THE KOKANEE SALMON HERITAGE PROJECT

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Introduction: The reason for this Website.

The Kokanee Salmon Heritage Project was developed as a result of the myriad of questions about Kokanee which arose during school and public interpretation talks at Mission Creek Spawning Channel, Kelowna, BC.
The scientific authority for the project is Dr. Peter Dill, a researcher on trout and salmon in Canada for over forty years and on Kokanee in the Okanagan since the mid 1980's.

Biology: A fish-out-of-water overview of Kokanee salmon (Oncorhynchus nerka) and their life cycle.

Kokanee salmon belong to the same species as sockeye salmon (Oncorhynchus nerka), but when sockeye migrate to the ocean to grow to maturity, Kokanee remain in lakes. Sockeye are referred to as anadromous fish while Kokanee are landlocked. Many lakes and streams in BC support both Kokanee and sockeye; sometimes they spawn side by side. Others support only sockeye or only Kokanee. Present scientific information suggests that Kokanee arose from sockeye in each system into which sockeye established a population. After the last ice age some 10,000 years ago, Columbia River sockeye are suggested to have migrated into what is now the Okanagan, and established a sockeye population. Kokanee populations then evolved off the sockeye population. Later, when access upstream into the Okanagan was blocked, the sockeye population disappeared, leaving the Kokanee population we see today. Similar patterns of Kokanee establishment are suggested for the Arrow and Kootenay lake systems. Thus the Kokanee of Okanagan Lake are more related to sockeye of the Columbia River than to the Kokanee of Kootenay Lake. This implies that each lake's Kokanee population is evolved for that specific lake, and is therefore uniquely adapted to that lake.

Okanagan Lake supports two types of Kokanee salmon – the stream spawners and the lake shoreline spawners or beach spawners. During their entire feeding life the two types mix in the lake. At sexual maturity, usually at age three (three years after being laid as eggs), they undergo a spawning migration, spawn, and die. Stream-spawners migrate into some 14 lake tributaries in early September and complete spawning by mid-October. Shore-spawners migrate to spawning beaches along the lake shoreline and spawn from mid-October to mid-November. (Fig 1)

The two types of Kokanee appear to be reproductively isolated. Recovery of spawning adults that were tagged during their fry outmigration from Mission Creek suggested most returned to their natal area, some strayed to other tributaries, but none spawned along the lake shoreline. Study of genetic material (mitochondrial DNA) enabled no genetic separation of fish among tributaries, or among shore-spawning areas, but separation between stream and shore ecotypes. If combined with their temporal and spatial separation at spawning this evidence strongly suggests that shore-spawning and stream-spawning Kokanee are distinct populations.

- scientific name: Oncorhynchus nerka kennerlyi
- "Kokanee" is a native word meaning "red fish"
- a type of sockeye salmon
- referred to as "landlocked" sockeye salmon because they spend their entire life in freshwater differing from the anadromous sockeye salmon which spends part of its life in the river and then the ocean, after which it returns to its home river to spawn
- native to British Columbia, Alaska, Washington, Idaho, Siberia and Japan
- Okanagan, Kalamalka and Wood lakes are unique in that they have both stream and shore spawning populations of Kokanee salmon

- two distinct populations of Kokanee salmon in the Okanagan: stream spawners and shore spawners
- common names in the Okanagan Valley: Kokanee, kickininee, little redfish, landlocked salmon, Kennerly's salmon, silver trout, yank

Appearance

- silver on sides with a bluish-black top and white on stomach
- body color changes during spawning season
- those that change the most have green heads and bright red sides
- 3 layers of muscle in salmon body — white, pink, red
- red or lateral muscle: found along sides, just under skin
- high fat content used in steady, untiring swimming activity during migration
- scales are embedded in the skin and protected by a thick coat of mucus
- smaller than the ocean sockeye salmon

Hearing

- fish hearing is limited to sound waves in water
- pores in a canal run along the sides of the salmon contain motion sensitive hair cells. This structure is called a lateral line
- functions:
    1. senses water movement
    2. detects moving objects
    3. used in schooling

Vision

- salmon have no eye lids
- the pupil of the eye is large and does not change shape like in humans so the salmon tend to avoid bright light
- they can perceive colors

Smell

- they detect odors by using sacs inside the snout
- these organs of scent are known as an olfactory system and are used for:
    1. predator avoidance
    2. migration direction
    3. mate choice

Biology: Life Cycle

1. FOOD SUPPLY
   Kokanee compete for zooplankton with species such as the freshwater shrimp (Mysis relicta), Rainbow trout, whitefishes, northern squawfish and suckers. A low food supply reduces the Kokanee growth rate resulting in insufficient body reserves to survive their first winter.
2. PREDATION ON KOKANEE
   Large Rainbow trout feed exclusively on Kokanee, therefore the Kokanee must avoid the trout in order to survive.
3. NUTRIENTS
   Most of the decaying vegetation and other waste products carried down by the streams during spring runoff are in a form not immediately available for plant growth.
   Such materials may settle out before they are decayed, and they become locked in the bottom sediments of a lake and therefore can not be utilized.
   The level of Okanagan Lake's productivity is known as being oligotrophic (nutrient poor).
4. AGE DETERMINATION
   Scales & otoliths (inner ear bones) are used to determine the age of a salmon.
   The scales of the salmon grow and as they do they form rings just like those of a tree trunk.
   These rings form bands which can be counted. The widely spaced rings occur in the spring and summer months when food supply is abundant, while the more tightly packed rings indicate the winter months when growth is slow from limited food supply.

Life Cycle

Hatching → Alevin Stage → Fry Stage → Silver Stage → Maturation → Digging a Redd → Fertilization

September and October, year 1: A female Kokanee contains between 250 and 2000 eggs which she will deposit in two to three nests, called redds, at spawning time in the late autumn. Over the winter months, the eggs develop and in February they hatch into tiny fish called alevin. The alevin remain in the gravel for one to two months.	

November to March, year 1: During their time in the gravel the alevin do not feed. They receive nutrition from their large yolk sac until the time when they emerge from the gravel as fry, sometime between March and early April.	
Yearling: March, year 1 to March, year 2 Fry: March, year 2 to March, year 3: The fry typically emerge from the gravel at night and are immediately swept downstream with the spring runoff water. Once in the lake, they feed on plankton and small attached organisms along the lakeshore. By the following spring, they have grown to a size which classifies them as yearlings. It will, however, take them three years to reach adulthood.	
March, year 3 (sometimes to March year 4, March year 5): By three years of age, Kokanee contribute to the sports fishery. The catch record for a “silver”, the local name often used for them at this age, is 9.8 pounds. Typically, by year three, they become mature and may begin a spawning migration. Some, however, migrate at four or five years in age. The age of a Kokanee is sometimes determined by examining its otolith (inner ear bone), but more often, it’s easier to tell the age of a salmon by looking at its scales. As the scales of a salmon grow they form rings, just like a growing tree. These rings form bands which can be counted. The bands even correspond to how much food the Kokanee is getting. They are widely spaced in the spring and summer months when food supply is abundant. The more tightly packed rings indicate the winter months when growth is slow, because of a more limited food supply.ited food supply.	

Jacks: Kokanee that reach maturity by year 3 (Most Kokanee reach maturity between April and March of year 4): Upon maturity, Kokanee become red over most of the body. The male develops a long, hooked jaw and a slightly humped back. They migrate into streams in August of their maturing year. By this time, both male and female stop eating. By spawning time much of the body mass has been converted to energy for migration and spawning, or to sperm or eggs. Even the fish's scales are absorbed.	
September and October, (usually) year 4: Kokanee, like other salmonids, are capable of returning to the stream of their birth using their acute sense of smell. Having arrived at a suitable site, the female begins to dig a nest called a redd. She turns on her side and violently flips her tail to move gravel downstream. The redd may be six to twelve inches deep.	
September and October, (usually) year 4: While the female is digging the redd, the males court the female. When the female is ready to spawn, she permits a male to join her in the redd. After a courtship that involves a series of subtle moves, both fish quiver and shake as the eggs and sperm are simultaneously released. The eggs and sperm mix in the water as they drop between the gravel crevices in the redd. The female then gently covers the eggs by moving gravel into the redd before moving to another nesting site. The female will dig two to three redds before all her eggs are spent. She will not necessarily spawn with the same male at each redd. Both adults will die within days of spawning.	

Illustrations by Murray Johnson

Ecology: The Kokanee in the environment of the Thompson-Okanagan. Kokanee incubation and growth.

1. SEDIMENT FREE WATER

Natural, healthy streams normally run clear water over a clean gravel bottom.

Impacts of sedimentation on the Kokanee salmon:

- sediments cover eggs and clog Kokanee gills to reduce the flow of oxygen;
- water temperature increases due to the sediments absorbing heat.

2. OXYGEN

Oxygen is needed in the growth and development of the embryo inside the egg.

The embryo extracts oxygen as water passes over the egg's membrane.

Impacts of low oxygen levels on developing Kokanee:

- growth may be slowed;
- embryo and alevin may die.

3. TEMPERATURE

Remember — fish are poikilotherms (cold-blooded).

Eggs and alevin are dependent on appropriate water temperatures for growth and development.

In the alevin, developmental rate and metabolic needs increase in warmer water, but growth rate is reduced resulting in a smaller than normal fry.

Fry emerge after a period of increasing temperatures and this emergence time is adapted to optimize food availability upon entering the lake; with warmer temperatures there is more zooplankton in the water.

4. CREVICES

Eggs settle in crevices between the rocks. Proper crevice size provides protection from:

- harmful light;
- losses downstream;
- freezing;

- predators (other fish and birds).

Smaller gravel is needed because it is more porous and the porous gravel allows water to flow through it to cover the eggs that are hidden deep down in the gravel.

5. TREE REMOVAL (LOGGING, HOUSING, AGRICULTURE)

Impacts:

- loss of bank stability results in erosion and this leads to siltation of the gravel in which the salmon spawn;
- no shade cover along the river increases water temperature.

6. WATER QUANTITY (DRAWDOWN)

Changes in stream flow will fluctuate with irrigation and domestic uses causing problems with temperature, siltation and oxygen levels.

Severe damage occurs along the shoreline where drying kills eggs and fry of shore spawners.

7. FLOOD CONTROL

Mission Creek was originally located on a flood plain with meandering streams and annual flooding occurring all the way down to Gordon Road.

This provided clean gravel bars and pools for Kokanee. Now straight dikes along much of the prime spawning habitat are causing channelization and gravel distribution downstream.

As a result, the original 8 km of spawning habitat has been reduced to 3 km.

8. HARMFUL FORESHORE DEVELOPMENT

Foreshore damage usually occurs when owners unintentionally destroy foreshore habitat (Littoral Zone).

Natural vegetation along shorelines provides refuge for animals that live there.

Aquatic vegetation (milfoil) removal reduces habitat needed for nursery fishes to grow.

9. INSTREAM GRAVEL IMPROVEMENT

Between 0.5 and 1 inch diameter gravel is preferred for spawning by Kokanee salmon (Peachland Creek is a good example of this).

10. PROVISION OF SPAWNING CHANNELS

The survival of Kokanee eggs are limited by stream flow and by silting of gravel that restricts the flow of water. If these factors are controlled and optimum stream conditions prevail then a greater production of young salmon will result.

11. SHORE SPAWNING HABITAT PROTECTION

By identifying shore spawning habitat, we can:

- set it aside for wildlife;
- influence developers to make the area compatible to the already existing environment.

12. MISSION CREEK SPAWNING CHANNEL

The spawning channel was established in 1988 and rebuilt in 1995 by the BC Ministry of Environment along with various community groups in order to compensate for the reduction of Kokanee salmon in Okanagan Lake.

The Mission Creek spawning channel is located 7 km upstream from the outfall of Mission Creek into Okanagan Lake.

The channel is approximately 1 km long and 3.6 meters wide. It provides 3200 square meters of sized spawning gravel arranged on 28 reaches separated by weirs approximately 30 cm high.

The most important times in the life of the Kokanee in terms of survival are spent during incubation in the stream and during growth in the lake.

The growth period for the Kokanee salmon fry takes place in the lake. It is at this stage that they must find the food they need to survive and once again there are certain requirements that must be met in order for them to do so. Twenty years ago Mission Creek provided a spawning and rearing environment for 80 – 90% of the tributary spawning Kokanee of Okanagan Lake.

The Ecology: Growth

1. KOKANEE GROWTH

Kokanee growth may be followed from egg to adult maturity and spawning. Both shore-spawning and stream-spawning Kokanee salmon spawn in the fall of the year.

Eggs incubate in the gravel over the winter, hatch into alevin (Fig 1) in the new year, and emerge from the gravel as fry from March to June. The precise period of incubation from egg deposition to emergence is dependent on water temperature (Fig 2) .

Fry begin feeding upon entry into the lake in spring. Up to this time, a length of approximately 23 mm, they have lived on yolk provided in their eggs by their mother. Further growth is very dependent on food availability. Typically they reach over 20 cm during their third feeding summer and spawn that fall. Those smaller than 20 cm postpone spawning to the next fall at age four. Some choose to grow very large (55 cm) before spawning. All die after spawning. Fig 2 shows the typical growth rate of Okanagan Kokanee salmon and typical size at spawning.

It is not understood why some postpone spawning until they are considerably larger than others but large males do have advantages in securing mates on the spawning ground, and large female do lay many more eggs than small females.

In contrast to other salmonid species, Kokanee salmon are plankton feeders throughout their lives. As such they would be placed at the third thophic level in a typical food chain presentation (Fig 3). A major food species throughout the first summer are copepods, while daphnia are preferred when available later in the summer. However, when their major food source consists of carnivorous zooplankton then Kokanee would be at the fourth level. For example, Kokanee larger than 25 cm in length feed on the introduced carnivorous zooplankton Mysis shrimp (Mysis relicta)
(Fig 4).

During several points in their life cycle Kokanee experience growth difficulties related to feeding. Upon fry emergence from the gravel they only have about five days to establish exogenous feeding or they die of starvation. Stream spawners must migrate down the stream and into the lake to begin feeding. Shore-spawners may emerge and feed immediately.

The seasonal timing of first feeding appears synchronized to the spring period when lake production of Kokanee food is increasing. We think that this is the explanation for the later fall spawning of shore-spawners compared to stream-spawners. Streams are colder therefore incubation is longer so back calculation from optimal lake conditions for spring fry feeding would necessitate stream spawning earlier in the fall (September 1 to October 15) compared to shore spawning (October 15 to November 15).

Survival through the first winter as fry in the lake also appears difficult. Lack of food leading into their first winter either due to competition or a colder than normal fall, may leave them without sufficient body storage to see them through the winter. This is exacerbated if the winter period is extended due to a late spring so that the typical spring increase in lake productivity is delayed. Some scientists think that this may be the major factor in the decline of Kokanee numbers in Okanagan Lake. The Mysis shrimp is hypothesised to outcompete the young Kokanee for their optimal food heading into their first winter.

Survivors of the first exogenous feeding winter then have a high expectation of surviving to adulthood if they are not consummed by predators. Kokanee are food for numerous fish and waterfowl species. In the Okanagan Rainbow trout, Burbot, Mergansers, Common Loon, typically eat all sizes of Kokanee, and at spawning time sculpin, suckers, carp, and mallards are often observed to consume Kokanee eggs.

2. **NUTRIENTS**

Plants and algae, when they grow, incorporate various nutrient elements (especially phosphorus) into their tissues. These incorporated nutrients are passed along the food chain to become part of animal tissues.

These nutrients exist naturally in waterways but when in excess can cause problems such as massive algae blooms and aquatic weed growth (milfoil).

Phosphorus normally enters the rivers and lakes from runoff waters and from decomposing vegetation and carcasses of spawned out salmon.

3. **FOOD SUPPLY**

Kokanee compete for zooplankton with species such as the freshwater shrimp (Mysis relicta), Rainbow trout, whitefishes, northern squawfish and suckers.

A low food supply reduces the Kokanee growth rate resulting in insufficient body reserves to survive their first winter.

4. **LOW PREDATION ON KOKANEE**

Large Rainbow trout feed exclusively on Kokanee therefore the Kokanee must avoid the trout to survive.

5. **WATER DAMS**

These dams cause a reduced flow of phosphorus thus reducing lake productivity. The phosphorus settles out of the water behind the dam.

6. **TERTIARY SEWAGE TREATMENT**

As far as we know, outfall from sewage treatment plants into Okanagan Lake does not impact the lake’s water quality other than reducing the phosphorus level.

Phosphorus loading to Okanagan Lake has been cut from 59,100 kg in 1970 to 3,500 kg in 1994 due to the improved sewage treatment plant.

7. INTRODUCTION OF EXOTIC SPECIES

Mysis relicta, the Oppossum shrimp, was introduced into Okanagan Lake in 1966 as a food source to enhance Kokanee production.

In 1973 Mysis were found in Rainbow trout and in plankton hauls. Since then they have become a common organism in the fauna of Okanagan Lake and are thought to outcompete young Kokanee for the zooplankton on which both populations feed.

8. ADDITION OF NUTRIENTS

Most of the decaying vegetation and other waste products carried down by the streams during spring runoff are in a form not immediately available for plant growth.

Such materials may settle out before they are decayed, and become locked in the bottom sediments of a lake thus can not be utilized.

The level of Okanagan Lake's productivity is known as being oligotrophic (nutrient poor).

9. REMOVAL OF COMPETITION

If the lake's productivity is increased there will be more food resources for all organisms so there will be less competition among the Kokanee and other species.

Perhaps the Mysis shrimp should be reduced in numbers. How this will be done is still unknown. But regardless of what is decided it is important to realize that the interaction between the Mysis, Kokanee and zooplankton are complex; thus quick fix solutions are not possible.

10. DETERMINATION OF AGE

Scales and otoliths (inner ear bones) are used to determine the age of a salmon.

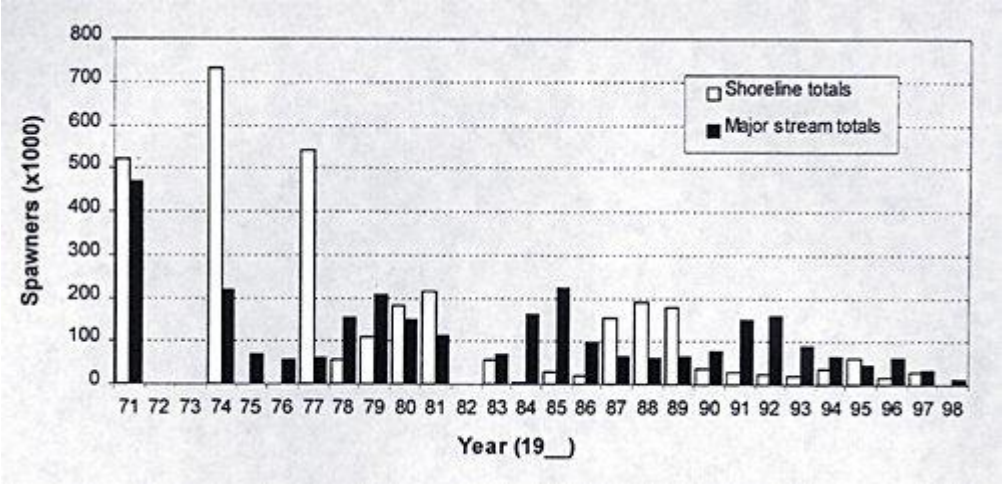
The scales of the salmon grow, and as they do they form rings just like those of a tree trunk.

These rings form bands which can be counted from the widely-spaced rings occuring in the spring and summer months when food supply is abundant, and the more tightly-packed rings which indicate the winter months when growth is slow from limited food supply.

Fishery: Introduction to human interventions through the years which have saved, conserved or reduced the Kokanee in the Thompson-Okanagan, and links to related topics.

Twenty years ago Mission Creek provided a spawning and rearing environment for 80 – 90% of the tributary spawning Kokanee of Okanagan Lake.

- Since then the Kokanee population has crashed to only 10 – 20% of those former years, with the most dramatic decline occurring in Mission Creek.Fig 6 From: S Matthews & B. Shepherd. Okanagan Lake Action Plan (1998).



- Today only 35% of the lake's stream spawners enter Mission Creek each fall.

Fishery: Saving the Kokanee

One of the major projects in the Okanagan to help restore Kokanee populations is the Mission Creek Spawning Channel. The channel was developed to restore favorable conditions for Kokanee spawners. Clean gravel and special fencing was installed to direct Kokanee into the best spawning areas. It was hoped that these efforts would increase egg and fry survival rates from 5 % in the wild to 80 % in the channel. To date, the channel has not been as successful as hoped. In 1992, 36,000 Kokanee used the spawning channel, but by 1995 this number dropped to 5,000.

In addition to costly enhancement projects such as the one at Mission Creek, the Province of British Columbia imposed a ban on Kokanee fishing in Okanagan Lake in 1995. Scientists believe that this ban will be in effect until at least the year 2001. To avoid Kokanee over-fishing in nearby lakes, the Province also reduced catch limits from 5 to 2 Kokanee per day on Wood and Kalamalka lakes.

Fishery: Conservation

- This drop in Kokanee population has occurred despite
- In recognition of the fisheries value of this habitat it was recommended in the Okanagan Basin Study, 1974, that water discharge flows not drop below that which will support 300,000 spawners.
  This recommendation was reaffirmed in 1992 in the Okanagan Lake Tributary Plan.
- In the late 1980's the decline stimulated construction of a 1 km spawning channel in Mission Creek, and the introduction of four years of hatchery reared fry.
- In 1995 the spawning channel under went considerable improvement.
- At the same time, however, other activities have reduced the quality and quantity of the Mission Creek habitat.
- Although, flow recommendations are in place to maintain a minimum flow of 1.13 cm during spawning and 0.85 cm during incubation, in only 8 of the last 19 years has even the average monthly flows met the minimum recommendations.
- Besides the low flows reducing the available spawning gravel, if it occurs during a warm September, the water temperature often exceeds the upper lethal limit for Kokanee eggs.
- If the Okanagan Lake Kokanee sports fishery is to depend on tributary spawners then Mission Creek requires more attention.
- The closing of the Kokanee fishery on Okanagan Lake was an attempt to minimize any further reduction of the Kokanee population.
- With the advent of global warming and increased dryness in the Okanagan Valley, dependence on Mission Creek will increase.
- Creeks that come from high elevations have high drainage areas which provide more stable water supplies.
- Without better success in its management, the creek habitat is not anticipated to be capable of meeting it's historical role in sustaining the Kokanee of Okanagan Lake.

