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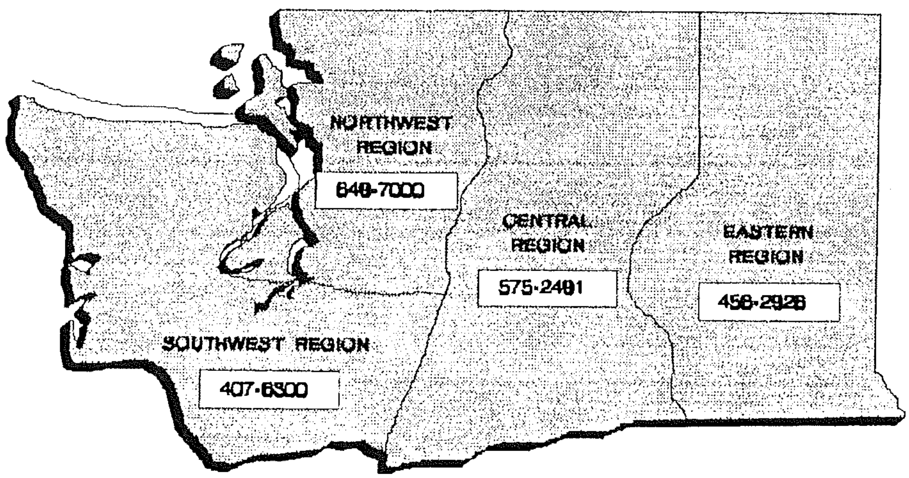

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Watershed Briefing Paper for the Spokane Water Quality Management Area

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Executive Summary

Biological Monitoring

The comparison of biota in Dragoon Creek and Little Spokane River at Chattaroy, both within proximity of each other, were influenced by different surrounding land uses (crops and grazing, respectively). Water quality measurements revealed no impacts at Dragoon Creek, yet very few species were collected. Further surveys should investigate the influence of herbicide and pesticide applications to crops and their effects on biota of nearby streams.

Streams that had minimal disturbance from human activity were difficult to locate. A thorough examination of possible 'least disturbed sites should be identified for future surveys.

Compliance Monitoring

Follow-up sampling for PCB Arochlors should be conducted at Kaiser (Trentwood).

Class II inspections are recommended for facilities of concern, including those with significant changes resulting from plant modifications or plant operation.

Ground Water Investigations

Need nitrate contamination studies in the Airway Heights, Chamokane Creek, and Deer Park areas to determine the extent of present ground-water contamination. Should talk to local government (Spokane County and Town of Deer Park) to determine where monitoring is most needed and the scope of monitoring that would best fulfill data needs.

Work with Spokane County Engineering Dept. (Stan Miller), Eastern Washington U., USGS, and others to design research that will define the surface-water/ground-water interaction between the Spokane River and the Spokane-Rathdrum Prairie Aquifer. Some project components may be: 1) water temperature survey of the Spokane River and river sediments to determine gaining and losing reaches, 2) gauging stations located based on knowledge gained about gaining and losing reaches long the stream, 3) placement of water-level/water-quality monitoring wells along the river to determine ground-water gradients and ground-water-quality information near the river.

Intensive Surveys

Concentrations of cadmium, lead, and zinc are expected to continue to exceed water quality standards in the Spokane River mainly due to sources in Idaho (e.g. mine tailings in the South Fork Coeur d'Alene River). Concentrations in the Spokane River will hopefully decrease as remedial actions are conducted in Idaho. A phased TMDL approach is recommended for establishing WLAs for NPDES permit's in Washington and Idaho. Under the phased approach, point sources would be allowed to discharge effluent of the same quality as the river while the river exceeds water quality standards. If metals concentrations are show to decrease below the standards, then mixing zones for individual NPDES permit's for metals may be allowed.

The following studies are recommended:

- Continued monitoring of dissolved and total recoverable Cd, Pb, and Zn in the Spokane River at the state line. Ecology should continue to collect ambient monitoring data for dissolved and total recoverable Cd, Pb, and Zn at the state line. These data will be useful to detect trends in concentrations to track the progress of loading controls in Idaho. The data will also be useful to document continued violation of water quality standards.

Eutrophication and Dissolved Oxygen in the Spokane River

Dissolved oxygen in the Spokane River may be threatened by the combined effect of wastewater discharges in the basin. The study of the Inland Empire Paper Company shows the sensitivity of the river to a single discharge. The proposed expansion of the City of Spokane's AWTP has raised similar questions about the capacity of the river and Long Lake to assimilate loads of oxygen demanding materials.

The following studies are recommended:

- Spokane River dissolved oxygen TMDL study. A basin-wide modeling analysis of dissolved oxygen should be conducted to establish allowable loading limits for significant sources of oxygen demanding materials. The geographical scope of the modeling analysis should probably be from the state line to Long Lake Dam or the mouth of the river. It may also be appropriate to extend the model upstream to the outlet of Lake Coeur d'Alene.

Studies Related to Mixing Zones for NPDES Dischargers

The City of Spokane is currently conducting studies and designing future studies of various parameters related to establishing water quality-based effluent limits for ammonia and metals. Water quality conditions at the boundary of proposed mixing zones needs to be assessed.

The following studies are recommended:

- City of Spokane mixing zone studies. Intensive surveys should be conducted for temperature, pH, alkalinity, hardness, and trace metals for evaluation of the mixing zones for ammonia and metals for the Spokane AWTP. The purpose of this study would be to verify the results of studies conducted by the City of Spokane.
-

Lakes Ambient Monitoring

It is recommended that Ecology continue to monitor Newman Lake to assess the effectiveness of restoring the lake and to monitor for trends in improving or deteriorating water quality over time.

Rivers and Streams Ambient Monitoring

Continue to monitor dissolved and total recoverable metals bi-monthly at the Spokane River at Stateline. Other potential metals stations include the Little Spokane River and Hangman Creek.

Confirm high nutrient concentrations in Dragoon Creek and collect additional baseline data at several stations prior to management activities. (This may already be underway through a grant to Stevens and Spokane County Conservation Districts. AMS monitoring should support and not duplicate their efforts.)

Collect additional baseline data at several stations on Latah (Hangman) Creek prior to management activities. (This should be done in support of the Watershed Plan developed by Spokane Conservation District and in conjunction with the district.)

Monitor small streams in the basin in support of on-going planning activities through county conservation districts, for example, Chamokane and Thompson Creeks.

Monitor small streams where data are not currently available (for example, Deep Creek).

Monitor additional Spokane River stations between Riverside State Park and Stateline in order to identify areas where water quality degradation is occurring.

Aquatic Plants Ambient Monitoring

Continue to offer technical assistance to local government officials and citizens concerning the lakes with populations of noxious weeds.

Continue monitoring lakes near waterbodies with noxious weeds to detect any new introductions of these plants at an early stage.

Increase public education on the impacts of noxious aquatic weeds and how to prevent their spread.

Toxics Investigations

Zinc, lead, cadmium, and PCBs have been the subject of numerous past investigations by TIS and others in the Spokane River and, perhaps by default, are the only chemical contaminants known to be a concern in this WQMA. TIS has only a small amount of information on the occurrence of toxics in Spokane River tributaries and is not aware of any data on lakes. The following additional work is recommended:

Metals: This issue is currently being pursued by the Attorneys General through NRDA and could result in additional studies in the river. Any data collection efforts done as part of the Water Quality Program's Watershed Approach should be undertaken in consultation with the Attorneys General.

Data gaps for metals in the Spokane River include the need for a thorough investigation of the sediments and associated biota to determine the extent and significance of contamination by zinc, lead, and cadmium. A risk assessment should be conducted for lead to determine the potential for adverse effects to human health, aquatic life, and wildlife.

The Water Quality Program should review EILS' recent data on chromium and mercury in the Spokane River and re-assess the 303(d) listing for these metals.

PCBs: Re-sample Spokane and Little Spokane River fish for PCBs after known sources are controlled.

Pesticides: The Water Quality Program should review EILS' recent data on chlorinated pesticides in the Spokane River and Hangman Creek, and either remove these compounds from the 303(d) list or recommend additional sampling appropriate for determining if water quality limited status remains warranted.

Other Waterbodies: Survey for toxics if and where appropriate.

Abstract

Existing documents produced by the Environmental Investigations and Laboratory Services and the ambient water quality data collected from the Spokane Water Quality Management Area were reviewed and summarized. Recommendations were made for specific projects to be initiated in Wateryear 99.

Bioassessment Monitoring

by
Robert Plotnikoff

Introduction

Collection and analysis of benthic macroinvertebrate (biological) information was completed at five sites in the Spokane WQMA (Figure 1). Water quality conditions defined by chemical analysis can fail to protect stream biota from physical changes in the environment or from 'slugs' of pollutants that are missed in regular sampling routines. The purpose of the biological monitoring program was to screen sites for various stream quality impacts (Plotnikoff and Ehinger 1997).

Site Locations

Five sites were surveyed in the Spokane WQMA that represented a variety of surrounding land use impacts (Figure 1). Sites were situated within the Little Spokane River watershed and the Hangman (Latah) Creek watershed. These sites had been subjected to grazing and suburban development. The following table lists the sites surveyed and the surrounding land use impacts.

Site	Surrounding Land Use
Little Spokane River at Chattaroy	grazing
Little Spokane River at Pine River Park	suburban development
Dragoon Creek	riparian removal/crops
Marshall Creek	suburban development/hobby farms
California Creek	grazing/hobby farms

Condition of Streams

Many of the streams in this region of the state are known to have sustained surface water flow during summer months through groundwater contribution. Even though ambient air temperatures are high during the daytime periods, surface water temperature in streams can be low. Local geology contributes to the high hardness concentrations characteristic of surface water in these drainage's.

California Creek and Marshall Creek contained stream biota that were sediment-tolerant and filtered organic particulates from the water column. Both sites were erodeable channels that was exacerbated by grazing cattle. Dissolved oxygen (DO) concentrations were lower at these sites than at others surveyed in this WQMA. Lower DO concentrations could have been a result of oxygen demand from decay of organics in the stream channel. Species collected from this site were tolerant of stressed environmental conditions.

Little Spokane River at Pine River Park and Dragoon Creek contained biota that filtered organic particulates from the water column. Few species were found at either of these sites even though physical stream conditions were good. The surrounding land uses may have contributed contaminants through groundwater that influenced the macroinvertebrate community. This would explain why the lack of species in an apparently hospitable environment.

Little Spokane River at Chattaroy contained a much greater variety of species than any of the sites surveyed in the Spokane WQMA. However, the greater number of species present were organic particle filterers and sediment-tolerant animals (resembling biota from the other sites). This site was influenced by upstream grazing, but did not appear to be as heavily degraded as the suburban site (Little Spokane River at Pine River Park) or the crop site (Dragoon Creek).

Environmental variables that were related to biological condition in streams of this WQMA were: pH, dissolved oxygen, conductivity, and stream gradient. Differences in this set of five streams were identified by dissolved oxygen concentration in surface water. Streams that were affected by surrounding land use contained biota that were tolerant to lower levels of dissolved oxygen.

Conclusions and Recommendations

1. Suburban streams and those surrounded by hobby farms are sensitive to minor physical changes. Grazing and destruction of streambanks can contribute sediment to streams that may be slowly transported downstream. The result is a reduction in living space for benthic macroinvertebrates and other biota.

2. Pollutants entering streams through groundwater was suggested by the biological surveys conducted in the Spokane WQMA. The comparison of biota in Dragoon Creek and Little Spokane River at Chattaroy, both within proximity of each other, were influenced by different surrounding land uses (crops and grazing, respectively). Water quality measurements revealed no impacts at Dragoon Creek, yet very few species were collected. Further surveys should investigate the influence of herbicide and pesticide applications to crops and their effects on biota of nearby streams

3. The suburban stream, Little Spokane River at Pine River Park, appeared to be degraded from sources other than physical stream condition. The biological community was similar to that collected in Dragoon Creek. This suggests that a pollutant contributed through overland runoff or groundwater may have degraded biological conditions at this site. Suburban development had been increasing in the Spokane WQMA and may be contributing many more pollutants from impervious surfaces to nearby streams.

4. Streams that had minimal disturbance from human activity were difficult to locate. A thorough examination of possible 'least disturbed sites should be identified for future surveys.

References

Plotnikoff, R.W. and S.I. Ehinger. 1997. Using Invertebrates to Assess Quality of Washington Streams and to Describe Biological Expectations. Washington Department of Ecology, Environmental Investigations and Laboratory Services Program. Olympia, WA. In press.

