Gene Spangrude

Attached are two (2) PDF's; one containing Water Temperature Data taken during the 1950's on the Lower Snake River between Clarkston, Washington; and Central Ferry, Washington. This data was taken in the 1950's and prior to the construction of any Lower Snake River Project; and therefore represents a 'Natural Condition' along that reach of the Snake River. As can be seen from this data, Water Temperatures exceeded the 68 Degrees F threshold during every year of data collection; even under 'Natural Snake River Conditions.' The Maximum Water Noted within the 'Natural Snake River' during the 1950's Data Collection Period was 79 Degrees F; or 11 Degrees F hotter than the 68 Degrees F Standard.

The other PDF contains excerpts from 'Columbia River Basin Reports' dating from the late 1800's. One of the reports contains a table of 'Water Temperature Data' which was collected on the Lower Columbia River downstream of Portland, Oregon; in 1875; and as can be noted from this table even in the 1870's Water Temperatures exceeded 68 Degrees F on the Lower Columbia; long before the construction of either the four (4) Lower Columbia River Dams or the four (4) Lower Snake River Dams.

At the time of this data collection (1875) no concern was apparently ever expressed over exceeding a Water Temperature of 68 Degrees F; and the data collection itself was terminated even when the Water Temperatures appeared to be still increasing.

I request that Historical Temperature Data such as contained in the attached PDF's be given some consideration and credence during the present studies underway; and especially to recognize that the current 68 Degrees F Standard was exceeded during every year of Data Collection within the Natural Snake River; as well as during 'Natural River Conditions' on the Lower Columbia River in 1875.

Very respectfully,

Gene R. Spangrude
Walla Walla, WA

Quality of Surface Waters of the United States 1952

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *Chief, Quality of Water Branch*

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1253

Prepared in cooperation with the States of California and Utah, U. S. Bureau of Reclamation, and with other agencies

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1957

Encl 3-1

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER NEAR CLARKSTON, WASH.

LOCATION.--One mile downstream from gaging station, 1 mile upstream from Alpowa Creek, 8 miles downstream from Clarkston, Asotin County, and 133 miles upstream from mouth.
DRAINAGE AREA.--103,200 square miles, approximately (above gaging station).
RECORDS AVAILABLE.--Chemical analyses, November 1951 to September 1952.
Water temperatures: November 1951 to September 1952.
EXTREMES, 1951-52.--Dissolved solids: Maximum, 283 ppm Sept. 21-30; minimum, 96 ppm May 21-31.
Hardness: Maximum, 152 ppm Sept. 21-30; minimum, 51 ppm June 1-10.
Specific conductance: Maximum daily, 463 micromhos Nov. 20; minimum daily, 118 micromhos May 28.
Water temperatures: Maximum observed, 73°F Aug. 8-11, 14; minimum observed, 32°F Jan. 14.
REMARKS.--Values reported for dissolved solids are residues on evaporation. Records of specific conductance of daily samples available in district office at Portland, Oregon. Records of discharge for gaging station near Clarkston for water year October 1951 to September 1952 available in WSP 1247. No appreciable inflow between gaging station and sampling point except during periods of heavy local rains.

Chemical analyses, in parts per million, water year November 1951 to September 1952

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C) Parts per million	Dissolved solids (residue at 180°C) Tons per acre-foot	Dissolved solids (residue at 180°C) Tons per day	Hardness as $CaCO_3$ Calcium, magnesium	Hardness as $CaCO_3$ Noncarbonate	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Color
Nov. 14, 16-7, 19-20, 1951	30,780	35	--	37	14	29	6.1	190	38	14	0.5	3.4	0.24	a 271	0.37	22,530	150	0	29	1.0	398	7.5	6
Nov. 21, 26-29	31,620	30	--	34	12	27	5.1	158	40	15	.5	2.5	--	a 244	.33	20,830	134	5	29	1.0	372	7.8	6
Dec. 1-10	44,540	30	0.14	32	11	34	5.3	147	37	13	.5	2.7	--	225	.31	27,060	125	5	30	.9	344	7.6	15
Dec. 12-15, 17	32,960	34	--	37	13	27	6.8	177	36	14	.4	3.2	.13	a 258	.35	22,960	142	0	28	1.0	385	7.0	20
Jan. 4-10, 1952	29,860	29	.02	34	11	26	6.4	151	40	16	.3	1.8	--	231	.31	18,630	130	6	29	1.0	366	7.2	10
Jan. 11-20	31,610	27	.02	34	12	26	3.0	151	41	15	.5	2.8	.08	236	.32	20,140	134	10	29	1.0	365	7.7	3
Jan. 21-31	33,460	27	.04	34	12	25	3.0	152	40	15	.5	3.0	--	235	.32	21,230	134	10	28	.9	361	7.8	3
Feb. 1-10	45,070	27	.20	29	11	22	3.2	132	34	12	.5	3.4	--	213	.29	25,800	118	9	28	.9	311	7.7	17
Feb. 11-20	36,820	27	.14	30	10	22	3.1	134	36	13	.5	3.0	.06	215	.29	22,540	116	6	29	.9	321	7.7	15
Feb. 21-29	37,240	26	.06	34	12	23	3.0	151	39	15	.5	2.7	--	231	.31	23,230	134	10	27	.9	354	7.8	7
Mar. 1-10	35,870	26	.04	35	12	25	3.2	156	40	16	.6	2.6	--	240	.33	23,240	137	10	28	.9	368	7.6	5
Mar. 11-20	46,610	25	.06	34	12	24	3.2	151	38	14	.6	2.8	.06	236	.32	29,700	134	10	27	.9	358	7.6	8
Mar. 21-31	75,750	25	.04	28	9.2	19	3.2	124	29	11	.5	3.5	--	197	.27	40,290	108	6	27	.8	295	7.6	15
Apr. 1-10	104,510	25	.04	22	7.5	15	2.7	100	22	8.0	.5	3.1	--	160	.22	45,150	86	4	27	.7	234	7.4	15
Apr. 11-20	148,100	24	.25	21	6.3	15	2.6	97	19	7.4	.5	2.5	.06	162	.22	64,760	87	7	27	.7	219	7.0	23
Apr. 21-30	194,500	23	.23	18	6.8	12	2.4	83	15	6.1	.5	1.7	--	137	.19	71,940	73	5	26	.6	186	7.3	22
May 1-10	183,600	18	.16	16	5.8	10	1.8	75	13	5.4	.5	1.4	--	123	.17	60,970	64	2	25	.5	167	7.3	17
May 11-20	196,700	19	.14	15	4.9	9.3	2.0	67	13	4.9	.4	1.7	.03	113	.15	60,010	58	3	25	.5	157	7.3	15
May 21-31	193,300	16	.06	14	4.2	8.8	1.4	60	11	4.0	.4	.9	--	96	.13	50,100	52	3	26	.5	137	7.4	14
June 1-12	155,500	15	.06	14	3.9	9.5	1.6	63	12	4.7	.4	1.1	--	97	.13	40,720	51	0	28	.6	144	7.4	13
June 13-20	104,940	20	.04	18	5.6	13	2.4	82	18	7.0	.4	.6	.04	138	.17	38,270	68	1	28	.7	190	7.6	5
June 21-30	84,330	19	.04	18	5.6	13	2.0	86	19	6.2	.4	.8	--	127	.17	28,930	68	0	29	.7	182	7.6	5

a Sum of determined constituents.

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER NEAR CLARKSTON, WASH.--Continued

Temperature (°F) of water, November 1951 to September 1952

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1		--	40	--	39	38	46	51	56	63	71	63
2		--	--	--	39	38	46	51	57	64	72	65
3		--	37	--	39	39	46	52	59	64	72	64
4		--	35	35	40	39	47	52	61	70	72	64
5		--	--	35	38	39	49	54	61	65	72	65
6		--	39	36	38	39	50	52	60	66	72	65
7		--	40	35	39	39	50	53	59	66	71	65
8		--	39	36	38	40	48	55	61	66	73	63
9		--	--	35	39	40	47	54	60	66	73	64
10		--	39	36	39	41	47	53	60	69	73	64
11		--	--	35	38	42	48	54	59	70	73	63
12		--	38	37	38	42	48	55	58	72	72	63
13		--	39	38	38	42	49	56	62	72	71	61
14		43	39	32	37	42	49	56	57	71	73	61
15		--	40	38	37	42	49	56	57	71	71	59
16		42	--	37	37	43	49	53	59	71	69	60
17		42	42	37	37	43	50	54	59	70	70	60
18		--	--	36	37	43	51	55	61	69	--	60
19		40	--	38	37	42	52	56	62	69	68	61
20		41	--	35	37	43	51	56	63	70	67	61
21		40	--	37	--	43	50	55	62	67	69	62
22		--	--	34	36	43	49	54	61	67	68	62
23		--	--	34	--	43	51	56	60	68	69	59
24		--	--	35	36	46	53	56	61	67	69	61
25		--	--	36	37	44	55	56	58	68	69	61
26		43	--	37	37	45	55	57	59	69	67	62
27		43	--	37	38	46	56	57	60	70	65	65
28		38	--	38	39	46	56	57	63	71	68	60
29		45	--	38	38	46	54	57	59	71	65	59
30		--	--	39	--	46	51	56	62	71	64	62
31		--	--	39	--	45	--	56	--	72	66	--
Average		--	--	36	38	42	50	55	60	69	70	62

Encl 3-2

Quality of Surface Waters of the United States 1953

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *chief, Quality of Water Branch*

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1293

Prepared in cooperation with the States of California and Utah, U. S. Bureau of Reclamation, and with other agencies

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1958

Encl 4-1

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER NEAR CLARKSTON, WASH.

