

THE STATUS
OF
MYSIS IN OREGON

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INTRODUCTION

The success of *Mysis* introduced in Kootenay Lake, British Columbia, prompted their introduction in many kokanee lakes in the Western states. Oregon introduced *Mysis* into eleven waters during the period 1965-67. Several states have conducted intensive studies to evaluate *Mysis* introductions. Many studies have concluded *Mysis* have had a negative impact on kokanee and zooplankton populations (Rieman and Bowler 1980; Morgan et al. 1978). After an initial documentation that *Mysis* survived in Wallowa Lake in 1968, they were a forgotten experiment in Oregon until 1986 when it appeared they were contributing to larger kokanee in Wallowa Lake. This report will summarize the current findings in Wallowa Lake and the status of *Mysis* in other Oregon lakes.

INTRODUCTIONS IN OREGON

Department personnel spent three years (1965-67) collecting two million *Mysids* from Waterton Lake, B.C. They were periodically flown to Oregon to convenient airstrips and transported to the various lakes.

Wallowa, Waldo, Cultus, and Timothy Lakes received *Mysis* all three years. Crescent Lake was stocked two years, while Detroit, Miller, Odell, Fourmile, Olive, and Ice Lakes were only stocked once in 1967. (See Table 1)

Lakes selected for introductions were quite variable in size and geographic locations. They ranged in size from 46-acre Ice Lake to 6,298-acre Waldo Lake. Elevations ranged from 1,569 feet at Detroit to 7,900 feet at Ice Lake. (See Table 2)

The general concept was that planktivorous kokanee populations in these lakes would excel in growth as they did in Kootenay Lake. The wide range in physical and biological parameters of the lakes stocked should have been a good sounding board for *Mysis* survival. (See Table 3)

Table 1

MYSIS RELEASED IN OREGON LAKES

<u>Lake.....</u>	<u>Years Stocked.....</u>	<u>Number <i>Mysis</i></u>
Waldo.....	1965, '66 and '67.....	519,000
Wallowa.....	1965, '66 and '67	390,000
Big Cultus.....	1965, '66 and '67.....	216,000
Timothy.....	1965, '66 and '67.....	178,000
Crescent.....	1966 and 1967.....	200,000
Detroit.....	1967.....	100,000
Fourmile.....	1967.....	75,000
Miller.....	1967.....	160,000
Odell.....	1967.....	125,000
Olive.....	1967.....	20,000
Ice.....	1967.....	<u>20,000</u>
Total		2,003,000

Table 2

LAKES STOCKED WITH *MYSIS*

Lake	Surface Acreage (Acres)	Max. Depth	Elevation	River Drainage
Timothy	1,282	80'	3,217	Clackamas
Waldo	6,298	420'	5,414	Willamette
*Wallowa	1,508	299'	4,383	Wallowa
*Detroit	3,580	340'	1,569	Santiam
Crescent	4,547	265'	4,839	Klamath
Odell	3,582	282'	4,787	Deschutes
*Cultus	792	211'	4,668	Deschutes
*Olive	153	90'	6,012	John Day
Miller	566	145'	5,630	Klamath
Ice	46	193'	7,900	Wallowa
Fourmile	763	175'	5,744	Klamath--Rogue

* *Mysis* documented

Table 3

CHEMICAL ANALYSIS OF OREGON
LAKES STOCKED WITH *MYSIS*

Lake	Na	K	Ca	Mg	Cl	SO4	Cond.	O2	Phos	pH	ALK
*Detroit	2.4	.8	3.5	1.1	.7	.05	34	9.5	.028	7.1	14
*Cultus	1.1	.3	2.0	.6	1.3	.6	18	7.2	.001	7.1	1
*Olive	1.2	.3	3.4	2.0	.6	.4	38	7.7	.008	7.6	13
*Wallowa	1.6	.8	14.0	.7	.6	6.2	86	9.6	.023	8.1	32
Odell	2.4	.8	2.8	.9	.7	.2	32	9.9	.028	7.6	13
Crescent	1.7	.9	2.4	.9	-	.8	26	9.1	.062	7.6	<.1
Miller	3.2	1.6	2.1	.6	1.2	.2	30	-	.023	7.2	7
Waldo	.2	.1	.5	.1	.6	.1	3	8.8	.004	6.5	<.1
Timothy	2.3	.5	4.6	1.9	2.6	.2	49	7.9	.012	7.2	26