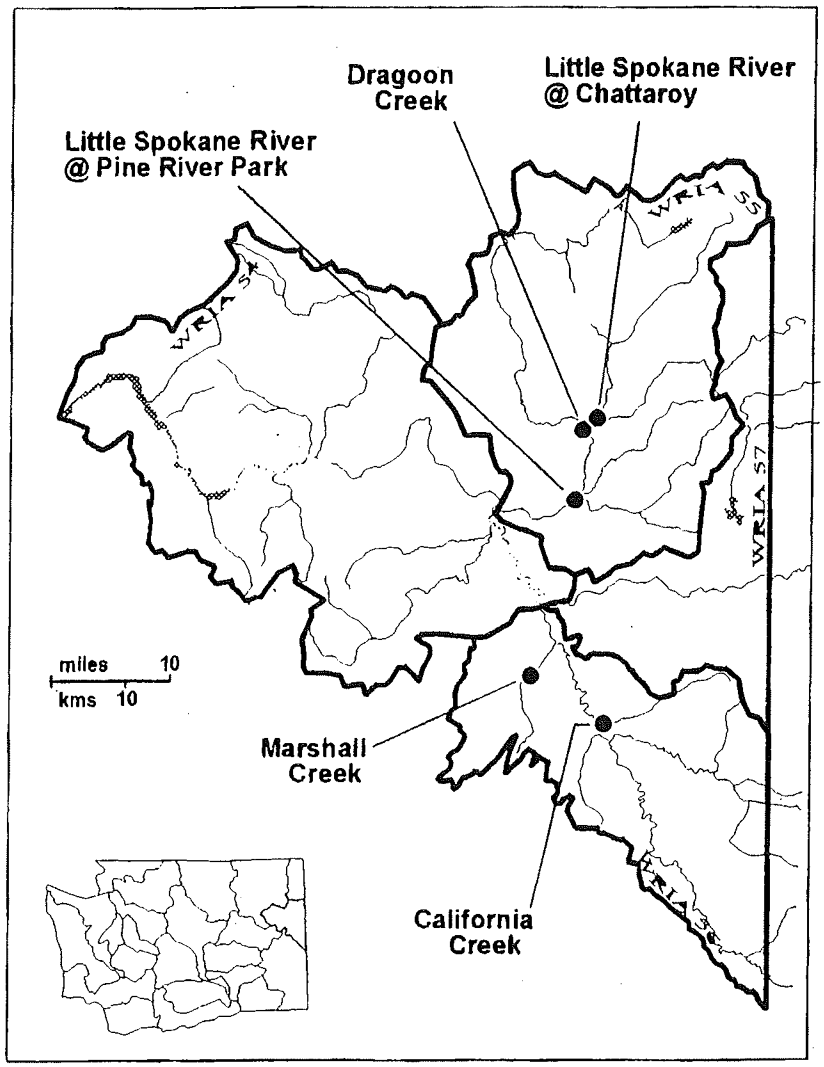

Figure 1. Spokane Water Quality Management Area. Summer 1994 biological monitoring sites.

Compliance Monitoring

by
Steven Golding

Introduction

There are currently 27 dischargers in the Spokane WQMA that have permits under the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Program (WAC 173-216). These include:

- NPDES Major Permits - 3 industrial, 1 municipal
- NPDES Minor Permits - 2 industrial, 6 municipal
- State Discharge to Publicly Owned Treatment Works (POTW) permits - 7 industrial
- State Discharge to Ground Permits - 1 industrial, 7 municipal

The following facilities have received EILS Class II inspections during the last ten years:
- Kaiser Aluminum and Chemical Corporation, Trentwood
- Inland Empire Paper Company
- Spokane Industrial Park
- City of Medical Lake
- City of Tekoa

Summary of Issues

Following are summaries of EILS Class II inspections and source monitoring conducted in the Spokane WQMA during the last ten years:

Golding, S., 1996. Spokane River PCB Source Monitoring Follow-up Study, November and December 1995.
Monitoring of several point sources believed to be contributing PCBs to the Spokane River was conducted in November and December 1995. The monitoring was a follow up to an investigation conducted during the summer of 1994. The three sources monitored were Liberty Lake Wastewater Treatment Plant, Kaiser Aluminum (Trentwood), and the Spokane Industrial Park.

Data from the Liberty Lake Wastewater Treatment Plant sludge indicate low levels of PCB-1248 in two of three samples with concentrations less than one tenth of the concentration from the single 1994 grab sample. Data from the Kaiser 001 discharge show PCB-1248 concentrations ranging from 0.025 µg/L to 0.034 µg/L, or 19% to 62% higher than in 1994. No PCBs were detected in Kaiser 002 effluent, compared with 1994 sampling which found PCB-1260. Two samples of Spokane Industrial Park wastewater showed PCB-1248 concentrations of 0.055 and 0.043 µg/L. No PCBs had been found in the Spokane Industrial Park wastewater in 1994. With the relatively high flow of the Kaiser outfall 001, the calculated PCB loadings from 1994 and 1995 sampling ranged from 1.7 g/day - 2.3 g/day over both years, more than 30 times the loadings from Kaiser outfall 002 in 1994 and SIP in 1995.

Remediation to remove PCBs from effluent and wastewater at Kaiser and the Spokane Industrial Park is recommended. Continued periodic monitoring of the discharge from the Kaiser 001 outfall was also recommended.

Glenn, N., and T. Nell, 1991. Kaiser Aluminum and Chemical Corporation-Trentwood, Class II Inspection.
Ecology conducted a Class II Inspection at Kaiser Aluminum and Chemical Corporation, Trentwood, Washington, on May 21-23, 1990. Kaiser operates an aluminum rolling mill and metal finishing plant. Kaiser is permitted to discharge wastewater to the Spokane River as regulated by NPDES Permit No. WA-000089-2. Wastewater generated at Kaiser is discharged to the river through a four million gallon wastewater lagoon. The influent to the lagoon consists of effluent from industrial and domestic wastewater treatment (DWT) facilities, and contact and non-contact cooling water.

Kaiser was operating within the permit limits except for oil and grease samples collected from the lagoon discharge. A moderate removal efficiency of TSS, BOD_5, and COD was realized in the domestic wastewater treatment facility; lead concentrations were somewhat elevated.

Effluent from the industrial wastewater treatment facility was high in solids, chromium^{+6}, and copper, and moderately high in selenium. Industrial wastewater effluent to the lagoon caused 100% mortality in all four bioassays, both acute and chronic, indicating the presence of toxicity. Kaiser has added multi-media filtration since the inspection.

No significant quantities of organic compounds were found in any of the sampled waste streams.

Das, T., and L. Zinner, 1991. Inland Empire Paper Company Class II Inspection, September 1990.
A Class II Inspection was conducted at the Inland Empire Paper Company (IEP) in Spokane, Washington, on September 10-13, 1990. The inspection was conducted in order to evaluate compliance with the NPDES permit limits. The effluent met NPDES permit requirements for BOD_5, TSS, pH, rainbow trout bioassay, and discharge. Copper was found at 17.4 μg/L, slightly above the chronic water quality criteria. Mercury was found in the effluent at the level of 0.052 μg/L, which is above the chronic water quality criterion. Hexavalent chromium was detected in the effluent at 0.202 mg/L and 0.023 mg/L levels, which are also above acute and chronic water quality criteria. No effluent or receiving water toxicity was indicated by rainbow trout, *Daphnia pulex*, *Ceriodaphnia dubia*, fathead minnow larvae, or Microtox®. No volatile organics, pesticides/PCBs, or BNAs were detected in sludge samples. However, a number of metals including chromium, copper, nickel, zinc, barium, and aluminum were detected. Resin/fatty acids and phenol were also detected in sludge. IEP and Ecology lab results from split samples for parameter analysis agreed well. Several remedial actions were recommended to address problems noted during the inspection.

Hoyle-Dodson, G., 1993. Spokane Industrial Park Class II Inspection, May 18-20, 1992..
A Class II Inspection was conducted in May 1992 at the Spokane Industrial Park Sewage Treatment Plant. The Spokane Industrial Park facility treats wastewater from a variety of industrial tenants with an oxidation ditch facility. Effluent quality during the inspection generally met weekly and monthly NPDES permit limits; or, in the case of metals, met interim limits. Three target organic compounds were detected in the influent or effluent. The pesticide heptachlor was found in the effluent at a concentration of about eight times the EPA criteria to protect against chronic toxicity in receiving waters. The effluent copper concentration exceeded EPA acute toxicity criteria for receiving waters by roughly ten times. Also, lead, cadmium, mercury, and silver effluent concentrations exceeded the EPA chronic toxicity criteria. Rainbow trout, *Daphnia magna* and *Ceriodaphnia dubia* bioassays found no measurable toxicity in the Spokane Industrial Park effluent.

Hoyle-Dodson, G., 1994. City of Medical Lake Sewage Treatment Facility, Class II Inspection.
A Class II Inspection was conducted September 20-22, 1993, at the city of Medical Lake Wastewater Treatment facility in Spokane County, Washington. The Medical Lake facility operates an aerated lagoon connected in series with two large unaerated treatment/settling lagoons. The plant discharge flows several miles in an open channel before discharging to Deep Creek. Effluent flow meter calibration was checked and the meter was found to be accurate. Recalibration of pump flow measurements or, if necessary, the addition of an influent flow measurement device is recommended. A higher than typical BOD_5/TOC ratio was found for influent samples. TSS removal efficiency was moderate likely due to algae growth in the settling ponds. NH_3-N removal occurred in the system. Most effluent results are within the Ecology compliance order load and concentration limits, but several exceed NPDES permit limits. Effluent pH exceeded both NPDES permit and compliance order limits. Effluent TSS concentration exceeded the percent of influent concentration stipulated by the monthly NPDES permit limit. Chlorine residual appeared high and it is recommended that the minimal concentration and optimal retention time be determined to reliably achieve permit fecal coliform limits. Split sample analyses found good correspondence between samples and good correspondence between laboratories for most parameters except BOD_5. Wastewater metal concentrations were all within EPA and state water quality criteria for receiving waters. Concentrations of sludge metals did not exceed EPA criteria for the land application of municipal sludge, although fecal coliform densities exceeded Class A land application standards.

Stasch, P., 1994. City of Tekoa. Wastewater Treatment Plan Class II Inspection, August 31 - September 1, 1993. Ecology Report, Publication No. 94-33, 18 pp. + appendices. (WB WA-56-1010)
A Class II Inspection was conducted on August 31 and September 1, 1993, at the City of Tekoa Wastewater Treatment Plant in Whitman County, Washington. The Tekoa facility is an activated sludge plant which discharges treated and disinfected effluent into upper Hangman Creek. The inspection data found the Tekoa facility was producing a high quality effluent. Effluent concentrations were all within the NPDES permit limitations. Effluent priority pollutant metal concentrations were all less than the EPA Water Quality Criteria for fresh waters.

Recommendations

Follow-up sampling for PCB Arochlors should be conducted at Kaiser (Trentwood).

Class II inspections are recommended for facilities of concern, including those with significant changes resulting from plant modifications or plant operation.

References

Golding, S., 1996. Spokane River PCB Source Monitoring Follow-up Study, November and December 1995. Ecology Report. 15 pp.

Glenn, N., and T. Nell, 1991. Kaiser Aluminum and Chemical Corporation-Trentwood, Class II Inspection. Memo to Roger Ray and Patrick Hallinan, November 8, 1991, 49 pp.

Das, T., and L. Zinner, 1991. Inland Empire Paper Company Class II Inspection, September 1990. Ecology Report, 47 pp.

Hoyle-Dodson, G., 1993. Spokane Industrial Park Class II Inspection, May 18-20, 1992. Ecology Report, 23 pp. + appendices.

Hoyle-Dodson, G., 1994. City of Medical Lake Sewage Treatment Facility, Class II Inspection. Ecology Report, Publication No. 94-156, 17 pp. + appendices. (WB WA-54-1020)

Ground Water Investigations

by
Robert S. Garrigues

Introduction

The following is a synopsis of ground-water quality issues, EILS ground-water studies, and recommendations for ground-water investigations in the Spokane Water Quality Management Area.

Ground-Water Issues in the Spokane Water Quality Management Area

Nitrate contamination of Spokane-Rathdrum Prairie Aquifer: According to Miller (1997), nitrate concentrations in ground water, in non-sewered areas, rise dramatically with the addition of new septic-system-based developments. Conversely, nitrate concentrations decrease dramatically when developed areas are converted to sewer systems. Rather than requiring developers to bring sewer lines to an area in conjunction with development, Spokane County continues to approve septic-system-based development in unsewered areas. Meanwhile, existing developments are being converted to sewer systems. Currently, more existing houses are being converted to sewer than new houses are being built with septic systems, so the nitrate contamination problem is slowly improving. However, if new septic-system-based development outpaces sewer-conversion efforts, nitrate contamination will get worse in the aquifer.

- The nitrate contamination problem in the Spokane-Rathdrum Prairie Aquifer could eliminated if sewer hook-up was required of all new developments and if the present effort to convert existing housing tosewer hook-ups was continued (Miller, 1997 personal communication).

