lower Twin Lakes, Emerald Lake, and Fault Lake (23, 24, 51, and 58b). In the absence of further disturbance the alkalinities in Upper and Lower Twin Lakes and Fault Lake would be expected to return to their original alkalinity concentrations over a period of a few years. Observations of this type of recovery in Lake 33 (Strange Pond) lend credence to this prediction. Emerald Lake (Lake 51) will probably be drastically altered in chemical, physical, and biological aspects for several years as a result of drill mud entering the lake. It will be instructive to study the recovery of this lake after the source of the drill mud is eliminated. Lake 26 (Weed Lake) and Lake 29 (Long Shot Pond) had slightly decreased pH and alkalinity during the FY 1971 sampling periods. The reasons for this are not yet resolved. However, a gradual decreased alkalinity in undisturbed alkaline lakes on Amchitka has been observed since the initiation of a sampling program in 1967.

Multiple changes were observed in Round Lake (31b) between pre-Milrow and post-Milrow sampling. Among these effects were decreases in water level, alkalinity, drastic decreases in numbers of zooplankton, and increases in suspended sediments. Between October 3 and October 16, 1970, a similar drastic reduction was observed in the zooplankton populations in Round Lake accompanied by considerably greater decreases in alkalinity than those observed during event-time sampling. A similar phenomenon occurred in Lake 26 (Weed Lake) during the same period in 1970. Zooplankton population crashes were also observed during this period in Lakes 10, 33, and 58b. The reason for these changes is not yet clear. It appears that these changes in alkalinity and zooplankton are seasonal and were not the result of the Milrow event. The trend of zooplankton population communities in nearly all lakes sampled was a decrease in total numbers of organisms from late September through mid-October. A knowledge of these trends is important to the interpretation of short-term event-related effects analysis on zooplankton populations.

The total limnetic organic matter concentrations on selected Milrow intensive-study lakes during FY 1971 were similar to those reported prior to the event. There were no indications of large amounts of organic matter entering the lakes as would be expected if peat mats in their drainage basins were extensively ruptured during Milrow. Rates of carbon fixation in intensive-study lakes during FY 1971 were similar to pre-event rates except in Lakes 9 and 10.

Rates of production of total organic matter by periphyton and associated organisms were estimated on nine lakes. These data suggest that these organisms may represent a considerable portion of the total autochthonous production of organic matter in these lakes.

Alkalinities in the Cannikin baseline-data survey lakes were either stable or tending to decrease during the autumn sampling period. Values of pH were stable or tending to increase. Zooplankton populations in these lakes were dominated by rotifers in both autumn and spring except for Lake 42e in which cladocerans were dominant.

The plankton populations were decreasing in most lakes throughout the autumn sampling period, and, with a few exceptions, cladocerans were essentially limited in distribution to the lakes in the SZ area.

Rates of total organic matter production by periphyton and associated organisms as well as rates of carbon fixation appeared to be low in the lakes sampled near SZ relative to rates for some of the highly productive lakes elsewhere on the Island. The autumn (1970) concentrations of total organic matter in the lakes near SZ were higher than those observed during the spring (1971) and probably reflect increased production of planktonic biomass during the autumn.

The effects to ten lakes in the SZ area from high wind associated with a storm produced some conditions of mixing of the lake water and disturbance of the surface sediments such as would be expected to result from ground motion from an underground test. Preliminary results from this investigation indicates that storm conditions resulting in changes in pH and alkalinity in the lakes are less likely to cause changes in dissolved chloride and specific conductivity. Changes to zooplankton populations were not drastic. Rotifer populations generally decreased but this was probably associated with a water temperature decrease.

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