Fishery: Reduction

Kokanee reductions in Okanagan Lake

Kokanee populations have been of great interest in the past two decades because many lakes that support them have undergone dramatic losses in Kokanee numbers. Okanagan Lake, British Columbia, Canada, is one of many lakes in which this has happened. Declining numbers are most often noted in the number of Kokanee that spawn each year. It is believed that almost one million Kokanee spawned in Okanagan creeks in the 1970s. This number declined to 101,000 by 1994.

There are a number of factors responsible for the decline in Kokanee numbers. Many of these factors destroy Kokanee spawning habitat. Scientists believe that of all Okanagan spawning habitat that existed 100 years ago, only 10 to 20 % remains today. Declining Kokanee populations are due to:

Over-fishing. It has been suggested that Okanagan Lake has been over-fished to a point where the Kokanee population has dropped, although this is not well documented. Over-fishing has likely played a part in the Kokanee fishery collapse, but it has probably been minimal. In 1988, biologists estimated that over 200,000 Kokanee were caught from Okanagan Lake. Normally this number would be acceptable for a lake the size of Okanagan, but with such limited spawning habitat, this count is considered very high. A similar situation occurred in the west arm of Kootenay Lake during the mid-to-late 1970s. The fishery there was many times larger than that of Okanagan Lake. In a study of the fishery collapse, over-fishing did appear to have a major effect, but several other factors contributed to the decline.

Logging Activities. Logging mainly affects Kokanee populations by impacting their spawning grounds. A number of stream characteristics, important to Kokanee, may be altered due to logging practices:

a) Logging alters stream flow hydrology. Logged areas tend to have decreased fall and inter flows and sudden rapid spring freshets (runoff), when compared to undisturbed areas. This means that fish eggs can dry out, be exposed to freezing, or be flushed out prior to hatching.

b) Logging and its associated activities, such as road building, can cause increases in stream sediment loads. Clear-cuts can cause increases in sediment loads due to mudslides and debris flows. Increased sediments may ruin spawning grounds by “choking” them out with fine particulate matter.

c) Logging practices can affect water quality, including temperature, water chemistry and dissolved oxygen concentration. Salmonid fishes, such as Kokanee, require pristine spawning conditions which include cold, clean, well-oxygenated water. Lethal temperatures are often achieved in streams that have had their riparian (streamside) vegetation removed. This has been observed in Mission Creek, one of Okanagan Lake’s major spawning channels. Improper logging techniques may result in increased nutrient loading in streams and decreased oxygen availability for Kokanee eggs.

Stream Modification. Many tributaries (streams) of Okanagan Lake have undergone some form of stream modification in recent decades. For example, the Okanagan River was diked and channeled during the late 1950s in an effort to reduce flooding in the Penticton area. Mission Creek in Kelowna was also channeled for a major portion of its lower reach. This resulted in effective flood control. Stream modification destroys Kokanee spawning habitat in several ways:

a) Channeling results in the scouring away of the spawning substrates. Good spawning substrates, consisting of small, unconsolidated rock and gravel, are replaced with larger rocks and boulders, which are useless to Kokanee.

b) Streamflow is altered so that suitable spawning areas are dry by the time spawning takes place, or shortly afterwards, resulting in high Kokanee egg mortalities. In other areas, stream flow is concentrated so it is too fast for the Kokanee to efficiently spawn. During spring freshets (runoff), boulders can crash over the spawning grounds due to increased stream velocities in the channels.

c) Channeling results in the destruction of riparian vegetation along modified streams. This decreases stream shading, resulting in higher temperatures in the fall, and much lower temperatures in the winter. These temperatures may be lethal to delicate Kokanee eggs.

Lakeshore Development. Although shore- spawning Kokanee are not well documented, lakeshore modification has likely affected their numbers. The development of lakeshore has resulted in the destruction of spawning beds along it. Man-made beaches and road-building alongside the lake have probably destroyed much of the habitat for shore-spawning Kokanee.

Water Use. The Okanagan Valley relies heavily on water for agricultural and domestic uses. Several streams have significant amounts of water removed for these purposes. In addition, many streams travel through residential areas where storm sewers empty into them. These uses have negatively affected Kokanee spawning habitat:

a) It is not uncommon to see streams that contain prime spawning habitat become reduced to a trickle by the end of the summer (when the Kokanee spawn). The lack of water leads to higher temperatures in the fall, which are also detrimental to Kokanee and their eggs. This situation has repeatedly occurred at Trout Creek, in Summerland.

b) Other streams are frozen during the winter months because water flow is minimal and this kills Kokanee eggs.

c) Low flows promote the settling of fine particulate matter (sedimentation) which results in the smothering and death of Kokanee eggs.

Mysis relicta. *Mysis relicta*, commonly referred to as **opossum** or **mysis shrimp**, was introduced into Okanagan Lake in 1966. These organisms were introduced in hopes of boosting the productivity of the lake, providing extra forage for game fish and enhancing the fisheries industry. Decisions for the introduction were based on several other North American and northern European lakes that observed increased productivity within a few years after the introduction of *Mysis relicta*. In the beginning , fish populations rose variably for the lakes, but then began to collapse. Scientists discovered that *Mysis relicta* is a good prey item for large Kokanee, but not for Kokanee aged less than one year. The shrimps are too large for small Kokanee to handle. The major food source for young Kokanee in Okanagan Lake is a small zooplankton species called *Daphnia*, otherwise termed the “water flea.”
Unfortunately, *Daphnia* is also the pref erred food item for *Mysis relicta*. This leads to competition for the same food source, but the shrimps are more efficient predators than the

Kokanee. They feed during the night, whereas the Kokanee do not, and they have a rapid generation time. The shrimps have few predators and normally inhabit different zones of the lake than the Kokanee. It is unknown if *Mysis relicta* populations have stabilized in Okanagan Lake. If they continue to rise, the Kokanee population will continue to drop.

Fishery: Related Topics

- Diversity of spawning behavior in Kokanee of Okanagan Lake

Project Synopsis
Diversity of spawning behaviour in Kokanee of Lake Okanagan, BC

Kokanee salmon (*Oncorhynchus nerka*) of Okanagan Lake spawn either in tributary streams or in the lake littoral zone. Since 1988 studies have been conducted on the diversity of these spawning habitats, and the adaptations of the kokanee to spawning under these diverse conditions.

Spawning behaviour of stream-spawners was conducted in Mission Creek, the tributary in which most of the stream spawning occurs in the Okanagan, at the location of the Mission Creek Spawning Channel. Much of this data is available in reports to the Ministry of the Environment on the adult migration into the channel during the fall of 1991, 1992, 1993 and 1994. Years 1988-1990 and behavioral data are in manuscript form and will be published in due course. Much of this work was supported by the Habitat Conservation Fund of BC.

Spawning behaviour of shore-spawners was conducted at Bertram Creek Regional Park, ten km south of the Mission Creek entrance into Okanagan Lake. To date spawning has been observed for three years, but progress is slow. Shore-spawning habitat and behaviour are very different from that in creeks. Reproductive strategies appear adapted to this uniquely different habitat. Manuscripts and a video are under development. This work is beginning supported by the Royal British Columbia Museum and Okanagan University College.

See Also [l] links to the **Kokanee Salmon Heritage Project.**
See Also [2] links to the abstract of Dr. Dill's presentation *Kokanee in Okanagan Lake.*


Credit: Desmond Murray


Credit: Peter Dill


Credit: Peter Dill

- Productivity of a Kokanee Spawning Channel

Project Synopsis
Productivity of a Kokanee spawning channel

At some time in the past, circumstances were appropriate for the evolution of two types of kokanee salmon (Oncorhynchus nerka) in Okanagan Lake. Although all Okanagan Lake kokanee appear to live together under similar conditions during growth, at sexual maturity half migrate to their place of hatching in streams, while the other half migrate to their place of hatching along the lake shore-line. In this study I describe the similarities and differences in the spawning behaviour of stream- and shore-spawning kokanee salmon, and attempt to explain the causation of the differences.

See Also [1] links to the **Kokanee Salmon Heritage Project.**
See Also [2] links to the abstract of Dr. Dill's presentation Kokanee in Okanagan Lake.

- Game Fish — *Fish BC*

Research: Projects that have helped save the Kokanee. Action Plan Reviews and proposals for Kokanee management in the Thompson-Okanagan. How you can help.

- *Mission Creek Spawning Channel* (1988/89,1990/91 – 1991/92)
  Improved existing diversion channel for spawning Kokanee and evaluated effectiveness of channel enhancement.
- *Okanagan River Kokanee Spawning* (1989/90)
  Improved Kokanee spawning habitat by removing milfoil from spawning gravel.
- *Peachland Creek Kokanee* (1988/89 – 1991/92)
  Maintained gravel platforms and incubation boxes, repaired rock weirs and controlled siltation. Also, evaluated previous projects by assessing Kokanee fry production.
- *Vernon Creek Improvement* (1988/89 – 1990/91)
  Performed various stream enhancement activities to help Kokanee spawning habitat: stream clearance, gravel placement, construction of boulder weirs, streambank stabilization and installation of fish barrier at creek junction.
- *West Kettle River Habitat* (1990/91 – 1991/92)
  Assessed feasibility of enhancing Rainbow trout rearing habitat. Surveyed trout in test areas and constructed debris catchers to increase rearing pool habitat for Rainbow trout.
- *Winfield Creek Enhancement* (1989/90)
  Improved Kokanee spawning habitat by excavating and replacing spawning gravel, excavating settling ponds to control silt and sand deposition and realigning stream course.

WATER CONTROL

- *Loch Long Dam Construction* (1991/92)
  Repaired dam and made storage reservoir which feeds Mission Creek and provides flows to spawning Kokanee when water is low.
- *Okanagan Tributary Assessment* (1989/90 – 1990/91)
  Assessed water availability in Okanagan Lake watershed and developed a plan to secure flows for Rainbow trout and Kokanee into tributaries.
- *Tadpole Lake Storage* (1988/89)
  Developed a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District to secure minimum flow for Powers Creek.
- *Trepanier Ditch* (1988/89)
  Upgraded ditch water system to a pressurized system which benefits Kokanee using Trepanier Creek.

HABITAT CONSERVATION FUND PROJECT REVIEW (1988 – 1992)
<u>Ecosystem Management</u>

- *Burnell Lake Aeration* (1988/89)
  Installed two electric aerators to increase winter survival of Rainbow trout.
- *Kilpoola Lake Aeration* (1988/89, 1990/91)
  Installed a solar aerator, then replaced it two years later with a diesel aerator to improve survival of Rainbow and Brook trout.
- *Fish Passage – Burns Lake Outlet Screening* (1989/1990)
  Installed a protective screen to prevent Rainbow trout from leaving the lake.

Information and Education

- *Mission Creek Awareness* (1989/1990)
  Constructed a 12 panel information kiosk and prepared brochures to promote fisheries awareness.
- *Okanagan Storm Drain Marking Program* (1988/89 – 1989/90)
  Implemented a storm drain marking program in Okanagan: coordinated schools and volunteers, marked storm drains and distributed pamphlets.
- *Peachland Creek Tours* (1988/89 – 1989/90)
  Conducted school tours and public education tours of Kokanee spawning habitat.

Protecting Habitats

- *Peachland Creek Erosion Control* (1989/90 – 1990/91)
  Constructed a series of dams to minimize siltation in creeks and to stabilize the entire gully which is used by Kokanee.

Spawning and Rearing Habitat Improvements

- *Kelowna Creek Enhancement* (1988/89)
  Planned enhancement projects for spawning habitat with public involvement following completion of a flood control project.
- *Lee Creek Fish Barrier* (1990/91 – 1991/92)
  Constructed a barrier to prevent Rainbow trout from leaving Osprey Lake and getting trapped in Lee Creek.
- *Middle Vernon Creek Kokanee* (1991/92)
  Dredged the stream, stabilized streambanks and placed gravel to improve spawning habitat for Kokanee and trout.

Research: Action Plan

The Ministry of Environment, Lands and Parks closed Okanagan Lake to Kokanee angling on March 15, 1995 in attempt to conserve remaining numbers of indigenous stream and shore spawning Kokanee (*Oncorhynchus nerka*).

On June 28-30, 1995 a technical workshop was held in Kelowna at Okanagan University College where representatives from government agencies, academic institutions and public stakeholder groups were invited to compare notes on the Kokanee decline and to develop an action plan aimed at restoring Kokanee populations in Okanagan Lake.

A number of factors appear to have contributed to the recent Kokanee decline.

These include:

- degradation and/or loss of stream spawning habitat;
- impoundment of streams and diversion of water for urban use;
- increased angling pressure;
- introduction of exotic species (Mysis shrimp);
- reduction of Kokanee shore spawning habitat;
- urban runoff; and
- competition between hatchery and native stocks of Kokanee.

The information presented at the workshop indicated that the Kokanee decline may be due to the reduction in carrying capacity of Okanagan Lake.

This reduction in lake productivity limits the number of juvenile fish due to reductions in nutrient loading and competition from introduced Mysis shrimp.

The workshop results indicated there are two approaches for increasing the carrying capacity of Okanagan Lake:

1. increasing productivity via large scale application of limiting nutrients; and
2. reducing the Mysis population to lessen competition with Kokanee.

The nutrient enrichment strategy generated considerable controversy due to differing regional and technical concerns about water quality versus fish, therefore the Mysis control strategy became the focus of the Okanagan Lake Action Plan.

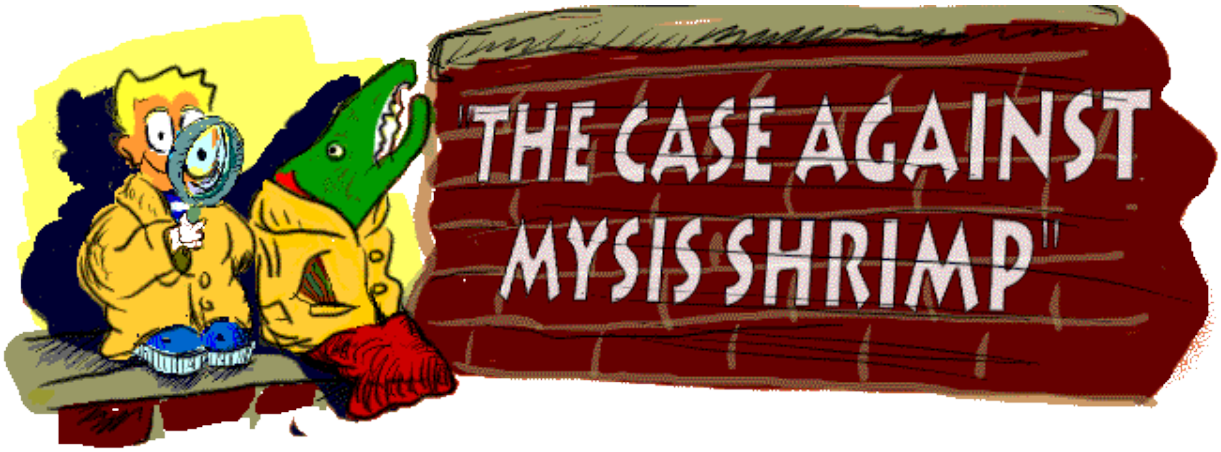
This will require involvement and co-operation of all groups of people along with regional government, and may involve some type of growth management plan and zoning restrictions to ensure key Kokanee spawning and rearing habitats are protected.

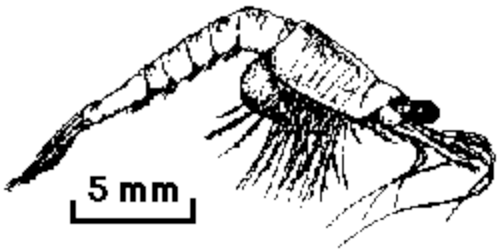
As quick fixes are not likely to be successful from either a technical or a biological perspective, the Okanagan Lake Action Plan is a long term recovery project.

Research: How to help

- Leave natural vegetation alone.
- If you live by, or are hiking along, a creek or around the lake's shoreline, do not alter the natural vegetation. Any change to your property along waterways requires permission from BC Environment.
- Remember trees shade the creek keeping the water temperature cool for fish. The roots hold the creek bank together so less soil is washed into the water covering the spawning ground of fish.
- If a creek is bare of vegetation, get active and plant some trees.
- Do not dig holes or try to redirect the flow of the creek.
- Digging in the creek can destroy spawning areas and fish may be stranded if the flow of the creek is altered.
- Keep pets and livestock away from creeks. They can trample and destroy vegetation or walk on and ruin spawning grounds.
- Keep household chemicals out of creeks.
- Never dump chemicals near a creek or into a ditch or storm drain. Ditches and storm drains are meant only to drain rainwater away. If waste oil, gasoline, anti-freeze or other chemicals get into the creeks, they pollute the water and kill the fish.
- Reduce the amount of fertilizers and pesticides used in your gardens. They harm people and fish as well as other animals. Excess amounts of fertilizers entering the waterways can make algae and weeds grow too fast. This disturbs the fishes' food supply and may use up the oxygen supply in the water.
- Remove garbage from the waterways.
- Don't litter. Litter in the creek and lakes can ruin water and it may be toxic to fish and wildlife that use it.
- Bottle caps, cigarette butts or cellophane wrappers which are thrown into the water may be eaten by fish and injure or kill them.
- Reduce the amount of water used in your house as well as out in the yard.
- Fish compete for water use with us. They require certain amounts of water flow during critical periods in their life such as spawning and low water levels in the creeks and along the shoreline can kill eggs and developing fry. Governments must be aware of effects of variations in water level.

Kokanee Kids: Study exercises and other fun for students.





Even when all the creatures in a particular ecosystem that scientists are interested in can be seen with the naked eye, scientists cannot figure everything out just by looking. For example, even if they observe that lots of Mysis shrimp (shown above) feed on young Kokanee fry, that isn't a good enough reason, by itself, to say that the Mysis shrimp are to blame for the decline of Kokanee. Scientists can't be everywhere at once. How do they know it's not really something else?

Rather, a case must be made before laying blame on the Mysis shrimp. Scientists sometimes call this finding the convergence of evidence. When things "converge" it means that they all arrive at the same point. When evidence, or "proof", converges, it means that a number of different occurrences seem to suggest the same thing.

A case against Mysis shrimp is made below. Notice that the evidence the scientists have found does several things:

- It eliminates some other causes of what could be causing the decline of the Kokanee, like Kokanee fishing.
- It finds situations that are "in common", e.g. the shore-spawning Kokanee are in the lake, the stream-spawning Kokanee are also in the lake, and so are the Mysis shrimp.
- It enables them to ask questions such as, "If this is happening, then why isn't that happening?" In number 4 in "The Case against Mysis shrimp", scientists ask the question "If there are fewer Kokanee in the lake, then why aren't they getting any bigger? There should be more food to divide between them."
- **QUESTIONS FOR KOKANEE KIDS:**What other things could the scientists try to discover in order to prove that Mysis are the main thing responsible for missing Kokanee?
  What kind of answers would they get if they were right?
  What kind of answers would they get if it were something else causing the missing Kokanee?

"The Case Against Mysis Shrimp"

1. The Mysis are implicated in other Kokanee crashes.
2. Fishing for Kokanee is no longer a major force in affecting numbers; the 1994 catch was fewer than 21,000 Kokanee.
3. Both shore- and stream-spawning Kokanee have declined dramatically. This suggests there is a common culprit in the lake.
4. Reduced population numbers have not resulted in larger size Kokanee. Is something else taking the Kokanee's food?
5. In 1993, only 1.2% of eggs became fry (in most other areas, it's 5%). Again, this suggests a culprit in the lake.
6. Biomass of Mysis in 1993 was equivalent to 2.6 to 4.3 MILLION Kokanee.
7. Recent modelling work using Okanagan Lake information suggests that mysids consume SIX TIMES the zooplankton that Kokanee do.

Credits

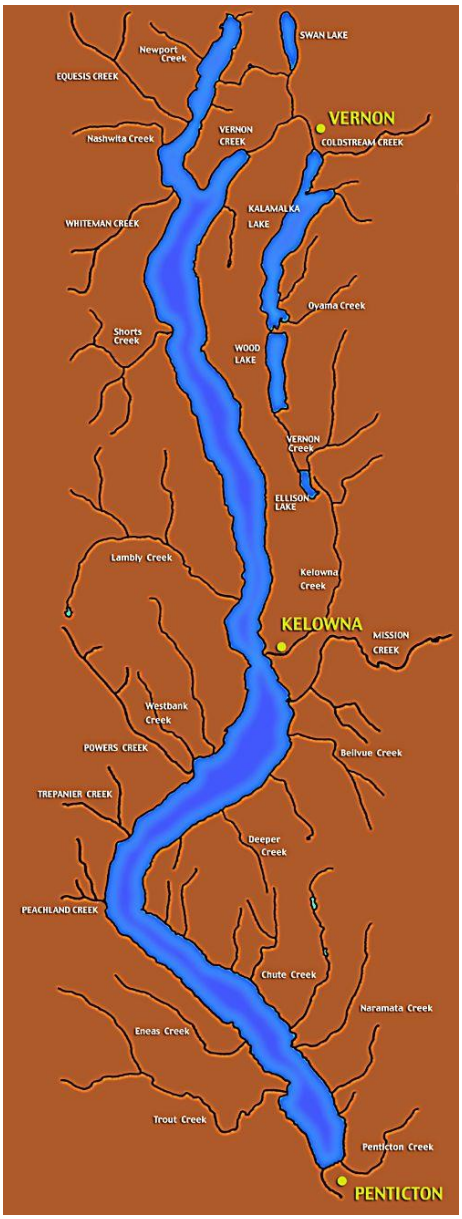
We wish to acknowledge the use of the Kokanee paintings by the late Kelowna artist, Murray Johnson, and the photographs and articles from the *Capital News* and the Kelowna *Daily Courier.*

Okanagan Basin Map

The Okanagan Basin

The Okanagan Basin is a series of lakes and tributaries which feed into the Columbia River system. Located in the burgeoning southern interior of British Columbia, it is considered by Environment Canada to be one of Canada's most environmentally endangered lake systems.

Click to see the location of Shore Spawners, and Stream Spawners.



New Articles: The Kokanee from the perspectives of Thompson-Okanagan history, geography and media.