- Nitrate contamination in the Airway Heights, Chamokane Creek, and Deer Park areas: According to Ebbert ((1984), nitrate contamination was prevalent in the aquifers in both the Airway Heights and Chamokane Creek areas. Deer Park has had a history of nitrate contamination of ground-water as well. All three areas still have nitrate contamination problems in ground water. There could be multiple nitrate sources: septic systems, domestic lawn fertilizers, municipal land applications, and various agricultural practices - chicken farms have been a problem in the past, dairy operations, land application of manure, and agricultural fertilizers. See recommendation # 1, below.

- Mining Ground-water in the West Plains area: Communities in the West Plains area are drilling new wells into the deep basalt aquifer (Grande Ronde) but we don't have a good handle on the recharge to this aquifer. Based on continued decline of ground-water levels, it appears that we are mining the ground water in the basalts west of Spokane (Miller, Buchanan, and Covert, personal communication, 1997).

- Water quality interaction between the Spokane River and the Spokane-Rathdrum Prairie Aquifer: The Spokane River has known water-quality problems with regard to metals from mining waste. The question is, how do the metal contaminants in the river interact with the Spokane-Rathdrum Prairie Aquifer (Covert, 1997 and Miller 1997)?

- There is a great deal of interaction between the river and the Spokane-Rathdrum Prairie Aquifer. The surface-water/ground-water interaction varies with river flow - influenced by releases from Coeur d'Alene Lake and seasonal flow changes. Depending on the hydrologic situation, huge amounts of water flows either from the river to the aquifer or from the aquifer to the river (Covert, 1997 and Miller, 1997). In areas where recharge from the river to the aquifer is prevalent, do the metal contaminants in the river contaminate the aquifer?

  Need to define the nature and extent of the interaction between the Spokane River and the Spokane-Rathdrum Prairie Aquifer (see recommendation #2, below).

- Proposed low-level radioactive waste-disposal site at Dawn Mining Company site, Ford, WA: There is a clear record of past contamination to ground water and Chamokane Creek from the old uranium mining and milling operation (Buchanan, 1997). Data suggests that contamination may have peaked about 10 years ago (Buchanan, 1997). Will the proposed low-level radioactive waste disposal operation cause further contamination (Peterson, 1997 and Buchanan, 1997)?

Ground-Water Quality Investigations Conducted by the EILS Program in the Spokane Water Quality Management Area

Carey, B. 1995, Vadose Zone Monitoring at Deer Park, Washington: A Municipal Effluent Land Application Site: 95-303
Vadose zone sampling equipment was installed and sampled at two locations on the City of Deer Park land application site near Deer Park, Washington. Effluent from the municipal wastewater treatment plant in Deer Park is applied on a 160-acre field to irrigate alfalfa. The purpose of the study was to evaluate treatment in the unsaturated zone and to compare three devices for sampling soil-pore water quality. Capillary wick, suction, and barrel lysimeters were used to obtain water quality samples. Total nitrogen (total N), total dissolved solids (TDS), specific conductance, chloride, sodium, potassium, calcium, iron, magnesium, pH, and chemical oxygen demand (COD) samples were collected at least five times during the period of May 6 to October 1, 1993.

Vadose zone monitoring showed that total N was partially treated in the top three to six feet. The range of total N treatment was low (26-35%), despite a relatively low application rate for total N of 100 lb/acre/year. Low treatment was likely due to frequent wet weather which caused irregular timing of effluent application over the season.

Suction and wick lysimeters provided more representative samples than the barrel lysimeters. Concentrations from the wick lysimeters tended to be higher than those from the suction lysimeters and, because the wicks sample continuously, are likely more representative of water leaving the root zone. Barrel samplers did not provide representative estimates of treatment at this site because of their shallow depth.

The mean total N concentration in the wick and suction lysimeters was 17 mg/L. The mean TDS concentration was 362 mg/L. The projected increases above background in ground water concentrations of total N and TDS are 5-7 mg/L for total N and 110-170 mg/L for TDS. Increases in nitrate+nitrite-N and TDS concentrations from the facility's down gradient monitoring wells suggest that effluent loading is affecting ground water quality.

Carey, B., 1997, Winter Soil Pore-Water Nitrate at the Deer Park Land Application Site 1995-96: WDOE Publication # 97-308
Nitrogen in soil pore-water was sampled at the Deer Park land application site in winter 1995-96 to follow up on a 1993 study. Composite winter samples were obtained from capillary wick (wick) soil pore-water samplers that accumulated water from October 1995 until April 1996. Ceramic cup suction pore-water samplers that were still intact were also sampled in April 1996.

Although effluent is not applied to the fields between November and March, wintertime concentrations of nitrate+nitrite-N were similar to summer 1993 concentrations based on results from the wick samplers.

Twenty-three percent of an estimated total annual load of nitrate+nitrite-N percolating below the root zone occurred in the winter. The resulting increase in underlying ground water nitrate+nitrite-N concentration is estimated as 5 mg/L after one year. Because the crop overlying the samplers was not managed or harvested as were crops in the field, these estimates may not be as representative of conditions in the undisturbed field as estimates would be if the field and study area had been managed identically.

Monitoring networks that use wick soil pore-water samplers may be useful at other small municipal land application facilities in eastern Washington to provide an early warning of nitrogen impacts on ground water. Such networks would be especially useful at sites where complicated geology makes ground water monitoring difficult. Soil pore-water information could be useful for adjusting land application operations to prevent or minimize detrimental effects on ground water.

Erickson, D., 1995, Loon Lake Class II Inspection, Ground Water, Permit No. ST 8019: WDOE Publication # 95-319.
A Class II inspection was conducted at the Loon Lake Wastewater Treatment Plant August 23-25, 1994. The inspection consisted of two parts: 1) an engineering evaluation of the effectiveness of treatment, and 2) an evaluation of the ground water monitoring program. This document describes the methods and findings of the ground water evaluation.

Treated wastewater at Loon Lake is land applied with a center pivot sprinkler to a 65-acre spray field. Ground water adjacent to the spray field is monitored by three wells. This inspection evaluated the adequacy of the monitoring network and ground water sampling procedures.

With the current monitoring network, it is not possible to verify the ground water flow direction and to assess the adequacy of well placement. The screened interval of two wells is appropriate; the screened interval of the third well needs to be verified. The wells do not meet current sealing requirements. Recommendations are made to address deficiencies. The most significant deficiency is that the ground water flow direction has not been defined.

The facility's sampling procedures were adequate for general chemistry parameters. However, the sampling program should be upgraded to include a written Sampling and Quality Assurance Plan, field quality assurance samples, and sampling equipment modifications to reduce the potential for sample contamination.

Marti, P., 1996, Argonne Road Ground Water Characterization of Organic Solvents, November 1995 and May 1996, WDOE Publication # 96-354.
Ground water samples for volatile organic analysis (VOAs) were collected from nine monitoring wells and three private wells along Argonne Road to define the current distribution and concentrations of contaminants in a small alluvial aquifer east of Spokane. The suspected source is a sludge disposal area.

PERC, TCE, and cis-1,2,-DCE were detected in three of the monitoring wells (29P3, 32C4, 32M3) and one private well (32C1). The highest concentrations were detected in 29P3, which is a shallow well (~ 30 feet deep) located about 1000 feet down gradient of the sludge disposal area. PERC, TCE, and cis-1,2,-DCE concentrations in this well were 88 mg/L, 11 mg/L, and 21 mg/L in November 1995; and 90 mg/L, 17 mg/L, and 28 mg/L, respectively, in May 1996. Model Toxic Control Act (MTCA) cleanup levels were exceeded for PERC (5.0 mg/L) in wells 29P3, 32C4, 32C1, and 32M3. TCE cleanup levels (5.0 mg/L) were also slightly exceeded in wells 29P3 and 32C4.

Overall, concentrations have decreased since the detection of contamination in 1981. Although down gradient municipal wells drilled in the Spokane Valley-Rathdrum Prairie (SVRP) aquifer have not been affected, migration of contaminated ground water to these wells continues to be of concern. To reduce contaminant loading to the SVRP aquifer, a ground water remediation and monitoring program should be designed and implemented to remove and treat the organic compounds. Periodic ground water sampling should continue.

Recommendations

1. Need nitrate contamination studies in the Airway Heights, Chamokane Creek, and Deer Park areas to determine the extent of present ground-water contamination. Should talk to local government (Spokane County and Town of Deer Park) to determine where monitoring is most needed and the scope of monitoring that would best fulfill data needs.

2. Work with Spokane County Engineering Dept. (Stan Miller), Eastern Washington U., USGS, and others to design research that will define the surface-water/ground-water interaction between the Spokane River and the Spokane-Rathdrum Prairie Aquifer. Some project components may be: 1) water temperature survey of the Spokane River and river sediments to determine gaining and losing reaches, 2) gaging stations located based on knowledge gained about gaining and losing reaches long the stream, 3) placement of water-level/water-quality monitoring wells along the river to determine ground-water gradients and ground-water-quality information near the river.

References

Buchanan, Dr. John, 1997, Personal communication: Eastern Washington University, Geology Department, Cheney, WA.

Covert, John, 1997, Personal communication: Washington Department of Ecology, Eastern Regional Office, Water Resources Program, Spokane, WA.

Ebbert, J.C., 1984, The quality of ground water in the principle aquifers of northeastern-north central Washington: U.S. Geological Survey Water-Resources Investigations Report 83-4102.

Miller, Stan, 1997, Personal communication: Spokane County Engineer's Office, Spokane, WA.

Peterson, Wayne, Personal communication: Washington Department of Ecology, Eastern Regional Office, Water Quality Program, Spokane, WA.

Intensive Surveys

by
Greg Pelletier

Introduction

In this chapter, existing water quality studies of the Spokane Water Quality Management Area (WQMA) are reviewed. From this review, potential information and study needs are identified.

The Watershed Assessments Section (WAS) has conducted four studies over the past ten years that contain information on waterbodies in the Spokane WQMA. These include the following:

- a study of cadmium, copper, mercury, lead, and zinc in the Spokane River with comparisons to water quality standards and recommendations for Waste Load Allocations;
- an evaluation of phosphorus attenuation in the Spokane River and allowable P loading to Long Lake;
- a study of dissolved oxygen in the Spokane River downstream from the Inland Empire Paper Company with recommendations for Waste Load Allocations;
- a receiving water survey and Class II inspection for Tekoa WTP.

Previous Studies

Metals in the Spokane River

All of the sections of the EILS program have conducted studies of heavy metals in the Spokane River, including the following:

- studies of Cd, Cu, Hg, Pb, and Zn in the water column during 1992-93 by the WAS;
- continued ambient monitoring at Riverside Park and at the state line by the Ambient Monitoring Section;
- sampling of fish and sediment during 1993-94 by the Toxics Investigations Section;
- special sampling of the water column during May-June 1997 by the Toxics Investigations Section and Ambient Monitoring Section.

In addition to the studies by EILS, several studies of metals contamination have been conducted by the USEPA, USGS, and state of Idaho in the Idaho reaches of the Spokane River watershed (Gugliemone, 1992; IDEQ, 1993, 1995, and 1997; USGS 1992, 1993, and 1994). The three metals of concern — cadmium, lead, and zinc — have been found to exceed water quality criteria for protection of aquatic life. Zinc exceed criteria year-round, and cadmium and lead usually exceed criteria during the high flow season. The studies by USEPA, USGS, and IDEQ have documented the major sources of contamination as deposits of mine tailings in the Silver Valley and fluvially deposited sediments contaminated with metals deposited in the bed and banks of the South Fork Coeur d'Alene and Coeur d'Alene Rivers.

This briefing paper summarizes information from the study by the WAS.

Pelletier (1994a) conducted a study of cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), and zinc (Zn) concentrations in the Spokane River. Samples were collected on eight occasions between July 1992 and September 1993. Three locations were sampled between river miles 63.5 and 96.0. Dissolved, total, and total recoverable metals were analyzed. Water quality criteria for dissolved Zn were not met at all three sampling locations during high and low flow seasons. Criteria for dissolved Pb were exceeded at all sampling sites during the high flow season. Criteria for Cd were exceeded in the upper river during the high flow season. Nonpoint sources of Cd, Pb, and Zn from historical mining practices in Idaho are considered to be the major reason for violation of Washington's water quality criteria and are considered likely to sustain excessive background loading for many years. Concentrations of trace metals relative to criteria in the Spokane River generally decreased downstream from the state line. The fractions of dissolved/total metals were similar throughout the study area and generally increased in the order of Pb < Cd < Zn < Cu. Most metals concentrations increased with river flow.

A seasonal strategy was proposed for total maximum daily loads (TMDLs), load allocations (LAs) from nonpoint sources, and waste load allocations (WLAs) for point sources regulated under the National Pollutant Discharge Elimination System (NPDES). WLAs were proposed for metals with background concentrations potentially greater than the water quality criteria (Zn throughout the river all year; Pb throughout the river during the high flow season and in the upper river during the low flow season; and Cd in the upper river all year).