* Lakes containing *Mysis*

SAMPLING FOR SURVIVAL

As it usually takes 12 years or so for *Mysis* introductions to become established, it was mostly a wait and see game for most waters (Lasenby, Northcote and Furst. 1986). However, Ken Witty, Enterprise District Biologist, did capture an adult by trawling in Wallowa Lake in February of 1968. Subsequent sampling later in 1968 and again in 1972 captured limit numbers. Juveniles in the catch indicated they had successfully reproduced. Trawling failed to collect *Mysis* in Cultus and Waldo Lakes in the late 1960's.

Some 25 years after the initial release in Wallowa Lake, the first known significant presence of *Mysis* was apparent. In 1986, *Mysis* were observed in the stomachs of kokanee. Many larger than normal (12-18 inches) kokanee were also documented in angler's creels. This prompted a study to determine the relationship of *Mysis* with kokanee growth and associated zooplankton production. The results will be discussed later in the report.

Wetherbee, Griggs, and Johnson accompanied Knox on an evening *Mysis* sample in Wallowa Lake in May 1987. After observing the methodology of capturing *Mysis* in a vertically towed standard plankton net, Wetherbee decided to try this method in Detroit Reservoir. No previous attempts had been made with a bottom trawl in Detroit because of existing stumps. On June 1, 1987, during a *Mysis* moon (dark phase), we collected two adults and five juveniles on the very first vertical tow at 190 feet. *Mysis* were also collected in three other tows over 100 feet. Our last tow at 11:00 PM captured four juveniles at a depth of 50 feet. So after 20 unknowing years, we documented *Mysis* in Detroit Reservoir. No attempts have been made to monitor *Mysis* on a regular sampling schedule. Subsequent random samples imply their abundance is not significant to impact either kokanee or zooplankton populations.

As the Salem district has a vessel equipped with an echo sounder and plankton sampling equipment, we volunteered to sample several other waters that received *Mysis*.

The first lake sampled in August of 1987 was Timothy in the upper Clackamas drainage. The lake had received 178,000 *Mysis* three successive years. Using the same methods, four vertical tows were made in the deepest part of the lake after dark. By tracking the plankton net ring and bucket on the depth finder, we were able to start the tows as close to the bottom as feasible. No *Mysis* were captured at the near bottom samples at 80 to 85 feet. Timothy Lake has a stunted kokanee population and a depressed zooplankton population. These factors could have some relevancy to the failure of *Mysis* to survive.

Mysis were found in Olive Lake in July of 1987 in a 90 foot vertical tow. A good *Cladoceran* population was present. Of

interest was the presence of *Polyphemus*, a zooplankter not recorded in any other lakes sampled. Only 20,000 *Mysis* were stocked in Olive Lake in 1967.

In July of 1988, we sampled five waters in Central Oregon that received *Mysis*. Several tows taken at night were made in Crescent, Odell, and Waldo Lakes. All tows were taken near the bottom in the deepest sections of each lake. No *Mysis* were captured. Even one tow of 400 feet was made in Waldo Lake which received the heaviest allotment of *Mysis* (519,000). A definite lack of nutrients in Waldo may not have been conducive to *Mysis* surviving. Four tows taken at the deepest part of Miller Lake were made in the daytime. Cultus Lake was the only lake where *Mysis* were captured. Every sample contained *Mysis* from 200 to 50 feet. Ironically, kokanee are no longer stocked in Cultus because of low zooplankton production. The lake does have a popular lake trout fishery. It is very likely juvenile lake trout utilize *Mysis* as they live at extreme depths. We observed fish echoes on our sonar chart near the 200 foot depth.

