(h) greatest oxygen deficit of any basin lake
(I) lowest average transparency

Wood Lake in 1935 was at about the same trophic state as Skaha Lake is today. Some of the largest kokanee found in the basin were caught in Wood Lake in the 1940's, but today few are caught at all and most are small. The paucity of benthos fauna may be related to the presence of a toxic substance.

Wood Lake is being loaded with phosphorus at a rate at least equivalent to the recommended maximum and probably in excess of it. Due to the poor water quality of Wood Lake at present, a reduction of from 30 to 40% of total annual phosphorus loading is recommended to at least maintain and, hopefully, improve water quality.

10.6 KALAMALKA LAKE (Table 10.6)

Kalamalka Lake is the most oligotrophic lake in the basin and lies in juxtaposition to Wood Lake. the most eutrophic. Many hypotheses have been advanced to explain the persistent oligotrophic condition displayed by this lake, the most credible being a co-precipitation mechanism involving PO_4 and $CaCO_3$. Most nutrients enter Kalamalka Lake from Coldstream Creek. Present evidence points to little change over conditions observed by Clemens and Rawson in 1935:

(a) no oxygen deficit in hypolimnion
(b) lowest PO_4(P) concentrations at spring overturn and throughout the summer
(c) lowest average chlorophyll-a concentration (10 ug/liter)
(d) lowest phytoplankton density
(e) dominance of diatoms and phytoflagellates
(f) lowest daily periphyton growth
(g) low Zooplankton settled volume
(h) low oligochaetes/chironomid ratio
(i) small populations of coarse fish
(j) highest salmonid relative abundance

The benthic fauna composition has shown changes since 1935 which can be interpreted as a gradual response to an increased nutrient load over the past 2 to 3 decades.

Kalamalka Lake is receiving phosphorus at below the recommended maximum level. It is presently assimilating all incoming phosphorus and no deterioration of water quality has occurred to date, except in localized shoreline areas.

TABLE 10.6

SUMMARY OF LIMNOLOGICAL DATA - KALAMALKA LAKE

Parameter	
Surface Area (Ao)	$25.9 \times 10^6 m^2$
Volume (V)	$1520 \times 10^6 m^3$
Mean Depth	59 m
Water Renewal (r)	65.0 years
Littoral /Ao (%)	5.6
Heat Income g cal/cm^2	25,100
Secchi Depth (Ave.)	9 m
Oxygen deficit mg/l/day	0.009
Nutrient Conc. (Ave.) µg/l	PO^4(P) 4 NO_3(N) 23
Limiting Nutrients(s)	Phosphate and Nitrate
Chlorophyll a (Ave.) µg/l	2.5
Total Phosphorus Load (Ave.)	2,350 kg/yr (0.10 g/m^2/yr)
Total Nitrogen Load (Ave.)	46,600 kg/yr (0.29 g/m^2/yr)
Phytoplankton (#/ml) (Ave.)	400
Phytoplankton dominants	Fragilaria crotenensis (D), Crytomonus ovata (D) Asterionella formosa (Ph)
Macrophyte dominants	-
Periphyton growth (mg/m^2/day)	124
Periphyton dominants	Diatoma hiemale (D), Synedra tenera (D) Gomphonema ventricosum (D)
Zooplankton (#/cm^2) (1971 - Ave.)	136
Zooplankton (mm^3/cm^3) (Ave.)	10 - 15
Zooplankton dominants	Diaptomus ashlandi, Cyclops bicuspidatus thomasi
Benthos (#/m^2)	1087
Benthos dominants	Trissocladius sp., Limnodrilus hoffmeisteri
Oligochaetes/chironomids	0.69
Fish species (#)	14
Fish Species dominants	Kokanee, Rainbow Trout
Coarse/salmonids	1.08
% salmonids	49
Most productive Region(s)	North Arm adjacent to Coldstream Creek
Probable cause(s)	Nutrient enrichment from Colstream Creek
Nuisance Condition	weeds
Drainage Basin Area x $10^2 m^2$	192
Population in Drainage Basin	4000
Trophic State	Oligotrophic
Water Quality	Excellent

10.7 GENERAL DISCUSSION

From the above discussion some salient points emerge with regard to the Okanagan Basin main valley lakes, their inter-relationships to each other and of the use and misuse made of them by man. With these points identified, the current trophic state of the lakes is established as well as some of the mechanisms responsible for current water quality problems.

As mentioned previously, Okanagan Lake is the "master lake" in the system. The ability of this lake to cushion effects from all its inflows and moderate them with age is a crucial point in the water management of the basin. With Okanagan Lake acting as a giant nutrient trap or repository, the effects of the Okanagan River on downstream lakes will be less abrupt and decisive than would be the case if Okanagan Lake were non-existant or much smaller.

Okanagan Lake, if loaded with nutrients heavily in excess of its capacity to assimilate them, will build up an excess nutrient load with time. If this should take place, then this enrichment would cause downstream as well as within-lake problems for decades before a water renewal and sedimentation could begin to ameliorate conditions. Thus, Okanagan Lake cannot be thought of as a permanent repository for excess nutrients. The massive volume and long exchange time of Okanagan Lake is a short-term boon, but a long term bane if it is not properly understood and used by man.

Skaha Lake and Vaseux Lake are very directly affected by the water quality of the Okanagan River. This effect is evident in Skaha Lake with the localized problems that occur in the influence of the river plume. This is not a reflection of present river water quality as it leaves Okanagan Lake, but is instead due to the effluent from the Penticton Sewage Treatment Plant being added to the river prior to its entry into Skaha Lake. Nonetheless it provides an example of the dependence of Skaha Lake on good water quality from upstream. Vaseux Lake, being in essence a widening and slowing of the Okanagan River, merely reflects river water quality (Skaha Lake water) in a short term lacustrine environment.

Osoyoos Lake is affected to a degree by the quality of the Okanagan River, however river water quality is considerably modified by the time it reaches the lake, thus the effects of Okanagan Lake are no longer of the same magnitude.

The carbonate chemistry of Kalamalka Lake indicates it will maintain its oligotrophic nature within the foreseeable future. Its ability to co-precipitate phosphorus indicates that perhaps Kalamalka Lake provides something of a small net downstream benefit, however it is suggested this may not be highly significant.

From their beginning, lakes move independently toward eutrophy as part of an aging process. This is an inherent happening which occurs irrespective of outside influence. It is also a momentum gathering process, in that the rate of eutrophication increases with increasing degree of eutrophy. When the activities of man are injected into such a system, generally the stage of eutrophy is advanced unnaturally, thus the rate of eutrophication is increased and a multiplier effect occurs. Wood Lake is an example of such a case. Thirty years ago water quality was good and salmonid fishes large and abundant. Due primarily to excessive nutrient additions from a number of land sources, and a substantial increase in exchange time due to headwater storage establishment, Wood Lake has become a problem area. Excessive production of undesirable biota has made the lake essentially unavailable to man for a number of potential uses. Fortunately, this occurrence has had limited downstream effects, since Wood Lake flows into the very oligotrophic Kalamalka Lake.

In summary, the Okanagan main valley lakes presently vary in trophic state from the extremely oligotrophic Kalamalka Lake through Okanagan, Skaha, Osoyoos, Vaseux to Wood Lake, the most eutrophic. All lakes are being "hurried" toward eutrophy by the influence of man's activities. Man's influence was first noted about 70 years ago, and is attributed to agricultural activity. Urban and residential activities have been the primary influences in the last two or three decades.

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Mr. G. McKenzie

*Affiliation shown is for the period 1969-72.

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