A phased TMDL approach is recommended which stipulates that USEPA and Idaho develop a schedule for managing and monitoring loads from Idaho to meet water quality standards for Cd, Pb, and Zn at the Washington border. The phased WLAs for point sources in Washington will ensure that Cd, Pb, and Zn concentrations are not elevated above existing concentrations that are sustained by loading from Idaho, groundwater inflows, and minor nonpoint sources in Washington. Phased WLAs will be adjusted if monitoring data show progress in reducing concentrations sustained by excessive loads from Idaho.

Phosphorus Loading to the Spokane River and Eutrophication of Long Lake

The Spokane River and its major reservoir, Long Lake, have a long history of water quality problems and associated controversies. One of the more severe water quality deficiencies was eutrophication in Long Lake, which previously exhibited very low hypolimnetic dissolved oxygen and excessive algal growth. Phosphorus removal at the Spokane Advanced Wastewater Treatment Plant (AWTP), the largest point source to the river, was initiated in late 1977, and markedly improved the trophic condition of Long Lake. The Spokane River Waste Load Allocation process was initiated by court order in 1979. The Department of Ecology determined the Total Maximum Daily Load (TMDL) for phosphorus loading to the lake in 1981 and established a site-specific water quality standard for phosphorus concentrations in the lake.

Patmont *et al.* (1985) conducted a study during the low flow season of 1984 to determine if significant losses of total phosphorus occurred within the river system from its source at Lake Coeur d'Alene, Idaho to Nine Mile Dam, Washington just above Long Lake. A detailed assessment of phosphorus transport within 15 reaches of the river and during 9 sampling dates revealed that more than 40 percent of the total influent load to the river was lost during transport.

Patmont *et al.* (1987) analyzed available data collected on the Spokane River system through 1985, for the purpose of updating the Long Lake data base and refining existing water quality models. Several hypothetical waste load allocation scenarios were evaluated to determine their effect on total phosphorus concentrations in Long Lake. These analyses revealed that reductions in future point source nutrient discharges were necessary to achieve the proposed phosphorus standard.

City of Spokane AWTP

The City of Spokane is conducting a study of water quality in the vicinity of the outfall for the Spokane AWTP. The consultant for the city, CH2M-Hill, has submitted several draft technical memos with analysis of existing data and water quality modeling. The WAS has been involved in reviewing the ongoing work and helping to develop a monitoring program. The purpose of the study by the city is to develop data to be used for establishing water quality-based permit limits for ammonia and metals in the effluent.

Several issues have been raised regarding potential water quality impacts of future discharges from expansion of the Spokane AWTP, including to following:

- temperature, pH, alkalinity, hardness, and metals at the mixing zone boundary compared with historical sampling stations at Meenach Bridge and Riverside Park;

- potential impacts of the discharge on dissolved oxygen downstream in the river and in Long Lake;

- appropriateness of various modeling approaches (e.g. steady-state, Monte Carlo simulation, or flow-based) for establishing permit limits.

Dissolved Oxygen in the Spokane River Downstream from Inland Empire Paper Company

Dissolved oxygen in the impounded reach of the Spokane River behind Upriver Dam has been observed to fall below state water quality standards. Pelletier (1994b and 1997) developed a steady-state model of dissolved oxygen in the Spokane River from river mile 83.0 to 72.8 using the USEPA stream water quality model QUAL2E. The model was calibrated and verified using data collected during August and September 1992. The segment of the Spokane River between Inland Empire Paper Company (IEPC) and Upriver Dam was found to be the most sensitive to changes in dissolved oxygen from loading of biochemical oxygen demand (BOD) by IEPC. The QUAL2E model was used to determine waste load allocations (WLAs) for BOD loading from IEPC. Various loads of BOD were input to the model until the load which satisfied the dissolved oxygen criteria was found. WLAs based on the QUAL2E model results were found to be more restrictive than loading limits allowed under the previous NPDES permit during both permit periods.

Eutrophication of the Upper Spokane River

Several studies of eutrophication of the upper Spokane River reach in Idaho have been conducted (Falter *et al.*, 1992; Harvey, 1992). The upper river reach can be classified as mesotrophic. Primary productivity in the upper Spokane is increasing due to increased nutrient loads. Falter's study suggested that the river is becoming more vulnerable to nutrients as urban development causes nutrient loading to increase and the metals which inhibit algal growth decline. Zinc is considered to be a primary factor in limiting algal growth (Cummins *et al.*, 1980; Falter and Mitchell, 1982).

The impounded reach of the river may stratify where water depth exceeds 20 feet during low flow conditions. Dissolved oxygen concentrations have been observed to decrease below water quality standards in this reach due to respiration of algae, decay of carbonaceous and nitrogenous BOD, and sediment oxygen demand.

Tekoa WTP

Carey (1989) conducted a receiving water study for the Tekoa Wastewater Treatment Plant (WWTP) discharge to Hangman Creek. Degraded conditions in Hangman Creek resulted from low effluent dilution as well as agricultural nonpoint sources. Conditions showing deterioration below the WWTP included: dissolved oxygen, macroinvertebrate viability, as well as nutrient and fecal coliform loading. A Total Maximum Daily Load (TMDL) analysis indicated extreme chlorine toxicity at dilution factors of less than 45. Recommendations included installation of a chlorine removal system and effluent diversion from the creek when dilution factors are less than 10.

1996 Section 303(d) List

The 1996 Section 303(d) list is presented in Table 1. The 303(d) list is a summary of all waterbody segments in the WQMA which are not presently meeting water quality standards according to data compiled from all available sources. The basis of the 303(d) listing for each waterbody is presented in Table 1 along with the related activities in the watershed and a proposed strategy for corrective actions to meet the requirements of the federal Clean Water Act.

Recommendations

Metals in the Spokane River

Concentrations of cadmium, lead, and zinc are expected to continue to exceed water quality standards in the Spokane River mainly due to sources in Idaho (e.g. mine tailings in the South Fork Coeur d'Alene River). Concentrations in the Spokane River will hopefully decrease as remedial actions are conducted in Idaho. A phased TMDL approach is recommended for establishing WLAs for NPDES permit's in Washington and Idaho. Under the phased approach, point sources would be allowed to discharge effluent of the same quality as the river while the river exceeds water quality standards. If metals concentrations are show to decrease below the standards, then mixing zones for individual NPDES permit's for metals may be allowed.

The following studies are recommended:

- Continued monitoring of dissolved and total recoverable Cd, Pb, and Zn in the Spokane River at the state line. Ecology should continue to collect ambient monitoring data for dissolved and total recoverable Cd, Pb, and Zn at the state line. These data will be useful to detect trends in concentrations to track the progress of loading controls in Idaho. The data will also be useful to document continued violation of water quality standards.

Eutrophication and Dissolved Oxygen in the Spokane River

Dissolved oxygen in the Spokane River may be threatened by the combined effect of wastewater discharges in the basin. The study of the Inland Empire Paper Company shows the sensitivity of the river to a single discharge. The proposed expansion of the City of Spokane's AWTP has raised similar questions about the capacity of the river and Long Lake to assimilate loads of oxygen demanding materials.

The following studies are recommended:

- Spokane River dissolved oxygen TMDL study. A basin-wide modeling analysis of dissolved oxygen should be conducted to establish allowable loading limits for significant sources of oxygen demanding materials. The geographical scope of the modeling analysis should probably be from the state line to Long Lake Dam or the mouth of the river. It may also be appropriate to extend the model upstream to the outlet of Lake Coeur d'Alene.

Studies Related to Mixing Zones for NPDES Dischargers

The City of Spokane is currently conducting studies and designing future studies of various parameters related to establishing water quality-based effluent limits for ammonia and metals. Water quality conditions at the boundary of proposed mixing zones needs to be assessed.

The following studies are recommended:

- City of Spokane mixing zone studies. Intensive surveys should be conducted for temperature, pH, alkalinity, hardness, and trace metals for evaluation of the mixing zones for ammonia and metals for the Spokane AWTP. The purpose of this study would be to verify the results of studies conducted by the City of Spokane.

References

Carey, B. M., 1989. Tekoa Wastewater Treatment Plant Limited Class II and Receiving Water Survey. Washington State Department of Ecology, Olympia, WA.

Cummins, J.M, C.E. Gangmark, R.L. Arp, P.R. Davis, and S. Fillip. 1980. An assessment of algal productivity in Spokane River waters collected from Lake Coeur d'Alene to Post Falls, Idaho, May-October, 1980. U.S. Environmental Protection Agency, Region 10, Surveillance and Analysis Division, Laboratory Branch, Manchester, Washington.

Falter, C.M., B. Riggers, and J.W. Carlson. 1992. Physical and chemical water quality of the Spokane River outlet reach of Lake Coeur d'Alene, Kootenai County, Idaho, 1990 and 1991. Prepared for the Idaho Division of Environmental Quality by the Department of Fish and Wildlife Resources, College of Forestry, Wildlife, and Range Sciences, and the Idaho Water Resources Research Institute, Moscow, Idaho.

Falter, C.M., and B.D. Mitchell. 1982. Aquatic ecology of the Spokane River between Coeur d'Alene and Post Falls, Idaho, 1980. Prepared for Idaho Department of Health and Welfare, Boise, Idaho.

Gugliemone, K.V. 1992. Spokane River (Idaho reach) problem assessment. Prepared for U.S. Environmental Protection Agency, Region X, Water Division, Seattle, Washington, by Tetra Tech, Inc., Fairfax, Virginia.

Harvey, G.W. 1992. Low flow plant growth nutrient, chlorophyll, and dissolved oxygen monitoring of the Spokane River, Idaho. Idaho Division of Environmental Quality, Coeur d'Alene, Idaho.

IDEQ, 1993. South Fork Coeur d'Alene River water quality assessment. Idaho Division of Environmental Quality. 2110 Ironwood Parkway, Coeur d'Alene, ID. 9pp.
IDEQ, 1995. Coeur d'Alene River water quality assessment. Idaho Division of Environmental Quality. 2110 Ironwood Parkway, Coeur d'Alene, ID. 14pp.

IDEQ, 1997. South Fork Coeur d'Alene River water quality assessment. Idaho Division of Environmental Quality. 2110 Ironwood Parkway, Coeur d'Alene, ID. 15pp.

Patmont, C.R., G.J. Pelletier, and Dr. M.E. Harper., 1985. Phosphorus Attenuation in the Spokane River. Prepared by Harper-Owes, Seattle, Washington. 144 pp.

Patmont, C.R., G.J. Pelletier, et al., 1987. The Spokane River Basin: Allowable Phosphorus Loading. Prepared by Harper-Owes, Seattle, Washington. 178 pp.

Pelletier, G., 1994a. Cadmium, Copper, Mercury, Lead, and Zinc in the Spokane River: Comparisons with Water Quality Standards and Recommendations for Total Maximum Daily Loads. Washington State Department of Ecology, Olympia, WA. Ecology Publication No. 94-99, 46 pp. + appendices.

Pelletier, G., 1994b. Dissolved Oxygen in the Spokane River Downstream from Inland Empire Paper Company with Recommendations for Waste Load Allocations for Biochemical Oxygen Demand. Ecology Publication No. 94-155, 33 pp. + appendices.

Pelletier, G., 1997. Waste Load Allocations for Biochemical Oxygen Demand for Inland Empire Paper Company. Ecology Publication No. 97-313, 18 pp. + appendices.

USGS, 1992. Water resources data Idaho water year 1991. Volume 2. Upper Columbia River basin and Snake River basin below King Hill. U.S. Geological Survey Water Data Report ID-91-2. pp. 267-276.

USGS, 1993. Water resources data Idaho water year 1992. Volume 2. Upper Columbia River basin and Snake River basin below King Hill. U.S. Geological Survey Water Data Report ID-92-2. pp. 77-87.

USGS, 1994. Water resources data Idaho water year 1993. Volume 2. Upper Columbia River basin and Snake River basin below King Hill. U.S. Geological Survey Water Data Report ID-93-2. pp. 77-89.

Table 1. 1996 303(d) list with a summary of the bas... he listing, related activities, and possible strategies for removal from the list.