THE SALMON TIMES

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1986	• Thousands of Kokanee dying in Okanagan Lake • Fish die-off ends, cause uncertain • Stocking of lake will build up catch
1988	• Okanagan Lake fishery in danger • Fish spawning project receives another grant • Bear Creek kokanee spawning in jeopardy • Spawning channel officially opens • Sewage kokanee could draw tourists
1989	• Kokanee population grows to 17 million • Kokanee — Gold in Mission Creek • Sewage fish should continue
1991	• Viability of Okanagan Lake fishery discussed • Dam rebuilt to help kokanee • Kokanee enhancement efforts now paying off
1992	• Breakwater builder put kokanee at risk • Huge kokanee return surprises • Kokanee spawning in troubled waters
1993	• Westside creek will be revived for kokanee • Returning kokanee are getting smaller • Locals watch spawning run
1994	• Fishy love real business • Money pouring into spawning channel • These kokanee won't get away • Kokanee spawning looks low • Low fish stocks a mystery • Life comes full circle in Mission Creek • Lake kokanee near extinction • Low water adding to fish kill • Kokanee collapse imminent? • Kokanee closure eyed for 1996

1995	• Death of a fishery • Closing fishery just the beginning • Spawning channel repairs may help save the kokanee • Fishing, the hard way • Task force to study kokanee • Kokanee rescue attempt begins • Giant aquarium could save kokanee • No stone unturned in quest to save fish • Kokanee head for the hills • Spawning channel to re-open on Mission Creek • Kokanee crisis continues • Kokanee a rare sight • Requiem for the kokanee • Sewage may save kokanee • Spawning numbers declining in creek • Conservation efforts do more harm than good
1996	• Fishing for solutions • Habitat funds to help restore Kokanee stocks • Out of the lake and into the fryer
1997	• Flood control endangers fish • The kokanee crisis • Fish habitat in jeopardy
1998	• Fish kill a mystery • Kokanee kill still poses mystery • Missing fish a dark omen
1999	• Kokanee still on the brink • Kokanee's last stand

Thousands of Kokanee dying in Okanagan Lake

by Brian Driscoll
Courier Staff
Tuesday, July 15, 1986

A viral infection may be killing thousands of young Kokanee in Okanagan Lake.

The Kokanee have been washing up on beaches from Squally Point to Okanagan Centre for the past five days, providing a culinary bonanza for birds and concern to Okanagan fishermen and Fish and Wildlife officials.

Samples of the dead fish have been sent by the provincial Environment Ministry to a lab in Nanaimo for analysis, though results of tests could take up to a week.

Brian Jantz, a Fisheries technician with the ministry in Penticton, said a viral or bacterial infection is suspected because only two-year old Kokanee have been killed. No other species are affected.

Jantz said the ministry first received reports of fish dying last Wednesday, but did not find any until Friday. The first large samples were gathered Sunday and sent to the lab Monday.

If a virus is causing the die-off, it may be difficult to prove.

Jantz said the samples must be dead less than 24 hours because the virus cannot survive in the dead fish.

There have been similar die-offs recently in Kootenay and Canim Lakes, and the cause was not determined in those cases.

Kokanee are more susceptible to viral infections than other species, Jantz noted, because they tend to stay in schools where the virus easily spread through skin contact.

Viruses can remain dormant for years in fish, he said, breaking out when conditions are right.

In the Kelowna area, hundreds of dead fish have been seen alongside Okanagan Lake Bridge and near Poplar Point.

Jantz said it is too early to estimate how many fish have been killed or how long the problem will continue.

The dead fish apparently pose no threat to birds feeding on the carcasses. And while the virus is not harmful to humans, Jantz recommends against eating fish found dead.

Kokanee caught live can be eaten, he said.

Fish die-off ends, cause uncertain

Thursday, July 17, 1986

The mysterious die-off of thousands of two-year-old Kokanee in Okanagan Lake appears to be over with, the cause still to be determined, says the head of the fisheries section with the Environment Ministry in Penticton.
Chris Bull said no new dead fish have been found during the past two days.

At least 10,000 fish, and possibly many more, were killed over the past 1 1/2 weeks.

Officials will never know how many because many fish have already sunk to the lake bottom.

They are also divided over the possible cause.

Lab tests are being conducted on fish samples sent to the Pacific Biological Station in Nanaimo, but Bull said it is difficult to determine the cause of fish kills from lab tests.

Bull feels it was a viral disease, and suggests infectious hematopoietic necrosis, the same one that forced the destruction of 1.5 million rainbow trout at a hatchery in Summerland in January. In past cases, two-year-old fish have proven susceptible to parasites and disease.

Others have suggested an algae bloom particularly toxic to young Kokanee or changes in the lake temperature or oxygen content at certain levels in the lake.

However, a plankton survey by the ministry appears to have ruled out the algae bloom theory.

Pollution was also ruled out because it would have affected other ages and species of fish.

The sickness will significantly affect fishing success next year, said Bull, because a typical annual spawning run is 250,000 fish.

There is nothing the ministry can do to prevent a similar “quirk of nature.” said Bull.

Stocking of lake will build up catch

by John Keery
Courier Staff
Friday, September 26, 1986

The Fish and Wildlife branch still does not know why thousands of Kokanee Salmon died in Okanagan Lake in June, nor do they have an accurate count of how many fish actually died.

“We tested them for disease, viruses and so on but couldn’t come to a definite conclusion,” fisheries technician Steve Matthews said Thursday.

He estimates that anywhere from 10,000 to 100,000 Kokanee may have been lost throughout the summer which “could have an effect on the number of fish in the spawning run.”

However, fisheries biologist Dave Smith says the dieoffs seem to be a kind of nature population control mechanism and usually do not result in a decline in fish catches.

The best fisheries can do to deal with the problem is to continue stocking Okanagan Lake with fingerlings, produced at the Skaha Hatchery and try to build up the population, say both Smith and Matthews.

Mission Creek, as the largest tributary to Okanagan Lake and the most important spawning stream for Kokanee Salmon and Rainbow Trout in the Okanagan River system, is also the chief source of eggs for the the Skaha Hatchery at Okanagan Falls.

Each fall when the four-year-old Kokanee swim up the creek to spawn fisheries officers are there to trap some of the fish, and collect up to 1.5 million eggs to be used to raise fish to restock Skaha and Okanagan lakes. During the egg collection process, a careful estimation of the number of spawning fish is also made.

Figures are not yet in for 1986, but to 1985 about 150,000 Kokanee went up Mission Creek. That same year 33,000 used Powers Creek and 12,000 used Peachland Creek.

“This gives you some indication of the importance of Mission Creek,” Matthews said.

Rainbow trout also use Mission Creek when they spawn in the spring. Trout eggs gathered there are then used by the hatchery to produce 20,000 to 40,000 rainbow trout fingerlings which are released into Okanagan Lake each year.

The reason fewer rainbow are put in than Kokanee is that rainbow eat Kokanee.

“If we put in too many rainbow we can’t enhance the Kokanees. So we decided to hold off on stocking the Rainbows,” Matthews explained.

One side effect of a lower fish population can be larger fish, Matthews says. While fisheries officers were collecting Kokanee eggs in Mission Creek the week of Sept. 15 to 20, they noticed that the fish were exceptionally large. “The average Kokanee is about 11 inches. This year we’ve seen fish up to 22 inches. That would be about seven to eight pounds.”

Okanagan Lake fishery in danger

Kokanee stocks must increase
by John Keery
Courier Staff
Kelowna Daily Courier
Monday, January 11, 1988

A provincial fisheries official and a spokesman for the B.C. Wildlife Federation agree the fishery in Okanagan Lake could collapse under current fishing pressure if stocks are not increased.

“We are worried that if nothing is done to enhance the kokanee we could see a collapse of the fishery in the next 10 years,” says federation spokesman Rene Barone.

Although Barone, chairman of the federation’s fisheries committee for the Okanagan Region, agrees with government biologists that the reasons for the kokanee decline are unclear, he says efforts to try and reverse it should be undertaken immediately.

“Fisheries are reluctant to do anything before they find the problem,” he said.

Fisheries biologist Chris Bull says although fishing is currently good there are a number of indications that stocks are declining.

“The fact that the size is good is another indication that the numbers are down,” Bull said.

One theory is that a new freshwater shrimp introduced into the lake in 1966 could be competing with newly-hatched kokanee for food. This would reduce the survival rate of kokanee but increase the amount of feed available for adult fish, causing them to grow larger.

The number of spawning kokanee has been declining steadily in the past few years, Bull said. Until last year it appeared that shore spawners were on their way to extinction.

Then this fall, numbers shot up to 165,000, from 2,000 to 3,000 in the past several years.

“We don’t even have a theory (to explain this),” Bull admits.

He also has no explanation for a massive dieoff of two-year-old kokanee in the summer of 1986. Studies of the dead fish revealed no apparent cause.

Bull said dieoffs and rapid fluctuations of kokanee populations also occur in other lakes in B.C. and the United States.

Mature rainbow trout eat kokanee, so if kokanee levels decline too far, it affects rainbow stocks.

Loss of spawning areas is a major factor affecting kokanee populations.

Bull estimates about 90 per cent of the spawning capacity in streams entering Okanagan Lake has been lost since 1900.

Creeks have been channelized, gravel beds silted up and water levels reduced due to irrigation demands.

Bull says water conservation measures will eventually have to be brought in in the Okanagan to preserve the fishery. “We just can’t keep on using water willy-nilly and still have a fishery.”

The wildlife federation wants fisheries to build a hatchery on the lake and increase spawning success with a new spawning channel.

Fisheries began diverting the million per year kokanee produced by the Skaha Lake hatchery to Okanagan Lake last summer.

The fish did not appear to be surviving longer than two years in Skaha. Bull says he does not know why. But similar problems have been experienced in lakes the size of Skaha in the United States.

The federation has a proposal for a hatchery at a beach south of Summerland which would produce up to 10 million kokanee per year for release into Okanagan Lake. It says the hatchery would cost about $700,000 and would require just one fisheries employee halftime to operate.

The federation also wants changes to the provincial Water Act which would force water users to release sufficient water for spawning fish during critical periods.

Fish spawning project receives another grant

Kelowna Daily Courier
Tuesday, September 6, 1988

The kokanee spawning enhancement project on Mission Creek has received an additional boost from a $15,000 grant from the Habitat Conservation Fund.
The project initially received $31,000 from the fund, but extra excavation costs to complete the spawning channel through Mission Creek Park required more money.

Fish and game clubs in the area have also provided $17,000 for the project.

Good rates on machines and material, co-operation from the City of Kelowna, and dozens of volunteer workers have also helped the project.

Project supervisor Pat Field hopes to complete most of the work of building up the channel sides with rock within a week.

Kokanee spawners are expected to begin using the channel in large numbers within two weeks.

Bear Creek kokanee spawning in jeopardy

Kelowna Daily Courier
Monday, September 12, 1988

Kokanee are beginning their journeys up Okanagan creeks, but the good will of some irrigation districts may determine the success of this year's spawning activities .
Dave Jones, Ministry of Environment habitat biologist, said Bear Creek in particular is in jeopardy unless the Lakeview Irrigation District increases its flow of water into the creek.

"Lakeview can divert the entire flow of the stream into Rose Valley," Jones said. "We rely on their good will and their surplus water."

The creek is almost dry now and the kokanee will start to spawn within the next few days.

In the past, Jones said, Lakeview has been co-operative in providing the water. He will contact them within the next few days to solicit their support again this year.

Bear Creek provides spawning grounds for about 1,000 kokanee out of perhaps 60,000 that may spawn this year in streams feeding Okanagan Lake.

While the survival rate from the artificial grounds is expected to be 70 to 80 per cent compared to two to four per cent in natural streams, Jones said there needs to be a variety of options for spawning in case something goes wrong in the enhanced grounds.

Fish are unlikely to seek alternate sites if a creek dries up. They are more likely to spawn near the lake shore, where all the eggs will probably die, Jones said.

The kokanee run will peak during the first two weeks of October, Jones said, but it will be four years before the large numbers that hatch next spring in Mission and Mill Creeks will return to spawn.

Spawning channel officially opens

by J.P. Squire
Courier Staff
September 26, 1988

"Four years from now, we'll see the results," said Kelowna Mayor Jim Stuart Saturday, as he officially opened a $150,000-plus kokanee spawning channel.

The mayor predicted there will be four or five times as many fish in the Mission Creek Regional Park channel when the offspring of this year's kokanee return to the creek.

During a brief ceremony at the Springfield Road park, Ron Taylor, president of the Oceola Fish and Game Club of Winfield, paid tribute to Gordon MacKinnon and Pat Field.

MacKinnon, a habitat technician with the Environment Ministry office in Penticton, proposed the spawning channel. Field, who works for the B.C. Conservation Foundation, implemented the concept.

The Oceola club launched a fundraising campaign by donating $6,000, and later kicked in another $4,100. The province's Habitat Conservation Fund contributed $25,000. The B.C. Conservation Foundation obtained a total of $82,000, and Field personally raised another $58,000.

The Kelowna and District Fish. and Game Club donated $10,000 and the Lonely Loon Flyfishers Society, $1,000.

Field noted the involvement of all four levels of government, two private foundations, 14 corporate sponsors and about 200 citizens who worked "two months solid" to construct it.

The spawning channel "is a first for the area," said Taylor, but "it won't be the last. I'm sure of that."

George Tinling, representing the Kelowna Chamber of Commerce, noted the kokanee spawning run is unique to the Interior.

The mayor joked the city can't find the water licences it promised to donate, another first, but would turn them over as soon as they are located. On a serious note, he said, "Everyone involved in the project had pride in it." Cliff Serwa (Social Credit-Okanagan South) said. "It is the first time kokanee have spawned in the channel since l948."

Stuart and Serwa unveiled a plaque bonded to a rock at the entrance to a channel walkway.

Sewage kokanee could draw tourists

December 15, 1988

Raising fish in Kelowna's sewage effluent could help the city's tourism industry, said Mayor Jim Stuart Wednesday.
"We want to get to the point where we can raise fish the tourists can keep (instead of catch and release)," Stuart told a news conference while officially announcing the city's latest fish-rearing venture.

"It's an excellent demonstration of the degree to which we treat our effluent. If it's going to enhance fishing in the Valley, then that's a payoff."

About 15,000 rainbow trout will be raised to .75-pound size in treated effluent from the city's Bardenpho sewage plant over the next 10 months. They will be prime fishing size when transferred to catch-and-release lakes in Okanagan high country, said Chris Bull, head of the Okanagan fisheries section of the Ministry of the Environment.

Kelowna is breaking new ground with its third fish-rearing project, said Bull, adding he knows of no other city in North America which is raising fish in sewage effluent ponds.

The 1988 batch of about 8,000 kokanee salmon were recently moved to Baker Lake in Okanagan Mountain Park. The lakes to receive next year's rainbow trout have not yet been named, but will be marked indicating the source of the fish, said Bull. In that way, fisheries experts will be able to gauge the public's acceptance of the fish.

Kokanee raised in sewage effluent were tested for over 75 different elements including heavy metals and came up with virtually the same results as fish raised in fresh water, said Bull. Health officials say it is not dangerous to consume the fish.

Kokanee population grows to 17 million

Saturday, September 9, 1989

The population of kokanee in Okanagan Lake has grown to about 17 million from less than 15 million two years ago, fisheries officials estimate.
The one million per year fry from Skaha hatchery being put into Okanagan Lake for the past two years have contributed greatly to this increase, fisheries biologist Bruce Shepherd said.

“We have more hatchery fish showing up in our catches than we would expect.”

Using their new research boat, fisheries technicians net fish in the lake to check them. They also count fish with echo sounding equipment.

Because kokanee run in schools at very specific water depths and at certain times, a very accurate estimate of numbers can be obtained through echo sounding, Shepherd said.

Initial experiments with hatchery kokanee in Skaha Lake several years ago were not successful. Few of the hatchery fish lived to be adults.

Shepherd said experiments with kokanee in similar small, relatively shallow lakes in the United States were also unsuccessful.

But Okanagan Lake is another story.

So far the supply of fresh underground water at the Skaha hatchery has kept the fry there relatively disease free and they appear to be doing well.

Fry being released weigh up to two grams. Fish from natural spawning beds weigh only about1/3 of a gram when they enter the lake so have far less of a chance of evading predators and surviving.

Kokanee — Gold In Mission Creek

by Dave Henshaw
Special to *Okanagan Sunday*
The Daily Courier
Sunday, October 8, 1989

THERE'S GOLD in Mission Creek — tourism gold. All it will take to dig it out is some foresight. The attraction is the kokanee spawning channel, developed over the past two years.

What started as a Fish and Wildlife Branch project to provide a spawning area for Okanagan Lake kokanee could turn into big tourism dollars.

The spawning run in 1988 attracted some 600 open house visitors.

This month, the day drew about 1,700 people.

Gordon MacKinnon, fisheries habitat technician, says the potential is there to develop a major regional tourist attraction, somewhat like the world famous Adams River sockeye run.

That happens every four years. The Okanagan kokanee (landlocked sockeye) run occurs every year.

How does the Okanagan turn fish into gold?

Dr. Peter Dill of Okanagan College is working on a project to develop the fisheries and wildlife viewing possibilities for Mission Creek Regional Park and adjacent 83-acre Sutherland Hills provincial park.

Dill has been meeting with groups with an interest in the area to get their input. He says it is a good area to interest a lot of people in nature and develop environmental consciousness.

MacKinnon is excited about the possibilities of a low-impact plan for the area.

"The potential is unlimited," he said. "It's Kelowna's Stanley Park."

With this plan, the Okanagan could be tapping into big dollars, he said. "If we go with it, the potential for funding is really great."

One possibility would be to have a viewing area built so people could observe spawning fish at eye-level.

“The place could really be promoted,” MacKinnon enthuses, “as an attraction during the run in September-October.”

One promotional idea could be for the City of Kelowna to declare the kokanee its official fish.

The idea is to come up with a low-impact program that could incorporate an information kiosk and trails to view the channel and wildlife in the park.

There are deer and many species of birds in Sutherland Hills.

“The emphasis would be to keep the area as natural as possible,” said MacKinnon. The original idea was to develop the spawning channel aspect, “then we thought we should add wildlife as well.”

Sutherland Hills Park is run by a local parks board headed by Fred Gerlinger. Last week, the board met with Dr. Dill and unanimously supported a low-impact concept.

There are still a few things to be worked out, said Gerlinger, emphasizing “We’d like to keep this place as natural as possible.” The board will have a meeting soon to draft some suggestions.

Local residents have done inventories of the park’s birds, trees and flowers, making for an impressive list of things to see.

The board’s blessing goes a long way to making the government-funded plan a reality, MacKinnon said.

The information kiosk would have panels explaining the kokanee run, the wildlife area and fisheries habitat protection suggestions (such as not dumping pesticides or grass clippings into creeks).

MacKinnon notes the Adams River run attracts tens of thousands of visitors in peak years. Okanagan residents live close to Mission Creek where landlocked sockeye often approaching the same size as ocean fish can readily be viewed.

Sewage fish should continue

Says the mayor

Kelowna Daily Courier

Friday, December 22, 1989

Kelowna Mayor Jim Stuart is insistent that fish rearing continue at the city's sewage treatment plant.

In 1988 the Ministry of Environment reared 8,000 kokanee in the outflow from the plant. Those fish tested healthy and were released into Baker Lake near Okanagan Mountain Park.

This year 15,000 trout were reared then released into Beacon Lake near Beaverdell. But those were the last fish slated for the site.

"It has been a great project," Stuart said Thursday. "It's a shame to see it dumped."

The fish demonstrate that the discharge from the plant is clean. But the Ministry of Environment, after showing the fish could survive there, has discontinued its support.

Stuart has elicited the backing of MLA Larry Chalmers (Social Credit Okanagan South), the City of Penticton and members of cabinet. He is frustrated that MLA Cliff Serwa (Social Credit Okanagan South) is still "dragging his feet" on his support.

Ultimately the plant could rear one million fish a year for sports fishing, Stuart said.

It will take years, however, before it is proven the fish can be safely released into the wild and are edible. It may take even longer to get public acceptance of sewer-reared fish.

The work at the plant has demonstrated the effectiveness of the Bardenpho treatment system in producing clean water to be discharged into Okanagan Lake. It is reputed to be the best in the world.

An ongoing project will serve as a continual monitor of the quality of water being discharged and as a classroom for Okanagan College students who have worked on past projects, Stuart said.

Viability of OK Lake fishery discussed

by Dave Henshaw
Daily Courier Wire Editor
Tuesday, January 22, 1991

The fate of the Okanagan Lake fishery was the prime topic Saturday at the annual meeting of the Okanagan region of the British Columbia Wildlife Federation.

The key issue, identified by both the fisheries committee and Fish and Wildlife branch spokesmen, was ensuring the viability of the fishery.

Wildlife region fisheries chairman Frank Shannon said in a report that possible closure of the Skaha kokanee hatchery due to lack of funds must not come about.

“Those kokanee are sorely needed to complete the Okanagan kokanee program to 1995,” he said. He urged all member fish and wildlife clubs to oppose the closure by pressuring local MLAs.

Concern about possible loss of some funding for the Okanagan Lake management plan through 1995 also prompted Shannon to say money must be made available without cutbacks.

“Politicians and fisheries people must be continually reminded that the goal is a major trophy rainbow fishery which will bring in $10 million to $15 million a year of new business to the Okanagan Valley,” his report said.

Dave Narver, director of recreational fisheries for the Ministry of Environment, said fish now in the hatchery will be raised to the point where they can be released into Mission Creek, site of a key kokanee spawning channel.

He said no funds have yet been identified for 1991, supposedly the last year of the five-year pilot hatchery project.

There were no direct funds allocated for the hatchery last year. It was run out of what is called “minister’s funds.”

“Right now, there are no funds available,” he said, but he would like to see it operate for another year.

Narver said a recent look at Mission Creek convinced ministry staff the spawning capacity has to be improved.

To that end, he said $50,000 has been allocated for Mission Creek and $25,000 for improvements to the Peachland Creek spawning channel.

Further, he has directed a plan be done to double Mission Creek spawning.

Current estimate of the Okanagan Lake kokanee population is 18 million, with the Skaha hatchery adding between 600,000 and one million a year.

Narver said the goal is to have a lake that is not dependent upon a hatchery. “Our technical people think there are enough out there now to carry the fishery,” he said.

Chris Bull, head of the fisheries section in Penticton, said “our best guess is that the decline in fish stocks is going to turn around.”

He said the estimate of the kokanee population four years ago was nine million.

There are apparently 18 million now, but he told the meeting he would like to see hatchery stocking continue for a few years, partly because he is not that comfortable with the technical data based mainly upon echo sounding from a research boat.

Ron Taylor, regional vice-president of the wildlife federation, said his Oceola Fish and Game Club in Winfield is willing to help fund the hatchery. He suggested an approach for funds might be made to chambers of commerce because they are the people who benefit from an improved fishery.