Zooplankton samples taken during *Mysis* sampling are shown in Table 4.

Table 4

ZOOPLANKTON SAMPLES FROM LAKES STOCKED

WITH *MYSIS*

MEAN N/M3

Lake	Date	<i>Daphnia</i>	<i>Diaptomous</i>	<i>Cyclops</i>	<i>Bosmina</i>	Total
Waldo	07/27/88	100	0	0	0	100
Crescent	07/25/88	11,050	0	7,250	300	18,600
Miller	07/26/88	67	0	0	20,550	20,617
Odell	07/26/88	6,400	0	15,900	450	22,750
1 Cultus	07/29/88	500	15,900	625	42	1,417
1 Wallowa	07/19/88	567	22,283	0	1,417	24,267
1 Detroit	07/14/88	15,229	625	20,875	1,688	38,417
1*Olive	07/29/87	12,364	0	55	9,818	22,783

1 Lakes where *Mysis* found.

* Also 491 *Polyphemus* in sample.

RATIONALE ON SURVIVAL

Only two lakes have not been sampled for *Mysis* survival now--Ice and Fourmile. Success in these is suspect. Ice Lake being the smallest (46 acres) and the highest (7,900 feet), and Fourmile reportedly has nearly gone dry. However, we would still recommend sampling these some time in the future just to complete the picture.

Why *Mysis* survived in the four known lakes is not clear. They do not represent a similarity in water chemistry. Any type of delayed mortality in the stocking process would be difficult to determine. Similar conditions must have existed in both the successful and unsuccessful lake introductions.

The question now is not a matter of why they did or did not survive, but what are the impacts involved in the lakes with established *Mysis* populations? As several other states have determined, *Mysis* introductions have not been a panacea of kokanee forage. In that respect, we may be fortunate survival was not as good in Oregon waters. Wallowa Lake is the only water where an objective study is being conducted to determine the impact of *Mysis*.

THE WALLOWA LAKE STUDY

Data has been collected for four years (1987-90) to determine the relationship of *Mysis* with kokanee growth and the standing crop of zooplankton. The first significant indication that *Mysis* may be utilized by kokanee was a notable maximum size increase in 1986. Samples of the spawning population were made from 1970 to 1984. Maximum lengths barely exceeded 10 inches.

Table 5 shows the average lengths increased for three years, but reverted in the 1990 sample. Average weights followed a similar pattern.

Table 5

LENGTH AND WEIGHT OF KOKANEE SPAWNERS COLLECTED
FROM THE WALLOWA RIVER, ABOVE WALLOWA LAKE
IN 1970 THROUGH 1990

Year	No.	Fork Length-mm (inches)		Weight-grams	
		Mean	Range	Mean	Range
1970	42	188(7.4)	165-203(6.5-8.0)	69	49-89
1971	36	191(7.5)	178-230(7.0-8.0)	71	59-96
1972	30	221(8.7)	203-231(8.0-9.1)	*	*
1973	40	236(9.3)	221-245(8.7-10.0)	158	120-201
1974	36	234(9.2)	203-254(8.0-10.0)	151	92-206
1975	36	201(7.9)	180-231(7.1-9.1)	93	69-143
1976	52	193(7.6)	165-211(6.5-8.3)	70	44-102
1977	50	196(7.7)	173-208(6.8-8.2)	80	52-95
1978	50	201(7.9)	181-214(7.1-8.4)	83	51-116
1979	*	*	*	*	*
1980	57	239(9.4)	212-270(8.3-10.6)	168	111-231
1981	51	242(9.5)	216-258(8.5-10.2)	154	104-221
1982	56	208(8.2)	197-237(7.8-9.3)	99	69-147
1983	47	214(8.4)	188-235(7.4-9.3)	108	65-155
1984	49	205(8.1)	178-252(7.0-9.9)	91	61-162
1985	56	198(8.1)	*	94	*
1986	73	219(8.6)	186-398(7.3-15.7)	129	67-681
1987	50	244(9.6)	211-380(8.3-15.0)	176	109-584
1988	53	259(10.2)	222-398(8.7-15.7)	196	99-676
1989	62	236(9.3)	212-377(8.3-14.8)	143	90-601
1990	63	220(8.7)	183-380(7.2-15.0)	118	60-525