LOCATION.--One mile downstream from gaging station, 1 mile upstream from Alpowa Creek, 8 miles downstream from Clarkston, Asotin County, and 133 miles upstream from mouth.
DRAINAGE AREA.--103,200 square miles, approximately (above gaging station).
RECORDS AVAILABLE.--Chemical analyses: November 1951 to September 1953.
Water temperatures: November 1951 to September 1953.
EXTREMES, 1952-53.--Dissolved solids: Maximum, 312 ppm Oct. 21-31; minimum, 96 ppm June 24-30.
Hardness: Maximum, 168 ppm Sept. 21-30; minimum, 53 ppm June 1-10.
Specific conductance: Maximum daily, 529 micromhos Nov. 30, Dec. 3; minimum daily, 133 micromhos May 21.
Water temperatures: Maximum observed, 72°F Aug. 7-8; minimum observed, 34°F Nov. 29-30.
EXTREMES, 1951-53.--Dissolved solids: Maximum, 312 ppm Oct. 21-31, 1952; minimum, 96 ppm May 21-31, 1952, June 24-30, 1953.
Hardness: Maximum, 168 ppm Sept. 21-30, 1953; minimum, 51 ppm June 1-10, 1952.
Specific conductance: Maximum daily, 529 micromhos Nov. 30, Dec. 3, 1952; minimum daily, 118 micromhos May 28, 1952.
Water temperatures: Maximum observed, 73°F Aug. 8-11, 14, 1952; minimum observed, freezing point Jan. 14, 1952.
REMARKS.--Values reported for dissolved solids are residue on evaporation. Records of specific conductance of daily samples available in district office at Portland, Oreg. Discharge records for gaging station near Clarkston for water year October 1952 to September 1953 given in WSP 1287. No appreciable inflow between gaging and sampling point except during periods of heavy local rains.

Chemical analyses, in parts per million, water year October 1952 to September 1953

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Color
														Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate					
Oct. 1-10, 1952..	21,890	35	0.09	39	15	35	3.9	217	47	15	0.6	1.9	--	305	0.41	18,030	159	0	32	1.2	459	8.0	5
Oct. 11-20	22,260	34	.07	39	16	37	3.9	211	52	18	.6	2.5	0.13	295	.40	17,730	163	0	32	1.3	479	7.6	5
Oct. 21-31	22,170	32	.04	39	16	37	4.5	205	53	18	.5	2.1	--	312	.42	18,680	163	0	32	1.3	472	8.2	8
Nov. 1-30	20,670	30	.04	40	16	36	4.5	204	54	19	.5	2.1	.11	310	.42	17,300	166	0	31	1.2	472	7.9	8
Dec. 1-31	20,960	35	.03	39	15	37	4.5	192	56	19	.6	2.9	.10	300	.41	16,980	159	2	33	1.3	474	8.0	5
Jan. 1-10, 1953..	23,120	33	.02	39	15	35	4.5	190	53	20	.6	3.0	--	291	.40	18,170	159	3	32	1.2	463	7.8	10
Jan. 11-31.....	48,630	28	.13	26	9.9	21	3.2	123	31	12	.5	2.9	.06	197	.27	25,870	106	5	29	.9	301	7.7	25
Feb. 1-10	58,030	27	.17	22	9.1	17	3.0	108	26	9.5	.5	1.7	--	173	.24	27,110	92	4	28	.8	256	7.7	25
Feb. 11-28	35,200	28	.09	29	11	24	3.0	142	36	14	.5	2.0	.09	218	.30	20,730	118	1	30	1.0	340	7.8	15
Mar. 1-10.....	32,450	28	.10	31	12	24	2.6	142	38	15	.5	1.9	--	229	.31	20,060	127	10	29	.9	352	7.5	10
Mar. 11-20.....	39,350	25	.09	29	11	22	2.8	130	37	14	.5	1.6	.10	210	.29	22,310	118	11	28	.9	330	7.4	10
Mar. 21-31.....	52,220	27	.23	26	10	19	2.3	116	31	11	.5	1.3	--	188	.26	26,510	106	11	27	.8	283	7.3	20
Apr. 1-10	50,910	24	.11	24	9.3	17	2.3	108	28	10	.5	1.0	--	173	.24	23,780	96	10	27	.7	266	7.6	20
Apr. 11-23	48,080	24	.11	23	9.1	17	2.3	108	28	10	.5	.8	.08	170	.23	22,070	95	6	27	.8	261	7.3	15
Apr. 24-30	112,060	21	.28	14	5.6	9.3	1.5	64	23	5.5	.5	.7	--	113	.15	34,170	58	6	25	.5	153	7.4	25
May 1-10	93,860	19	.20	15	5.7	11	1.9	68	17	5.9	.5	.5	--	117	.16	29,650	61	5	27	.6	169	7.4	25
May 11-20.....	93,740	20	.05	15	4.6	12	1.5	70	18	5.8	.2	.8	.10	112	.15	28,350	56	0	31	.7	166	7.4	20
May 21-31.....	115,800	21	.06	15	4.9	13	1.5	72	19	5.2	.3	.7	--	116	.16	36,270	58	0	32	.7	171	7.6	20

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER NEAR CLARKSTON, WASH.--Continued

Temperature (°F) of water, water year October 1952 to September 1953
(Once-daily measurement at approximately 8 a.m.)

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	58	51	35	37	45	42	49	50	56	61	70	65
2	62	48	36	38	45	42	47	50	56	61	68	65
3	61	48	37	38	45	41	49	50	56	62	70	65
4	61	45	37	39	45	43	48	52	56	63	70	64
5	58	46	37	39	45	42	49	54	55	64	--	64
6	57	--	37	39	46	42	50	56	55	64	71	64
7	57	44	39	40	45	44	50	56	55	65	72	64
8	57	42	39	40	44	46	50	55	55	61	72	66
9	58	42	37	42	42	44	50	53	55	61	71	66
10	57	45	39	42	42	47	47	51	55	66	70	64
11	58	47	38	42	43	47	48	53	57	67	70	68
12	56	44	39	42	42	46	48	53	57	69	71	68
13	60	47	39	42	43	47	48	54	57	70	70	67
14	52	46	39	43	42	45	49	54	57	70	70	67
15	52	44	38	42	42	46	48	55	57	70	69	67
16	53	44	40	43	43	47	50	56	56	69	71	66
17	53	45	40	42	42	46	52	57	58	70	70	65
18	56	44	39	42	43	45	52	56	58	--	69	65
19	55	44	39	43	41	45	50	56	58	70	70	65
20	53	45	39	43	41	45	49	55	57	69	71	60
21	51	44	40	43	43	45	51	54	57	69	70	60
22	55	40	36	44	39	47	50	53	58	69	67	61
23	55	40	39	43	39	45	50	53	58	69	69	62
24	56	40	37	44	39	47	52	53	59	67	66	60
25	51	39	38	45	40	49	50	52	59	69	66	56
26	51	39	36	44	42	48	58	53	59	67	66	59
27	52	37	38	43	46	49	50	54	59	68	67	59
28	50	36	36	41	45	49	49	54	60	68	67	61
29	52	34	37	42	--	50	51	56	59	69	66	57
30	51	34	37	43	--	49	50	55	60	69	70	57
31	52	--	38	43	--	49	--	55	--	70	65	--
Average	55	43	38	42	43	45	50	54	57	67	69	63

Encl 4-2

Quality of Surface Waters of the United States 1954

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *Chief, Quality of Water Branch*

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1353

Prepared in cooperation with the States of California and Utah, U.S. Bureau of Reclamation, and with other agencies

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1959

Encl 5-1

SNAKE RIVER NEAR CLARKSTON, WASH.

LOCATION.--One mile downstream from gaging station, 1 mile upstream from Alpowa Creek, 8 miles downstream from Clarkston, Asotin County, and 133 miles upstream from mouth.
DRAINAGE AREA.--103,200 square miles, approximately (above gaging station).
RECORDS AVAILABLE.--Chemical analyses: November 1951 to September 1954.
Water temperatures: November 1951 to September 1954.
EXTREMES, 1953-54.--Dissolved solids: Maximum, 314 ppm Oct. 21-31; minimum, 79 ppm May 11-22.
Hardness: Maximum, 176 ppm Oct. 21-31; minimum, 37 ppm May 11-22.
Specific conductance: Maximum daily, 500 micromhos Oct. 26; minimum daily, 91.8 micromhos May 22.
Water temperatures: Maximum observed, 71°F July 16-17; minimum observed, 35°F Jan. 21.
EXTREMES, 1951-54.--Dissolved solids: Maximum, 314 ppm Oct. 21-31, 1953; minimum, 79 ppm May 11-22, 1954.
Hardness: Maximum, 176 ppm Oct. 21-31, 1953; minimum, 37 ppm May 11-22, 1954.
Specific conductance: Maximum daily, 529 micromhos Nov. 30, Dec. 3, 1952; minimum daily, 91.8 micromhos May 22, 1954.
Water temperatures: Maximum observed, 73°F Aug. 8-11, 14, 1952; minimum observed, freezing point Jan. 14, 1952.
REMARKS.--Values reported for dissolved solids are residues on evaporation. Records of specific conductance of daily samples available in district office at Portland, Oreg. Records of discharge for gaging station near Clarkston for water year October 1953 to September 1954 given in WSP 1347. No appreciable inflow between gaging and sampling point except during periods of heavy local rains.

Chemical analyses, in parts per million, water year October 1953 to September 1954

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
														Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-10, 1953..	22,320	31		36	16	39	4.2	198	51	17		1.6	--	295	0.40	17,840	156	0	34	1.4	459	7.5
Oct. 11-20.....	22,620	34		39	16	40	4.5	211	50	18		2.0	0.13	305	.41	18,630	163	0	34	1.4	474	7.7
Oct. 21-31.....	22,910	32		44	16	40	4.2	225	57	18		2.0	--	314	.43	19,420	176	0	32	1.3	490	7.8
Nov. 1-10	23,600	34		36	15	38	4.2	193	54	18		1.9	--	300	.41	19,120	152	0	34	1.3	463	7.7
Nov. 11-20	22,340	31		40	15	33	3.8	190	50	18		2.3	--	285	.39	17,190	162	6	30	1.1	440	7.6
Nov. 21-30	25,980	30		36	14	33	3.8	170	51	18		2.3	--	272	.37	19,080	147	8	32	1.2	420	7.6
Dec. 1-6	25,980	29		36	13	30	3.8	164	48	18		2.0	--	262	.36	18,380	143	9	31	1.1	403	7.6
Dec. 11-20	26,020	28		37	13	31	3.8	164	50	20		1.8	--	266	.36	18,690	146	11	31	1.1	409	7.6
Dec. 21-31	28,260	28		34	14	28	3.2	160	44	16		2.6	--	248	.34	18,920	142	11	29	1.0	392	7.6
Jan. 1-10, 1954..	26,440	27		34	13	30	3.3	160	45	17		2.0	--	251	.34	17,920	138	7	31	1.1	399	7.7
Jan. 11-20.....	26,520	28		36	14	28	2.8	164	47	19		1.8	.08	255	.35	18,260	147	13	29	1.0	402	7.8
Jan. 21-31.....	27,790	28		34	14	26	2.8	152	42	17		2.0	--	240	.33	18,010	142	18	28	.9	374	7.8
Feb. 1-10	33,750	27		29	12	22	2.8	134	36	16		2.1	--	212	.29	19,320	122	12	28	.9	327	7.6
Feb. 11-20	38,450	26		27	11	21	2.8	125	34	14		1.9	.06	200	.27	20,760	113	10	28	.9	303	7.5
Feb. 21-28	41,140	27		26	9.8	19	2.1	117	32	12		1.6	--	189	.26	20,990	105	9	28	.8	293	7.6
Mar. 1-10.....	35,970	27		28	10	21	1.9	127	34	12		1.5	--	199	.27	19,330	111	7	29	.9	314	7.6
Mar. 11-20.....	48,720	24		23	8.7	16	2.0	106	27	10		1.3	.04	166	.23	21,840	93	6	27	.7	256	7.4
Mar. 21-31.....	34,860	23		25	9.0	19	2.6	118	31	11		1.7	--	178	.24	16,750	99	3	29	.8	287	7.8