Mike Edall of Okanagan Falls was elected president of the Okanagan region. Ron Taylor of Winfield is vice-president and Len Michalkow, also of Winfield, is treasurer.

Dam rebuilt to help kokanee

by J.P. Squire
Courier Staff
August 31, 1991

Incubating kokanee won't be left high and dry in Mission Creek this fall.

Uneven water flow in the creek is a major problem during the low flows of summer and fall. The answer is a supply of water from Loch Long, located 57 km northeast of Kelowna in the Mission Creek watershed.

It was identified by Environment Ministry staff as having the best unused water storage potential in the Greystokes. It even had an old irrigation district dam built in the 1930s.

By the 1970s, other sources of water had been developed and the dam was sold to the ministry. By 1990, the dam was in such disrepair that it was breached for safety reasons.

The rebuilt dam will hold back water during spring runoff and then release it into Mission Creek, the Okanagan's most important spawning stream, during the summer and fall. Kokanee spawn in mid-September.

The suggestion to rebuild the Loch Long dam to provide water for the kokanee spawning beds coincided with Finning Ltd. approaching the ministry with an offer of assistance for environmentally-friendly projects.

Finning, the B.C. dealer for Caterpillar Equipment, provided the use of an excavator, bulldozer and all-terrain dump truck, plus $5,000 cash, for a total contribution of $35,000.

The Habitat Conservation Fund, funded primarily by a licence surcharge paid by anglers, hunters, trappers and guides, provided another $46,000.

Finning operators in Vernon and Kamloops also got private sector donations of a grader and operator from Fletcher Challenge, and fuel tanks from Schweb Contracting and Balcaen Consolidated Contractors Ltd.

Work on the dam began in early August with upgrading of an existing forestry road and site preparation.

Dry mix concrete was hauled from Kelowna and water added on-site to maintain maximum quality and minimize loads on forestry roads. A new concrete spillway was built and an old pipe filled with concrete to seal it off.

The new two-metre-high concrete structure, completed this week, will increase the maximum depth of Loch Long to four metres. A 50-cm pipe through the concrete and a sliding gate will control normal outflow.

The rest of the 200-metre long dam is earth fill, rising one metre above the concrete structure. A saddle dam on the north side of the lake will supplement the main dam.

If Loch Long exceeds its maximum level, water will spill over the concrete structure and go directly into the channel. Water levels will be monitored and controlled jointly by the ministry's fisheries section and Black Mountain Irrigation District.

Kokanee enhancement efforts now paying off

by Judie Steeves
Staff Writer, *Capital News*
Wednesday, Dec. 4, 1991

All the volunteer work on fish enhancement for spawning kokanee is beginning to show in this year's increased numbers of returning fish to local streams.

Okanagan Lake's major spawning creek, Mission Creek, and the recently constructed spawning channel for that creek show numbers of fish returning this fall to that area more than triple the previous year's returns.

Bruce Shepherd, senior fisheries biologist in the valley for the ministry of the environment, admits it's frustrating for volunteers to work in a stream but not see any increased numbers of spawners for four years.

Since three or four years pass before hatching kokanee return to their stream of birth to spawn, it takes that long for results of enhancement projects to show.

However, this year there are dramatic increases in the returns to Mission Creek and the spawning channel created there in 1988, and this is the first year for adult returns of those hatchery fish.

An estimated 94,300 kokanee returned this year to the creek, and 21,500 to the channel; compared to 25,000 and 6,000 last year; 20,000 and 7,000 in 1989.

In other creeks where enhancement work has been underway Shepherd expects to see larger increases next year.

All major spawning streams except Trepanier and Shorts Creeks on the Westside have undergone enhancement work, he noted, and both those creeks could benefit from some volunteer work now.

Spawning numbers on Powers Creek have increased this fall to 17,900 from 13,100 last year and 7,100 the previous year; while numbers on Peachland (Deep) Creek in Peachland have actually decreased slightly to 7,800 this year from 8,100 the previous year, but up from 6,200 the previous year.

Any group interested in sponsoring a project on either Trepanier or Shorts Creek can contact Shepherd at 1-800-642-8256.

Breakwater builder put kokanee at risk

Daily Courier
Friday, April 24, 1992

A company whose work put Kokanee sport fishing at risk in Okanagan Lake was fined in court Thursday.

It was carelessness, not a profit motive, that led to Hume-Smith Contracting building a breakwater in the lake without ensuring the property owner had the necessary permits under the Water Act and Fisheries Act.

The company was fined $1,100, a little less than the $1,500 levied earlier against the homeowner who hired the company to do excavation work.

Judge Dennis Overend said the key difference in this case, compared to others, was the company didn't turn a blind eye to regulations for a profit and no actual harm occurred to the fish habitat where the work was carried out.

Prosecutor Norm Yates said an estimated 4,800 Kokanee salmon spawn annually in the area where the work was done.

Building the breakwater at the end of April last year caused mud and silt to cover the gravel spawning bed.

After about six hours of work, neighbors noticed silt extending about 300 metres into the lake and notified authorities. Neighbors were concerned because they obtain their domestic water from the lake.

The breakwater was removed two months after construction was completed. Once removed, the spawning bed appeared to return to normal.

Yates wanted a sentence that would deter others from carrying out such work without approval.

"Shore owners too often feel they can do what they want to do when they own property adjacent to the foreshore," he said. He sought a $5,000 fine, saying increased fines approved by Parliament reflect public concern about protecting the environment.

Yates said a conservation officer quoted a spokesman for the company saying contractors have done similar work in the lake "hundreds of times without a permit. This time we just got caught."

Huge kokanee return surprises

Fisheries day is Sunday
by Rob Munro
Courier Staff
Thursday, September 24, 1992

Mission Creek spawning channel is closed.

It was closed earlier this week when Ministry of Environment staff found 16,000 kokanee crowding the channel in Mission Creek Park.

It only has room for about 15,000 spawning kokanee without risking damage to eggs deposited earlier this month.

"It took us a little bit by surprise," fisheries technician Brian Jantz said today. "When we did a count and it was 16,000, we closed it off immediately."

The record return of spawning kokanee this year is the result of two factors, Jantz said. One is the quality of the spawning channel itself, which results in a high survival rate of the fry.

For the past few years, fisheries staff also removed eggs from kokanee, took them to a hatchery for the winter then released the fry back into the channel. That means the fish return to the channel to spawn.

"Last year, they didn't want to go into the channel," Jantz said. "This year, we had no trouble getting them to go in."

Kokanee, when they reach the age of three to five years, return to the place they hatched, lay their eggs and die.

These fish will be in the channel for about one more week, Jantz said, so there will be plenty of live kokanee for people to see on Fisheries Awareness Day, from 10 a.m. to 4 p.m. Sunday.

It's sponsored by three local groups: Oceola Fish and Game Club, Lonely Loon Flyfisher's Society and Kelowna and District Fish and Game Club.

There will be displays on fish enhancement projects, fly-casting and fly-tying techniques along with native Indian fisheries practices.

Proceeds from the sale of food and refreshments will be used to fund educational tours for elementary schools.

Kokanee spawning in troubled waters

by Rob Munro
Courier Staff
Kelowna Daily Courier
Wednesday, December 2, 1992

Kokanee spawning in Okanagan creeks will probably never reach the peaks of past years, but things are getting better.

“We’re still in the basement but, hopefully, we’re climbing out the backside,” Bruce Shepherd, fisheries biologist with the Ministry of the Environment, said today.

In the 1970s almost one million fish spawned in Okanagan creeks. That plummeted to 111,000 by 1990 and has slowly climbed to 182,000 this year.

“We’re water short in the Okanagan,” Shepherd said. “Their habitat has been destroyed quite drastically.”

Spawning areas that haven’t been damaged by development have usually had significant amounts of water taken from them for agriculture or domestic use, he said. Many streams flow through residential areas with storm sewers emptying into them.

Shepherd is hoping for another $500,000 to improve the Mission Creek spawning channel in the next few years and, hopefully, double its capacity.

Mission Creek took almost 100,000 fish this year, with the spawning channel filled to its capacity of 36,000 fish.

That’s still a long way from the 300,000 recorded in the 1970s.

Shepherd doesn’t want all the spawning to come from Mission Creek. It’s important to spread it around to other creeks, he said.

Peachland Creek more than doubled its run this year to 7,800 and a fishway on Powers Creek made it easier for fish to get upstream. That count increased by about 3,000 to 20,700.

Shepherd is pleased with co-operation from native Indians in allowing, for the first time, Ministry of Environment staff to visit creeks on reserves.

Spawning fish in three streams along the north arm of Okanagan Lake were counted for the first time in 20 years, adding almost 11,000 to the total count.

The creeks were Whiteman, Equesis (Six Mile) and Nashwito (Siwash). That work was part of a joint project involving the Westbank Indian Council, Okanagan Indian Band and Okanagan Regional Wildlife Heritage Fund Society.

The Indians are becoming more involved with the fishery so Shepherd hopes for improvements along those creeks in the future.

Westside creek will be revived for kokanee

by Ron Seymour
The Daily Courier
September 2, 1993

A Westside creek that used to be full of fish is being revived as a spawning channel for kokanee.

The provincial government is spending $50,000 to build a new spawning channel alongside Keefe Creek on the Westbank Indian Reserve.

The creek flows under Westside Road into Okanagan Lake about a kilometre north of Okanagan Lake Bridge.

“When I was a kid, I remember the salmon used to spawn in that creek every season,” band councillor Pat Fosbery said today.

“But the creek got silted up, and there hasn’t been any fish there for years,” he said. “It’ll be good to see it brought back to the way it was.”

Local sportsmen welcomed the government’s decision to build the spawning channel, saying it reverses a general decline in concern for the preservation of fish stocks.

“In the last couple years, the government has been really cutting back on their funding for restocking and enhancement projects,” said Dave Newman, president of the 1,000-member Kelowna fish and game club.

“It doesn’t make any sense, because fishing is getting heavier and heavier all the time,” Newman said. “Any money they put into fishing now is money well spent.”

Fisheries Minister Bill Barlee was to present the band with the money needed to build the 100-metre spawning channel today.

“This is an investment in community spirit and local volunteer effort that will generate immediate and long-term benefits for B.C.,” Barlee is quoted as saying in a government press release.

The money comes from a $1-million fund aimed at strengthening kokanee stock across the province.

Fosbery said construction of the channel has already started, and should be completed in time for the mid-September start of the spawning season.

Returning kokanee are getting smaller

by Don Plant
The Daily Courier
September 27, 1993

The kokanee swimming up Okanagan creeks just aren't the same size as when Stephen Burnell was a lad.

Burnell and his brother used to snare and gaff fish out of Mill Creek as far back as 1919. It was against the law, of course, but the Depression was an exceptional time.

"You had to get something to eat," Burnell recalled as dozens of parents and children scrambled for a better view of kokanee struggling up Mission Creek's spawning channel on Sunday. "You had to do things you weren't supposed to do in those days."

The average size of an adult kokanee back then was at least 35 centimetres (14 inches). On Sunday, the average size of the same breed of fish was about 10 cm (3 1/2 inches) smaller.

"I'm surprised by how small they are, and I don't know why," he said to fisheries technician Brian Jantz. "These are like minnows."

The smaller size has to do with the amount of feed available in Okanagan Lake, said Jantz. The more kokanee there are, the less feed there is to go around.

"Also, some may be three-year-old spawners as opposed to four-year-olds. We used to have more older, larger fish," he says.

Locals watch spawning run

by Don Plant
The Daily Courier
September 27, 1993

More than 1,000 children, parents and grandparents took advantage of a sunny fall day to learn about spawning kokanee on Sunday.

About 250,000 of the landlocked salmon, colourful cousins of Pacific Coast salmon, are now filling creeks throughout the Okanagan Lake system. And a large proportion of them began the arduous journey up Mission Creek's spawning channel two weeks ago.

"After they spawn, the 100,000 or so expected to make the run up Mission Creek, will die.

Because the run is approaching its peak, fish and games clubs set aside Sunday as Fisheries Awareness Day, when experts rolled in displays and interpreted the strange phenomenon known as the annual kokanee run.

"People don't often get to see the spawning process," says Brian Jantz, a fisheries technician who demonstrated egg fertilization several times Sunday. "They don't have an appreciation for eggs and how fragile and important they are."

Jantz demonstrated the miracle of fertilization before 80 people by rubbing the bell of a female caught Sunday morning and forcing about 20 eggs into a small pail.

"When eggs come out of a fish, they're soft, sticky and fragile," he explains over a microphone. "When the female deposits them, she'll hang around the rocks and give a swirling motion, which attracts the sperm to the eggs."

Jantz then picked up a male and rubbed its belly, forcing the milt (sperm) into the same pail. The eggs were fertilized almost instantly.

After people get a look at the orange eggs close up, Jantz takes a two-metre rubber tube and shoves one end deep into the gravel bed of the spawning channel.

He then pours the eggs down the high end of the tube so they drop into the gravel, just as they would if laid naturally.

The demonstration is important, he says later, because the more aware people become, the more care they'll take of wildlife and habitat.

Across the blue bridge toward Springfield Road, kids clambered inside a hollow 13-metre (40 foot) fibreglass salmon.

They love it," says Patty Gunning, who volunteers for a non-profit environmental group from Washington called Wild Olympic Salmon. "Kids get a sense of security and hope when they see adults who care about the environment."

Meanwhile, Jantz expects 7,000 local students to visit Mission Creek, Coldstream Creek in Vernon and Deep Creek in Peachland during the next two weeks.

Fishy love real business

by J.P. Squire
The Daily Courier
Sunday, January 9, 1994

It sounds fishy, but Peter Dill plans to spend two weeks next fall watching kokanee make love.

He's not a fish voyeur, but an Okanagan University College biology professor who wants to enhance the annual spawning run along the shores of Okanagan Lake.

"We know quite a bit about creek-spawning kokanee., but we really know very little about shore-spawners," he said Saturday.

Dill, 52, has a $1,000 grant from the university college's new research fund to conduct his study into the shore-spawning variety of landlocked salmon.

"I'm an animal behaviorist with fish my main organism. I'll be looking basically at their behavior to see what the difference is," he said.

It could be environmental since Mission Creek and Okanagan Lake bottoms are quite different, he said, or it could be genetic.

"I will try to determine what happened in the past which separated these groups."

Although hundreds of thousands of dollars have been spent on the Mission Creek spawning channel for example, "we haven't spent much money to determine if the shore-spawners have certain needs," he said.

“There are so many people living on the shoreline of Okanagan Lake now that we could inadvertently damage their habitat. Docks could change the flow of water, increasing or decreasing silting which could affect spawning areas.”

An increase in Eurasian aquatic milfoil growth could affect water circulation and the movement of gravel on the lake bottom, he said.

Environment Ministry officials like biologist Bruce Shepherd began studying shore-spawning kokanee several years ago.

The kokanee population averages 250,000 with only 20,000-30,000 of those shore-spawners.

The latter spawn from Squally Point in the South Okanagan to urbanized Kelowna, Poplar Point in Kelowna to Whiskey Island in the North Okanagan, and on the Westside from Bear Creek Provincial Park to the North Arm.

“They are very, very different fish,” said Shepherd from his Kaleden home Saturday.

Shore-spawners keep their bright silver color, getting mottled at best, while the bodies of stream-spawners turn red and their heads turn green.

Creek-spawners pick a site, prepare it and guard it until they die while shoreline spawners appear to scatter their eggs and don’t guard them.

The latter also spawn at three years. Fifty per cent of creek kokanee are four-year-olds and the rest are three.

The shoreline variety spawn for five days in late October while creek kokanee spawn four to six weeks in September and early October.

“Shore-spawners seem to spawn in areas where there is a rip-rap shoreline, where there is coarse, sharp-edged rock six to eight inches (15-20 centimetres) across,” said Dill.

Dill began his preliminary work last fall by watching the spawning run from the shoreline in late October.

He may hire a co-op student from the water quality technology program to assist him. However, he still hasn’t figured out a better way to observe kokanee behavior than sitting on the shoreline.

"It's going to be difficult. I want to disturb the fish as little as possible since it is an enhancement project, but I want to be able to take out individual fish to measure how big they are, for instance, to sample the fish without disturbing the rest."

A professor in the OUC biology department for the past 16 years, Dill has researched salmon and trout behavior for the past 25 years, almost since he graduated from the University of B.C. with a master's degree in 1965.

Money pouring into spawning channel

The first phase of a project to clean up
the water in the Mission Creek
spawning channel will go ahead

by Rob Munro
The Daily Courier
Sunday, April 17, 1994

Spawning kokanee will be able to lay their eggs in cleaner water this fall.

An $79,000 grant from the Habitat Conservation Fund will start the revitalization of the Mission Creek spawning channel this year. It's expected to cost $310,000 over two years.

"We're very, very happy," Ron Taylor, past-president of the Oceola Fish and Game Club, said. "This was turned down two years ago because the Habitat Conservation Fund will not fund projects in excess of $100,000."

The grant application was restructured so the fund will pay $79,000 for the first phase this year. If Oceola, Kelowna and District Fish and Game Club and other local organizations can raise $100,000 this year, they can get $130,000 from the Habitat Conservation Fund for a second phase next year.

Bruce Shepherd, acting section head of the Ministry of Environment's fisheries department in Penticton, said the headgate that diverts water into the channel will be relocated and a larger settling pond built in the first phase.

"That will make it less of a risky operation," he said. "At times, now, we have an interruption in water flow."

In the winter, the channel can be blocked by ice and during spring runoff gravel and sediment may block the channel opening. Shepherd hopes to avoid those problems by moving the headgate upstream.

If approved, next year the channel will be totally rebuilt so it can be properly lined with clay to prevent leaks. Now, about half the water can leak out if the main channel is low.

That will also allow a slight expansion in capacity from 17,000 spawners to 19,000. In the future, the channel could be extended downstream to allow another increase.

The existing channel was created in 1988 with $46,000 from the Habitat Conservation Fund and $40,000 from local sponsors, along with many hours of volunteer labor. It was built in response to concerns about declining kokanee populations in Okanagan Lake.

That population can range from seven to 15 million with spawning fish numbering 100,000 to 250,000, depending on the year (kokanee spawn every four years).

Last year, about 32,000 kokanee spawned in Mission Creek below the spawning channel and another 15,000 in the channel, Shepherd said.

Mission Creek is the largest spawning creek for Okanagan Lake. The Oceola club will meet in June to start planning its fundraising efforts. The City of Kelowna has already committed $5,000.

These kokanee won't get away

Fisheries Awareness Day is Sunday,
the peak day of the annual run

by J.P. Squire
The Daily Courier
Thursday, September 1, 1994

More than 100,000 kokanee will fight their way up Mission Creek to spawn — and then die — this year.

More than 10,000 of the landlocked sockeye salmon are expected to spawn in the spawning channel.

Thousands of people are expected at the creek Sunday for Fisheries Awareness Day, sponsored by Central Okanagan fish and game clubs.

The peak of the spawning run, which started about two weeks ago and is expected to last another two or three weeks, will be Sunday.

After they spawn, "the kokanee die and rot, providing nutrients to feed the little critters like small bugs and crayfish who live in the stream," said Ron Taylor, vice-president of the Okanagan region of the B.C. Wildlife Federation.

"Every resident of the Central Okanagan should take the opportunity to view this phenomena of nature."

"Many creeks in the Okanagan Lake system will see some kokanee, but the major run will be in Mission Creek," said Taylor.

Last year, the flow of water down Mission Creek was one of the lowest ever, he said, adding: "There was hardly any water in the main channel."

Most kokanee return to spawn when they are four years old, he said, so this year's spawners are the first from the spawning channel built in 1989.

The larger kokanee in this year's run are five or six years old and would have spawned in the main channel.

Public displays and demonstrations are scheduled for 10 a.m. and 4 p.m. in Mission Creek Regional Park, also known as Lions Park.

More than 3,000 people attended last year's event and even more are expected this year.

"This year, the emphasis is on supplying children with information on fish, their habitat and their life cycle," said Taylor.

Two displays in particular are bound to catch children's attention.

Youngsters can enter a seven-metre (2-foot) long fibreglass fish and see paintings of fish habitats, he said. A 13-metre (40 foot) long plastic fish will contain educational materials on fish.

In addition, there will be demonstrations of fly fishing and a display by the Westbank Indian Band.

"Brian Jantz from the fisheries branch will strip fish (remove their eggs), put the eggs in a bucket and fertilize them with milt (male fish semen)," said Taylor.

Jantz will use a special pipe to dig under gravel in the spawning channel, pour the fertilized eggs down the pipe and then gently pull the pipe out, he said, similar to two fish mixing their eggs and milt, and then covering up the eggs.

The first 2,000 people arriving at Fisheries Awareness Day will receive free hotdogs prepared by local politicians and provincial fisheries staff.

Dave Narver, director of fisheries in Victoria, and Steve Willett, regional director of wildlife in Kamloops, are planning to attend.

Fishing in the Okanagan "brings in excess of $1 million to the tourist industry," said Taylor, including the sale of gasoline, boats, boat motors, fishing tackle, food and accommodation.

Two local women are conducting school tours involving 1,500 children during the spawning run. The tours are on Mission, Peachland and Vernon creeks, and were organized by local fish and game clubs.

Like kokanee trying to swim upstream, local fish and game clubs are fighting an uphill battle to upgrade and expand the spawning channel in Mission Creek. S

In 1989, the clubs, local government and provincial Habitat Conservation Fund all contributed toward construction of the $100,000 plus spawning channel located at Mission Creek Regional Park on Springfield Road.

“There was not enough room for all of the fish which wanted to spawn there last year,” said Taylor.

“The headgate (which diverts Mission Creek water into the channel) needs work to maintain an even flow,” he said, “and there is a leak somewhere in the channel, about one-third of the way down.”

Last year, local fish and game clubs submitted a $475,000 upgrade-expansion proposal to the Habitat Conservation Fund, but it was turned down.

“We wanted to redo the the whole thing, to make it bigger and longer, with a new bridge,” said Taylor.

The project has since been downsized to about $200,000 and will be resubmitted to fund officials this fall. This time, a video on the spawning channel will accompany the application.

Kokanee spawning looks low

by Don Plant
The Daily Courier
Sunday, September 18, 1994

The number of kokanee in Mission Creek is unusually low for this time of year, but it's too early to conclude the spawners are in trouble.

Preliminary tests show the number of kokanee in the spawning channel of the creek was about 700 on Thursday. At the peak spawning time in late September last year, there were about 6,000 fish.

"Mission Creek appears to be unusually low for this time of year," said Brian Jantz, a regional fisheries technician. "We don't know if they're just late or they're not coming."