WBID:	Name:	Parameter:	Basis for Listing:	Related Activities:	Strategy:
WA-54-1010	SPOKANE RIVER	Temperature	10 excursions beyond the criterion at Ecology ambient monitoringstation 54A050 between 1991 and 1994.	The likely cause of these excursions beyond the criterion are due to stratification behindimpoundments. Remedies to the problem may not be available.	
WA-54-1010	SPOKANE RIVER	pH	4 excursions beyond the criterion at Ecology ambient monitoringstation 54A050 between 1992 and 1994.		
WA-54-1010	SPOKANE RIVER	PCBs	Johnson, et al. 1994.- excursions beyond the criterion in multiplesamples of edible fish tissue of several species in 1993-94.;Dept. of Ecology, 1995. - excursions beyond the criterion inmultiple samples of edible fish tissue of several species in 1993-94		
WA-54-1010	SPOKANE RIVER	4,4'-DDE	2 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543106 in 1972.		
WA-54-1010	SPOKANE RIVER	Dieldrin	2 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543106 in 1972.		
WA-54-1010	SPOKANE RIVER	Sediment Bioassay	Batts and Johnson, 1995. - Microtox and Hyalella composite samplein 1994.		
WA-54-1010	SPOKANE RIVER	Dissolved Oxygen	2 excursions beyond the criterion at Ecology ambient monitoringstation 54A050 on 10/9/91 and 9/10/92.	The likely cause of these excursions beyond the criterion are due to stratification behindimpoundments. Remedies to the problem may not be available.	
WA-54-1015	CHAMOKANE CREEK	Temperature	Sullivan et al, 1990. - 27 excursions beyond the criterionmeasured during 8/88.		
WA-54-1020	SPOKANE RIVER	Zinc	Pelletier, 1994. - 2 excursions beyond the criterion on 11/2/92and 3/31/93 at RM 65.	All major pollution sources of metals are located in Idaho. Ecology's Water Quality Program Policy onTMDLs adopted 8/93 specifies that EPA is expected toconduct all interstate TMDLs according to the federalClean Water Act. EILS completed a TMDL on 6/94.	EPA should conduct an interstate TMDL and require implementation of pollution controls in Idaho so that Washington's water quality standards are meet at the border per the Supreme Court ruling.
WA-54-1020	SPOKANE RIVER	Chromium	2 excursions beyond the criterion at Ecology ambient monitoringstation 54A120 on 3/7/89 and 9/3/91.		
WA-54-1020	SPOKANE RIVER	PCBs	Johnson, et al. 1994.- excursions beyond the criterion in multiplesamples of edible fish tissue of several species in 1993-94.;Dept. of Ecology, 1995. - excursions beyond the criterion inmultiple samples of edible fish tissue of several species in 1993-94		
WA-54-1020	SPOKANE RIVER	pH	6 excursions beyond the criterion at Ecology ambient monitoringstation 54A120 between 1988 and 1993.		
WA-54-1020	SPOKANE RIVER	Ammonia-N	5 excursions beyond the criterion at Ecology ambient monitoringstation 54A120 between 1988 and 1992.		
WA-54-1020	SPOKANE RIVER	Total Phosphorus	Completed Phase I State Clean Lakes Restoration Project in 1993;Soltero, et al. 1992.		
WA-54-1020	SPOKANE RIVER	Fecal Coliform	7 excursions beyond the criterion at Ecology ambient monitoringstation 54A120 between 11985 and 1993.		
WA-54-9040	LONG LAKE (RESERVOIR)	DDT	13 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1969 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	4,4'-DDE	11 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1969 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	4,4'-DDD	9 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1969 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	Heptachlor	7 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1970 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	HeptachlorEpoxide	6 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1970 and 1971.		

Table 1. 1996 303(d) list with a summary of the basis of the listing, related activities, and possible strategies for removal from the list.

WBID:	Name:	Parameter:	Basis for Listing:	Related Activities:	Strategy:
WA-54-9040	LONG LAKE (RESERVOIR)	Aldrin	7 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1970 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	Dieldrin	13 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543002 between 1969 and 1971.		
WA-54-9040	LONG LAKE (RESERVOIR)	PCBs	Johnson, et al. 1994.- excursions beyond the criterion in multiplesamples of edible fish tissue of several species in 1993-94.;Dept. of Ecology, 1995. - excursions beyond the criterion inmultiple samples of edible fish tissue of several species in 1993-94		
WA-55-1010	LITTLE SPOKANE RIVER	Fecal Coliform	2 excursions beyond the criterion at Ecology ambient monitoringstation 55B070 in 12/87 and 1/91.;2 excursions beyond the criterion at Ecology ambient monitoringstation 55B080 in 12/90 and 1/91.;3 excursions beyond the criterion at Ecology ambient monitori		
WA-55-1010	LITTLE SPOKANE RIVER	Temperature	2 excursions beyond the criterion at Ecology ambient monitoringstation 55B082 on 7/10/90 and 8/7/90.;3 excursions beyond the criterion at Ecology ambient monitoringstation 55B100 on 7/10/90, 8/7/90, and 8/2/94.	Boise has scheduled a TFW watershed analysis for the WAU 550101 with a tenative start date of 10/95.	Compile the required information for completing a TMDL or consideration of delisting under "other required controls" per federal regulations.
WA-55-1010	LITTLE SPOKANE RIVER	Dissolved Oxygen	2 excursions beyond the criterion at Ecology ambient monitoringstation 55B070 on 8/4/87 and 10/6/87.		
WA-55-1010	LITTLE SPOKANE RIVER	PCBs	Dept. of Ecology, 1995. - excursions beyond the criterion inmultiple samples of edible fish tissue of 2 species in 1994.		
WA-55-1010	LITTLE SPOKANE RIVER	pH	2 excursions beyond the criterion at Ecology ambient monitoringstation 55B070 on 9/9/86 and 9/13/88.;3 excursions beyond the criterion at Ecology ambient monitoringstation 55B082 during 1990.		
WA-55-1011	DEADMAN CREEK	Temperature	2 excursions beyond the criterion at Ecology ambient monitoringstation 55C070 on 7/10/90 and 8/7/90.		
WA-55-1011	DEADMAN CREEK	pH	3 excursions beyond the criterion at Ecology ambient monitoringstation 55C070 during 1990.		
WA-55-1012	DRAGOON CREEK	Fecal Coliform	Juul, 1991.	The Spokane Conservation District has developed the Dragoon Creek Watershed Management Plan.	Identify what additional activities are needed to complete the Watershed Plan as a TMDL or for delisting under "other control required" per federal regulations.
WA-55-1012	DRAGOON CREEK	Dissolved Oxygen	Joy, 1981.Juul, 1991.	TMDL based on removal of Deer Park wastewater discharge submitted 3/9/92. EPA determined that theTMDL was incomplete on 2/12/92. EPA provided no documentation describing rationale for the incomplete determination.;It is expected that removal of this disc	Conduct monitoring of the creek to determine if dissolve oxygen standards are being met. Also, EPA should document the rationale for the incomplete determination so that the TMDL can be finished if necessary. Identify what additional activities are need
WA-56-1010	HANGMAN CREEK	Temperature	24 excursions beyond the criterion at Ecology ambient monitoringstation 56A070 between 1985 and 1993.	The Spokane Conservation District has developed the Hangman Creek Watershed Management Plan.	Identify what additional activities are needed to complete the Watershed Plan as a TMDL or for delisting under "other control required" per federal regulations.
WA-56-1010	HANGMAN CREEK	pH	32 excursions beyond the criterion at Ecology ambient monitoringstation 56A070 between 1984 and 1993.	The Spokane Conservation District has developed the Hangman Creek Watershed Management Plan.	Identify what additional activities are needed to complete the Watershed Plan as a TMDL or for delisting under "other control required" per federal regulations.
WA-56-1010	HANGMAN CREEK	4,4'-DDE	2 excursions beyond National Toxics Rule (40 CFR Part 131) criterion at USEPA station 543150 (mouth) in 1972.	The Spokane Conservation District has developed the Hangman Creek Watershed Management Plan.	Conduct monitoring to determine if the problem with DDT metabolites still exists.

Table 1. 1996 303(d) list with a summary of the basis of the listing, related activities, and possible strategies for removal from the list.

WBID:	Name:	Parameter:	Basis for Listing:	Related Activities:	Strategy:
WA-56-1010	HANGMAN CREEK	Fecal Coliform	13 excursions beyond the criterion at Ecology ambient monitoringstation 56A070 between 1984 and 1993.;Carey, 1989.	The Spokane Conservation District has developed the Hangman Creek Watershed Management Plan.	Identify what additional activities are needed to complete the Watershed Plan as a TMDL or for delisting under "other control required" per federal regulations.
WA-56-1010	HANGMAN CREEK	Dissolved Oxygen	Carey, 1989.	The Spokane Conservation District has developed the Hangman Creek Watershed Management Plan.	Identify what additional activities are needed to complete the Watershed Plan as a TMDL or for delisting under "other control required" per federal regulations.
WA-57-1010	SPOKANE RIVER	Cadmium	Pelletier, 1994. - 2 excursions beyond the criterion on 3/31/93and 5/25/93 at RM 96.	All major pollution sources of metals are located inIdaho. Ecology's Water Quality Program Policy onTMDLs adopted 8/93 specifies that EPA is expected toconduct all interstate TMDLs according to the federalClean Water Act. EILS completed a TMDL on 6/94.	EPA should conduct an interstate TMDL and require implementation of pollution controls in Idaho so that Washington's water quality standards are meet at the border per the Supreme Court ruling.
WA-57-1010	SPOKANE RIVER	Zinc	2 excursions beyond the criterion at Ecology ambient monitoringstation 57A150 on 5/3/94 and 7/6/94.;Pelletier, 1994. - 6 excursions beyond the criterion between 7/92and 9/93 at both RM 85 and RM 96.	All major pollution sources of metals are located inIdaho. Ecology's Water Quality Program Policy onTMDLs adopted 8/93 specifies that EPA is expected toconduct all interstate TMDLs according to the federalClean Water Act. EILS completed a TMDL on 6/94.	EPA should conduct an interstate TMDL and require implementation of pollution controls in Idaho so that Washington's water quality standards are meet at the border per the Supreme Court ruling.
WA-57-1010	SPOKANE RIVER	Mercury	3 excursions beyond the criterion at Ecology ambient monitoringstation 57A150 in 1991 and 1992.	All major pollution sources of metals are located inIdaho. Ecology's Water Quality Program Policy onTMDLs adopted 8/93 specifies that EPA is expected toconduct all interstate TMDLs according to the federalClean Water Act. EILS completed a TMDL on 6/94.	EPA should conduct an interstate TMDL and require implementation of pollution controls in Idaho so that Washington's water quality standards are meet at the border per the Supreme Court ruling.
WA-57-1010	SPOKANE RIVER	PCBs	Johnson, et al. 1994.- excursions beyond the criterion in multiplesamples of edible fish tissue of several species in 1993-94.;Dept. of Ecology, 1995. - excursions beyond the criterion inmultiple samples of edible fish tissue of several species in 1993-94		
WA-57-1010	SPOKANE RIVER	SedimentBioassay	Batts and Johnson, 1995. - Microtox and Hyalella composite samplein 1994.		
WA-57-1010	SPOKANE RIVER	Temperature	3 excursions beyond the criterion at Ecology ambient monitoringstation 57A150 on 8/7/91, 8/5/92 and 8/2/94.;10 excursions beyond the criterion at Ecology ambient monitoringstation 57A190 between 1986 and 1990.	Ecology ambient monitoring station 57A150 is 0.1 milewest of the Washington-Idaho border. Ecology ambientmonitoring station 57A190 is in Idaho near Post Falls. All pollution sources causing this listing are locatedin Idaho. Ecology's Water Quality Progr	
WA-57-1010	SPOKANE RIVER	Dissolved Oxygen	7 excursions beyond the criterion at Ecology ambient monitoringstation 57A150 between 1991 and 1994.;6 excursions beyond the criterion at Ecology ambient monitoringstation 57A190 between 1985 and 1990.	Ecology ambient monitoring station 57A150 is 0.1 milewest of the Washington-Idaho border. All pollutionsources causing this listing are located in Idaho. Ecology's Water Quality Program Policy on TMDLsadopted 8/93 specifies that EPA is expected to conduc	
WA-57-9020	NEWMAN LAKE	Total Phosphorus	Completed Phase I State Clean Lakes Restoration Project in 1988 - Problems Encountered: Blue-green algae, hypolimnetic anoxia,turbidity, tributary nutrient inputs, sediment phosphorusrecycling, low transparency.Funk and Moore, 1988.	Cpmpleted Phase II State Clean Lakes RestorationProject in 1995:Control measures implemented based on the Phase Istudy - phosphorus precipitation/inactivation,hypolimnetic aeration, watershed nutrient management(streambank fencing, septic system managemen	

Lakes Ambient Monitoring

by
Kirk Smith

Introduction

Eloika and Diamond Lakes are the only two lakes Ecology has monitored in recent years. In 1997 Ecology began monitoring Newman with the help of a volunteer.

Summary of Findings

Diamond Lake was sampled by Ecology staff only in 1994.

Secchi depths and a chlorophyll *a* concentration indicated that algal growth was low on both sampling dates. (The August chlorophyll result is not reported here due to concern about data quality.) The only unusual result from profile data was that the thermocline was rather deep on both sampling dates, so that there was no real distinction between the metalimnion and the hypolimnion. Based on results from all three major trophic state parameters (total phosphorus, chlorophyll *a*, and Secchi depths), Diamond Lake was classified as oligotrophic in 1994 (Smith and Rector, 1994).