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER NEAR CLARKSTON, WASH.--Continued

Temperature (°F) of water, water year October 1953 to September 1954

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	57	51	46	38	42	45	46	50	54	61	69	67
2	55	49	46	41	45	46	46	54	54	63	69	66
3	59	47	45	38	43	44	46	51	55	63	69	66
4	55	48	48	41	43	42	47	51	55	58	65	65
5	55	48	44	42	43	45	47	54	56	69	65	66
6	55	48	44	41	43	45	47	54	55	68	69	65
7	58	49	--	42	41	44	47	55	58	70	65	65
8	55	51	--	42	44	45	49	56	57	69	67	61
9	--	47	--	42	43	47	--	56	56	68	69	61
10	56	49	--	39	42	47	48	57	55	68	67	62
11	60	46	--	--	41	46	51	55	56	68	65	64
12	57	47	43	39	44	47	50	54	56	68	66	66
13	56	47	39	39	42	46	51	55	58	69	67	64
14	62	47	41	38	44	45	52	54	56	69	67	--
15	57	48	41	38	44	44	50	56	60	70	67	63
16	57	47	41	37	44	46	50	59	58	71	67	63
17	60	45	42	36	44	43	52	59	56	71	68	61
18	59	47	42	36	44	45	50	58	55	70	66	62
19	59	48	41	37	43	46	52	57	58	70	68	61
20	58	46	41	36	45	45	52	57	56	70	66	61
21	53	46	41	35	44	43	53	56	58	70	67	63
22	50	45	39	39	47	43	51	55	60	68	66	61
23	55	44	40	37	45	45	54	57	59	--	66	60
24	55	46	38	38	46	46	--	55	61	69	65	61
25	53	46	--	38	43	45	53	55	60	68	65	62
26	48	47	39	38	46	47	54	54	62	69	65	--
27	--	--	38	38	44	47	54	54	61	68	67	61
28	54	48	39	38	45	46	54	54	60	68	65	59
29	56	45	40	39	--	46	--	55	61	68	64	58
30	56	47	38	41	--	45	52	54	60	69	68	55
31	50	--	38	39	--	44	--	54	--	70	66	--
Average	56	47	41	39	44	45	50	55	57	68	67	62

Encl 5-2

Quality of Surface Waters of the United States 1955

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *Chief, Quality of Water Branch*

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1403

Prepared in cooperation with the States of California and Utah, U.S. Bureau of Reclamation, and with other agencies

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1959

Encl 6-1

SNAKE RIVER MAIN STEM

SNAKE RIVER NEAR CLARKSTON, WASH.

LOCATION.--One mile downstream from gaging station, 1 mile upstream from Alpowa Creek, 8 miles downstream from Clarkston, Asotin County, and 133 miles upstream from mouth.
DRAINAGE AREA.--103,200 square miles, approximately (above gaging station).
RECORDS AVAILABLE.--Chemical analyses: November 1951 to September 1955.
Water temperatures: November 1951 to September 1955.
EXTREMES, 1954-55.--Dissolved solids: Maximum, 298 ppm Sept. 21-30; minimum, 76 ppm June 9-16, 18, 23.
Hardness: Maximum, 166 ppm Dec. 21-31; minimum, 34 ppm June 9-16, 18, 23.
Specific conductance: Maximum daily, 513 micromhos Dec. 23; minimum daily, 97.9 micromhos June 13.
Water temperatures: Maximum, 74°F July 23, 24, 25; minimum, 33°F Feb. 21, Mar. 4.
EXTREMES, 1951-55.--Dissolved solids: Maximum, 314 ppm Oct. 21-31, 1953; minimum, 76 ppm June 9-16, 18, 23, 1955.
Hardness: Maximum, 176 ppm Oct. 21-31, 1953; minimum, 34 ppm June 9-16, 18, 23, 1955.
Specific conductance: Maximum daily, 529 micromhos Nov. 30, Dec. 3, 1952; minimum daily, 91.8 micromhos May 22, 1954.
Water temperatures: Maximum, 74°F July 23, 24, 25, 1955; minimum, freezing point Jan. 14, 1952.
REMARKS.--Values reported for dissolved solids are residues on evaporation. Records of specific conductance of daily samples available in district office at Portland, Oreg. Records of discharge for water year October 1954 to September 1955 given in WSP 1397.

Chemical analyses, in parts per million, water year October 1954 to September 1955

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
														Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-10, 1954...	23,110	31		37	15	40	4.1	187	59	18		1.6	--	294	0.40	18,340	154	1	35	1.4	457	7.9
Oct. 11-20	25,580	32		36	15	39	4.0	181	59	20		2.1	0.12	286	.39	19,750	152	3	35	1.4	452	7.8
Oct. 21-31	25,550	31		37	14	37	3.9	178	55	18		2.2	--	276	.38	19,040	150	4	34	1.3	437	8.0
Nov. 1-10	24,740	31		37	15	36	4.0	187	54	18		2.6	--	290	.39	19,370	154	1	33	1.3	455	8.0
Nov. 11-20.....	25,560	29		36	14	34	3.7	179	50	18		2.4	.08	275	.37	18,980	147	1	33	1.2	434	7.6
Nov. 21-30.....	25,000	31		37	13	32	3.6	174	49	17		2.5	--	273	.37	18,430	146	3	32	1.2	426	7.8
Dec. 1-10.....	23,880	30		37	14	34	4.0	181	52	18		2.7	--	282	.38	18,180	150	2	32	1.2	445	7.8
Dec. 11-20.....	21,850	31		38	15	34	4.0	183	52	19		3.0	.06	286	.39	16,870	156	7	31	1.2	450	8.0
Dec. 21-31	20,990	34		42	15	33	3.3	190	56	19		2.3	--	296	.40	16,780	166	11	30	1.1	465	7.8
Jan. 1-10, 1955...	23,070	32		39	15	32	3.3	176	52	18		2.5	--	278	.38	17,320	159	15	30	1.1	434	7.9
Jan. 11-20	21,680	32		40	15	32	3.3	186	52	19		2.1	.08	285	.39	16,680	162	9	30	1.1	440	7.9
Jan. 21-31	21,460	31		38	14	31	3.3	172	50	18		1.7	--	270	.37	15,640	152	11	30	1.1	424	8.1
Feb. 1-10.....	21,840	29		40	14	31	3.3	176	49	18		2.0	--	270	.37	15,920	157	13	29	1.1	427	7.6
Feb. 11-19.....	20,790	30		35	12	29	3.6	164	46	18		1.2	.05	256	.35	14,370	137	2	31	1.1	405	7.7
Feb. 20-28.....	19,590	29		37	12	30	3.6	168	47	19		1.7	--	262	.36	13,860	142	4	31	1.1	417	7.9
Mar. 1-10	20,220	27		36	12	30	3.6	168	45	18		1.3	--	255	.35	13,920	139	2	31	1.1	408	7.7
Mar. 11-20.....	23,090	25		32	11	28	3.6	150	43	18		1.1	.05	238	.32	14,840	125	2	32	1.1	379	7.8
Mar. 21-31.....	26,380	24		31	12	27	3.6	149	42	17		1.1	--	234	.32	16,670	127	5	31	1.0	372	8.0

SNAKE RIVER NEAR CLARKSTON, WASH.--Continued

Temperature (°F) of water, water year October 1954 to September 1955

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	55	48	38	38	38	39	46	49	54	57	71	65
2	--	47	38	38	36	39	45	51	53	59	72	68
3	55	46	39	38	35	39	47	51	53	57	70	68
4	59	47	40	35	34	33	46	53	54	56	71	72
5	56	47	38	37	38	--	45	54	57	59	70	69
6	55	50	38	37	36	39	45	54	55	56	70	68
7	57	47	38	37	40	45	--	54	56	59	69	--
8	56	49	39	37	42	39	45	55	56	59	70	68
9	60	47	39	36	37	38	49	53	57	59	69	71
10	59	47	43	35	35	39	47	54	57	61	70	68
11	56	46	43	34	36	41	47	54	58	61	72	67
12	57	47	40	35	39	41	47	54	58	64	70	64
13	58	47	39	36	40	41	47	54	59	64	70	62
14	55	--	39	35	39	40	47	51	57	65	71	66
15	56	48	39	35	38	39	47	49	57	67	67	63
16	58	48	36	35	39	39	47	50	57	70	71	61
17	55	47	36	38	37	38	47	52	57	69	69	61
18	59	48	35	36	34	38	47	52	56	70	70	59
19	53	46	37	35	35	38	47	54	57	70	68	60
20	52	46	34	36	36	41	47	56	58	71	70	60
21	--	46	35	36	33	41	49	55	60	71	67	58
22	52	47	35	37	38	43	50	54	61	73	68	58
23	58	49	39	37	37	45	50	54	60	74	68	57
24	59	48	36	36	40	40	50	54	59	74	67	--
25	52	50	35	37	40	39	50	53	59	74	66	50
26	59	47	34	36	38	39	50	54	58	72	66	58
27	47	45	34	38	37	--	48	53	59	72	65	56
28	46	43	34	35	39	44	48	54	59	70	68	60
29	46	44	35	35	--	44	50	54	58	70	60	56
30	47	40	38	35	--	45	49	52	--	69	66	55
31	47	--	40	35	--	45	--	54	--	70	61	--
Average	55	47	38	36	37	40	48	53	57	66	68	62

Encl 6-2

Quality of Surface Waters of the United States 1956

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *Chief, Quality of Water Branch*

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1453

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UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1960

Encl 7-1

SNAKE RIVER MAIN STEM

SNAKE RIVER AT CENTRAL FERRY, NEAR POMEROY, WASH.