Despite the lower count, the severe drop of more than 1.3 million sockeye salmon in the Fraser River this season hasn't been reflected in the streams flowing into Okanagan Lake.

Peachland Creek is about normal for this time of year. Scientists counted nearly 1,000 kokanee on Thursday. "It should have a healthy run," said Jantz.

Last year, officials counted the lowest number of stream-spawners (90,000) and shore-spawners (20,000) in and around Okanagan Lake in years. Mission Creek saw 15,000 stream-spawners last year, down from 36,000 in 1992.

Stream-spawners around the lake tend to fluctuate between 75,000-150,000 from year to year, but the shore variety, which spawn in late-October, have been steadily declining.

Last year scientists counted 20,000 in Okanagan Lake, well below the peak of 560,000 reached in the early 1970s. "We don't know why," said Jantz. "It's something we're quite concerned about."

Several environmental pressures may have contributed to the drop, including habitat destruction, fluctuating lake levels, and more anglers fishing the lake.

Adding to the stress on the shore-spawners is an increase of predators like rainbow trout, which eat one- and two-year-old kokanee, and competitors for food, such as carp, suckers and burbot (also known as freshwater ling).

"A number of these factors could be at work, but it's hard to pin down," said Jantz.

The biggest pressure on kokanee, ironically, is from a food source officials introduced in the mid-1960s as a way to improve kokanee stocks, a tiny freshwater shrimp called Mysis.

“The (Mysis) populations are at extremely high levels,” said Jantz. “They compete for plankton, as do the kokanee fry.

“The plan backfired. They turned out to be competition in the kokanees’ early life stages.”

The stream-spawners have fared better, in part because sporting clubs have enhanced stream beds so eggs can mature better. Jantz is confident the numbers will be as good or better than last year, despite the early poor showing in Mission Creek.

Low fish stocks a mystery

by Ron Seymour
The Daily Courier
September 25, 1994

Something fishy is happening in creeks around Okanagan Lake, worried anglers say.

Kokanee stocks are down dramatically from past years despite attempts to revive crucial spawning grounds.
“If the numbers don’t start coming up soon, there might not be any kokanee fishing allowed. Period. I mean, what else could you do?” Bill Bosch, vice-president of the Oceola Fish and Game Club, said Friday.
As recently as the mid-seventies, more than one million kokanee used to spawn each year in streams connected to the lake. That has dropped to 175,000 in recent years.
“I remember going to Mission Creek as a kid and it was red, literally red, with millions of fish in it,” said Ron Taylor, president of the Okanagan Region of the B.C. Wildlife Federation.
“Now when you go there to watch the kokanee spawn, you can almost count the fish,” Taylor said.
Sam Saprunoff, president of the Lonely Loons Flyfishers, said he’s seen a variety of fish decline over the past two decades.
“I’ve fished that lake for 15 years and it’s definitely deteriorated,” he says. “They’re simply not there in the numbers they used to be.”
Sportsmen and Ministry of Environment officials hope to make the public aware of the threats facing kokanee stocks during this Sunday’s Fisheries Awareness Day at Mission Creek Regional Park.
Key reasons for the drop in kokanee stocks include:
€ the introduction of a small shrimp that was supposed to provide more food for rainbow trout. The shrimp have eaten a lot of plants that young kokanee also depend on.
€ the alteration or degradation of many steams and creeks, and diversion of water for

residential and commercial development.
€ pollution of waterways.
“The whole intent of Fisheries Awareness Day is to make the public more aware of the plight of the kokanee,” Taylor says.
Anglers and government officials hope that would lead to boosted public support for costly revitalization projects, such as a proposed quarter-million-dollar enhancement of the Mission Creek spawning channel.
Events and activities at the park run from 10 a.m to 4 p.m. The day also marks the official opening of a new interpretive centre.

Life comes full circle in Mission Creek

by Judie Steeves
Staff Writer *Capital News*
Sunday, September 25, 1994

Ironically, it’s a run for survival of the species but it means immediate death for the individual.

In an awesome phenomenon of nature, at three or four years of age land-locked salmon, or kokanee, join their sea-going brothers and sisters in an almost-unerring navigational feat to return to their place of birth.

Annually in September the glistening red bodies of mature fish flick upstream from the lake to complete their odyssey by spawning and then dying.

Each female kokanee lays 400 or so eggs in gravel beds in the streams in which they were born, and they are fertilized by the male.

Only 10 per cent will survive in natural situations the dangers from silting, which can smother the eggs; fluctuations in stream flow, which can disturb the gravel beds full of eggs; or freezing.

Environment Ministry biologist Bruce Shepherd says spawning channel fish such as those which hatch in the Mission Creek spawning channel have a doubled or tripled chance at survival.

The annual spawning run of the kokanee begins with the month of September, and often continues to mid-October, peaking about now; while shore spawners, a genetically separate stock, spawn about a month later, says Shepherd.

Over winter the eggs incubate in their gravel beds, water temperatures defining when they “button up” or use up their yolk.

By April or May accumulated thermal units (ATU) or the degree of freezing determines metabolically when they will develop eye spots and begin to hatch.

It all depends on external temperatures, Shepherd explains.

One night, when there are fewer predators about, the fry will emerge and head downstream and directly to the middle of the lake.

For the next three to four years the young fish will feed and grow in the lake, feeding at dawn and dusk on plankton, evading anglers and other predators, until it's time for their homecoming.

By now they are 250 mm or 10 inches in length. Larger kokanee usually are sterile, although if there are fewer fish in a lake they will tend to grow larger, says Shepherd.

During the annual run interpretive tours for classes of students are held on both Mission Creek and Peachland (Deep) Creek, usually in the mornings, beginning at 9 a.m.

Members of the public are welcome to tag along on these tours which will continue until Oct. 7, says Shepherd.

Lake kokanee near extinction

by Ron Seymour
The Daily Courier
September 26, 1994

The sight of rotting fish floating belly up in Mission Creek is an irresistibly gruesome attraction for Jason Wilder.

Like most nine-year-olds, Jason can get pretty excited by dead things, especially if they're in an advanced state of decay.

"Gross, there's another one over there," Jason said Sunday afternoon as he pointed to the disintegrating cream-colored carcass of a kokanee.

Despite Jason's morbid interest, a dead kokanee is not unusual in September as the landlocked salmon expire soon after spawning.

But what is unusual and extremely worrying for anglers, biologists and anyone else who cares about the future of Okanagan Lake is just how few kokanee, dead or alive, there are this fall.

Kokanee have thrived for millennia in the Okanagan, but they may have come to the verge of extinction in just the past few years.

"It's quite possible there won't be any fish at all in the creek next year at this time," said Peter Dill, an Okanagan University College biologist.

Rapid urban growth that has destroyed natural habitat coupled with a botched attempt to "improve" the natural food supply in Okanagan Lake are blamed for the calamitous decline of kokanee stocks.

As recently as the mid-seventies, there were more than a million kokanee spawning each year in the Okanagan, most of those in Mission Creek in Kelowna.

By 1991, the number was 9O,000. In '92, 60,000. Last year, 30,000.

With only about two weeks left in this spawning season, only 2,000 kokanee have been counted in the creek.

"We don't know if they're just late or if they're simply not coming. But it is very low for this time of year," said Brian Jantz, regional fisheries technician for the Ministry of Environment.

“It’s a real question mark if the kokanee are going to survive. Right now, they’re on the edge,” Jantz said. “Obviously, there’s a message there that we’re doing something wrong. ”

At the turn of the century, kokanee were so plentiful in the 50 or so streams that feed into Okanagan Lake that Indians used to scoop them up with nets.

Oldtimers can recall that every fall, streams would turn blood red as millions of the fish returned to spawn after spending three or four years in the lake.

“The creeks were so jammed with fish you could practically walk across them without getting your feet wet,” Howard Hazelman recalled as he joined about 1,800 other people wandering along Mission Creek during the annual Fisheries Awareness Day, put on by local sportsmens clubs and the Ministry of Environment.

“It’s hard to believe it could have changed so much,” Hazelman, 66, said as watched a handful of the kokanee struggle to haul themselves over a series of small weirs in the specially built spawning channel.

Of the natural spawning habitat that existed a century ago, biologists estimate that probably only about 10-20 per cent remains today. The rest has been lost to development, with water diverted for commercial and residential projects.

Logging, agriculture and other upstream uses have also introduced potentially harmful chemicals in many of the creeks that once supported large numbers of kokanee.

Scientists think the single most important factor in the demise of the kokanee stocks is also man-made but, ironically, it was part a project designed to help the fishery, not hurt it.

A tiny form of shrimp was supposed to provide more food for rainbow trout, but the shrimp have eaten a lot of the plankton the young kokanee also rely on.

“Now the shrimp are almost impossible get rid of,” said Dill, the OUC biologist. Fisheries officials are reluctant to make much of an effort for fear of causing some of the equally unforeseen disruption in the natural food chain.

Instead, they’ve focused on restoring and enhancing natural spawning charnels where the survival rate for eggs laid by kokanee rises 30-40 per cent from the 10 per cent common so-called ‘wild streams’.

But the man-made spawning channels are expensive; a proposed addition to the Mission Creek channel would cost at least $250,000. And given the sharp drop in kokanee numbers, even some fish-and-game enthusiasts wonder if there’s any point.

“It’s pretty hard to justify spending that kind of money if the kokanee are just about finished anyway,” said Ron Taylor, president of the Okanagan Region of the B.C. Wildlife Federation.

Virgil Willett, a lifelong Winfield resident, is also pessimistic.

“Thirty years ago, I could go out and has two fish in my boat in half an hour,” says Willett, 74. “A little while ago, I went out 15 times before I caught a single fish. . . they’re just not out there any more.”

Low water adding to fish kill

by Rob Munro
The Daily Courier
October 5, 1994

In a year when the number of spawning kokanee has dropped dramatically, fish are dying because of lack of water in local creeks.

Bear Creek on the Westside dried up to a mere trickle last week until a man who jogs regularly in the area notified fisheries staff.

And, Powers Creek in Westbank was also unusually low.

“There’s no doubt we’ve been in a long dry spell,” fisheries biologist Steve Matthews said. “This problem has been around for a long time and is one of the major reasons kokanee are in a bad state right now.”
The jogger, who didn’t want his name published, runs along the Bear Creek trails every day. Bear Creek is about five kilometres north of Highway 97 along Westside Road.

One day the creek was flowing normally. The next, it was down to a mere trickle and hundreds of fish lay dying in shallow pools or on shore.

“Don’t tell me a river would cut off overnight,” he said. “Somebody diverted all the water.”

He estimated 700-800 fish died. He stepped on a few and eggs squished out so, obviously, they hadn’t spawned.

Their deaths came at the same time the number of fish spawning in Mission Creek was down to about half the normal level.

Matthews, who wasn't able to view the Bear Creek kill himself, was skeptical about 700-800 fish dying.

"We don't usually get a lot of production out of that creek because it always has flow problems," Matthews said. "I've seen years when the fish couldn't even get into the creek."

When contacted by the jogger, Matthews called the irrigation districts and asked for help.

Lakeview Irrigation District is the main user on Bear Creek, but it was only using a small pipe open to take water, and that had been running for weeks before the water disappeared.

That was shut off and the Westbank Irrigation District diverted some water into the creek, so flow was restored quickly.

Westbank also put more water into Powers Creek, where the water was so low that fish couldn't swim upstream to spawn. The creek flows into Okanagan Lake below downtown Westbank.

But, this fall's weather has been unusual. The region has had mostly dry weather since early July.

While water supplies are low, the irrigation districts don't fear any shortages.

The cooler weather helps since people aren't watering as much and supplies to orchards are being cut off.

Kokanee collapse imminent?

Fishermen may pay the price if a catch-and-release rule is implemented

by John Keery
The Daily Courier
November 17, 1994

A drastic drop in the number of spawning kokanee this year has fisheries officials worried about the future.

“We feel we are teetering on the edge of collapse now,” said Steve Matthews, acting senior fisheries biologist with B.C. Environment in Penticton. “It is kind of scary what is happening.”

They don’t know why the decline has been so dramatic.

Matthews said his department is considering going to a catch-and-release rule for local fishermen, to replace the current fishing limit of five kokanee a day.

There were an estimated 101,000 spawners in tributaries to Okanagan Lake this fall, compared to 110,000 last year, 182,000 in 1992 and 214,000 in 1989.

This is the lowest number since records have been kept.

The biggest drop has been in Mission Creek, which traditionally accounts for half of the spawning from the lake, and Powers Creek near Peachland.

There were just 19,600 spawners counted in Mission Creek this year, compared to 32,000 last year and 94,000 in 1991.

The artificial spawning channel in Mission Creek Regional Park accounted for another 6,000 spawning kokanee this year, down from 15,000 last year and 36,000 in 1992.

However, the kokanee, which is a landlocked sockeye salmon, is an unpredictable species of fish and these numbers in Mission Creek have been seen before.

In 1989, there were 20,000 spawners in the creek and in 1990 there were 6,000 in the spawning channel.

Other streams on the lake seem to be holding their own and the.number of kokanee spawning on the shoreline instead of creeks appears stable.

Matthews said kokanee seem to be hatching successfully at the spawning channel in Mission Creek, but no one is sure why more are not returning four years later to spawn.

“A lot of things going on out in the lake are baffling the good results (of the spawning channel),” he said.

It is now known that mysis shrimp, introduced into the lake about 20 years ago to provide additional food for the kokanee, actually eat the same plankton immature kokanee survive on.

Rainbow trout and several other species eat kokanee and fishermen catch them.

Some also suffer gill lice that can retard their development and even kill them in extreme cases.

Plans to upgrade the spawning channel Mission Creek are still going ahead, but it will not solve the problem of too few fish returning, Matthews said.

Fishing regulations are set on a two-year basis so 1996 would be the first opportunity to change to a catch-and-release rule.

Most people would probably concentrate on rainbow trout and stop fishing for kokanee if a catch-and-release rule was brought in on Okanagan Lake, Matthews said.

“We expect that would be like a closure for most people.”

Kokanee are doing well in Kalamalka, Skaha and Wood lakes so fishing regulations in those lakes would probably not change.

Kokanee closure eyed for 1996

by Judie Steeves
Staff Writer
Capital News
Friday, November 18, 1994

Although it might not even be the answer to this year's drastic reduction in the number of kokanee that returned to spawn in creeks around Okanagan Lake, a virtual closure of the fishery is being considered for 1996.

In fact fishing for kokanee in Okanagan Lake would be limited to catch and release, but because people usually fish them to eat rather than for sport, senior fisheries biologist Steve Matthews admits officials do not expect people to fish for them.

Because the kokanee are a fragile fish they often do not survive release either, the Environment Ministry biologist said, so calling it catch and release is a 'soft way' of closing the fishery.

The trout and kokanee fishery on Okanagan Lake is estimated to be worth $1.8 million a year, based on 60,000 angler days, and the expectation that the value of each is $30, said Matthews. If you split the value between trout and kokanee, the kokanee fishery is worth nearly a million dollars annually.

A complete lake closure is considered too drastic, since the rainbow trout population is relatively stable at present, but they do rely on the kokanee for survival, noted Matthews.

Estimates for this year's kokanee run were the lowest on record, particularly in Kelowna's Mission Creek and its spawning channel which contributes half the stream spawning kokanee to Okanagan Lake.

Interestingly, the spawning levels in most of the other spawning creeks on Okanagan Lake did not drop significantly this year — in fact the production of Penticton Creek, where considerable habitat enhancement has now been done by the Penticton Shooting Sports Association, was up considerably.

Possible reasons for the drop range from predators to competition for feed with the Mysis freshwater shrimp introduced several years ago, to pressures from urban development in this valley and from the number of anglers.

The picture is much brighter further up the valley at Kalmalka and Wood lakes, at least partly due to the efforts of the Oceola Fish and Game Club which has long been involved in egg incubation and enhancement work, including work on the Mission Creek spawning channel.

Ron Taylor, regional president for the B.C. Wildlife Federation as well as a director with Oceola, says club members voted Wednesday night to support the ministry in its proposal to go to a catch and release restriction on Okanagan Lake, even though there is concern that might increase the pressure on Wood Lake.

However, he feels strongly that the Skaha Lake Fish Hatchery, which used to supply kokanee to streams such as Mission but which closed down in 1989 due to ministry budget cuts, should be re-opened.

Matthews admits the facility still exists and could be opened up, and said it cost about $45,000 a year to operate in its last year, but operating funds were cut from the ministry's budget.

In 1991 and 1992 spawning numbers in Mission Creek were 116,000 and 99,000, compared to 25,000 this year. Those were returns from the eggs incubated from the Skaha hatchery, said Matthews.

Death of a fishery

Saturday, February 18, 1995

Okanagan Lake is in trouble.
Can we save it?

Frank Shannon of Summerland is deeply concerned the Okanagan Lake fishery is in imminent danger of collapse.

The 1992 kokanee catch in the big lake was only 10 per cent of the harvest in 1971. To make matters worse, the Fisheries Branch in Penticton says spawning kokanee numbers are at an all-time low.

There are fears a total collapse of the kokanee fishery will be followed a few short years later by the loss of the rainbow trout fishery.

Kokanee are now extinct in the South Arm of Kootenay Lake.

It could happen here.

Shannon is sounding a warning that must be heeded by all who care about the environment in general and Okanagan Lake in particular.

by Frank Shannon
B.C. Wildlife Federation
The Okanagan Saturday

THIS IS A STORY THAT IS IMPORTANT to every angler in southern B.C. It is the story of a major biological mistake.

Sadly, it took 15 – 20 years before the mistake was realized.

It is also the story of a political unwillingness to face the facts and do what is necessary to save our kokanee and rainbow trout fisheries in large lakes of southern British Columbia.

The story starts in Kootenay Lake where there once was a bonafide world-famous rainbow trout fishery. A whole tourist and recreational industry in the Kootenays was built up based on that fishery. Greedy and self-serving fishermen have their part in the story, too.

There were, at one time, many stories of washtubs full of rainbow trout over 10 pounds caught in weekend fishing expeditions. These fish were the famous Gerrard strain of rainbow trout.

In 1916, the provincial government, strapped for money, started selling and trading eggs from Gerrard (on the upper Lardeau River north of Kootenay Lake), the spawning area of the largest rainbow trout in the world.

Those eggs were sold all over! I have seen records where those eggs were shipped as far away as New Zealand and South America. They were also sent to a number of locations in the U.S. and other places I cannot remember.

In spite of the pressure put on the resource, those egg collections continued until 1949, when biologists were sent to find out what was wrong with the Kootenay Lake rainbow fishery! In 1949, spawners counted on the Gerrard spawning beds did not exceed 45 fish, and only 22 of those were female! This was a radical reduction from the hundreds which spawned there previously.

Concerned anglers had lobbied helplessly for years about the loss of this huge recreational resource. (Does that remind you of the Atlantic fishery?)

The late 1940s saw the dawn of biological research, such as it was, in B.C. There was a new crop of young biologists coming from the University of British Columbia and other Canadian universities. They had the courage of their convictions to order a stop to the sale of Gerrard eggs. That was a good thing, because if the sale had carried on much longer, Gerrard strain rainbow trout, the world record holder for size, would be extinct!

The biologists thought that if the trout's early growth could be accelerated, the fishery would recover. To understand the biologists' thinking, you need to know something about the life cycle of the Gerrard rainbow.

They are three years old before they attain 14 inches in length. At that age and size they become predacious and start feeding on kokanee. With this new source of protein. they grow very quickly to a large size. They don't spawn for the first time until they are five, six or even seven years old.

The biologists had heard of a good rainbow population at Waterton Lakes in southwestern Alberta. These trout had good early growth. Their major food source was the mysid shrimp. Some of these shrimp were taken from Waterton lakes and released into Crawford Bay, on the Kootenay Lake, in 1949.

It was hoped, once they became abundant, the shrimp would spur the early growth of the Gerrard rainbow and speed up their recovery.

No evidence of the mysid's progress was obtained until the late 1950s. The mysids had seemed to disappear.

In the late 1950s there appeared, in the west arm of Kootenay lake, near Balfour, an outstanding kokanee fishery. With daily limits of 25, and kokanee up to 10 pounds, Balfour was inundated with anglers from all over, particularly from Washington state's Spokane area. The community of Balfour became very prosperous!

At this point, an explanation of mysids habits is in order.

They can feed not only on bottom-dwelling (benthic) animals, but also on swimming (pelagic) plankton. To avoid predation, the plankton feed mostly at night, rising to near the surface in the late evening, and retreating to the depths shortly after daylight.

Mysid shrimp follow the same pattern. The trouble is that kokanee alevin and fry (small recently-emerged kokanee) also feed on plankton.

There is strong evidence that the mysid are out-competing the kokanee alevin and fry for the same essential but common food source. This may be causing the young kokanee to starve, or at best grow so slowly that they are more vulnerable to predation.

There is a pressing need for more research. Unfortunately, research being done on Kootenay Lake does not address this situation. (That research is being funded by B.C. Hydro which has inherited the problems created by the Columbia River Treaty. That is another story in itself!)

A short explanation of Kootenay lake history is needed here to explain what happened following the introduction of the mysid shrimp into Kootenay Lake.

At one time in past geological history, Kootenay Lake and Kootenay River flowed southward into Pend Oreille Lake near present-day Sandpoint, Idaho, then westward to a confluence with the Spokane River finally joining the Columbia east of the present site of the Grand Coulee dam.

Volcanic eruptions about 250,000 years ago covered the Spokane area and created a mountain which dammed the river about five miles west of Bonners Ferry, Idaho. This, and subsequent glacial events caused the Kootenay River to back up and become a huge lake, which formed a new outlet over a low summit west of Balfour, near Nelson, B.C.

Years of water erosion have worn the summit down to its present level. Kootenay lake is over 300 feet deep just eat of Balfour, but less than 60 feet deep at the Balfour outlet.

As the mysid shrimp rise to the surface at night to feed on the plankton, they are swept over the bench at Balfour and into the west arm of Kootenay Lake. As the mysid are unable to

retreat to great depths in the shallow west arm, they become an excellent food source for trout and larger kokanee. This situation resulted in the tremendous fishery which occurred in the early 1960s.

That fishery attracted the attention of biologists all over the world, particularly in the whole of the Pacific Northwest, which had many large lakes with co-existing rainbow trout and kokanee populations.

Biologists became elated over this method of creating a world-class recreational fishery. As a result, mysid shrimp were planted in nearly every large lake in the Pacific Northwest which contained rainbow and kokanee populations. Some mysid were even released in Sweden and probably other locations world-wide.