* Missing data

Table 6

CONTENTS OF STOMACHS FROM ANGLER-CAUGHT KOKANEE
WALLOWA LAKE 1987-1990

#(%) Of Stomachs By Food Item						
Year	# stomachs examined	<i>Mysis</i>	Copepods	Cladoc- erans	Aquatic Insects	Terrestrial Insects
1987	150	4 (2.7%)	-	-	-	-
*1988	159	16 (10.1%)	111 (69.8%)	52 (32.7%)	90 (56.6%)	9 (5.7%)
*1989	192	12 (6.3%)	191 (99.5%)	84 (43.2%)	167 (87.0%)	19 (9.9%)
1990	111	2 (1.8%)	103 (92.8%)	98 (88.2%)	105 (94.6%)	14 (12.6%)

* Cladocerans were not found until June 17, 1988, and May 20, 1989.

Table 7

MEAN NUMBER ZOOPLANKTERS/M3

WALLOWA LAKE 1987-1990

Year	<i>Daphnia</i>	Species <i>Diaptomous</i>	<i>Bosmina</i>	Total
1987	1,160	6,619	507	8,286
1988	4,889	12,262	772	17,923
1989	411	4,146	1,511	6,068
1990	177	(9808) 9,797	(689) 230	(12,674) 10,204
4 Yr. Mean	1,659	8,206 (8,209)	755 (870)	10,620 (10,738)

Stomach samples from kokanee were analyzed each year. *Mysis* comprised only 10% or less of the total stomach contents as shown in Table 6.

Zooplankton samples were taken on a monthly basis when possible. The mean number per cubic meter for each year are shown in Table 7. Counts varied from 6,068 to 17,923, *Diaptomus* was the most abundant species. *Daphnia* numbers decreased sharply from 1988 to 1990. This may confirm suspicions that *Daphnia* are a prey base for *Mysis*. Studies in other Western lakes with *Mysis* populations have shown *Daphnia* declines. It will be interesting to see if *Daphnia* rebound at all or are virtually eliminated in the next few years.

Mysis sampling was done at night in the spring, summer, and fall months. The number per cubic meter from vertical tows was transformed to number per square meter as seen in Figure 1. The mean number per year corresponds with mean annual zooplankton numbers as displayed in Figure 2.

CONCLUSIONS

We may be fortunate that *Mysis* introductions were not successful in more Oregon lakes. Most Western states evaluating *Mysis* introductions have given them a bad grade. Their sensitivity to light and temperature limit their availability to kokanee except in the crepuscular hours. Several studies give strong evidence that *Mysis* predation on the slower moving *Cladocerans* has virtually eliminated them.

Wallowa Lake is the only known water in Oregon where *Mysis* is currently of some significance and concern. Data collected in the next year or two should conclude whether the zooplankton *Daphnia* continues to decline, and if kokanee are truly utilizing *Mysis*.