Water clarity in Lake Eloika was fairly poor in 1994. However, Secchi depths measured in 1994 were similar to those measured during previous years (see graph of Secchi depth data), and there was no apparent change in Secchi depths from 1989 through 1994. This was tested using the seasonal Kendall test for trend, and results indicated that there was not a significant trend in Secchi depths from 1989 through 1994 ($p = 0.56$).

Secchi depths and a chlorophyll a concentration indicate that algal growth was moderately heavy to heavy when the lake was sampled. (The chlorophyll *a* concentration from August is not reported due to data quality concerns.) Total phosphorus concentrations were high on both sampling dates.

Based on results for all three major trophic state parameters, as well as the heavy population of aquatic plants in the lake, Lake Eloika was classified as eutrophic in 1994 (Smith and Rector, 1994).

Recommendations

It is recommended that Ecology continue to monitor Newman Lake to assess the effectiveness of restoring the lake and to monitor for trends in improving or deteriating water quality over time.

References

Smith, A. Kirk and J. Rector, 1997. Water Quality Assessments of Selected Lakes within Washington State, 1994. Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, WA, 418 pp.

Rivers and Streams Ambient Monitoring

by
David Hallock

Introduction

The objectives of this chapter of the EILS Spokane Basin Briefing Paper are to identify past river and stream work done in the Spokane Basin by the Ambient Monitoring Section (AMS) and briefly summarize findings. Based on this information, I have made suggestions for monitoring in water year (WY) 1999.

I hope that the Spokane watershed work group will
1. Identify five stations based on the recommendations in this briefing paper and new issues and information presented at the workshop,
2. Endorse the proposed stations where metals data should be collected or identify up to three alternate stations, and
3. Propose specific objectives on which we may focus data analysis efforts during the analysis year of the watershed management planning cycle.

Historical River and Stream Monitoring by AMS

Ecology's AMS has monitored 12 stations in the Spokane Basin from WY 1987 to the present (Table 1). Four of these are "core" stations, that is, they have been monitored more or less continuously. These four stations are expected to remain as core stations. We have also monitored metals concentrations bimonthly at the Spokane River at Riverside State Park and Spokane at Stateline. Recently, we have been monitoring dissolved metals monthly at the Stateline station and more intensively in May and June of this year at several additional stations.

In the past few years, AMS has conducted the following data analysis projects on AMS data from the Spokane Basin:

1. A brief analysis of trends in total phosphorus concentrations in tributaries to Long Lake on the Spokane River (Hallock, 1990).

2. An analysis of trends in total phosphorus concentration and flux at the mouth of the Little Spokane River (Hallock, 1991a).

3. An analysis of conventional and total mercury data from five lower-reach stations in the Little Spokane River basin monitored in 1990-91 (Hallock, 1991a). This report focused mainly on mercury results (the Little Spokane had been listed as impaired due to high mercury concentrations), but included an analysis of the ancillary conventional data.

4. A general review of water quality from mid-reach stations on the Little Spokane River monitored in WY 94 (Hallock, 1996). This monitoring and analysis was part of a previous cycle of the basin approach to watershed management in this basin. The review included an updated trend analysis of total phosphorus concentration at the mouth of the Little Spokane River.

Table 1. River and stream stations monitored by AMS from WY 87 to the present:

Station Number	Name	Years Monitored 1980----1990----------------- 7	8	9	0	1	2	3	4	5	6	7
54A050	Spokane R @ Mouth			x	x	x	x					
54A120[a]	Spokane R @ Riverside State Pk	x	x	x	x	x	x	x	x	x	x	x
55B070[a]	Little Spokane R nr Mouth	x	x	x	x	x			x	x	x	x
55B080	Little Spokane R nr Griffith Spring				x	x						
55B082	Little Spokane R abv Dartford Creek				x	x						
55B100	Little Spokane R abv Deadman Creek				x	x			x			
55B200	Little Spokane @ Chattaroy								x			
55C065	Deadman Cr nr Mouth								x			
55C070	Peone (Deadman) Creek abv L Deep Cr				x	x						
55E070	Dragoon Cr nr Chattaroy								x			
56A070[a]	Hangman Cr @ Mouth	x	x	x	x	x		x		x	x	x
57A150[a]	Spokane R @ Stateline Br	x[b]	x[b]	x[b]	x[b]	x	x	x	x	x	x	x

[a] Core Stations

[b] Prior to WY 1991, this station was located five miles upstream (Spokane near Post Falls, 57A190)

Summary of Findings

Trend analyses were conducted with WQHYDRO analytical software (Aroner, 1997) on data collected approximately monthly by AMS since October, 1987. Only total phosphorus, nitrate plus nitrite, fecal coliform bacteria and total suspended solids were evaluated for trends. Recent (WY 1996) potential water quality standards violations are excerpted from Hallock, et al. (1997). Other conclusions may be excerpted from previous analyses, cited above.

Main Stem Spokane River

The most immediately pressing issue for the main stem Spokane River are the chronically high metals concentrations, especially zinc, but also cadmium and lead. The EILS study of metals contamination in the Spokane River is on-going and results will be reported in detail separately. In WY 1996, 18 results exceeded water quality standards. Eleven of these were from Stateline and seven from Riverside. At least one result exceeded criteria every time we looked. Most of these results exceeded the acute zinc criteria, but eight exceeded the chronic cadmium or lead criteria.

Conventional water quality is considerably deteriorated in the 30 miles between the Washington-Idaho state line and Riverside State Park, just below the Spokane wastewater treatment plant. Based on data collected since October, 1987, median suspended solids, conductivity and fecal bacteria increased 50, 115 and 367 percent, respectively. Median total phosphorus more than doubled, ammonia tripled and median nitrate plus nitrite increased from 0.03 to 0.47 mg/L. However, maximum temperatures were lower at the downstream station; in WY 1996, there were no temperature standards violations downstream and three upstream. Except for temperature, there were few water quality standards violations at either station.

There has been a significant declining trend in total phosphorus at Riverside during the last 10 years (-5.7% of the median annually; p=0.040), perhaps related to the total phosphorus ban in laundry detergents; perhaps not. (A more detailed evaluation of this issue is a potential candidate for investigation during the data analysis year.) There was no discernible trend at the upper station, perhaps because concentrations were often below detection limits and these results are routinely censored by the laboratory.

Nitrate plus nitrite increased at both stations (Riverside: +4.9%, p=0.05; Stateline: +10.7%, p=0.01). There was a very strong inverse correlation with flow at the lower station and no flow correlation at the upper station. This indicates either a point source between the two stations or a constant contribution from groundwater sources.

Fecal coliform bacteria also increased at both stations (Riverside: +8.7%, p=0.056; Stateline: +3.3%, p=0.036). Results greater than 100 colonies/100mL have been twice as common in recent years at the lower station. Bacteria counts were not strongly correlated with flow indicating point source(s) for bacteria.

There was no significant trend in discharge or total suspended solids at either Spokane River station.

Little Spokane River Basin

Water quality near the mouth of the Little Spokane River was generally good, with few water quality standards violations. Quality and quantity at the downstream station were greatly buffered by large springs in the lower reach. Above the springs, temperature and fecal bacteria exceeded standards occasionally and pH exceeded standards in and below Deadman (Peone) Creek. Temperature was highest at the most upstream station (Chattaroy)--which is unusual--perhaps from the influence of Eloika and other lakes in the drainage. Nutrient concentrations were moderate except nitrate plus nitrite which was higher than expected at the mouth, probably from groundwater influences from the springs, and all nutrients were quite high in Dragoon Creek. Non-point sources may be responsible for higher than expected suspended solids at Deadman Creek and the Little Spokane River at the Mouth and for occasional high fecal coliform bacteria counts. However, with the possible exception of Dragoon Creek, serious non-point source problems were not evident in the 1994 study (Hallock 1996). That study suggested Dragoon Creek for additional monitoring.

There were no noteworthy trends over the last 10 years at our station near the mouth in total phosphorus, nitrate plus nitrite, discharge, or phosphorus flux (mass of phosphorus per day). Total suspended solids increased slightly (+2% of the median per year; p=0.17).

Fecal coliform bacteria increased more significantly (+10%; p=0.02), although bacteria counts were still low and standards violations were no more common at the end than at the beginning of the time series.

Latah (Hangman) Creek at the Mouth

Water quality was generally poor at this station. Temperature, pH, and fecal bacteria all exceeded water quality standards criteria one or more times each year. Phosphorus concentrations tended to be high, especially when compared to other stations in the Spokane Water Quality Management Area. Sediment concentrations were low at flows less than 300 cfs but concentrations increased rapidly as discharge rose above that level.

The data series showed a significant increasing trend in instantaneous discharge (+6% of the median discharge annually; p=0.02). There was no trend in phosphorus concentration, but there was a strong decreasing trend in concentration after accounting for the trend in discharge (-22%; p=0.009). In other words, there may be less phosphorus entering the stream from watershed activities, but this reduction was masked by increasing discharge--which was positively correlated with phosphorus. In fact, the increase in discharge was so pronounced that phosphorus flux increased slightly during the period evaluated (+2% of the median annually; p=0.14) in spite of indications of decreasing concentrations for a given discharge. Nitrate plus nitrite increased significantly (+4.5%; p=0.03) but there was no trend after accounting for the increase in discharge. That is, the increasing trend in nitrate plus nitrate can be explained by the increase in discharge during the period evaluated.

Recommendations

1. Continue to monitor dissolved and total recoverable metals bi-monthly at the Spokane River at Stateline. Other potential metals stations include the Little Spokane River and Hangman Creek.

2. Confirm high nutrient concentrations in Dragoon Creek and collect additional baseline data at several stations prior to management activities. (This may already be underway through a grant to Stevens and Spokane County Conservation Districts. AMS monitoring should support and not duplicate their efforts.)

3. Collect additional baseline data at several stations on Latah (Hangman) Creek prior to management activities. (This should be done in support of the Watershed Plan developed by Spokane Conservation District and in conjunction with the district.)
4. Monitor small streams in the basin in support of on-going planning activities through county conservation districts, for example, Chamokane and Thompson Creeks.

5. Monitor small streams where data are not currently available (for example, Deep Creek).

6. Monitor additional Spokane River stations between Riverside State Park and Stateline in order to identify areas where water quality degradation is occurring.

References

Aroner, E. 1997. WQHYDRO. WQHYDRO Consultants, Portland, Oregon.

Hallock, D. 1990. Total Phosphorus Additions to Long Lake. Memo to Ken Merrill, February 14, 1990. 2 pp.+ figures.

Hallock, D. 1991a. Little Spokane River Total Phosphorus Analysis. Memo to Ken Merrill, March 26, 1991. 15 pp.

Hallock, D. 1991b. Little Spokane River Study, Final Report. Memo to Ken Merrill, November 14, 1991. 18 pp.

Hallock, D. 1996. Spokane Basin Data Analysis Report, Little Spokane Sub-Basin. Ecology Report No. 96-329. 12 pp+appendix

Hallock, D., W. Ehinger, and B. Hopkins. 1997. Water Year 1996 Annual Report (DRAFT)

Aquatic Plants Ambient Monitoring

by
Jenifer Parsons

Introduction

This chapter of the EILS Spokane Basin Briefing Paper will provide information on which waterbodies in the basin have been surveyed for aquatic plants, which waterbodies are known to have populations of noxious weeds or listed rare plants, and recommend future work to be done.

Historical Aquatic Plant Monitoring

Ecology's Ambient Monitoring Section has monitored aquatic plants in lakes and rivers of the state since 1994. Table 1 provides the names of waterbodies included in this program within the Spokane Basin.

Table 1: Waterbodies Monitored for Aquatic Plants:

WRIA	County	Waterbody Name	Years Surveyed
54	Spokane	Long Lake (Reservoir)	94, 95
55	Pend Oreille	Diamond Lake	94, 96, 97
55	Pend Oreille	Fan Lake	94, 97
55	Pend Oreille	Little Spokane River	94
55	Pend Oreille	Sacheen Lake	94
55	Spokane	Eloika Lake	94
55	Spokane	Reflection Lake	95
57	Spokane	Liberty Lake	95

The waterbodies listed in Table 2 are those known to contain listed noxious weeds. For reference, the aquatic plants included on the state noxious weed list are:

Cabomba caroliniana (fanwort)
Egeria densa (Brazilian elodea)
Hydrilla verticillata (hydrilla)
Lysimachia vulgaris (garden loosestrife)
Lythrum salicaria (purple loosestrife)
Lythrum virgatum (wand loosestrife)
Myriophyllum aquaticum (parrot feather)
Myriophyllum spicatum (Eurasian milfoil)
Nymphoides peltata (floating heart) - on the monitor list

Table 2: Waterbodies with listed noxious aquatic weeds:

WRIA	County	Waterbody Name	Noxious Aquatic Weed
54	Spokane	Long Lake (Reservoir)	*Lythrum salicaria, Nymphoides peltata*
55	Pend Oreille	Fan Lake	*Lythrum salicaria*
55	Pend Oreille	Little Spokane River	*Myriophyllum spicatum*
55	Pend Oreille	Sacheen Lake	*Lythrum salicaria, Myriophyllum spicatum*
55	Spokane	Eloika Lake	*Myriophyllum spicatum*
57	Pend Oreille	Trask Pond	*Myriophyllum spicatum*
57	Spokane	Liberty Lake	*Myriophyllum spicatum*

No locations of listed rare plants have been found by the aquatic plant monitoring program in the Spokane Basin. However, comprehensive data on rare plants are not maintained by this program. The Natural Heritage Program at the Washington State Department of Natural Resources should be contacted for a complete review of rare plant locations.