LOCATION.--At bridge on U. S. Highway 295 at Central Ferry, Garfield County, 14 miles northwest of Pomeroy, and about 36 miles downstream from gaging station near Clarkston.
DRAINAGE AREA.--103,200 square miles, approximately (at gaging station).
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1956.
Water temperatures: October 1955 to September 1956.
EXTREMES, 1955-56.--Dissolved solids: Maximum, 257 ppm Oct. 21-31; minimum, 68 ppm May 15-31.
Hardness: Maximum, 136 ppm Oct. 1-10; minimum, 32 ppm May 15-31.
Specific conductance: Maximum daily, 434 micromhos Oct. 25; minimum daily, 73 micromhos May 25, 27.
Water temperatures: Maximum, 79°F July 25; minimum, freezing point several days during January and February.
REMARKS.--Chemical quality samples were collected at station near Clarkston, Washington (1 mile downstream from gaging station) from November 1951 to September 1955. Records of specific conductance of daily samples available in district office at Portland, Oreg. Records of discharge for gaging station near Clarkston for water year October 1955 to September 1956 given in WSP 1447. No appreciable inflow between sampling point and gaging station except during periods of heavy local runoff.

Chemical analyses, in parts per million, water year October 1955 to September 1956

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
														Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-10, 1955	21,940	20	0.05	33	13	33	4.2	160	51	17	0.4	1.9	--	256	0.35	15,160	136	5	34	1.2	415	8.0
Oct. 11-20.....	25,510	23	.05	31	12	31	4.1	151	49	16	.3	2.4	0.04	246	.33	16,940	127	3	34	1.2	396	7.9
Oct. 21-31.....	23,480	23	.01	32	12	33	4.0	157	51	18	.4	2.1	--	257	.35	16,290	129	0	35	1.3	413	8.0
Nov. 1-5, 9-11, 15-20.....	26,310	24	.01	30	12	29	3.8	149	46	16	.3	2.2	.02	238	.32	16,910	124	3	33	1.1	383	8.0
Nov. 6-8, 12-14, 21-30.....	32,410	21	.05	25	9.8	23	3.5	121	36	12	.3	2.6	--	197	.27	17,240	103	4	32	1.0	309	7.7
Dec. 1-4, 13-15, 20-21.....	34,300	22	.04	27	8.1	22	3.1	116	33	12	.3	2.7	--	191	.26	17,690	101	6	31	1.0	298	7.7
Dec. 5-12, 16-19	28,430	25	.00	29	11	25	3.6	133	39	14	.5	2.2	.08	218	.30	16,730	118	9	31	1.0	347	7.7
Dec. 26-31	69,400	--	--	16	4.2	11	2.5	66	--	5.5	--	3.0	--	--	--	--	57	3	28	.6	166	7.6
Jan. 1-14, 1956.	40,690	25	.03	24	7.5	19	2.9	103	28	10	.3	2.5	--	174	.24	19,120	91	7	31	.9	258	7.0
Jan. 15-31.....	47,490	26	.10	24	8.4	20	3.0	110	28	10	.4	2.5	.02	188	.26	24,110	94	4	31	.9	274	7.0
Feb. 1-10, 12-14, 17-19	32,920	25	.00	30	10	24	3.2	132	36	14	.3	2.3	--	214	.29	19,020	116	8	30	1.0	334	7.6
Feb. 11, 15-16, 20-29	38,320	24	.02	29	8.3	21	3.1	120	31	12	.3	2.5	.04	194	.26	20,070	106	8	29	.9	301	7.6
Mar. 1-19.....	43,730	25	.06	27	8.6	19	3.0	117	29	11	.3	2.6	.02	187	.25	22,080	103	7	28	.8	286	7.7
Mar. 20-31.....	98,870	23	.19	17	6.0	11	2.7	76	16	6.5	.2	2.7	--	141	.19	36,880	67	5	25	.6	182	7.4
Apr. 1-13	87,120	22	.05	20	5.6	12	2.7	84	18	7.8	.2	1.6	--	138	.19	32,460	73	4	25	.6	202	7.6
Apr. 14-30	153,900	17	.06	12	2.6	7.0	1.8	50	9.6	3.2	.2	1.0	.01	98	.13	40,720	41	0	25	.5	120	7.3
May 1-14	141,400	17	.02	13	3.1	8.9	1.7	57	12	4.5	.3	.8	--	94	.13	35,890	45	0	29	.6	135	7.1
May 15-31	223,600	11	.04	8.7	2.4	5.7	1.4	41	7.5	3.0	.2	.8	.04	68	.09	41,050	32	0	27	.4	92	6.8

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER AT CENTRAL FERRY NEAR POMEROY, WASH.--Continued

Temperature (°F) of water, water year October 1955 to September 1956

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	59	--	41	37	32	38	--	51	60	68	71	68
2	--	46	42	39	32	40	47	51	59	64	71	68
3	59	46	41	37	32	40	48	52	54	64	71	67
4	57	47	--	--	32	--	47	53	55	64	72	67
5	56	46	39	39	33	41	47	--	55	64	70	67
6	--	44	--	38	34	40	47	--	55	65	72	62
7	58	45	--	38	33	41	48	53	58	67	73	61
8	55	--	39	--	34	41	--	49	61	68	74	61
9	55	47	39	40	35	40	50	51	63	72	74	--
10	54	38	38	39	36	40	50	50	61	73	74	61
11	54	--	--	39	36	--	51	50	59	73	74	68
12	54	39	39	39	--	40	51	51	60	75	74	69
13	55	--	37	38	37	42	53	--	61	74	75	70
14	--	35	36	--	--	43	53	53	60	74	76	69
15	58	33	34	--	35	42	--	55	52	74	76	69
16	58	--	--	39	34	40	50	--	54	73	75	70
17	58	33	35	--	35	44	52	--	59	74	78	71
18	57	34	--	--	--	--	52	58	61	76	78	70
19	59	35	35	--	--	44	52	58	60	76	77	71
20	58	--	35	39	34	45	53	--	62	75	77	--
21	58	34	36	40	36	46	52	55	62	75	76	--
22	56	33	--	40	--	46	--	56	62	75	76	--
23	57	--	--	42	36	45	52	55	60	77	--	--
24	55	--	--	41	39	40	51	55	--	76	--	--
25	56	39	--	33	39	--	51	55	62	79	72	--
26	--	40	41	37	38	44	51	54	64	76	71	--
27	--	--	39	37	39	46	--	56	67	77	71	--
28	52	38	--	35	40	47	--	55	66	77	61	--
29	51	40	--	32	39	47	--	54	66	77	61	--
30	--	40	--	31	--	--	50	--	67	76	68	62
31	48	--	--	32	--	--	--	--	--	76	69	--
Average	--	--	--	--	35	--	--	--	60	73	72	--

Encl 7-2

Quality of Surface Waters of the United States 1957

Parts 9–14. Colorado River Basin to Pacific Slope Basins in Oregon and Lower Columbia River Basin

Prepared under the direction of S. K. LOVE, *Chief, Quality of Water Branch*

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Encl 8-1

SNAKE RIVER MAIN STEM

SNAKE RIVER AT CENTRAL FERRY NEAR POMEROY, WASH.

LOCATION.--At bridge on U. S. Highway 295 at Central Ferry, Garfield County, 14 miles northwest of Pomeroy and about 36 miles downstream from gaging station near Clarkston.
DRAINAGE AREA.--103,200 square miles, approximately (at gaging station).
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1957.
Water temperatures: October 1955 to September 1957.
EXTREMES, 1956-57.--Dissolved solids: Maximum, 269 ppm Oct. 1-15; minimum, 69 ppm June 1-15.
Hardness: Maximum, 150 ppm Jan. 1-31; minimum, 22 ppm Apr. 27-30.
Specific conductance: Maximum daily, 449 micromhos Oct. 18; minimum daily, 93 micromhos June 6.
Water temperatures: Maximum, 76°F July 25; minimum, freezing point Feb. 16-18, 20.
EXTREMES, 1955-57.--Dissolved solids: Maximum, 269 ppm Oct. 1-15, 1956; minimum, 68 ppm May 15-31, 1956.
Hardness: Maximum, 150 ppm Jan. 1-31, 1957; minimum, 22 ppm Apr. 27-30, 1957.
Specific conductance: Maximum daily, 449 micromhos Oct. 18, 1956; minimum daily, 73 micromhos May 25, 27, 1956.
Water temperatures: Maximum, 79°F July 25, 1956; minimum, freezing point on several days during January and February, 1956, February 1957.
REMARKS.--Chemical quality samples were collected at station near Clarkston, Washington (1 mile downstream from gaging station) from November 1951 to September 1955. Records of specific conductance of daily samples available in district office at Portland, Oreg. Records of discharge for gaging station near Clarkston for water year October 1956 to September 1957 given in WSP 1517. No appreciable inflow between sampling point and gaging station except during periods of heavy local runoff.

Chemical analyses, in parts per million, water year October 1956 to September 1957

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
														Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-15, 1956..	25,780			36	13	35		168	54	18		2.2	--	269	0.37	18,720	143	5	34	1.3	432	7.7
Oct. 16-31.....	28,920			36	12	34		164	54	18		2.4	0.05	268	.36	20,930	139	5	34	1.3	428	7.6
Nov. 1-30	28,100			35	12	31		158	49	16		2.3	--	254	.35	19,270	137	7	33	1.2	406	7.5
Dec. 1-4, 31....	25,840			37	12	31		162	47	16		2.1	.01	256	.35	17,860	142	9	33	1.1	405	7.6
Jan. 1-31, 1957..	23,960			37	14	31		168	51	18		2.3	.01	266	.36	17,210	150	12	31	1.1	425	7.7
Feb. 1-25	26,500			34	12	28		153	44	16		2.6	.04	237	.32	16,960	134	9	29	1.0	382	7.5
Feb. 26-28	119,800			17	5.5	13		78	18	5.5		4.1	--	160	.22	51,750	65	1	30	.7	190	7.5
Mar. 1-21.....	70,990			21	6.9	16		98	24	8.5		2.1	.06	166	.23	31,820	81	1	29	.8	237	7.7
Mar. 22-31	57,540			17	6.0	12		80	17	6.5		1.3	--	132	.18	20,510	67	1	28	.6	190	7.6
Apr. 1-26	86,860			17	5.0	12		78	17	6.0		1.2	.05	126	.17	29,550	63	0	29	.7	180	7.5
Apr. 27-30	81,720			6.0	1.6	7.1		50	9.7	3.5		.7	--	80	.11	17,650	22	0	27	.7	115	7.1
May 1-21.....	197,400			11	2.0	6.5		45	8.8	2.5		.5	.04	78	.11	41,570	36	0	28	.5	103	7.1
May 22-31.....	203,400			13	3.6	7.9		59	13	4.8		.7	--	91	.12	49,980	47	0	25	.5	134	7.3
June 1-15.....	179,700			10	2.6	6.6		48	9.7	3.2		.5	--	69	.09	33,480	36	0	26	.5	106	7.0
June 16-30	75,380			14	3.5	10		64	14	4.2		.5	.05	92	.13	18,720	49	0	30	.6	149	7.1
July 1-17.....	42,470			19	6.2	17		91	25	8.0		.7	.08	139	.19	15,940	73	0	33	.9	224	7.4
July 18-31.....	27,990			25	7.8	25		121	37	11		1.0	--	185	.25	13,980	94	0	35	1.1	303	7.7

SNAKE RIVER MAIN STEM--Continued

SNAKE RIVER AT CENTRAL FERRY NEAR POMEROY, WASH.--Continued

Temperature (°F) of water, water year October 1956 to September 1957
(Once-daily measurement at approximately 4 p.m.)