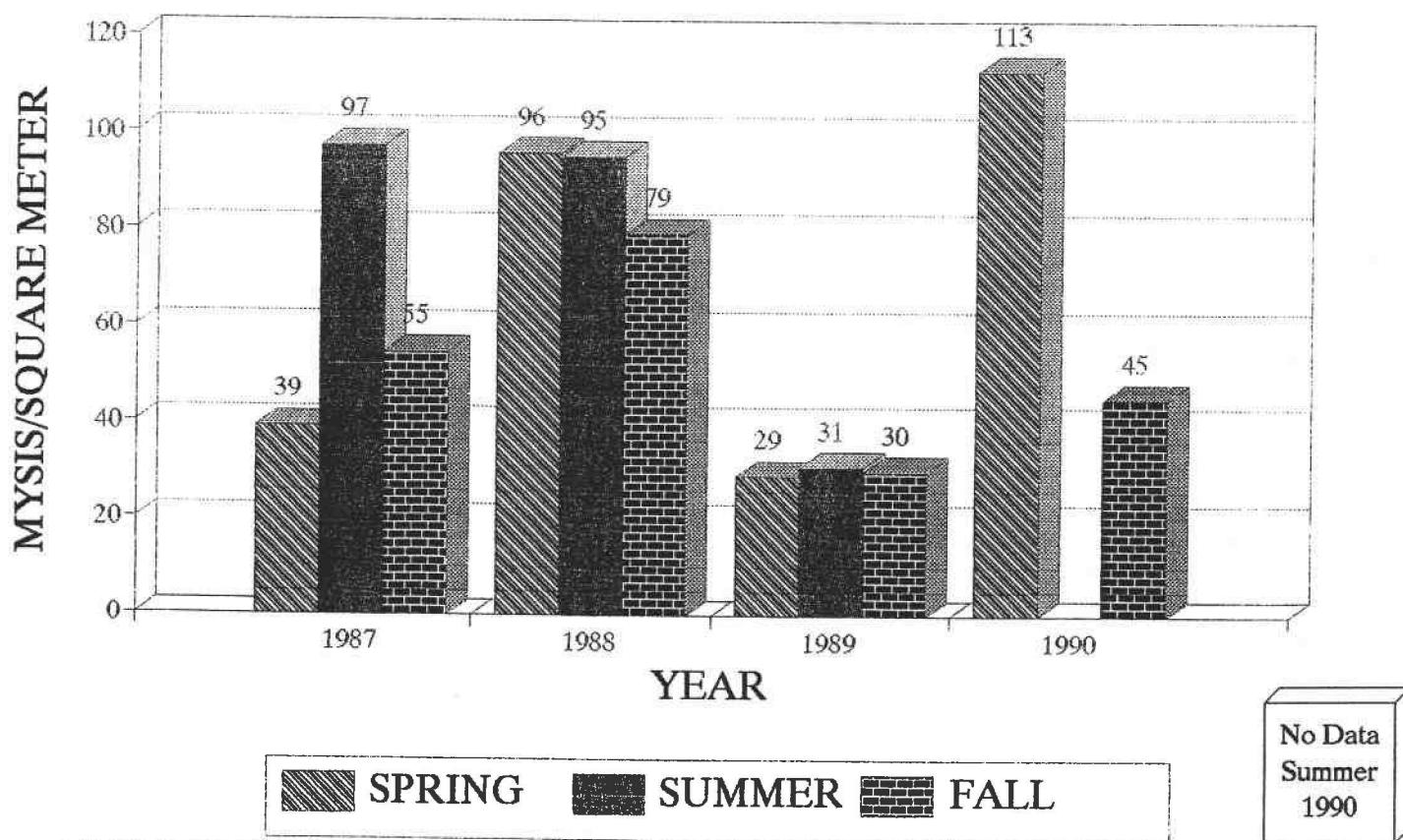
The *Mysis* population in Detroit doesn't seem abundant enough to impact either kokanee or *Daphnia*. No zooplankton base data was collected prior to 1979. *Mysis* may not be too high in the water column during the summer months because of temperature penetration. Their avoidance of warm water and light may restrict them from where *Daphnia* are found. (See Figures 3, 4, and 5 for Detroit zooplankton data).

In Cultus Lake, where kokanee are no longer stocked, *Mysis* could be a forage item for juvenile lake trout. Their impact in this water is unknown and may be insignificant.

Except for Wallowa Lake, *Mysis* may not have any significant impact in other lakes with established populations, although only one sample was taken from Olive Lake.

AVERAGE MYSIS DENSITIES WALLOWA LAKE

Figure 1.



ZOOPLANKTON TRENDS WALLOWA LAKE

Figure 2.