The sequence of events following the release of the mysids into Kootenay Lake probably went something like this: When the first mysids were introduced into Kootenay Lake, there was a good population mix of all generations of kokanee. Larger kokanee happily gobbled the swelling mysid population and grew tremendously large. This resulted in the fabulous kokanee fishery a few years after the mysid plant, and the record-breaking size of kokanee in lakes where there were already a number of near mature kokanee available.

In most lakes where the mysids were planted, there was initially a short lived “bonus” fishery, followed by a slow decline to alarmingly-low levels.

All kokanee populations in the south arm of Kootenay Lake are now considered extinct!

Most, if not all large lakes, where mysids were planted are showing similar experiences with declining kokanee stocks.

The problem is young kokanee also use plankton as a critical food item during their first years in lakes. As previously stated, mysids use plankton, too. As a result, there is competition for this common critical food source.

Apparently, mysids are winning the food wars!

In Flathead Lake in northern Montana, the same sequence has happened. Historically there has been a major migration of eagles through the Kananaskis Park area in Alberta into the Flathead in the early fall. The eagles rested there and fed on spawning kokanee.

Now that the kokanee runs are sadly depleted, there is a great concern as to what will happen to that eagle migration. The declining kokanee problem can have a domino effect throughout the environment.

In the Okanagan, there were historically large spawning populations of kokanee consisting of both creek and shore spawners. They were small fish, mostly in the six-to-eight-inch range at maturity.

Every creek and suitable shore area was populated by kokanee in the late summer and early fall. Pioneer farmers raked them out and used them for fertilizer! There was also a commercial kokanee fishery. For generations, the natives dried kokanee and stored them for their winter food supply.

Rainbow trout were also numerous. Early settlers had no problem catching a feed of rainbow trout for the family. The larger Mission Creek strain was sometimes called salmon because most settlers didn't believe trout could grow that big.

With the arrival of more settlers came the need for more dependable water supplies for both domestic and irrigation use. Creeks were dammed and water was cut off during the critical kokanee spawning periods in the fall.

It took a long time before declining kokanee populations caused any comments, probably because shore-spawning kokanee helped to partially maintain their numbers. However, shore spawning can be precarious when water levels are relatively high, but the eggs hatch in February and March when water levels are relatively low.

The Okanagan wasn't exempt from the mysid transplants, which only compounded the problems for the kokanee.

The biologists believed (at the time) that the mysids would give a boost to the Okanagan's fishery just as they had given a boost in the Kootenay. The shrimp were planted in Okanagan and Christina lakes, along with other large lakes in southern B.C. during the mid-1960s.

There followed in the mid-to-late 1970s a "bonus" kokanee fishery in these lakes. Okanagan Lake's "bonus" kokanee fishery extended into the early 1980s, when a small hatchery was activated near Okanagan Falls.

Kokanee were raised to about three inches in size and released into Skaha Lake as an experiment. They prospered for about two years, then disappeared!

Nobody knows where they went, but coincidentally there was a good kokanee fishery in Osoyoos Lake. During the next few years, the hatchery kokanee were planted in Okanagan Lake.

A research project was commenced in conjunction with the kokanee fingerlings' release into Okanagan Lake. Among other things, the research was going to study the kokanee-mysid

relationship. The biologists were curious as to why the kokanee grew to such an unusually-large size.

There was a theory that only larger kokanee would feed on the mysids, and the small kokanee would not. Mysids, being an excellent food source, might explain why nine- and 10-pound kokanee had been caught in Kootenay Lake.

An excellent kokanee fishery resulted allover Okanagan Lake with many large fish being taken.

A record kokanee, 10 3/4 pounds was caught near Okanagan Centre in 1988. Biologists believed they were finally finding the answers to the kokanees' larger sizes. Apparently the kokanee fingerling were consuming mysids and growing to a large size because of improved nutrition.

This had two positive results: it improved the kokanee fishery which in turn reduced the mysid population, thereby helping the kokanee alevin emerging from their natal creeks by reducing the competition between the young kokanee and the mysids for their common food.

The good fishing continued for a few years and then the Okanagan Falls hatchery was closed and the on-going research was terminated, all due to lack of funding. Many organizations — both political and non-political — private citizens, and the Okanagan Region of the B.C. Wildlife Federation, have fought long and hard to have that hatchery reopened, but to no avail. The provincial government has turned down all requests for funding of the hatchery even though the statistics have proven reopening it is economically viable.

The biologists have stated that the rejuvenation of Okanagan Lake's kokanee stocks rests with stream rehabilitation, such as at Deep Creek near Peachland, Penticton Creek in the Peach City, and Mission Creek at Kelowna.

Most of this work has been done by the Okanagan's sportsmen's clubs. Some of the enhancement projects have been done by local native bands on creeks running through their reserves. Most of the financing has come from the Habitat Conservation Fund. (The main source of funding for which is the surcharge paid on every hunting and fishing licence.)

Also, the biologists are waiting for the results of the studies presently being conducted on Kootenay Lake.

However, the local clubs are afraid of the possible results of any delays. What if the mysids are winning the food wars in Okanagan Lake also?

Then the question must be asked, would there be any point reopening the hatchery to increase the numbers of young kokanee in Okanagan Lake, only to have them starve? The answer to this

question is “yes,” if the kokanee research which was cancelled is restarted and funded until its completion.

In our opinion, the Okanagan Falls hatchery experiment was a win-win situation. Anglers got good kokanee fishing and the larger kokanee were feeding on the mysids.

Yet the biologists say that three-inch kokanee don’t feed on the mature mysids. They say the kokanee fingerlings must survive on some other food source until they become mature mysid-eaters. The excellent fishery of the late 1970s proved that the kokanee fingerlings were feeding on something favorable. Could they have been feeding on juvenile mysids? Unfortunately, juvenile mysids are difficult to identify in kokanee stomach samples. More research is required to determine just what the young kokanee are feeding on.

The problem today is that we are never going to get rid of the mysids. Research must find some way to control the mysid population and find a way to help the young kokanee populations recover if we are ever to have a decent kokanee fishery in Okanagan Lake (or any other lakes with similar problems) again.

Biologists don’t necessarily agree with this. What they do agree on is that more basic research must be done if we are ever to know the answer to the kokanee’s problems.

Next we must trace the history of the large kokanee-eating rainbow trout in the Okanagan.

There are as many races of rainbow trout as there are of kokanee. Minor biological work but no long-term studies have been done on the Okanagan Lake rainbow trout.

Most of our knowledge is gleaned from work done elsewhere, mainly Kootenay Lake. The two major kinds of rainbow in Okanagan Lake are the Pennask and Mission Creek strains.

Pennask fish prefer to feed on insects. Any hatchery rainbow in the lake have come from accidental releases of Pennask trout. Also, Pennask rainbow enter the lake from creeks during freshets. Those, plus native stocks from the smaller creeks, are the main source of insect-eating rainbow in Okanagan Lake. The Mission Creek trout is similar to the large Gerrard strain of Kootenay Lake rainbow.

These fish feed on plankton and insects until they reach about 14 inches in size, when they become predacious and start eating kokanee. This extra protein source makes them grow quickly to a large size.

While the Pennask strain spawn at three or four years of age, the Mission Creek strain — like the Gerrard strain — doesn’t spawn for the first time until they are five, six or even seven years of age.

Closing fishery just the beginning

by Judie Steeves
Staff Writer, *Capital News*
Sunday, March 12, 1995

Banning angling first step in reviving
Okanagan kokanee stocks, experts say

Closing the fishery, alone, may not be the answer to dwindling kokanee stocks in Okanagan Lake.

Both anglers and biologists agree it's a necessary first step, but that's where the disagreements begin.

Hand in hand with a closure should be the re-opening of the Skaha Lake Fish Hatchery, closed in 1989 due to ministry budget cuts, believes the B.C. Wildlife Federation.

The estimated annual operating cost of $60,000 is more than made up for in the estimated financial return to this valley of nearly a million dollars a year from anglers.

Ron Taylor, regional president for the BCWF and a director of the Oceola Fish and Game Club, says he can't believe local municipal councils and chambers of commerce haven't come forward to support the venture.

He believes if everyone was willing to chip in to fund the facility the way Summerland council is it could actually become a reality.

The hatchery is presently sitting idle and could conceivably be re-opened, but would have to be staffed and stocked.

Stocking it presents another problem, notes Dr. Peter Dill, a professor in the biology department at Okanagan University College.

If the hatchery were reopened, "where would the eggs come from?" he asks.

He also questions what point there would be in the long-term to beef up kokanee stocks with hatchery fish without determining why the kokanee stocks are declining.

There's no point in increasing fish numbers without tackling the problem of healthy spawning beds, either, he says.

For example, in addition to the $300,000-plus committed this year by the provincial environment ministry to reconstruct the Mission Creek spawning channel, an additional channel is needed, as are channels in other areas.

He points out that the Mission Creek spawning channel was only intended as a pilot project when it was built in 1988.

“It has worked out reasonably well as a pilot project,” he says with a scientist’s caution, but, he adds, “there’s a problem in the lake.”

Biologists speculate that problem is mainly the fault of the Mysis shrimp introduced into the lake in 1966 as a fish food.

The plan appears to have backfired, with the shrimp in fact competing for feed with kokanee fry, and only serving as a food source for larger fish.

As well, Dill says there’s a need for biological research into just what is causing the drop in numbers of kokanee in Okanagan Lake, and whether Mysis is at the root of it.

If the hatchery is reopened, he would like to see it used as a research and enhancement facility by students from the college, which is already the home of a young and informally-organized Institute of Freshwater Studies.

Whatever is done, Dill is adamant, and not alone, in emphasizing it has to be a long-term commitment.

Don Peterson, manager of the Fish Culture Section of the environment ministry in Victoria agrees that habitat enhancement or restoration is needed along with the closure.

However, he disagrees with the need for re-opening the hatchery: “It won’t solve the problem in the long-term, and it won’t help the recovery of wild stocks.”

Because a vast majority of streams are diverted for irrigation, a great deal of spawning habitat is simply no longer there, he says.

The problem is also one of greed; of exploitation of the resource, he says.

Spawning channel repairs may help save the kokanee

by John Keery
The Daily Courier
May 15, 1995

The Fish and Wildlife Branch will spend more than $500,000 this year on nine Okanagan conservation projects.

More than half of the money from the Habitat Conservation Fund will be used to rebuild the Kokanee spawning channel in Mission Creek Park.

“That one leaks a lot and the head gate ices up in winter,” said fisheries biologist Dave Smith. “We have to rip all the gravel out and put in some geotextile cloth and establish a good base.”

The head gate is unreliable and sometimes gets plugged with ice in winter allowing too little water to run to protect the Kokanee eggs in the channel.

An improved channel should result in double the number of Kokanee hatching each spring, Smith said.

He said up to 90 per cent of the natural spawning capacity of streams flowing into Okanagan Lake has been lost this century due to settlement and other forms of human activity.

In 1994, officials estimated just 19,600 kokanee spawned in Mission Creek, down from 400,000 in 1971.

A total of about 101,000 kokanee spawned in the whole lake in 1994, compared to one million in 1971.

Emcon, a road maintenance company based in Merritt, has won the contract to build the channel.

The Fisheries Branch also has $40,000 to study the population decline of Kokanee in Okanagan Lake.

Another $4,000 will go to investigate why shore spawning kokanee are declining.

Fisheries introduced a ban on kokanee fishing in March after determining numbers have declined to 10 per cent of what they were to decades ago.

Wildlife has five projects aimed at protecting declining or endangered species in the Okanagan.

The Westside Sheep Project will get $40,000 to help the mountain sheep herd in Short Creek, on the west side of Okanagan Lake half way to Vernon.

Wildlife biologist Orville Dyer said he has some pretty good ideas why the herd is declining and what can be done.

“There has been a long-term habitat decline,” Dyer said.

“The population has had a severe crash in the last three to five years.”

Isolation from other sheep herds, loss of winter range to agriculture and urban development and attacks by cougars are some of the problems.

The modern passion for stopping forest fires has resulted in the decline in the quality of range for sheep, Dyer said.

A deer population which has grown rapidly because of new feeding sources in logging cut blocks has supported a growing cougar population.

But some cougars prefer relatively scarce sheep to deer.

The enhancement project will include controlled burns to improve sheep range.

A similar project for $35,000 will carried out in the Ashnola, near Hedley, to improve sheep range.

The other three projects will help protect endangered species of birds, insects and mammals in the South Okanagan.

Fishing, the hard way

by Judie Steeves
Staff Writer *Capital News*
June 14, 1995

Using plastic kitchen strainers, more than 30 local volunteers helped officials from the environment ministry save about 400 fish caught in the Mission Creek Spawning Channel when it was dried up on the weekend.

Members of local fish and game clubs, the B.C. Wildlife Federation and Kelowna Community Services waded into the pools remaining in the channel after the flow of water was shut off, to net fish and put them back into the main channel of Mission Creek.

Fisheries biologist Dave Smith from the environment ministry's Penticton district office explained this is the first time since the kokanee spawning channel was first constructed as a pilot project in 1988 that it has intentionally been drained.

Beginning Thursday, contractor Emcon Services of Merritt, which was the successful bidder for the $288,465 contract to rebuild the channel, will start work on the job.

It will include improvements to the intake, the sedimentation pond and the quality of the spawning gravel, as well as sealing the channel with a clay liner to prevent the present loss of water, which endangers eggs and affects critical water temperatures.

In the past there have been serious problems with ice jams building up at the intake in winter, interrupting the flow of water while kokanee eggs are in the bottom of the channel.

As well, settling basins have silted up, preventing those ponds from collecting sediment to prevent them from suffocating the eggs and maintaining clean gravel for spawning.

A second bypass intake will also be constructed for use in emergencies and clean-outs and the channel will be rebuilt to accommodate an additional 2,000 kokanee to use it.

At present 15-20,000 adult fish can use it during the fall spawning run, but in the past two years the return in numbers have declined alarmingly, and it's hoped this work will have some effect ultimately on those numbers.

Smith said of the 400 fish moved out of the channel Saturday many were juvenile rainbow trout, and others were adult sculpins and suckers, including eight large adults.

Rainbow don't spawn in the channel, which isn't large enough to interest them, Smith explained.

There will be some mortalities from the draining, he said, but garter snakes had already emerged to make use of them, and he expected raccoons will also be attracted.

Task force to study kokanee

The number of spawning kokanee dropped
to about 101,000 fish last fall
from almost one million fish
20 years ago

The Daily Courier
Monday, June 26, 1995

PENTICTON (TNS) — A provincial task force is being formed to develop plans to restore kokanee fish stocks in Okanagan Lake.

Scientists, government officials and representatives from wildlife groups begin meeting Wednesday for a three-day workshop to develop the plan, in Kelowna.

"This is a complex problem and we have to bring the experts and local people to the table to find a solution," Jim Beattie, Okanagan Penticton MLA, said. "We have to take actions to restore stocks."

The number of spawning kokanee dropped to about 101,000 fish last fall from almost one million fish 20 years ago. The declining fish stocks prompted the provincial government to ban kokanee fishing on Okanagan Lake.

The advisory panel being formed by the provincial government will attempt to pinpoint the cause for the kokanee's decline and identify the best method for restoring fish populations.

"There are some different points of view about the right course of action," Beattie said.

Some advocate increased use of fish hatcheries to supplement kokanee stocks. Others take the long-term view that spawning grounds must be protected and improved.

The government wants a preliminary plan ready for next month. The public would then be asked to review and comment on the plan, prior to it being put into action.

“This is a legitimate attempt to address the problem,” Beattie said.

The strategy includes bringing together different government agencies to mesh out a common agenda. This is already being done to some degree, Beattie said. Recently the provincial government created a regional growth planning system to let municipalities make common development plans.

The decline of kokanee fish is attributed to a number of factors. The introduction of mysis, a food source for rainbow trout, proved detrimental to kokanee. The shrimp spread throughout Okanagan Lake eating up plankton, a source of food for kokanee.

“The regulations we put in place to help rainbow trout may have chewed away at the kokanee,” said Bruce Shepherd, head of the provincial fishery section in Penticton.

Habitat areas, particularly spawning in rivers and along the shore, were lost to urban development.

Shepherd said that by the 1950s, more than 90 per cent of the kokanee’s traditional habitat had been lost. Increased numbers of anglers and lower water levels are also believed to have contributed to the kokanee decline.

While kokanee fish stocks are in decline, the remaining population appears relatively healthy, Shepherd said. The problem hasn’t reached the crisis level like it has among some spawning areas for other fish. Sockeye salmon in the Upper Snake River in Idaho fell to a single fish in recent years, he said.

“We implemented the closure (of kokanee fishing) at a point where we have room to move,” Shepherd said.

Kokanee remain numerous enough to allow for a healthy recovery.

“If you leave it any longer you could face a loss of the entire stock,” Shepherd warned.

Although the action plan has yet to be developed, the government is going ahead with a $270,000 project to rebuild a one-kilometre spawning area of Mission Creek.

Shepherd said rehabilitation has paid dividends in the past. In fact, without the habitat renewal, kokanee fish stocks would have been far lower.

“If we had let nature take its course, we would have seen spawning runs of less than 100,000,” Shepherd said.

Kokanee rescue attempt begins

by Judie Steeves
Staff Writer, *Capital News*
June 28, 1995

Scientists from across the province gather in Kelowna today to peer under the surface of Okanagan Lake at how best to turn around the drastic decline in numbers of kokanee.

The first step was a ban on kokanee fishing this May.

More than 40 biologists, specialists in such areas as limnology and fisheries management, meet with local civic representatives and environment ministry staff at Okanagan University College from Wednesday through Friday.

The object is to come out of it with a scientific action plan for dealing with a drastic reduction in the number of kokanee, said the head of the environment ministry's fisheries branch, Harvey Andrusak.

He pledged to come up with the money to embark on whatever action is recommended as a result of this week's conference, even if it's as high as the $500,000 estimated.

Not only is the value of the kokanee fishery estimated by the B.C. Wildlife Federation at as high as $25 million, but its loss will likely also have a rebound affect.

Okanagan-Penticton MLA Jim Beattie said the fact this high-level conference has been scheduled shows the government is taking this reduction in stocks very seriously.

"I think we're committed to finding the money required here," commented Beattie.

However, the bottom line is that there's no simple answer and such strategies as watershed protection, protection of spawning grounds and possibly the re-opening of hatcheries may be needed to kickstart the program.

In fact, one delegate has even questioned whether reductions in the level of phosphorus in the lake in recent years might even have played some part in the decline.

Dr. Carl Walters, who produced the controversial paper on the demise of the West Coast salmon fishery and developed the model for Kootenay Lake, will give an overview of the Okanagan Lake problems to open the conference Wednesday.

He said the group will take its “proposed plan to the public in the fall to keep people informed.”

Giant aquarium could save kokanee

The number of spawning kokanee has dropped to 100,000 from one million in the past 20 years

Daily Courier

July 5, 1995

KELOWNA — Okanagan Lake could be turned into a giant aquarium in an attempt to restore kokanee stock.

A large-scale experiment — with one pump sending air up from the bottom of the lake — is one of several recommendations included in a report now being prepared by the provincial environment ministry.

Eventually, up to 100 of the bubblers could be used in the lake.

One reason for the decline of kokanee was the introduction of mysis shrimp to feed rainbow trout. The shrimp eat the same kind of plankton as kokanee.

Scientists believe giant bubblers would pull shrimp off the bottom of Okanagan Lake, said Bruce Shepherd, head of the provincial fishery section in Penticton.

“The warmer water may shock or kill them, and fish can have at them,” he said.

However, other problems could arise from raising cold water to the surface, even in the middle of the lake, he said.

Recreational users of the lake could object and ling cod, which feed on shrimp at the bottom, could go after other fish.

Ten bubblers could cost $500,000 and at this point, “we’re very dependent on funding. There are no guarantees, but we should be better able to make our case,” said Shepherd.

As a result of a recent three-day workshop in Kelowna, he is preparing a draft action plan for kokanee recovery.
The plan, expected to be ready in August, will have a number of components from large-scale experiments to remedial action on kokanee spawning creeks to long-term research and development.

The number of spawning kokanee has dropped to 100,000 from one million during the past 20 years. The average size and age are decreasing.

Less kokanee survive today due to inadequate water flow as well as removal of spawning material from creeks.

No stone unturned in quest to save fish

by Judie Steeves
Staff Writer
Capital News
July 7, 1995

Some innovative and controversial approaches to such Okanagan Lake problems as control of the Mysis shrimp and water quality were among the approaches discussed at a high-level scientific think tank held in Kelowna late last week on declining kokanee stocks.

Attention at the three-day conference, held at the north campus of Okanagan University College, was focused on the need for rehabilitated and increased spawning habitat before stocks are boosted back up, and on the reduction in kokanee rearing capacity in Okanagan Lake because of such changes as the introduction of Mysis shrimp.

Environment ministry biologist Bruce Shepherd said there were some controversial approaches to Mysis control, including the idea of feeding the kokanee until they're beyond the size at which they compete with Mysis for feed, and to the stage where they begin to feed on the tiny shrimp.

Experimental approaches such as the possibility of aeration to bring the Mysis from the bottom part of the lake up the water column closer to the surface, where warmer water and feeding fish could kill them and reduce their populations, are also being seriously considered, said Shepherd.

Although a report on the conference probably won't be completed until the end of this summer, a priority must be remedial: taking inventory and drawing up a plan for the rehabilitation and preservation of spawning areas, both in streams and along shores.

Ironically, scientists even looked at the possibility that Okanagan Lake water is now too clean — that the water's phosphorus content must be increased to increase the amount of feed available for fish, noted Shepherd.

Such agencies as the Okanagan Basin Water Board have put considerable emphasis on reducing phosphorus entering the lake in the past few years in order to reduce the weed and algae growth.

Controversial projects such as a reopening of the Skaha Lake fish hatchery brought differing comments from the various experts attending the conference, but there was agreement that such a move doesn't make sense until other experiments for improving lake habitat, and work on increasing and improving spawning grounds is completed.

Kokanee head for the hills

Conservationists hopeful as kokanee run begins

by Ron Seymour
The Daily Courier
Sunday, August 27, 1995

WESTBANK — Sportsmen revitalizing a Westside creek were cautiously optimistic Saturday that their efforts would not be in vain.

By spreading gravel, clearing fallen trees and rebuilding a fish ladder, the volunteers hoped to make Powers Creek a better spawning ground for kokanee.

But stocks of the landlocked salmon have dropped dramatically in recent years — almost to the point of extinction, some scientists say — so no one knows for sure how many kokanee will turn up this fall in Powers Creek or the other streams that feed Okanagan Lake.

Still, members of the Peachland Sportsmen's Association were heartened by the few kokanee they've already seen struggling up against the current in the fast-flowing creek.