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	60	46	40	38	--	--	40	45	62	68	73	73
2	60	45	40	--	--	35	40	45	62	69	75	73
3	62	45	40	38	--	35	40	45	62	70	74	73
4	61	45	39	38	--	35	43	45	62	--	--	73
5	60	45	--	38	--	35	43	--	62	70	73	--
6	60	46	--	38	--	35	43	45	60	--	74	73
7	61	45	--	36	--	35	43	45	60	72	74	73
8	61	45	40	36	--	--	--	45	60	71	75	--
9	62	45	40	36	--	35	43	45	58	72	75	--
10	59	45	40	--	--	35	43	45	60	73	75	72
11	59	45	--	36	--	35	43	45	60	74	--	72
12	59	45	--	34	--	--	43	--	60	74	--	72
13	59	45	40	34	--	--	43	53	60	74	--	--
14	58	45	42	34	--	37	43	53	60	--	--	--
15	56	45	42	34	--	35	43	--	60	73	75	--
16	56	--	42	--	32	37	43	--	--	73	74	--
17	56	--	42	34	32	40	--	53	60	72	74	--
18	55	--	--	34	32	40	43	53	60	72	--	70
19	54	--	42	34	--	40	43	--	62	73	--	70
20	54	--	42	34	32	40	45	--	64	73	--	71
21	54	--	42	--	35	40	--	--	63	--	--	--
22	--	--	40	--	--	--	45	--	63	74	74	--
23	50	--	40	--	--	40	45	57	--	72	--	70
24	50	--	40	--	--	40	45	58	64	75	--	69
25	51	--	--	--	35	40	45	60	65	76	--	65
26	50	--	40	--	35	40	45	60	65	73	75	--
27	48	--	38	--	35	40	45	60	66	74	72	65
28	47	40	40	--	35	40	45	62	--	--	74	67
29	47	40	40	--	--	40	45	62	66	74	74	66
30	47	40	40	--	--	40	48	60	--	75	74	66
31	47	--	38	--	--	40	--	--	--	73	73	--
Average	55	--	--	--	--	38	44	--	62	73	--	--

Encl 8-2

Encl 1-1

UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART IV.

REPORT

OF

THE COMMISSIONER

FOR

1875–1876.

A—INQUIRY INTO THE DECREASE OF THE FOOD-FISHES.
B—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1878.

APPENDIX B.

INLAND FISHERIES.

umet, it will probably be useless to introduce new food-fishes. But other streams, and the numerous lakes in this part of the State can be successfully restocked. Eels would without doubt succeed, and the finding of the small shad at Riverdale proves that they have lived for a few years in that stream.

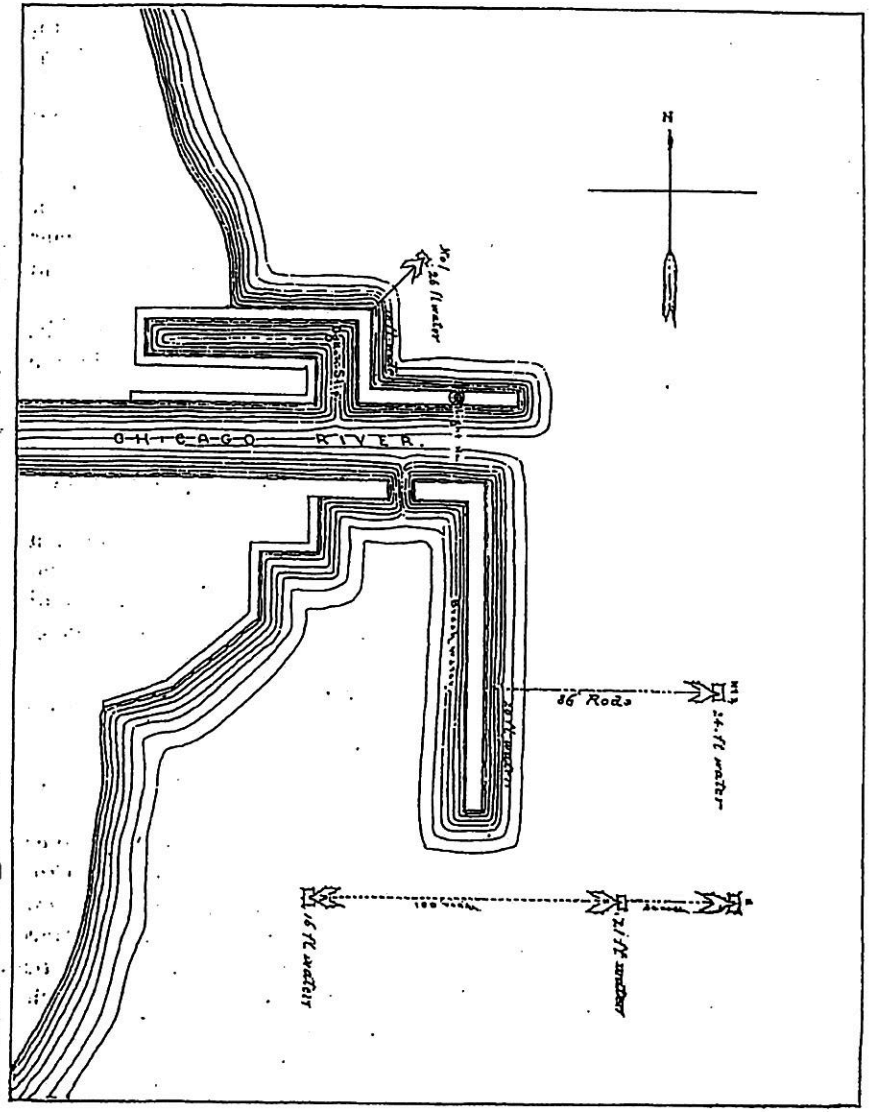


Diagram showing position of nets in Chicago Harbor.

Enc 1-3

III.—THE SALMON FISHERIES OF THE COLUMBIA RIVER.

By Livingston Stone.

San Francisco, Cal., *December* 31, 1875.

Sir: I beg leave to report as follows:

In pursuance of instructions received from you from Washington, I left San Francisco for the Columbia River on the 1st day of May, 1875, and arrived at Portland, Oreg., on the 6th day of the same month. From this point I made various excursions up the Willamette and up and down the Columbia from the ocean to Celilo, 210 miles from the mouth of the river, giving special attention to the natural history of the salmon and the business of the river canneries, besides looking up a favorable point for the artificial propagation of salmon.

In regard to the natural history of the salmon I was able to gather quite a large number of facts, but could make only very little certain progress, in the limited time that I had to spend on the Columbia, toward determining the number and characteristics of the many varieties of salmon which frequent the river.

The facts which I collected in regard to the natural history of the salmon, together with the other results of my investigations, will be found in the course of the following report.

LIVINGSTON STONE.

Prof. Spencer F. Baird,
United States Commissioner of Fish and Fisheries.

A—THE COLUMBIA RIVER.

The Columbia, as is generally known, is the most productive salmon river of the world. Its vast tributaries, extending over many degrees of latitude and longitude, furnish immense spawning-grounds for the accommodation of the parent fish, while the broad and deep channel of the main stream for hundreds of miles affords a magnificent highway, free of obstruction, for their easy ascent of the river.

These advantages the salmon have availed themselves of in an extraordinary degree, and they pour through the mouth of the Columbia and up its current in an abundance unknown to any other river in the inhabited portions of the globe.

The abundance of the salmon, however, is not their only peculiarity in this wonderful river. They occur in greater variety also than in any other known river of the world.

While there is only one anadromous salmon in the Sacramento, one in the Penobscot, one in the Miramichi, one in the Rhine, and one in the British rivers, there are said to be no less than twelve distinct varieties in the Columbia. These in all their Protean forms, occasioned by differences of age, season, and sex, have constituted a labyrinth which has always been an invincible puzzle to naturalists.

In the very brief time that I spent on the Columbia it was quite impossible to acquire anything like an exhaustive knowledge of the different varieties in the river. I consequently confined myself chiefly to inquiries into the characteristics of the Chinook salmon (*Salmo quinnat*), which I had an opportunity to see and study, and to gathering such information as I could regarding the other kinds, from the fishermen and other salmon-experts of the river.

The results of my investigation in regard to the *Salmo quinnat* will be found in the form of answers to Professor Baird's very valuable series of questions relating to fishes.

B—QUESTIONS RELATIVE TO THE FOOD-FISHES.—SALMO QUINNAT.

1.—NAME.

Question. What is the name by which this fish is known in your neighborhood? If possible make an outline sketch for better identification.

Answer. This fish is known in the Columbia River as the "Chinook salmon," the "Tyee salmon," and the "common salmon of the Columbia."

2.—DISTRIBUTION.

Question. Is it found throughout the year, or only during a certain time; and for what time?

Answer. The Chinook salmon are not found in the main Columbia throughout the year, but begin to enter the river in February and continue to run until some time in September.

Question. If resident, is it more abundant at certain times of the year, and at what times?

Answer. They are most abundant from April to August, the greatest number making their appearance in the mouth of July.