Additional details - Waterbodies with Noxious Weeds

- Long Lake on the Spokane River has some dense patches of the floating leaved plant *Nymphoides peltata*, and scattered patches of *Lythrum salicaria* where sampling occurred at the western end of the lake. A more extensive aquatic plant map which was produced under contract indicated that the *N. peltata* forms dense patches at least as far east in the reservoir as Nine Mile Falls (Marquez, 1994).

- Fan Lake, Pend Oreille County has *Lythrum salicaria* plants widely scattered along much of the shoreline. County Noxious Weed Control personnel have been working to eradicate this plant for several years, and the population is gradually being reduced (Sorby, 1997).

- Sacheen Lake and the Little Spokane River at Sacheen Lake were treated with the systemic herbicide Sonar® in 1995 to eradicate the *M. spicatum*. Some *M. spicatum* patches survived, and bottom barriers and hand pulling are being used to remove them (Lamb, 1997).

- Eloika Lake had a dense population of *M. spicatum* in the area around the public boat access at the time of the survey. The lake also supported dense populations of several native species. No lake-wide efforts to control the *M. spicatum* have been made.

- Liberty Lake had a very small population of *M. spicatum*. Aquatic Plant Management Fund money was used for some diver pulling and survey work in 1996. In 1997 the community is continuing to support these control efforts, which apparently are keeping the plant under control (Hamel, 1997).

Recommendations

- Continue to offer technical assistance to local government officials and citizens concerning the lakes with populations of noxious weeds.

- Continue monitoring lakes near waterbodies with noxious weeds to detect any new introductions of these plants at an early stage.

- Increase public education on the impacts of noxious aquatic weeds and how to prevent their spread.

References

Hamel, K. 1997. Washington State Department of Ecology. Personal Communication.

Lamb, D. 1997. Resource Management, Inc. Personal Communication.

Marquez, E. 1994. Stevens County Aquatic Weed Survey, 1994. Resource Management, Inc. Tumwater, WA.

Sorby, S. 1997. Pend Oreille County Noxious Weed Control Board. Personal Communication.

Toxics Investigations

by
Art Johnson

Introduction

Table 1 summarizes sources of data on chemical contaminants in the Spokane River Water Quality Management Area, from sampling conducted by the Toxics Investigations Section (TIS) and others. Historically, studies have focused on the impact of metals to the mainstem Spokane River due to mining that began along the South Fork Coeur d'Alene River at the turn of the century. These concerns and attendant data collection by EILS continue to the present day. The state Attorney General's office is currently evaluating whether a Natural Resources Damage Assessment suit should be brought against mining companies in Idaho.

During the late 1980's and early 1990's, investigations by TIS on the pollution of Lake Roosevelt by Canadian industry included sampling in the Spokane River Arm and Long Lake. More recently, several TIS studies have evaluated the levels and sources of PCBs in the Spokane and Little Spokane Rivers.

Results from these and other TIS efforts over the past 10 years are summarized below by chemical group:

Metals

The Spokane River is on the 303(d) list as being water quality limited for zinc, lead, cadmium, chromium, and mercury. Results from sediment bioassays on samples from the Spokane Arm and above Upriver Dam have also exceeded 303(d) standards. Sediment toxicity appears to be due to metals, rather than PCBs or other contaminants

The chromium and mercury listings are due to 2-3 excursions beyond water quality criteria at Ecology ambient monitoring stations during 1989 - 91. Ambient data collected since that time, as well as results from analysis of chromium and mercury in Spokane River fish and sediments (Johnson et al., 1994; Batts & Johnson, 1994), show no further evidence of elevations in these two metals.

Current conditions with respect to dissolved zinc, lead, and cadmium in the Spokane River are described in Hopkins & Johnson (1997). Figure 1 from this report shows that zinc concentrations are in almost continual violation of EPA acute and chronic water quality criteria at the stateline. Lead exceeds chronic water quality criteria during the high flow season. Concentrations decrease relative to criteria going downstream, chiefly due to increasing hardness, but a similar pattern of violations is observed at Riverside State Park (see also Pelleteir (1994) in Intensive Surveys and TMDLs). Cadmium (not shown) slightly exceeds chronic criteria during high flow, but only at the stateline.
Intensive monitoring during the unusually high flows experienced in the Spokane River this spring showed an extended period from April through June with substantial dissolved

lead concentrations of 1.38 - 2.69 ug/L. Concentrations of zinc, lead, and cadmium at the stateline were indistinguishable from those measured 2.5 miles upstream in Idaho, and comparable to concentrations measured at Post Falls by USGS (Paul Woods, personal communication). While there appears to be some dilution of zinc and cadmium sources during runoff events, lead continues to increase with flow. (Hopkins & Johnson, 1997)

The concentrations of dissolved zinc, lead, and cadmium in the Spokane River are one-to-two orders of magnitude higher than other major rivers in Washington. The Spokane is the only major river in the state known to exceed water quality criteria for metals (Hopkins & Johnson, 1997; see also Rivers and Streams Ambient Monitoring).

Only limited recent data are available on metal concentrations in Spokane River fish (Johnson et al., 1994; Johnson, 1994a; Serdar et al., 1994). There is a general trend toward increasing concentrations of zinc, lead, and cadmium going upstream, reaching a maximum in Idaho. Concentrations in upper river fish are high from both a state and national perspective. Elevated lead concentrations have been measured in upper river crayfish (0.5 - 0.9 mg/Kg) and, inconsistently, rainbow trout fillets (0.4 - 0.7 mg/kg in 1993, but only 0.1 - 0.2 mg/Kg in 1994). The Washington State Dept. of Health (WDOH) has concluded that these concentrations may represent a human health concern, depending on consumption rate (Patrick, 1994).

Relatively few sediment samples have been analyzed from the Spokane. Table 2 shows the existing data on zinc, lead, and cadmium. Elevated-to-high concentrations occur throughout the river. As shown in Table 2, of the 15 samples that have been collected, 14 are at or above adverse effects levels for zinc, 11 approach or exceed effects levels for cadmium, and three, all in the upper river, exceed for lead. Four samples were subjected to bioassays; the three that exceeded adverse effects levels showed evidence of toxicity.

PCBs

The Spokane River is on the 303(d) list for PCBs. During the 1980s, sporadic sampling by the Ambient Program showed elevated concentrations of PCBs in some Spokane River fish tissue samples (Hopkins et al., 1985). This ultimately lead Ecology's Eastern Regional Office to request a survey by TIS in 1993 to determine if there was widespread contamination in the river and which areas were most affected (Johnson et al., 1994). The 1993 survey showed total PCB concentrations in fish reached high levels of 1,000 - 2,775 ug/Kg above the City of Spokane and then fell to low levels in Idaho, indicating the sources were in Washington's portion of the upper river. A sediment sample above Upriver Dam had 3,200 ug/Kg total PCBs vs. 13.8 - 38 ug/Kg above and below this reach.

More intensive field work followed in 1994 to obtain data for the state and local health departments and to locate sources (TIS, 1995). A fish consumption advisory was issued for the upper river in 1994, but the health departments have not maintained it, largely due to their conclusion that people are not consuming significant amounts of fish. The results from source sampling - - which identified the Kaiser Trentwood aluminum mill, Spokane Industrial Park, and Liberty Lake WWTP as being significant PCB dischargers - - and follow-up sampling in 1995 (Golding, 1996) are discussed in the Compliance Monitoring chapter. In 1996, further sampling was done for PCBs in upper Spokane River fish (Johnson, 1997).

Table 3 summarizes the 1993-96 fish tissue data. Results show some evidence that PCB concentrations have declined from when first sampled, perhaps in response to source control efforts, not yet completed (see Compliance Monitoring). However, concentrations in a number of species continue to be the highest reported among Washington lakes and rivers (e.g., Davis, 1995) and still exceed levels of 100-110 ug/Kg considered protective of fish-eating birds and mammals (IJC, 1975; Newell et al., 1987). In a recent human health assessment for the lower Columbia River, WDOH endorsed "health protective values" for total PCBs of 50 ug/Kg @ 140 g/day and 220 ug/Kg @ 32 g/day (Laflamme, 1996).

Findings for the Little Spokane River (Table 3) may be noteworthy in that PCB-1260 is a significant contributor to total PCB concentrations (59-74%) compared to main stem fish samples which are dominated by PCB-1254. No sources of PCBs have been identified in the Little Spokane drainage.

Pesticides

The Spokane Arm, Long Lake, and Hangman Creek are currently classed as water quality limited for one or more chlorinated pesticides: DDE (all three areas); dieldrin (Spokane Arm and Long Lake); DDD, heptachlor, heptachlor epoxide, and aldrin (Long Lake). These listings are based on very old 1969-72 EPA data. Newer information obtained by TIS suggests there is not significant pesticide contamination in the Spokane River or in Hangman Creek.

Johnson (1991) and Serdar et al. (1994) include data on Long Lake that show only DDE in fish tissue samples and none of the above pesticides detectable in sediment samples. Serdar et al. analyzed two composite, edible fish tissue samples from Long Lake and detected only 2 ug/Kg of DDE in each, well below the 32 ug/Kg human health criteria used for 303(d). Davis (1995) analyzed chlorinated and selected organophosphorus pesticides in a composite rainbow trout fillet sample collected above Upriver Dam and detected 19 ug/Kg of DDE and 1 ug/Kg of chlordane.

Neither DDE, other chlorinated pesticides, nor organophosphorus pesticides were detectable in water samples collected by Davis (in prep) in April, June, and August 1997 from Hangman Creek and another Spokane tributary, Deadman Creek. Trace concentrations (sub-ppb) of herbicides were found in both creeks.

Dioxins & Furans

As part of studies on Lake Roosevelt, polychlorinated dioxins and -furans were analyzed in one each composite sediment and whole fish samples from Long Lake (Johnson et al., 1991). Low concentrations of TCDF (2,3,7,8-tetrachlorodibenzofuran) were detected in the samples, 1.4 and 0.6 ng/Kg, respectively. Dioxin (2,3,7,8-TCDD) and other congeners were not detectable. By way of comparison, TCDF concentrations in similar samples from Lake Roosevelt ranged up to 116 ng/Kg in sediment and 48 ng/Kg in whole fish. The levels of TCDF found in Long Lake are similar to those in other Washington lakes and rivers removed from sources.

Volatiles

TIS conducted two surveys in connection with groundwater inputs of 1,1,1-trichloroethane to the Little Spokane River from Colbert Landfill (Johnson, 1989; Johnson & Davis, 1990). Trichloroethane entered the river at Sterling Spring, due west of the landfill. In December 1989, concentrations were <0.2 ug/L above the spring, 3.0 ug/L immediately below the spring, and gradually fell to 1.1 ug/L approximately two miles downstream. These concentrations are well within water quality criteria. No follow-up sampling has been done by TIS.

Volatiles have been analyzed sporadically in water samples from the Spokane main stem since the early 1980's (Table 1). Nothing of significance has been detected.

Semivolatiles

Limited sampling for semivolatiles in the sediments of the Spokane River and Deadman Creek has not detected contamination (Johnson, 1991b; Serdar et al., 1994; Holy-Dodson, 1994; Batts & Johnson, 1994; TIS, 1995).

Recommendations

Zinc, lead, cadmium, and PCBs have been the subject of numerous past investigations by TIS and others in the Spokane River and, perhaps by default, are the only chemical contaminants known to be a concern in this WQMA. TIS has only a small amount of information on the occurrence of toxics in Spokane River tributaries and is not aware of any data on lakes. The following additional work is recommended:

Metals: This issue is currently being pursued by the Attorneys General through NRDA and could result in additional studies in the river. Any data collection efforts done as part of the Water Quality Program's Watershed Approach should be undertaken in consultation with the Attorneys General.

Data gaps for metals in the Spokane River include the need for a thorough investigation of the sediments and associated biota to determine the extent and significance of contamination by zinc, lead, and cadmium. A risk assessment should be conducted for lead to determine the potential for adverse effects to human health, aquatic life, and wildlife.

The Water Quality Program should review EILS' recent data on chromium and mercury in the Spokane River and re-assess the 303(d) listing for these metals.