"It's looking pretty good so far, but we'll have a better idea how many fish there's going to be in a couple weeks," club member Jerry Kneller said as he supervised about a dozen shovel-wielding men in hipwaders.

Spawning season doesn't usually begin until the first or second week of September, but the cool summer has quickened the drop in water temperature in most creeks.

"The fish think it's time to do their thing," Kneller said, watching about a dozen of the blood red kokanee lay or fertilize eggs in a 50 foot stretch of Powers Creek.

As recently as the mid-seventies, there were more than a million kokanee spawning each year in the Okanagan, most of those in Mission Creek in Kelowna.

Last year, however, fewer than 5,000 kokanee were counted in Mission Creek, with the drop blamed on the effects of urban growth and a botched attempt to improve the natural food supply in Okanagan Lake.

“It’s quite possible there won’t be any fish at all in the creek next year at this time,” Peter Dill, an Okanagan University College biologist, said last September.

Ministry of Environment officials monitoring Powers Creek and other spawning streams can’t yet predict the impact of a government-ordered ban on kokanee fishing.

“It’s darn near impossible to say with kokanee how many there will be this fall, because there’s just too many other things going on in the lake,” Ministry of Environment fish biologist Steve Matthews said from Penticton.

After Mission Creek, Powers Creek is the second largest spawning ground producing between 10,000 and 20,000 fish. Officials attribute that, in large part, to the enhancement work done by the Peachland Sportsmen Association in each of the past five years.

Aside from volunteer labor and donated materials, the club will spend about $2,000 on Powers Creek and other streams this year, with the money raised through raffles and banquets.

“There’s a lot of people that fish and hunt, not all of them will come out and do things like this. If we didn’t do this work, it just wouldn’t get done,” said club member Al Springer.

After spreading the fine gravel, in which the kokanee can more easily lay and then cover their eggs, Garth Saunby expressed the optimism of other club members. “It’s good to know we got a few fish in there anyway,” he said. “Hopefully in a few weeks there’ll be a couple thousand more.”

Spawning channel to re-open on Mission Creek

Rivers Day to be celebrated throughout province

by Jean Russell
Staff Writer *Capital News*
Sunday, September 17, 1995

Local efforts will be celebrated on Sept. 24, Rivers Day in B.C., with the opening of the $300,000 in renovations to the kokanee spawning channel on Mission Creek in Kelowna.

The channel was first opened in 1988. It runs adjacent to Mission Creek and extends for about one kilometre along its border. The channel can accommodate up to 20,000 kokanee during the spawning season which runs for about three weeks from mid-September to early October. Last year about 30,000 spawners were counted in the entire length of Mission Creek.

The spawning channel enhances a kokanee's breeding success by providing it with the right environment to do what it does naturally. The creek bed is spread with gravel that is the exactly the right size for the fresh water fish to scoop a shallow nest, called a redd, and lay eggs which are then fertilized by the male.

"This way we get a better survival of the eggs," said Ron Taylor from the B.C. Wildlife Federation, "and then a better survival of the alevins – the very tiny kokanee once it's lost its egg sac."

Elsewhere along the creek the bed is a jumble of everything from rocks to fine sand and its difficult for the fish to dig a nest. The tiny fish will stay in the channel and creek until March.

The renovations to the spawning channel were paid for by licence fees from fishers, hunters and trappers in the province. Five dollars from every licence goes into the fund.

The last Sunday of every September has been Rivers Day in British Columbia since 1980. In other locations around B.C., it will be celebrated with family paddles, picnics and walks by shore lines.

Kokanee crisis continues

Fishing ban only prevents further loss

by Judie Steeves
Staff Writer *Capital News*
September 22, 1995

A repeat of last year's record low numbers of spawning kokanee in local streams is predicted by the fisheries head for the environment ministry's district office.

Biologist Bruce Shepherd admits that if pushed to predict, he would estimate that a total of 100,000 spawning kokanee will return this year to shores and streams, with a further 20,000 because of the ban on fishing them this year in Okanagan Lake.

Like the ocean-going salmon, these little silver landlocked salmon turn red and miraculously navigate back to the stream or shore of their birth in the fall of their fourth year, before they die.

Last year's record low number of kokanee returning to spawn rang alarm bells that reverberated throughout the province, resulting in an immediate ban of fishing them in the big lake, and a weekend "think tank" of scientists trying to ferret out the possible reasons for the decline in population.

A report on that meeting, held at Kelowna's Okanagan University College campus at the end of June, was not ready in August as had been hoped, and Shepherd doesn't now expect it will be ready until closer to the end of the year because of the press of other fishery business, including the Forest Practices Code, and the Land and Resource Management Plan.

However, at least one of the possible causes for the drastic reduction in kokanee is the introduction of mysis shrimp in Okanagan Lake years ago as food for fish. They turned out to be in competition for food with young kokanee.

How to reduce the numbers of those shrimp now was one of the questions discussed in June, and Shepherd says he was surprised to learn they aren't as prolific as he'd thought, so it might be possible to reduce their numbers.

Also called opossum shrimp, they're a pouch breeder, producing 10-15 young which have a 2-3 year lifespan, so even a slight increase in their mortality rate could make a big difference in the population.

Kokanee a rare sight

Officials hope improvement to spawning channel will help the fish

by John Keery
The Daily Courier
October 3, 1995

KELOWNA — While it is getting harder to find kokanee in Okanagan Lake, you can still see a few in the newly rebuilt spawning channel in Mission Creek.

Judy Toms is a volunteer interpreter at the spawning channel in Mission Creek Regional Park on Springfield Road.

“I tell the story about the tradition of the kokanee,” Toms said. “People should know they are dependent on us for their habitat.”

Last year, the number of kokanee spawning on the shoreline and streams flowing into Okanagan Lake declined to about 100,000, down from about a million 20 years ago.

Mission Creek accounted for about 30,000 spawners last year. That is down from300,000 in the early ’70s and probably a million in the early part of this century.

“There is a grab-bag of compounding factors,” provincial fisheries biologist Bruce Shepherd said.

“Everything is meshing together and putting pressure on the fish,” he said.

The Fish and Wildlife Branch closed Okanagan Lake to kokanee fishing in April, the first time this has ever been done.

Shepherd said the exact reasons for the decline are difficult to pinpoint but biologists think it is a combination of factors.

Mysis shrimp introduced into the lake to provide more feed for the fish actually compete with small kokanee for food, limiting the number that survive to adulthood.

Species such as whitefish, carp and yellow perch that were introduced to the lake earlier this century also complete with the native fish for feed.

Recent efforts to reduce the amount pollution from sewage might be having a negative effect on the fishery by reducing plant growth in the lake, Shepherd said.

“The cleanup is perhaps a factor putting pressure on fish production.”

Kokanee will eat mysis shrimp if they get big enough.

But Shepherd estimates only 10 per cent reach the approximately 25 centimetres of length that enables them to regularly catch shrimp.

Toms said people have to realize that everything they do affects the environment including fish habitat.

She tells her tour guests that pollution from cars, erosion from poor logging practices, loss of wetlands to urban development and chemical sprays used by farmers and home gardeners all affect the water the fish live in.

“We have virtually destroyed Mission Creek,” she said.

Toms and Shepherd hope the $300,000 upgrade on the spawning channel completed this summer will help reverse the trend.

The channel was originally built in 1988 with a lot of volunteer help from Kelowna Fish and Game Club, Lonely Loons Fly Fishers Club and Oceola Fish and Game Club.

It had become clogged with silt and needed a new water control gate to ensure a steady flow of water over the gravel beds in winter.

The upgrade was paid for by the Habitat Conservation Fund which gets its money through surcharges on hunting and fishing licences.

Toms and a fellow interpreter take school tours through the spawning grounds on weekdays.

Tours will be conducted at 9:15, 10:15, 1:15 a.m. and 12:15 and 1:15 p.m., Monday, Tuesday and Wednesday.

Tours can be arranged on weekends by request.

Call 860 6410 for information or to make arrangements.

Requiem for the kokanee

by Ron Symour
The Daily Courier
Wednesday, May 1, 1996

KELOWNA — A legal ban on kokanee fishing may be unnecessary in a few years — because there wouldn't be any of them left to catch anyway.

Conservation efforts intended to halt the decline of the landlocked salmon aren't yielding much result, biologists say.

The number of kokanee in Okanagan Lake has dropped to a record low according to this fall's count, and the future is bleak unless the government provides more money to enhance spawning grounds.

"Basically, there's no light at the end of the tunnel," Bruce Shepherd, acting fisheries section head for the Ministry of Environment, said Tuesday.

This fall's kokanee run might be as low as 50,000 — just half the number that were counted last year. The figures are preliminary, however, since the season for shore-spawning kokanee is not over.

"We'll have to wait a while before we know the total numbers," Okanagan University College biologist Peter Dill said. As recently as the mid-197Os, there were more than a million kokanee spawning in the Okanagan, most of those in Mission Creek.

One possible — though unlikely — way to boost kokanee stocks would be for the government to spend several times the approximately $300,000 now budgeted annually for spawning enhancement projects. Such work, funded by fees collected from fishing licences, typically involves building fish ladders and spawning platforms in the 15 Okanagan creeks considered suitable for kokanee spawning.

"If we could do that sort of work virtually simultaneously, which is a tough order because of budget constraints, we could certainly see the picture turning around," Shepherd said.

Another possible strategy would be to increase the number of rainbow trout that anglers can take from the lake each season. "Each rainbow chews its way through about 250 kokanee every year," Shepherd said.

The chief reason for the decline in kokanee stocks was the ill-fated introduction to the lake several decades ago of mysis shrimp. The shrimp were supposed to provide food for the kokanee, but instead wound up eating much of the plankton that young kokanee rely on.

In the next few months, the Ministry of Environment will prepare a funding submission for an innovative approach to reduce the number of mysis shrimp in the lake. By installing aerators at certain spots on the lake bottom, scientists think they may be able to drive the mysis shrimp up to warmer levels where they can't survive.

"Our best chance for offsetting the decline (in kokanee stocks) is through this kind of multipronged approach," Shepherd said.

But one critic of the Ministry's management of fish stocks doubts that measures under consideration will bolster the number of kokanee. Frank Shannon of Summerland, who has written about fishery issues for years, believes the mysis shrimp are in the lake to stay.

They're so numerous that I don't think there's anything that can be done about them," says Shannon.

"The number of kokanee is eventually going to get so low that it'll be a point of no return. Maybe we've reached that point now."

Sewage may save kokanee

by Rob Munro
The Daily Courier
Wednesday, May 1, 1996

KELOWNA — Flushing the toilet could save the kokanee.

The dramatic decline in the Okanagan Lake kokanee population in the last few years has rekindled memories of a unique experiment in the late 1980s when fingerlings were reared in the city's sewage treatment plant.

"If we're serious about wanting to get kokanee back into our lake, here's a way to do it," Mayor Jim Stuart told city council Mondays

He will write the Ministry of Environment asking for help in exploring what could be a low-cost solution to declining fish populations.

In 1984, the city joined forces with the ministry and Okanagan University College instructor Peter Dill to rear the fingerlings in treated sewage water.

The experiment was conducted mainly to prove that the city's Bardenpho sewage treatment plant really was purifying the water it discharged into the lake.

"Because of the fish, we could prove 100 per cent that nothing was wrong with the water," said Coun. Henry Markgraf, who worked on the project. "The water was cleaner than anything in the lake."

The fish were tested for 70 elements and all were within acceptable limits, Markgraf said.

The project ran from 1984-89. In one year 10,000 trout were reared while an equal number of kokanee were reared another year.

In 1984, it only cost about $10,000 for fencing to keep birds out and other equipment to start the project in one of eight outflow chambers at the treatment plant. The program then cost about $10,000 a year to run.

Markgraf said the number of fish could be eight or 10 times what were reared in the 1980s, meaning up to 100,000 a year.

“For the students, it was a project of love,” Stuart said. “It was a pleasure to go down there to see it.”

It ended when funding from the provincial government stopped.

The city wanted to release the kokanee into Okanagan Lake but the Ministry of Environment refused.
“They felt tourists would look at it in a negative way because, technically they were raised in number two water,” Markgraf said.

Coun. Robert Hobson, chairman of the Okanagan Basin Water Board, explained that one of the reasons the kokanee have declined is because they can’t compete with fresh-water shrimp at an early age.

The idea, then, would be to rear the fingerlings until they’re old enough to feed on the shrimp.

“But,” he joked, “is there a possibility the fish would try to swim up the sewage pipe to spawn?”

Not likely. Stuart explained that the fish would likely be released in Mission Creek with the hope they would return there to spawn.

Spawning numbers declining in creek

by Judie Steeves
Staff Writer
Capital News
Wednesday, November 22, 1995

The final numbers are disappointing, but not entirely unexpected, said fisheries officials this week as they released the final Kokanee spawning estimates for this fall.

Ironically, there was a crash in the numbers of Kokanee using Kelowna's Mission Creek spawning channel, which underwent a $300,000 reconstruction this year. While 36,000 fish used it in 1992, only 5,000 came into the refurbished facility this year.

In total, throughout Okanagan Lake there were actually 5,000 more spawning Kokanee this year than last, but less than half the number from 1989 when 241,000 spawned.

Although the stream spawning fish hit the lowest number ever recorded on the lake's tributaries this fall, the shore spawning Kokanee numbers are the highest since 1989, a bright spot in a bleak picture.

Fisheries biologist Steve Matthews pointed out there does seem to be some cycling in Kokanee populations, with a similar low in spawning numbers in 1990 when a total of 111,000 were estimated to have spawned.

"We may start to see an upswing," he commented optimistically.

Without the ban on fishing for the landlocked salmon instituted earlier this year, numbers would have been 20 per cent lower still, estimated senior fisheries biologist Bruce Shepherd.

In Mission Creek itself numbers were nearly half last year's, at 10,800, while the run in Powers Creek was also at its lowest since 1989, at 9,200.

Even Peachland Creek numbers were down to 5,800, down from 8,100 last year, and a third of the numbers there in 1992, despite considerable efforts by the Peachland Sportsmen's Association.

However, efforts in Penticton Creek by the local sports clubs paid off again this year, with runs of 12,000 both years, compared to 2,000 three years ago, and less than 100 a decade ago.

Efforts are under way by the Fisheries Branch to tackle the complex problem, with an Okanagan Lake Action Plan being prepared and reviewed by a Scientific Advisory Panel.

A number of projects to investigate and test different theories are in the planning stages.

Kokanee runs on Wood and Kalamalka Lakes were strong again in 1995, at least in part because of enhancement by clubs such as the Kalamalka Fly Fishers and the Oceola Fish and Game Club, noted Matthews.

All stocks remain highly susceptible to human impact, he said, but all spawning areas must be protected and enhanced to ensure a healthy diversity of runs.

If you'd like to help or want more information, contact the Fisheries Branch toll-free at 1-800-461-1127.

Conservation efforts do more harm than good

Primary culprits are humans and a little shrimp introduced to the lake by man many years ago

by Judie Steeves
Staff Writer, *Capital News*
Friday, December 15, 1995

There's no argument amongst the technical experts that Okanagan Lake no longer has the capacity to maintain life that it once did.

Primary culprits are humans and a little shrimp introduced to the lake by man many years ago.

Within the last two decades, Kokanee stocks have declined dramatically and Rainbow stocks would also appear to be at risk," reports Bruce Shepherd, fisheries biologist with the regional office of the environment ministry.

His words are contained in the draft of a lengthy and detailed report from a panel of scientists with various areas of expertise relating to lakes, called together last summer in an emergency session to brainstorm on the problem in Okanagan Lake and possible solutions.

The disappearance of the Kokanee alerted the public to the problem but the solution is less clear.

Although we're conditioned to believe a lake of crystal clear water is the ideal, fish don't agree with our perception, says Shepherd.

There must be a balance between nutrient-rich lakes and those so crammed with the resulting growth that the oxygen level gets too low for other organisms to survive.

In Okanagan Lake right now that balance does not favor fish.

To better balance the nutrient levels in that lake either nitrogen and phosphorus must be added to it, or the Mysis relicta, the small shrimp introduced, ironically, by the provincial fisheries branch three decades ago as food for Kokanee, eradicated, says the report's coauthor, Ken Ashley, a research biologist at UBC.

The good news is there's hope it might not be as difficult as he once thought, to reduce the populations of that thriving shrimp, says Shepherd.

The realization that Mysis shrimp do not “breed like flies,” but have a limited capability of producing perhaps 9O young in a few years encouraged Shepherd, since any disruption could make a significant difference in their populations.

(Their competition with young Kokanee for the same feed is one of the main limiting factors in the population of those land-locked salmon in Okanagan Lake.)

That lends credence to a proposal to use aerators to raise columns of the lake’s water, Mysis in them, from the colder depths of the lake to warmer upper levels where they might perish and be eaten by fish.

Shepherd and Ashley wouldn’t release the 10 recommendations in the report until all members of the technical advisory panel have seen it, and they’ve only just received it, but some will deal with public education.

Fishing for solutions

Controversial report concludes public will have to pay to bring back Okanagan Kokanee

by Judie Steeves
Staff Writer, *Capital News*
Sunday, February 25, 1996

It's going to cost money, the public must get involved and still there's no guarantee an action plan to rebuild Kokanee stocks in Okanagan Lake will succeed.

However, a 110-page report on an Okanagan Lake workshop held at Okanagan University College last June will be released Monday in Penticton and the first step taken to fight crashing numbers of the little land-locked salmon native to the valley.

The report contains some controversial suggestions, including experiments to replace the phosphorus that governments have spent millions in the past few years rernoving from wastewater entering Okanagan Lake.

Although it states flatly that two large-scale experiments involving fertilization or changes in the operation of wastewater treatment plants were deleted by workshop participants because of the controversy around them, not all the scientists and technicians involved have forgotten the proposal.

There's no question a microscopic shrimp named *Mysis relicta* is at fault for the decline in Kokanee stocks, because it competes with young Kokanee for feed, although the larger fish do feed on the shrimp as they mature. However, biologists shrug in frustration when it comes to the question of how to get rid of the little creature, ironically, introduced by man to local lakes three decades ago to improve fish stocks.

A list of 10 recommendations, including that a series of public information sessions be held this year, are included in the report, along with a five-year-plan of action to work on the problem.

Other recommendations are that a task force, consisting of a scientific advisory panel and technical committees should be set up, and the Okanagan Basin Study, completed in the early 1970s, should be updated.

Harvey Andrusak, director of the fisheries branch of the environment ministry, said from his Victoria office he estimates $150,000 will be needed in 1996 to get the plan underway, and more than $500,000 in the coming years.

He is committed to putting together a budget to try and deliver on some of the recommendations, he said, including monitoring programs and a continued investigation by OUC's Dr. Peter Dill of shore spawning Kokanee.

He's hopeful other levels of government will be prepared to buy into the program, since the loss of the Kokanee will have a significant impact on the valley's tourism.

A ban on fishing for Kokanee in Okanagan Lake was instituted a year ago, and there's no recommendation that it be lifted until at least the year 2001.

Habitat funds to help restore Kokanee stocks

by Judie Steeves
Staff Writer, *Capital News*
Wednesday, May 1, 1996

One of the largest projects to be funded through the Habitat Conservation Fund this year will put in motion an action plan to try and save the Kokanee in Okanagan Lake.

Environment Minister Moe Sihota has announced that $150,000 will go toward efforts to rebuild and maintain Kokanee stocks through monitoring activities, comparative analysis studies, large scale experiments and remedial measures.

However, the scientists who drew up the plan estimated it would cost more than $500,000 over the next five years to carry it out, and local B.C. Wildlife Federation officials say the funding should be matched by the provincial government.

Dan Santano, president of the Okanagan Region commented, “The biologists admitted we have a Kokanee problem because they introduced Mysis shrimp (three decades ago), and one of the solutions is to get rid of them, but it’s no fault of sportsmen, so why should we pay to fix problem?”

The HCF fund consists mainly of funds from surcharges on hunting and angling licences.

Since the sports community is putting up this $ 150,000, Santano contends a similar amount should be put up by the government from general revenue to tackle the problem.

He also feels the Kokanee fishery has such an impact on the tourism industry, it should also be footing part of the bill.

New provincial president of the federation is John Holdstock of Kelowna, who notes the government would also like to use the HCF fund to pay for wildlife inventories, normally the task of regional office staff.

“That fund just wasn’t intended for this,” comments Holdstock.

Of $4.9 million approved to support 154 habitat conservation projects around B.C., a further $31,000 was okayed for efforts to recover the declining Shorts Creek sheep herd on the Westside.

A project to place gravel to improve spawning habitat for Rainbow Trout near Winfield also was included, along with a $45,000 project to develop a community based 100-year plan for the recovery of species at risk in the South Okanagan.

Out of the lake and into the fryer

by Judie Steeves
Staff Writer, *Capital News*
Friday, May 24, 1996

Shore spawning Kokanee fry that emerged earlier this spring on at least one section of Okanagan Lake beach were marooned and died before they could swim out into the lake because of low water levels.

If the scenario was repeated, or is repeated regularly on Okanagan beaches, it could have a huge impact on the population of the little silver fish.

At the beginning of April on that Kelowna beach, Dr. Peter Dill, a biologist at Okanagan University College involved in studying the shore spawning species of Kokanee, was gently digging holes.

Under the rocks and within the top few inches he found hundreds of tiny live fish, the recently-hatched fry from eggs laid at the cost of the adult's life last fall.

Five days later when he returned to check on his subjects, he found the sand had dried and so had the fish.

Dill was out tagging and studying those red-flushed adult fish last October as they came into shore, laid their eggs and died, and had hoped to be able to begin an egg-to-fry assessment this spring as they emerged.

However, it was a cold winter and the fry emerged late, the lake level was drawn down in order to leave room from the inflow of the spring freshet, or runoff, from creeks in the Okanagan Basin, and not long after those fry emerged, sunny days heated the rocks around them, and the marooned babies were killed.

Dill estimates 25 per cent of the fry on the beach he's been studying for several years died this spring; hundreds of Kokanee.

Now he's writing the technical report for the environment ministry on his work this spring, and waiting for confirmation of whether funding has been allotted for him to continue his work, and if so, at what scale he'd be able to continue to conduct his studies.

His work is just part of a long-term study on the differences between stream and shore spawning Kokanee, the conditions the latter need to spawn successfully, and the number of fry that survive.

Those efforts are now a vital part of studies being conducted to try and resolve the current crisis of crashing populations of this little landlocked salmon in Okanagan Lake, a crisis that has resulted in a ban on fishing them being instituted last spring. Dill can't say yet what effect the marooning of these few hundred fish might have, but believes the reduction in populations of Kokanee in Okanagan Lake is a result of a combination of events, rather than just one.