3.—ABUNDANCE.

Question. How abundant is it, compared with other fish?

Ans. They vastly exceed in abundance any other fish of the river.

Question. Has the abundance of the fish diminished or increased within the last ten years, or is it about the same?

Answer. The salmon have not increased in the Columbia River during the last ten years, and it is not known that they have diminished any. Fewer Chinook salmon now make their appearance in the upper rivers, but this is sufficiently accounted for by the fact that such a vast quantity are now netted in the main river on their way up. On the Willamette River the fishermen claim that the salmon have very much diminished, and that they caught only twenty or thirty now where they used to catch a hundred. This is undoubtedly true, but it does not prove that the salmon of the Columbia are diminishing, for it may be, and probably is, only the natural result of so many thousand more being stopped and caught in the main river below than there used to be. This must, of course, lessen the number that enter the Willamette.

Question. If diminished or increased, what is the supposed cause?

Answer.

Question. What is the amount, or extent, of the change in abundance?

Answer.

4.—SIZE.

Question. What is the greatest size to which it attains (both length and weight), and what the average?

Answer. The largest specimen that I ever saw weighed had a length of 35 inches, a girth of 31 inches, and a weight of 65½ pounds. One of the fishermen told me that he saw one caught in May, 1843, which weighed 83 pounds. This is the largest Columbia River salmon that I have heard of. The average weight is 22 or 23 pounds whole, and 16¾ or 17 pounds dressed. Out of 98,000 salmon taken at Clifton, Oreg., in 1874, only one weighed as much as 65 pounds.

Question. State the rate of growth per annum, if known, and the size at one, two, three, or more years.

Answer. The rate of growth is not known. There is every reason to believe, however, that it is similar to that of the Sacramento salmon. (See Report of United States Commissioner of Fish and Fisheries, 1872–'73, pp. 185, 186.)

Question. Do the sexes differ in respect to shape, size, rate of growth, &c.?

Answer. In the spring the sexes are exactly alike in appearance. At and near the spawning-season they differ very much. Their rate of growth appears to be nearly the same.

5.—MIGRATIONS AND MOVEMENTS.

Question. By what route do these fish come in to the shore, and what the subsequent movements?

gression to that point is about 100 miles a month. Dr. Suckley, in the Pacific Railroad Reports, estimates that the *Salmo scouleri* ascends the river at the rate of 100 miles a week. This variety, however, is a fall salmon and in great haste to deposit its spawn, which undoubtedly accounts for the difference of speed in the two instances. The spring (or summer) salmon are a week going from the Cascades to the Dalles. They are only a day or two getting through the Dalles, for they are seen above the Dalles a day or two after their first appearance at the mouth of the Dalles.

Question. If anadromous, what is the length of their stay in fresh water, and when do they return to the sea?

Answer. This question cannot be determined until it is known whether the fall runs of salmon are distinct from the *Salmo quinnat*. All of this latter variety return to the sea (or die) in August and September, as none are found in the river after that time having the characteristics of the spring run of the *Salmo quinnat*. It may be added here that vast shoals of the young of some salmon descend the Columbia in summer, passing the lower fisheries in June and July, and also that full-grown salmon of some variety are caught in considerable quantities, nearly exhausted, on the back of the drift-nets of the Lower Columbia in July and August.

Question. Do the different sexes or ages vary in this respect?

Answer. They do not.

Question. Do these fish come on to the breeding grounds before they are mature; or do you find the one or two year old fish with the oldest?

Answer. Fish of all sizes and ages above a year old are found together, on the breeding-grounds, except the salmon parrs recently hatched.

Question. What are the favorite localities of these fish? Say whether in still water or currents; shallow or deep water; on the sand; in grass; about rocks, &c.

Answer. These salmon are found anywhere in the river in deep water, in shallow water, over sand, gravel, and rocks; everywhere except in lagoons or sloughs, aside from the river, where the water stagnates.

Question. What depth of water is preferred by these fish?

Answer. No depth in particular.

Question. What the favorite temperature and general character of water?

Answer. The temperatures of the Lower Columbia are given below.

Encl 1-5

Table of daily temperatures of the water of the Columbia River at Clifton, Oreg., Sundays excepted.

Date.	7 a. m.	12 m.	Date.	7 a. m.	12 m.	Date.	7 a. m.	12 m.
1875.	°	°	1875.	°	°	1875.	°	°
May 10	51	51½	June 11	52½	60	July 14	66	67
11	50½	51	12	52½	60	15	66	67
12	50	50½	14	59	60	16	66	67½
13	51	52	15	59½	60½	17	66	68
14	52	52	16	59½	61	19	67	68½
15	52	52½	17	59	61	20	67½	69
17	53	54	18	59	60	21	67½	69
18	51	54	19	59	60	22	68	68
19	53½	51	21	59½	59½	23	68	68
20	54	54½	22	58	59	24	68	69
21	54	54½	23	58	59	26	68	70
22	54	54½	24	58	58½	27	68	70
24	54	55	25	58	59	28	68	69
25	54	55½	26	58	59½	29	67	68
26	51	53½	28	59	60	30	67	68
27	54½	55½	29	60	60½	31	66	67½
28	54½	56	30	60	60½	Aug. 2	66	67
29	54½	56	July 1	60	61	3	65½	66
31	55	56	2	60½	61½	4	65	67
June 1	55	56	3	60½	60½	5	65	66
2	55	56	5	62	63	6	66	67
3	55	56	6	63	64½	7	67	68
4	55½	56½	7	64	65	9	66	67
5	53½	56½	8	64	65	10	65	67½
7	56	57	9	65	66	11	66	67
8	56½	57½	10	64½	67	12	67	69
9	57	58	12	66	67	13	67	69½
10	58	59	13	66	67	14	68	70

The headwaters are, of course, much colder in the summer months. All parts of the river seem to suit the salmon, from which it may be inferred that all the temperatures of the table, together with the colder ones of the tributaries, are satisfactory to the *Salmo quinnat*

6.—RELATIONSHIPS.

Question. Do these fish go in schools after they have done spawning, or throughout the year, or are they scattered and solitary?

Answer. They do not go in proper schools as mackerel and other sea fish do. I think each salmon makes its progress on its own individual account; but such vast numbers ascend the river at a time that they appear to move in schools.

Question. Have they any special friends or enemies?

Answer. Seals, sea-lions, otters, eagles, and ospreys are their special enemies. They have no friends that are of any good to them, that I am aware of. I should, however, except the Oregon legislature, which has at last provided a close-time for salmon, which example the Washington Territory assembly ought to follow as soon as possible.

Question. To what extent do they prey on other fish; and on what species?

Answer. The salmon devour great quantities of smelts and other smaller fish, when in salt water; but in fresh water they do not eat anything. Out of 98,000 salmon examined at the cannery of J. W. Cook & Co., at Clifton, Oreg., in 1875, only three had food in their stomachs,

the Silverside Salmon, the Hard-heads, the Humpback Salmon, the Hooknosed Salmon, the Brook Trout, the larger Brook Trout, the Salmon Trout, the Lake Trout.

I discovered afterward that Mr. Cook was right as far as he went; but as I had just arrived on the river and had not identified any of the fishes at that time except the *Salmo quinnat*, the contradictory character of my information seemed very discouraging.

The varieties mentioned by Mr. Cook I afterward found to be as follows:

The Chinook Salmon is the *Salmo quinnat.*
The Blueback is the *Salmo gairdneri.*
The Silverside Salmon is the *Salmo* sp.?
The Hard-head is the *Salmo truncatus.*
The Humpbacked Salmon is the *Salmo proteus.*
The Hooknosed Salmon is the *Salmo scouleri.*
The Brook Trout is the *Fario stellatus.*
The large Brook Trout is the *Salmo masoni.*
The Salmon Trout is the *Salmo gibbsii.*
The Lake Trout is the *Salmo* sp.?

On the Willamette I was told by the fishermen that there were, besides the varieties just mentioned, the Dog Salmon, the Klackamas Chinook Salmon, the Klackamas Trout, the Fall Chinook Salmon, the Fall Silver Salmon, and, in fact, a different salmon or trout in almost every different river. I could not identify any of these except the first, which is certainly the *Salmo canis* of Suckley, but it is very doubtful whether the *Salmo canis* and also the *Salmo Scouleri* are not merely the altered forms of some of the varieties of fish already mentioned after undergoing the very great changes which come on as the eggs and milt become ripe for the spawning-season. Indeed I feel very sure that the *Salmo canis* is a form of one of the other varieties which it takes at the approach of the spawning-period.

D—METHODS OF FISHING.

The various methods of fishing for the *Salmonidæ* on the Columbia may be found mentioned in the answers given above to Professor Baird's questions on the *Salmo quinnat*, but I will also offer here a recapitulation of the different methods of capturing the fish. They are—

1. By drifting with drift-nets, as at all the canneries of the Columbia.
2. By hauling a seine, as at Chinook and various points on the Columbia.
3. By set (gill) nets, as at Oregon City, on the Willamette.
4. By scoop-nets, as at the Dalles and the Falls of the Willamette.
5. By dip-nets, as at the Dalles.
6. By hook and line, as at the mouth and also at the headwaters of the Columbia, for salmon, and in all the smaller streams for trout.

Encl. 1-6

7. By traps and weirs, as at Oak Point and various places on the Columbia.
8. By fishing-rakes, as at the Lower Columbia, and the Cowlitz for smelts.
9. By "twitching-hooks," as at the Falls of the Willamette for salmon.
10. By spearing, as everywhere, among the Indians, where the water is shallow enough.

E—THE CANNERIES OF THE COLUMBIA.

Every one has heard of the canneries of the Columbia. They have well deserved the reputation they have acquired, for seldom has a branch of industry assumed so quickly such large proportions or yielded such large profits to those engaged in it. It is only a very few years since the first salmon-cannery on the Columbia, commenced operations, and last year (1874) there were fourteen large establishments, employing in the aggregate nearly two thousand men and turning out nearly twenty million pounds of salmon in cans.

In May, 1875, I visited the cannery of the Oregon packing company carried on by J. W. and V. Cook through whose kindness I was enabled to obtain much information about the process of canning salmon, as well as about the fisheries and natural history of the salmon of the Columbia. The Messrs. Cook employ about one hundred and fifty men, mostly Chinamen. They run an average of twenty boats through the fishing season, (from the middle of April to the middle of August) and their buildings which are conveniently located and very methodically constructed cover nearly half an acre of ground. The buildings extend to the waters edge or rather they are built out over the water so that small boats can go under them. In front of the cannery is a platform very firmly built on piles which forms a wharf to which the ocean steamers can run up. At one corner of the establishment, and just in the rear of the wharf is a large rack opening on the river which receives the salmon fresh from the water just as the boats bring them in from the seines. This rack is capable of holding one or two thousand salmon. From the rack the salmon are passed to the cleaning bench, where the heads, tails, fins, and entrails are removed, and the body of the fish thoroughly washed in three different waters and with a hose. From the cleaning bench the salmon is passed on to the cutter where a system of revolving knives cuts the fish transversely into pieces about 4 inches long. These pieces are then passed on to the canning bench, where chinamen who are required to wash their hands every half hour, cut up the fish with meat knives into pieces of a suitable size for canning, and pack them into cans. The filled cans are then pushed on to the next bench where the covers are fitted on. The next set of Chinamen solder on the covers and pass them on to another set, who place them on iron racks and lower them into the boilers. After being sufficiently boiled the cans are taken out, washed, cooled, tested, labelled, cased, and placed on the wharf ready for shipment. In the course of the entire

process the salmon pass through forty or fifty hands. In 1874, the Cook Bro's. cut up 98,000 salmon, averaging in weight between 16 and 17 pounds when dressed. They shipped upwards of 30,000 cases containing 48 one-pound cans each.

There were in all in the spring of 1875, fourteen canneries on the Columbia the first being at Astoria, only a few miles above the bar at the mouth of the Columbia, and the last or uppermost being 60 miles up the river at Rainier.

I give below a list of the Columbia River canneries in May, 1875, in the order in which they come as one descends the river from Portland, Oregon.

Name.	Number of cases shipped in 1874. (In round numbers.)
1. R. D. Hume, Rainier. (Sixty miles from the mouth of the river. Not running now	6,000
2. William Hume	23,000
3. George W. Hume	35,000
4. Joseph Hume	30,000
5. A. S. Hapgood	25,000
6. John West & Co	35,000
7. T. M. Warren	25,000
8. Watson Bro's & Braman	16,000
9. Oregon Packing Company, (J. W. & V. Cook)	30,000
10. R. D. Hume, Bayview	37,000
11. Columbia River Salmon Company	10,000
12. Meigler & Co	16,000
13. Badalot & Co., Astoria	15,000
14. Booth & Co., Astoria. (Had not begun operations)	
Total	303,000

As each case contains 48 one-pound cans* this makes a total of 14,256,000 pounds of canned salmon that were put up at the canneries of the Columbia River in 1874.

The cannery of Booth & Co., at Astoria, which made no returns last year for the simple reason that it was not built, was ready to commence work at the beginning of the season of 1875. This establishment now employs about 175 men and does a large share of its work by steam. It is the largest on the river and in May, 1875, the proprietors expected to turn out 45,000 cases of salmon, the coming season.

Some notion of the magnitude of these establishments may be arrived at by considering that at some of the larger ones the tin alone for the cans costs between $50,000 and $100,000. The salmon themselves that are consumed in all the canneries of the river in a year, if placed lengthwise in a line, would reach upwards of 500 miles; while the cans if laid on their sides and placed end to end would reach from New York to Omaha.

The prices of canned salmon have varied very much during the last few years. In 1874 the average price was $6 a case, or 12½ cents per

*Usually, though, some two-pound cans are put up.

Enc 1 - 7

pound can. At the beginning of the season in April, 1875, prices had dropped to $4.80 a case, or 10 cents a can, which did not pay expenses, the cost being on an average, $5 a case. In consequence the canneries in 1875 did not open at all at first, but a little later prices went up again to $5.90, which gave a margin of profit, and the canneries began operations.

Prices have averaged between $5.20 and $5.40 a case this year, which has enabled the canning establishments to make a moderate profit; but the business is not as it has been in past years, when the larger canneries cleared from $30,000 to $70,000 in a season.

Besides the fish that were canned on the Columbia last year, (1874,) there were about 250,000 salted and barreled. The salted salmon bring from $7 to $8 per barrel of 200 pounds in San Francisco. A considerable number of salmon are, of course, consumed fresh, but owing to the very limited market for them at home, and the impracticability of exporting them fresh, the quantity so used is in comparison exceedingly small. (See answers to questions relative to food fishes of the United States pages 4–44.)

In concluding these notes on the Columbia River, I will say that in pursuance of my instructions to look up a suitable point for hatching the Columbia River salmon artificially, I made careful inquiries and at last found a place which appears to be in every way suited to the purpose. It is at Klackamas Falls, about 25 miles up the Klackamas River, where both the *Salmo quinnat* and the *Salmo truncatus* can be captured at their respective spawning seasons in vast quantities. Should the United States Fish Commission ever decide to carry on salmon hatching operations on the Columbia, I think it can be done here with distinguished success.

REPORT

OF THE

W. S.

COMMISSIONER OF FISH AND FISHERIES

ON

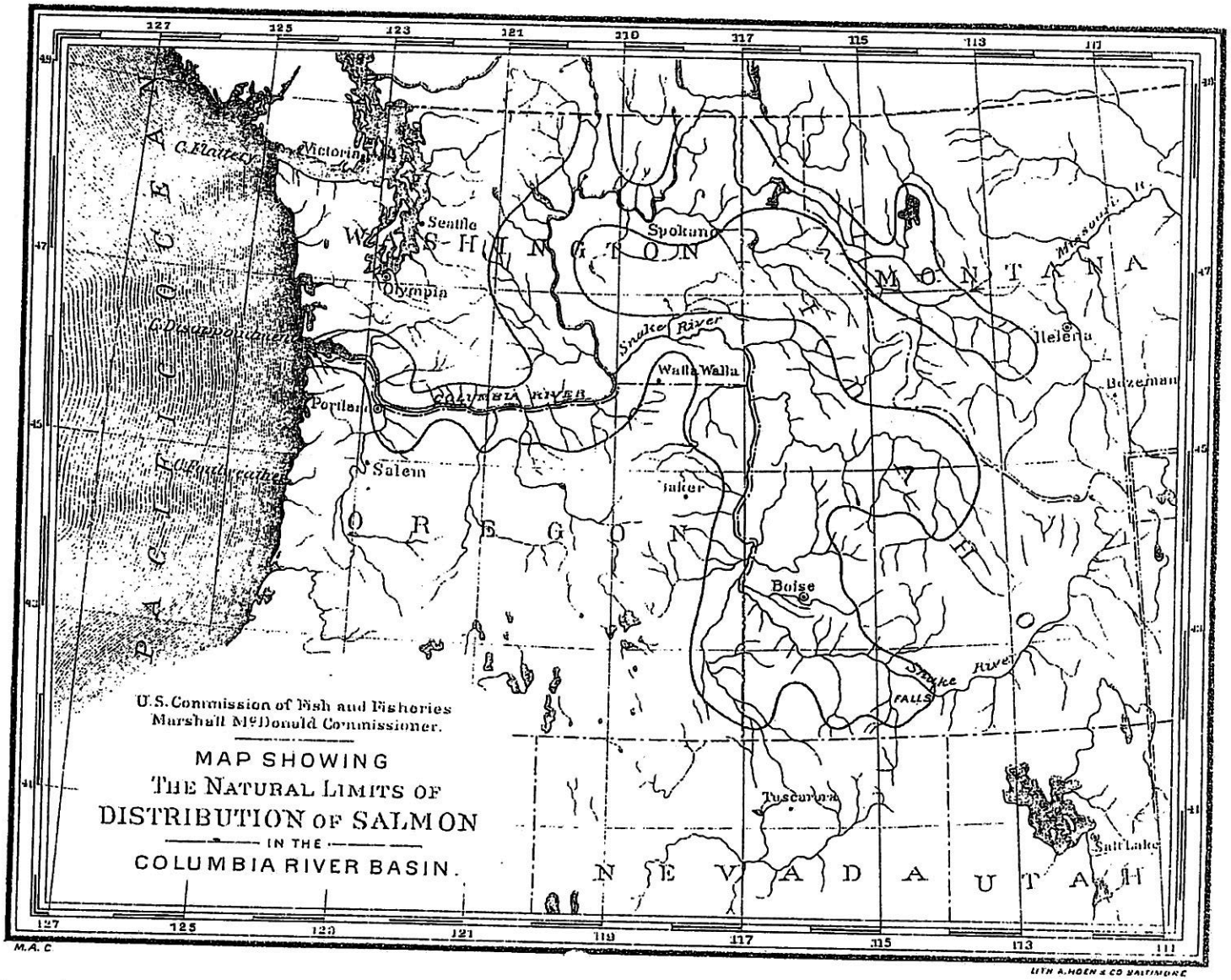
INVESTIGATIONS IN THE COLUMBIA RIVER BASIN

IN REGARD TO

THE SALMON FISHERIES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

Encl 2-1


U.S. Commission of Fish and Fisheries
Marshall McDonald Commissioner.
MAP SHOWING
THE NATURAL LIMITS OF
DISTRIBUTION OF SALMON
IN THE
COLUMBIA RIVER BASIN.
PACIFIC OCEAN
C. Flattery
Victoria
Seattle
Olympia
C. Disappointment
Cape Foulweather
WASHINGTON
Spokane
Snake River
Walla Walla
COLUMBIA RIVER
Portland
Salem
OREGON
Baker
Boise
Snake River
FALLS
Tuscarora
NEVADA
UTAH
MONTANA
Missouri R.
Helena
Bozeman
Salt Lake
127
125
123
121
119
117
115
113
111
49
47
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THE SALMON FISHERIES OF THE COLUMBIA RIVER BASIN.

By MARSHALL McDONALD,
United States Commissioner of Fish and Fisheries.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., May 31, 1894.

Hon. ADLAI E. STEVENSON,
President of the Senate:

SIR: In compliance with instructions conveyed in the provisions of the Sundry Civil Bill, which became a law August 5, 1892, I have the honor to submit a report of investigations in the Columbia River Basin.

The first of the provisions above referred to authorized the expenditure from the appropriation for inquiry respecting food-fishes of $2,000, or so much thereof as may be necessary, "In examining the Clarke's Fork of the Columbia River, with the view to ascertain the obstructions which prevent the ascent of salmon up said river to the Flathead Lake and adjacent waters."

The second provision directed an investigation and report respecting the advisability of establishing a fish-hatching station at some suitable point in the State of Washington, and appropriated for the same "$1,000, or as much thereof as may be necessary."