He hopes next fall to be able to expand his studies to include spawning shorelines in deeper water, perhaps at Carr's Landing.

The good news this spring is that there's been an excellent survival rate of fry now migrating from the Mission Creek Spawning Channel, even though there was a record low number of fish spawning in there last fall. On one evening last week Dill says one of his students counted 100,000 of the little inch-long fry leaving the channel for life in the big lake.

Flood control endangers fish

Capital News
March 7, 1997

We could lose half this year's population of shore spawning Kokanee due to attempts to prevent serious flooding around Okanagan Lake this year says Dr. Peter Dill, biology professor at Okanagan University College.

Already the lake is 2.5 cm lower than it was at this time last year says Brian Symonds, head of the hydrology branch at the environment ministry's district office.

That draw-down of the lake's level, to allow the deeper-than-normal snowpack at higher elevations to flow in without overfilling the lake, has already left some of those fragile Kokanee eggs exposed on the shore, says Dill.

It's particularly problematic this year because the lake is colder than normal for March, so development of the fish has slowed, leaving them even more vulnerable.

However, if the snowmelt begins soon, input from swollen creeks will alleviate the effects of the larger releases of water from the system, he noted.

"If the weather stays cold it could be very serious for the fish," said Dill.

Ironically, the loss would occur just as scientists such as Dill are learning about the optimum incubation conditions of these shore-spawning Kokanee.

With his students, he will continue to study the shore-spawners as they emerge this year.

The kokanee crisis

This fall's spawning numbers were so low, some scientists are quietly wondering if it's already too late to save the lake's population

by Judie Steeves
Staff Writer, *Capital News*
Sunday, November 23, 1997

With a splash and thunk, the big rock hit the water and landed on the gravel bed of the creek, pinning a frantic fish. The young boy let out a whoop of victory from his perch on the footbridge over Mission Creek.

His companions were upstream, cavorting in the water, with a puppy amongst them excited by the flipping fins of the red-flushed fish making their way slowly upstream to lay their eggs before dying.

Although at first glance it may appear to be a Norman Rockwell-type picture of kids having fun with their pets, closer inspection reveals that a species is being helped toward extinction.

Kokanee numbers released this week show a native species of fish rapidly becoming extinct in Okanagan Lake: half last year's numbers of stream-spawning kokanee made their way back to the creek of their birth this fall to repeat the cycle of life.

In all, 35,000 of the little land-locked salmon returned to spawn in streams from Okanagan Lake. In 1992, 157,000 made it.

There are many reasons for the recent dramatic decline in their population, and many more aren't yet known.

It's certainly not all the fault of little boys.

But, when all the details are stripped away, humans are the most likely culprits says Okanagan University College biologist Dr. Peter Dill, who has been studying the valley's kokanee for many years.

While he observes the habits of kokanee with the goal of discovering what may be the cause of their decline, Dill says they are in serious trouble if this years numbers are correct.

However, he admits quite frankly, "It may be too late for this population, but we may be able to apply what we discover to others."

He notes that sockeye salmon are adapters all over the world, so for them to have suffered here like this is unrealistic.

For this reason, he points to the interference of people in their habitat as the villains in the piece.

Senior fisheries biologist Bruce Shepherd with the environment ministry's district office in Penticton agrees.

He tells stories of people sicking their dogs on spawning kokanee as they fight their way upstream from the lake to lay their eggs, as well as youngsters being encouraged to practice their proficiency with a slingshot on the colourful spawning fish.

One Penticton resident actually brought footage into the environment ministry office showing a man stabbing the helpless fish with a hunting knife, but he was frightened to leave the tape for evidence because it was obvious from which home it was filmed.

Wherever the pathways follow spawning streams or roadways provide access, people find them who (with their pets) will harass the little fish as they battle their way upstream to continue their species.

Then there are the earthmovers who wish to move the stream or muck about in it for one reason or another, and in the process, destroy essential gravel spawning beds and stir up silt which suffocates kokanee eggs as it resettles.

It is illegal to do any of these things without a permit from the environment ministry, and usually the only window when productive streams are not being used by trout spawning in the spring or kokanee in the fall, is in late August.

Rapid population growth has led to unprecedented development in the Okanagan, along with the inevitable destruction of natural habitat for all wildlife and fish in recent years.

Human settlement in this valley is also responsible for this year's damage from high water, although the weather played a part too.

In controlling the lake's outflow, water management branch staff walked a tightrope this year between trying to protect lakeshore properties from flooding, while not releasing so much water from the system that the valley was short of water in the dry months; and the needs of shore spawning kokanee.

The kokanee lost.

Record snowpack in the hills surrounding the valley this spring meant officials had to prepare the lake to receive the extra water, and that drawdown caused many shore spawned fry to be beached, high and dry, when they emerged.

The problem still exists, with Okanagan Lake at a higher than usual level due to continued inflow from precipitation throughout the year, and this fall's shore spawners will likely have laid their eggs higher up.

Dill is hopeful that a warm winter will lead to early emergence next spring, before the lake is drawn down significantly, so those fry will have a better chance of survival.

But again, it will be the little fish against human needs.

Ian McGregor, Kamloops/Okanagan fisheries section head for the environment ministry, doesn't feel efforts to restore the stocks of kokanee in Okanagan Lake is one of the areas that has suffered from staff and budget cutbacks in the ministry.

Compared to other fisheries needs throughout the province, he feels it has fared well.

"Okanagan Lake is still one of the highest priorities," he says.

He does concede that not everything can be done as hoped because of cuts, but he notes most of the research and monitoring is paid for with money from the Habitat Conservation Fund, so hasn't suffered from budget cuts.

Extinction is a long way off, he feels.

One of the recommendations of a 110-page report released following a scientists' think tank workshop in Kelowna in June, 1995 was that public involvement in efforts to rebuild stocks is vital.

The beginning of that involvement comes this fall when public meetings will be held throughout the valley, and residents asked to commit some of the time and money not available from the ministry to undertake the daunting task.

One of the messages at those meetings will be that not only the police can police the resource. Everyone can — and must.

Fish habitat in jeopardy

Kokanee crisis
by Rob Munro
The Daily Courier
September 15, 1997

The future is gloomy for Okanagan Lake kokanee. Even though a ban has been imposed on fishing for the landlocked salmon they may still have trouble surviving because of continued impact on spawning streams.

“I’m getting more and more pessimistic about the situation,” said Bruce Shepherd, senior fisheries biologist with the Ministry of Environment.

“Man wants to live along streams and they want to build right on the bank because it’s a nice environment — until they get flooded. Then, they want to build big walls along the creek.”

Mission Creek is a prime example of what’s wrong.

It’s the largest single source of water for Okanagan Lake and the major spawning stream.

Yet, it’s accommodating a mere 10 per cent of spawning kokanee compared to the 1970s.

Shepherd doesn’t expect it to get any better.

The creek was confined behind dikes after the 1948 flood. A small dam in Mission Creek Park was removed in the 1970s, allowing gravel to wash downstream, filling in spawning areas.

The creek was dredged 10 years ago and again a few weeks ago.

“The dredging in Mission Creek is not going to do the fish any favours,” Shepherd said.

Channels were dug out and spawning gravel put into the stream bed to make it suitable for the fish.

Unfortunately, an unusually heavy rainstorm last week pushed flows to five cubic metres per second from 1.2, washing much of a protective berm into the creek and damaging the prepared spawning beds.

Last year, 23,000 kokanee laid their eggs in Mission Creek while another 12,000 used the man-made spawning channel in Mission Creek Park.

That was up from the previous year, but far below even the 1991 and 1992 runs when the spawning channel was filled to its 20,000-fish capacity.

While that channel isn't filling to capacity, that doesn't mean additional spawning channels, further downstream, couldn't increase the creek's capacity, Shepherd said.

But land along the creek is privately owned so there's no room for a spawning channel.

Work on Mission Creek Greenway isn't helping, Shepherd said.

That project included swapping old creekbed outside the dike — ideal for future spawning channels — for land along the dike.

But Mission Creek isn't the only problem.

A 1992 study identified seven of Okanagan Lake's most important spawning streams and recommended their flows be regulated to benefit fish more than humans.

Those included Mission, Bear (Lambly), Peachland (Deep), Powers, Trepanier, Kelowna (Mill) and Vernon creeks.

Since then, Penticton Creek has become more important while Bear and Vernon creeks have dropped off.

Except for Mission Creek, they all have a common deficiency — too little water.

"We could double fish production if we boosted the flows," Shepherd noted.

But the water in those creeks is being used for irrigation and drinking. The only way to increase fall and winter flows enough to boost spawning would be to build expensive upland dams.

While Shepherd would like more water, the irrigation districts that hold licences on those creeks aren't the villains.

Peachland administrator Bill Brown pointed out that his municipality pumps water from Okanagan Lake into Trepanier Creek when it dries up in the late summer.

"We pump water uphill for them, at great expense," Brown noted.

He acknowledged that greater flows would help fish — it's just that no one has the money to spend on dams.

A third human influence is the level of Okanagan Lake.

“Flood control efforts meant we lost half the shore spawners last spring,” Shepherd noted.

Twenty-five to 75 per cent of kokanee spawn along the lake shoreline.

Because of the huge snowpack, efforts were made to lower Okanagan Lake farther down than usual in the spring.

That work paid off from a flood control perspective — keeping the lake 10 feet below where it could have peaked.

But it destroyed the eggs of half the 10,000 kokanee that spawned along the shoreline.

Because of continued high lake levels, Ministry of Environment officials are struggling to get the lake down to its target level by mid-October when the shore spawning starts.

Ministry engineer Brian Symonds expects to be back on target by the end of September. That means dropping the lake by 18 – 20 centimetres.

He does that by letting out more than 60 cm a second at Penticton — enough water to fill a community swimming pool in one second, but only lowers the lake by 1 – 1.5 cm a day.

Normally, the outflow rate drops to 10 – 15 cm a second by mid-September. That’s essential for sockeye salmon that spawn in the Okanagan River channel below Vaseux Lake.

If they spawn in high water the eggs may dry out when the river drops.

Symonds, therefore, has the challenge of balancing the needs of the kokanee and sockeye. His success at that task depends on how much it rains this fall. Too much precipitation could hurt both salmon runs.

Fish kill a mystery

Okanagan Lake kokanee stocks at their lowest ebb ever, in wake of puzzling die-off

by Don Plant
The Daily Courier
Thursday, May 21, 1998

A mysterious fish kill in Okanagan Lake could be solved after scientists analyze the organs of two nearly-dead kokanee plucked from the lake Tuesday.

Up to 50,000 kokanee salmon have perished in the north end of the Lake since last week. Most of the dead fish were found in the Vernon arm of the lake, but remains have been discovered as far south as Okanagan Centre.

Biologist Steve Matthews estimates five to 15 per cent of the lake's kokanee stocks aged two to three years have died. Scientists suspect the kill was likely caused by a disease, virus or parasite, dropping kokanee numbers to their lowest level on record.

"We're at the lowest ebb we've been at with kokanee populations," he said. "This is the last thing we need."

The die-off probably wasn't caused by humans, but residents say a concentration of adolescent kokanee died near the City of Vernon's outflow of treated sewage by Tronson Road. Matthews, who motored by the area in a boat Tuesday, ruled out sewage as a cause, saying fish are doing well down the lake from the discharge.

"I really think it's not man-caused," he said. "I don't think people should automatically assume that because there's some dead fish appearing that there's some toxin in the water."

It's hard to determine the cause of death from dead fish, so Matthews and biologist Vic Jensen spent several hours on the lake looking for live ones. They found two moribund kokanee, dissected them and preserved the organs in Formalin.

The samples have been sent to a fish health unit in Nanaimo, where scientists will determine the cause of death. Results will take about two weeks.

Fish kills have happened in Okanagan Lake three or four times in the last 10 years, said Matthews, but usually in the summer when it's warmer. The worst one-year toll was up to 100,000 kokanee.

“A native lady said this phenomenon has been observed every few years since the turn of the century,” said Ron Taylor, member of the Oceola Fish and Game Club. “There seems to be no rhyme or reason. It could be the lake turning over or a lack of oxygen.”

About 10 kokanee, each six or seven inches long, were visible from Lloyd and Arlene Duggan’s house in Carrs Landing Wednesday morning.

“They’re laying on their sides — one’s on the beach, the rest are in the water,” said Arlene. “I haven’t seen a big die-off like this in the 11 years we’ve been here.”

Witnesses first reported dying fish last Wednesday. They’re widely dispersed, but pose no risk to people swimming in the lake, said Matthews. Whatever’s killing them is targeting only young kokanee, and it’s not clear when the carnage will end.

“We don’t know if it’s getting worse. Fish are still dying. It’s hard to say what’s happening. We don’t know if we’re over the peak yet or not,” he said.

There’s no reason for people to be alarmed, say experts. If you find dead fish on the shoreline, bury it or use it as fertilizer, said Matthews.

Kokanee kill still poses mystery

Scientists in Nanaimo will study fish in an effort to find answers

by Don Plant
The Daily Courier
Thursday, May 28, 1998

They may be dying at a slower rate, but what's killing kokanee in Okanagan Lake remains a mystery.

An estimated 25,000 freshwater salmon have perished in the north end of the lake since May 13. Most of the dead fish were found in the lake's Vernon arm last week, but in the last few days bodies have been washing up further south between Okanagan Centre and Whiskey Island.

"My best guess is we're over the peak, but I wouldn't bet on it," said biologist Steve Matthews, who has spent two days on the lake monitoring the carnage.

"It's still going on, but we're not seeing the number of stressed, dying fish there were last week."

Scientists suspect the kill was caused by a disease, virus or parasite, dropping kokanee numbers to their lowest level on record.

The victims are all two- and three-year-olds, each about 15 to 22 centimetres long.

Matthews, of B.C.'s environment ministry, has collected four nearly-dead kokanee which he sent to the ministry's fish-health lab in Nanaimo for analysis.

"In previous kills, we've never been able to collect moribund fish," said Matthews. "But no one should hold their breath we'll find the answer."

Similar die-offs of kokanee have been documented in Okanagan Lake, Skaha Lake, Kootenay Lake, and Canim Lake in the Cariboo district. All of them lasted just a few days in the warm summer months, the affected kokanee were of a narrower age and size range, and their deaths coincided with a storm and/or lightning.

"This one is more mysterious," said Matthews. "Lightning could have been a factor in previous kills, but not at all for this one."

Scientists have measured the water's temperature and oxygen levels and found them normal for this time of year.

The City of Vernon pumped treated sewage into Okanagan Lake from Feb. 23 until last Thursday, but repeated tests show the phosphorus content of the discharge is less than .5 part per million, said Eric Jackson, the city's director of water reclamation.

Staff have also collected water samples to test for toxicity.

"We don't believe there is," said Jackson. "We're awaiting results from a lab on toxicity tests … We expect to hear from the lab by Thursday."

Jackson believes fish are dying as a result of the annual turnover of the lake, caused by warm weather heating the surface.

Because this spring has been warmer than usual, toxic compounds may be rising from the bottom layer of the lake and targeting a specific age of kokanee, he said.

Meanwhile, staff at the fish health unit in Nanaimo are preparing for the four moribund fish, now preserved in formalin. Biologist Sally Goldes will analyse the tissue, look for lesions and check for viruses and bacteria.

"We've never been able to collect fresh-enough specimens," she said. "We've had these events before, but the samples were dead … Hopefully we'll get new information which may rule out diseases."

Results of the tests will take up to three weeks.

"No one has identified exactly what it is that kills them," said conservation officer Grey Hoyer. "So you can't rule anything out."

Missing fish a dark omen

Editorial
The Daily Courier
Monday, September 28, 1998

Pity the kokanee.

What was once a healthy, flourishing freshwater species is now on the brink of obliteration. Fewer than 1,000 spawners are struggling up Mission Creek, Okanagan Lake's largest source. Twenty-six years ago, 300,000 filled the same creek.

Peter Dill, a leading expert on kokanee behaviour, fears the worst. Despite superhuman efforts by sports clubs and volunteers, this is a population that appears destined for extinction.

Why? Dill blames it on poor water management. The keepers of our flood-control systems, irriagation and drinking water didn't consider other animals living in the Okanagan.

They focused only on water — not water as part of the ecosystem. As a result, the gravel on creek beds where spawners lay their eggs was largely washed away.

By ignoring water as a component of the environment and exploiting it as a separate entity, our forebears robbed us of a crucial link in our ecosystem. Without the kokanee, other organisms will meet the same fate.

It may be too late for this species. but we can certainly pull up our socks to save others. By thinking locally and acting locally, we can all make a difference.

Children are painting storm drains. Volunteers are cleaning up creeks and planting trees.

Students at four local schools are fertilizing kokanee eggs in 30-gallon taks and will release them as fry in June.

Children are learning how to make bird feeders using pine cones, peanut butter and seeds. Adults are rejuvenating Brandt's Creek, one of the most neglected streams in our area.

Residents are installing low-flush toilets, composting table scraps, watering their lawns at night, and eating food in season.

But we need to do and learn more. By understanding mistakes of the past, we plan a less-intrusive future.

If we're not part of the solution, we're part of the problem.

The kokanee represent our wake-up call.

Kokanee still on the brink

Expert offer suggestions to give threatened species a better chance at survival

by Don Plant
The Daily Courier
Monday, September 27, 1999

If we want more kokanee to spawn in Mission Creek, we'll have to reverse the damage done to its spawning habitat, says a leading biologist.

About 1,500 kokanee are now spawning in Mission Creek at the peak of their annual migration — a tiny fraction of the 300,000 to 500,000 that reproduced there in the 1970s. Dr. Peter Dill, a fish-biology professor at Okanagan University College, attributes the rapid decline to the diking system along the creek, which has washed out gravel that's crucial to the eggs' survival.

"The gravel in the creek is pathetic. The creek needs to be improved," Dill said Sunday. "I think the kokanee are a tragic illustration of our failure to put environmental considerations right in front of the planning process."

To prevent Kelowna from flooding, engineers built dikes at the lower end of the creek and pushed large boulders to the side. The dikes are built too close together to allow the creek to meander and form natural gravel beds ideal for building kokanee nests, said Dill.

When the water's high, the dikes create a long, straight, smooth-bottom ditch, and the current scoops out the gravel.

"There's no room for the creek to move," he said. "If there was no dike, or they were set back further, the stream would move back and forth between the dikes and you'd create spawning habitat. But it's very hard to correct that."

Twenty years ago, 90 per cent of all the kokanee in Okanagan Lake spawned in Mission Creek, the lake's largest source of water. Dill now estimates the creek provides habitat for 30 to 40 per cent of the lake's kokanee.

He suggests dropping large rocks into the creek at certain intervals. They'd create the turbulence and variety in water flow, and generate a diverse habitat — including gravel.

Boulders have been effective in other systems, says Brain Jantz, fisheries technician with the Environment Ministry. But if they're too large in Mission Creek, logs and other wood drift can get hung up and cause flooding, he said.

Human development has virtually robbed the kokanee of the water and habitat they need. The creek provides water for agriculture and domestic use, and homeowners live on its banks.

"It's a huge problem because of all the urbanization that takes place on either side of the stream," said Jantz. "In some cases, you can't move the dikes back because it encroaches on private property."

Seven kilometres upstream from the creek mouth is a spawning channel built in the 1980s. Its bottom is covered in clean gravel that looks ideal for egg-hatching. Yet fewer than 150 spawners were in the channel on Sunday. Most of the fish traditionally spawn below the seven-kilometre mark, where there's little gravel to lay eggs on.

The Environment Ministry has considered building a spawning channel closer to the creek mouth.

"But if the fish aren't using the habitat in this channel, why go to that trouble?" said Jantz. "In a perfect world, this system would have been designed with dikes set back further to allow the stream to operate naturally and retain its gravel."

Meanwhile, smaller waterways like Peachland Creek and Powers Creek attract more spawners because sports clubs have dumped gravel and created better habitats. But they don't have enough spawning habitat to pick up the slack in Mission Creek.

"Mission Creek is going down faster than other creeks, which means it's not being maintained properly," Dill said. "It's a political issue. Mission Creek is the major supplier of water for the Okanagan … The needs of water management are in conflict with the needs of fish."

The Environment Ministry blames the mysis shrimp for the kokanee's decline. Introduced as a food source in the 1960s, the tiny crustaceans now compete with young kokanee for plankton. Three trawlers are now dragging nets in the lake to determine whether a commercial mysis fishery is feasible.

Dill argues there's little evidence to prove the shrimp are killing off the kokanee.

"If mysis are part of the problem, and we get rid of them, where are the fish going to spawn? We have such a mess in this creek … Deal with Mission Creek first, and then the mysis."

Salmon Links: Links to other sites about Kokanee and other members of the salmon family.

Ecology / Environment

- Explore BC By Region – British Columbia Adventure Network.
- Canada's First Peoples. Northwest Coastal People. Food/Hunting

Fishery

- Fisheries and Aquaculture Branch
- BC Salmon Farmers' Association
- Go Wild — BC Salmon Marketing Council
- BC Salmon Facts
- The Salmon Page
- Wild BC Salmon

Geography – Tourism

- Adams River Salmon Run
- British Columbia's Travel Guide

Glossaries

- Fish Information Service (FINS) Index

Photos and descriptions.

Kokanee Salmon Heritage Project

The Kokanee Salmon Heritage Project was developed as a result of the myriad of questions about Kokanee which arose during school and public interpretation talks at Mission Creek Spawning Channel, Kelowna, BC. The scientific authority for the project is Dr. Peter Dill, a researcher on trout and salmon in Canada for over forty years and on Kokanee in the Okanagan since the mid 1980s. The online project was developed by the *Living Landscapes* project of the Royal British Columbia Museum and the RBCM has granted permission to the Lake Country Heritage and Cultural Society to reproduce it on its website. *Click once on photo to enlarge.*

Shore-spawning kokanee alevin stranded on beach as lake-level dropped.

In search of dewatered shore-spawning kokanee alevin. Note higher water mark showing lake depth at spawning

Shore-spawning kokanee salmon in Okanagan Lake. Note large size of gravel, single female on right with egg distended belly, and numerous males courting.

Shore-spawning kokanee. Female digging. Males courting female.

Steam-spawning kokanee. Probably a three-year-old brownish coloured female and a four year old reddish coloured male

Equipment for sampling stream-spawning kokanee fry as they outmigrate the spawning channel into Mission Creek and Okanagan Lake. The data is used to estimate the productivity of the channel.

The Royal BC Museum originally developed this project.