It was not known whether the failure of the salmon to enter the Clarke Fork of the Columbia was due to natural obstructions preventing their ascent, or was to be attributed to the extensive fishing operations prosecuted in the Lower Columbia, or possibly to other causes to be disclosed by the proposed investigation. Again, the location of the hatchery proposed for the State of Washington would be necessarily determined by our ability to secure an adequate supply of spawning salmon within convenient distance of the hatchery.

It appearing probable that the methods of the large fisheries pursued in the Lower Columbia, if permitted to continue, would effectually intercept the run of salmon to the headwaters, and thus defeat the object for which the hatchery is proposed, it was thought proper and expedient to institute a general investigation covering the entire Columbia River Basin, and if conditions were disclosed threatening disaster to these valuable and productive fisheries, to bring the matter to the attention of Congress and the States interested in their prosperity.

The direction of the field investigation was intrusted to Prof. B. W. Evermann, assistant in the Division of Inquiry Respecting Food-Fishes, whose report is appended to and constitutes an integral part of the report of the Commissioner of Fisheries.

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A very complete statistical investigation into the history, methods, apparatus, present conditions, product, and annual value of the salmon fisheries of the Columbia has also been made by Mr. W. A. Wilcox, under the direction of Dr. H. M. Smith, assistant in charge of the Division of Statistics and Methods of the Fisheries, the results of which are embodied and discussed in the report which is herewith respectfully submitted.

CONDITIONS DETERMINING THE SALMON PRODUCTION OF A RIVER BASIN.

There are fundamental conditions determining the salmon production of a river basin and the nature and extent of the fisheries which may be maintained without overtaxing the productive capacity of the river. All the species of salmon which are the object of the fisheries are alike under the constraint of a natural law, which compels them to enter the fresh waters for the purpose of spawning. Some species ascend to a relatively short distance above tide water. Others, like the chinook, push their migrations to the remotest sources of the rivers and tributary streams when not prevented by natural or artificial obstructions. Where the area of distribution is contracted by the erection of barriers, dams, or other obstructions which the salmon can not surmount, the production of the river is diminished *pro tanto*, for the reason that the young salmon remain for some months in the waters in which they are hatched—they must here find their food—and consequently the extent of the feeding-grounds open to them will be the measure of nature's ability to repair the waste occasioned by natural casualties and the fishing operations. If there be no contraction of the breeding area by artificial obstructions, but, on the other hand, the times, methods, and apparatus of the fisheries are such as to intercept or in a large measure prevent the run of salmon into and up the rivers, then a serious decline in the fisheries is inevitable.

It is possible by fish-cultural operations pursued on an adequate scale, by hatching and planting the fry in the head waters of the Columbia and its tributary streams, to realize the full productive capacity of the river, so long as eggs can be obtained in sufficient numbers to furnish a basis for the extensive operations required. This would not be possible, however, if the fishing operations in the lower river practically excluded the salmon from the streams to which it would be necessary to have recourse to obtain a supply of eggs. It is evident, therefore, that fish-cultural operations can not be relied upon exclusively or chiefly to maintain the salmon supply in the Columbia. The regulation of the times, methods, and apparatus of the fisheries should be such as to assure the largest opportunity practicable for reproduction under natural conditions. Artificial propagation should be invoked as an aid and not as a substitute for reproduction under natural conditions.

THE LIMITS OF MIGRATION OF SALMON.

The limits of migration of salmon in the Columbia River basin, as determined by impassable falls in the larger tributaries of the Columbia and their affluents, is shown in the accompanying chart, there being no serious obstructions existing in the main river within the limits of the United States.

The area of distribution is approximately 90,000 square miles. This immense tract is drained by innumerable streams of clear cold water, into which the salmon enter for the purpose of spawning and up which they ascend till their progress is stopped

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by falls or other obstructions which they cannot surmount. These waters furnish the feeding-grounds of the young salmon during their early life, which is spent in the fresh waters. Their migration seaward does not begin until they are at least a year old and have attained a length of from 8 to 10 inches. These streams are the nurseries of the great salmon fisheries of the lower Columbia. From each goes out every year a colony, more or less numerous, to swell the aggregate of young salmon necessary to repair the waste by natural casualty and by capture.

The area of natural distribution has not as yet been very materially abridged. Certain streams, such as the Bruneau and the Boise, have been obstructed by dams near their mouths, but the vast extent of waters still accessible to salmon and affording suitable breeding and feeding grounds, indicates that we must look to other causes to explain any ascertained deterioration in the salmon fisheries of the Columbia.

DECREASE OF SALMON IN THE HEAD WATERS OF THE COLUMBIA RIVER.

The investigations made by Prof. Evermann and the parties under his direction establish conclusively the fact that there has been a very great reduction in the number of salmon frequenting the head waters of the Columbia River and its tributaries. This decrease is more notable in the main river. In the early history of the fishery salmon were found in the head waters in marvelous abundance. According to the information obtained by Prof. Evermann:

> They were abundant in the Columbia River at Kettle Falls as late as 1878. Since then there has been a great decrease. They have been scarce since 1882. Since 1890 there have been scarcely any at Kettle Falls. The Meyers Brothers say that they have been almost unable to buy any salmon for their own table from the Indians for three years. Certain Indians with whom we talked at Kettle Falls said salmon were once very abundant there, but that very few are seen now. Other persons testified to the same effect. Essentially the same information was obtained regarding the decrease of salmon in other parts of the upper tributaries of the Columbia, viz: at Spokane, in both the Big and Little Spokane rivers, and in the Snake River and its various tributaries.

Dr. O. P. Jenkins, an assistant of Prof. Evermann, makes the following report in reference to the Yakima River, Washington:

> The Yakima is the main stream of the valley. It receives many tributaries, the main ones being Manistash and Wilson creeks. The river near the city (Ellensburg) is 160 feet wide, by an average of 10 feet deep, and flows with a velocity of 1 foot per second. Temperature at 9:15 a. m., August 24, 1893, 60° F.; water clear. Those acquainted with the facts state that formerly, up to about 1885, salmon of three or four kinds, including the quinnat, ran up the stream to this valley and spawned in the river in great numbers; at present very few make their appearance.

There is no reason to doubt—indeed, the fact is beyond question—that the number of salmon now reaching the head waters of streams in the Columbia River basin is insignificant in comparison with the number which some years ago annually visited and spawned in these waters. It is further apparent that this decrease is not to be attributed either to the contraction of the area accessible to them or to changed conditions in the waters which would deter the salmon from entering them. We must look to the great commercial fisheries prosecuted in the lower river for an explanation of this decrease, which portends inevitable disaster to these fisheries if the conditions which have brought it about are permitted to continue.

The relations of the decreased number of salmon in the head waters to the development of the commercial fisheries is brought out in a very instructive way by an analysis of the following table:

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Summary of the salmon-canning industry of the Columbia River from its origin to the present time.

Year.	Gross weight of salmon utilized.	Number of cases packed.	Value.	Average value per case.	Year.	Gross weight of salmon utilized.	Number of cases packed.	Value.	Average value per case.
	Pounds.					*Pounds.*			
1866	260,000	4,000	$64,000	$16.00	1881	35,750,000	550,000	$2,475,000	$4.50
1867	1,170,000	18,000	288,000	16.00	1882	35,184,500	541,300	2,600,000	4.80
1868	1,820,000	28,000	392,000	14.00	1883	40,911,000	629,400	3,147,000	5.00
1869	6,500,000	100,000	1,350,000	13.50	1884	40,300,000	620,000	2,915,000	4.70
1870	9,750,000	150,000	1,800,000	12.00	1885	35,997,000	553,800	2,500,000	4.51
1871	13,000,000	200,000	2,100,000	10.50	1886	29,152,000	448,500	2,135,000	4.76
1872	16,250,000	250,000	2,325,000	9.30	1887	22,140,000	356,000	2,124,000	5.97
1873	16,250,000	250,000	2,250,000	9.00	1888	24,211,005	372,477	2,327,981	6.25
1874	22,750,000	350,000	2,625,000	7.50	1889	20,685,495	309,885	1,809,820	5.84
1875	24,375,000	375,000	2,250,000	6.00	1890	28,781,385	495,774	2,407,456	5.53
1876	29,250,000	450,000	2,475,000	5.50	1891	26,450,635	398,963	2,240,984	5.62
1877	24,700,000	380,000	2,052,000	5.40	1892	32,185,995	487,338	2,879,069	5.50
1878	29,900,000	460,000	2,300,000	5.00	1893	24,050,000	370,000	2,107,500	5.70
1879	31,200,000	480,000	2,640,000	5.50					
1880	34,450,000	530,000	2,650,000	5.00	Total	658,424,515	10,098,427	59,029,790	5.85

Canning operations on the Columbia River began in 1866, when 4,000 cases were packed and sold at an average of $16 per case. As early as 1872 the total pack reached 250,000 cases, the price per case having declined to $9. Each succeeding year operations were extended and reached their culmination in 1883 and 1884, when upwards of 600,000 cases were packed each season. From this time on the catch declined, having reached its lowest point in 1889, the number of cases packed that season being 309,885, or less than half the number of cases packed in 1883 and 1884.

Up to 1888, practically the entire pack consisted of the king or chinook salmon, and the fishing season did not extend beyond the first of August. In 1889 the packers began canning bluebacks and steelheads to make up the deficiency in the supply, and extended their operations to the first of September.

DETAILED STATISTICS OF THE SALMON INDUSTRY OF THE COLUMBIA RIVER, 1889-92.

The following series of tables shows, in some detail, the extent of the salmon fishery and canning industry of the Columbia River during the years 1889 to 1892, inclusive, as determined by the inquiries conducted by this Commission.

The number of fishermen and shore employes connected with the salmon industry in each of the years named is indicated in Table A:

A.—*Table showing the number of persons employed in the salmon industry of the Columbia River from 1889 to 1892.*

How engaged.	1889.	1890.	1891.	1892.
Oregon:				
Fishermen	1,606	1,648	1,929	2,064
Shoresmen and cannery employes	870	1,028	1,057	1,100
Total	2,476	2,712	2,986	3,164
Washington:				
Fishermen	1,535	1,510	1,575	1,677
Shoresmen and cannery employes	594	602	654	704
Total	2,129	2,112	2,229	2,381
Total for river:				
Fishermen	3,141	3,194	3,504	3,741
Shoresmen and cannery employes	1,464	1,630	1,711	1,804
Total	4,605	4,824	5,215	5,545

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