- PCBs: Re-sample Spokane and Little Spokane River fish for PCBs after known sources are controlled.
- Pesticides: The Water Quality Program should review EILS' recent data on chlorinated pesticides in the Spokane River and Hangman Creek, and either remove

these compounds from the 303(d) list or recommend additional sampling appropriate for determining if water quality limited status remains warranted.

- Other Waterbodies: Survey for toxics if and where appropriate.

References

Bailey, G.C. and J. Saltes. 1982. The Development of Some Metals Criteria for the Protection of Spokane River Rainbow Trout. Project completion report to: Washington State Dept. Ecology. Washington State Univ., Pullman.

Bailey, G. and L. Singleton. 1984. Spokane Industrial Park Receiving Water Survey. Memorandum to R. Ray. Washington State Dept. Ecology, Olympia.

Batts, D. and A. Johnson. 1994. Bioassays of Spokane River Sediments. Memorandum to C. Nuechterlein and P. Hallinan. Washington State Dept. Ecology, Olympia.

Beckman, L.G., J.F. Novotny, W.R. Persons, and T.T. Terell. 1985. Assessment of the Fisheries and Limnology of Lake F.D. Roosevelt., 1980-83. Prep. for U.S. Bureau Reclamation. U.S. Fish and Wildlife Service. FW-14-06-009-904.

Bortleson, G. et al. 1994. Sediment-Quality Assessment of Franklin D. Roosevelt Lake and the Upstream Reach of the Columbia River, Washington, 1992. USGS Open File Rept. 94-315.

Chern, L. 1989. Reconnaissance Survey of the Impacts of Northside Landfill Leachate on Ground/Surface Water Quality, Spokane, Washington. Washington State Dept. Ecology, Olympia.

CH2M Hill. 1995. PDC Spokane River field and laboratory data summary. Memorandum to S. Hubbard-Gray and S. Dethloff. Project NPE34674.82.ZZ.

Cubbage, J. D. Batts, and S. Breidanbach. 1997. Creation and Analysis of Freshwater Sediment Quality Values in Washington State. Washington State Dept. Ecology, Olympia. Pub. No. 97-323.

Davis, D. In prep. Washington State Pesticide Monitoring Program: 1996 Surface Water Sampling Report. Washington State Dept. Ecology, Olympia.

Davis, D., A. Johnson, and D. Serdar. 1995. Washington State Pesticide Monitoring Program: 1993 Fish Tissue Sampling Report. Washington State Dept. Ecology, Olympia. Pub. No. 95-356.

Funk, W.H., H.L. Gibbons, R.M. Duffner, T. Notestine, and T. Nielsen. 1983. Water Quality of the Upper Spokane River and Evaluation of Methods for Measurement of the Effect of Effluent upon Primary and Secondary Producers. State of Washington, Water Research Center, Pullman. Rep. 48.

Gibbons, H.L. et al. 1984. Baseline Study to Determine the Water Quality and the Primary and Secondary Producers of the Spokane River, Phase I. Joint project completion report to: Washington State Dept. Ecology. State of Washington, Water Research Center, Pullman.

Golding, S. 1996. Spokane River PCB Source Monitoring Follow-up Study, November and December 1995. Washington State Dept. Ecology, Olympia. Pub. No. 96-331.

Hallinan, P., T. Nell, and N. Glenn. 1991. Kaiser Aluminum and Chemical Corp., Trentwood Class II Inspection. Washington State Dept. Ecology, Olympia.
Hallock, D. 1991. Little Spokane River Study - - Final Report. Memorandum to K. Merrill. Washington State Dept. Ecology, Olympia.

HartCrowser. 1995. Final Report: Supplemental 1994 Spokane River PCB Investigations, Kaiser Aluminum and Chemical Corp., Trentwood Works, Spokane Washington. J-2644-44.

Hopkins, B. and A. Johnson. 1997. Metal Concentrations in the Spokane River during Spring 1997. Memorandum to J. Manning and C. Nuechterlein. Washington State Dept. Ecology, Olympia.

Hopkins, B.S., D.K. Clark, M. Schlender, and M. Stinson. 1985. Basic Water Monitoring Program: Fish Tissue and Sediment Sampling for 1984. Washington State Dept. Ecology, Olympia. Pub. No. 85-7.

Hoyle-Dodson, G. Unpublished data collected during May 18-20, 1992 Class II Inspection at Spokane Industrial Park. Washington State Dept. Ecology, Olympia.

Holye-Dodson, G. 1994. Kaiser Aluminum (Mead) Class II Inspection. Washington State Dept. Ecology, Olympia. Pub. No. 94-108.

Huntamer, D. 1996. Particulate Matter and Polychlorinated Biphenyls in the Spokane River, Washington State. Microscope 44(1):1-6.

IJC. 1975. Great Lakes Water Quality 1975. 4th Annual Rept., Appendix A. Great Water Quality Board, International Joint Commission, Windsor, Ontario.

Johnson, A. 1989. Survey for Volatiles in the Spokane River. Memorandum to M. Blum. Washington State Dept. Ecology, Olympia.

Johnson, A. 1991a. Review of Metals, Bioassay, and Macroinvertebrate Data from Lake Roosevelt Benthic Samples Collected in 1989. Memorandum to C. Nuechterlein. Washington State Dept. Ecology, Olympia.

Johnson. A. 1991b. Results of Screen for EPA Xenobiotics in Sediment and Bottom Fish from Lake Roosevelt (Columbia River). Memorandum to C. Nuechterlein. Washington State Dept. Ecology, Olympia.

Johnson, A. 1994a. PCB and Lead Results for 1994 Spokane River Fish Samples. Memorandum to G. Patrick. Washington State Dept. Ecology, Olympia.

Johnson, A. 1994b. Planar PCBs in Spokane River Fish. Memorandum to C. Nuechterlein. Washington State Dept. Ecology, Olympia.

Johnson, A. 1997. 1996 Results on PCBs in Upper Spokane River Fish. Memorandum to C. Nucheterlein and D.T. Knight. Washington State Dept. Ecology, Olympia.

Johnson, A. and D. Davis. 1990. Follow-up Survey for Volatiles in the Little Spokane River. Memorandum to M. Blum. Washington State Dept. Ecology, Olympia.

Johnson, A., D. Norton, and B. Yake. 1988. An Assessment of Metals Contamination of Lake Roosevelt. Washington. State Dept. Ecology, Olympia.
Johnson, A., D. Norton, B. Yake, and S. Twiss. 1990. Transboundary Metal Pollution of the Columbia River. Bull. Environ. Contam. Toxicol. 45:703-710.

Johnson, A., D. Serdar, and D. Norton. 1991. Spatial Trends in TCDD/TCDF Concentrations in Sediment and Bottom Fish Collected from Lake Roosevelt (Columbia River). Washington State Dept. Ecology, Olympia. Pub. No. 91-29.

Johnson, A., D. Serdar, and D. Davis. 1994. Results of 1993 Screening Survey on PCBs and Metals in the Spokane River. Washington State Dept. Ecology, Olympia.

Joy, J. 1992. Inland Empire Paper Company Mixing Zone Survey, September 1990. Washington State Dept. Ecology, Olympia.

Kaiser. Unpublished total/dissolved data on zinc, chromium, and aluminum. Kaiser Aluminum & Chemical Corp., Spokane.

Laflamme, D. 1996. Health Analysis of Chemical Contaminants in Lower Columbia River Fish. Washington State Dept. Health, Olympia.

Miller, S. Unpublished 1994 data collected by Spokane Public Works.

Munn, M.D., S.E. Cox, and C.J. Dean. 1995. Concentrations of Mercury and Other Trace Elements in Walleye, Smallmouth Bass, and Rainbow Trout in Franklin D. Roosevelt Lake and the Upper Columbia River, Washington, 1994. USGS Open-File Rept. 95-195.

Newell, A., D. Johnson, and L. Allen. 1987. Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife. NY State Dept. Environmental Conservation. Tech. Rept. 87-3.

Patrick, G. 1994. PCB in Spokane River Fish. Memorandum to A. Johnson. Washington State Dept. Health, Olympia.

Pelletier, G.J. 1994. Cadmium, Copper, Mercury, Lead, and Zinc in the Spokane River: Comparisons with Water Quality Standards and Recommendations for Total Maximum Daily Loads. Washington State Dept. Ecology, Olympia. Pub. No. 94-99.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Sediment Quality in Ontario. Ontario Ministry of Environment. ISBN 0-7729-9248-7.

Reif, D. 1986. Kaiser Aluminum & Chemical Corporation Class II Inspection, May 6-7, 1986. Memorandum to R. Ray. Washington State Dept. Ecology, Olympia.

Saltes, J.G. and G.C. Bailey. 1984. Use of Fish Gill and Liver Tissue to Monitor Zinc Pollution. Bull. Environ. Contam. Toxicol. 32:233-237.

Seitz, H.R. and M.L. Jones. 1982. Flow Characteristics and Water Quality Conditions in the Spokane River, Coeur D'Alene Lake to Post Falls Dam, Northern Idaho. USGS Open-File Rept. 82-102.

Serdar, D., A. Johnson, and D. Davis. 1994. Survey of Chemical Contaminants in Ten Washington Lakes. Washington State Dept. Ecology, Olympia. Pub. No. 94-154.

Stinson, M. 1993. Spokane River Metals Water Effects Ratio Study. Memorandum to G. Pelleteir. Washington State Dept. Ecology, Olympia.

Sumioka, S.S. 1991. Quality of Water in an Inactive Uranium Mine and Its Effects on the Quality of Water in Blue Creek. USGS Water Resources Investigations Report 89-4110.

Toxics Investigations Section. 1995. Department of Ecology 1993-94 Investigation of PCBs in the Spokane River. Washington State Dept. Ecology, Olympia. Pub. No. 95-310.

USFWS. (in prep.) Report on metals concentrations in benthic invertebrates. (Dan Audet, Spokane)

USGS. NASQAN data for Spokane River @ Riverside State Park (historic) and Spokane River near Post Falls Idaho (current).

Woods, P.F. Personal communication. May 22, 1997 data. USGS, Idaho.

Woods, P.F. and M.A. Beckwith. 1996. Nutrient and Trace Element Enrichment of Coeur D'Alene Lake, Idaho. USGS Open-File Rept. 95-740.

Yake, W.E. 1979. Water Quality Trend Analysis -- The Spokane River Basin. Washington State Dept. Ecology, Olympia. Project Rep. No. DOE-PR-6.

Yearsley, J. 1980. Water Quality Studies of the Spokane River between Coeur D'Alene, Idaho, and Post Falls, Idaho 1978-79. EPA Region 10. EPA 910/9-80-072.

Table 1. Sources of Toxics Data on the Spokane River and Tributaries (since 1978)

Year	General Location	Metals	PCBs	Dioxins/Furans	Pesticides	Semivolatiles	Volatiles	Water	Sediment	Fish/Biota	Reference
1978-81	Upper Spokane River & Idaho	x						x			Yearsley (1980,81)
1978 - 81	Upper Spokane River	x						x			Gibbons (1984)
1980	Upper Spokane River to Stateline	x						x			Funk et al. (1983)
1980 - 81	Idaho	x								x	Seitz & Jones (1981)
1980 - 84	ab.Nine-Mile Dam, ab.Upriver Dam	x	x		x					x	Hopkins et al. (1985)
1981	Upper Spokane River into Idaho	x						x		x	Bailey & Saltes (1982)[†]
1981	Upper Spokane River into idaho	x								x	Saltes & Bailey (1984)
1982-83	Spokane Arm	x						x	x	x	Beckman et al. (1985)
1983	ab. Upriver Dam	x	x		x	x	x	x		x	Bailey & Singleton (1984)[†]
1984 - 96	Spokane Arm to Stateline	x						x			AMS (unpublished data)
1984 - 95	Spokane R. tributaries (various)	x						x			AMS (unpublished data)
1984-85	Blue Creek (Spokane Arm trib.)	x						x			Sumioka (1991)
1986	ab.Upriver Dam	x						x			Reif (1986)[†]
1986	Spokane Arm	x						x	x	x	Johnson et al. (1988, 1990)
1988	ab. Upriver Dam	x				x	x	x			Chern (1989)
1989	Spokane Arm	x						x	x		Johnson (1991a)[†]
1989	Little Spokane River						x	x			Johnson (1989) Johnson & Davis (1990)
1990	ab.Upriver Dam	x						x			Joy (1992)
1990	ab. Upriver Dam	x	x		x	x	x	x			Hallinan et al. (1991)
1990 - 91	Little Spokane River	x						x			Hallock (1991)

Yearsley, J. 1981 (draft). An Examination of the Nutrient and Heavy Metals Budget in the Spokane River between Post Falls and Hangman Creek. EPA Region 10.

Zheng, Y. 1995. M.S. Thesis. Eastern Wash. Univ., Cheney, WA.

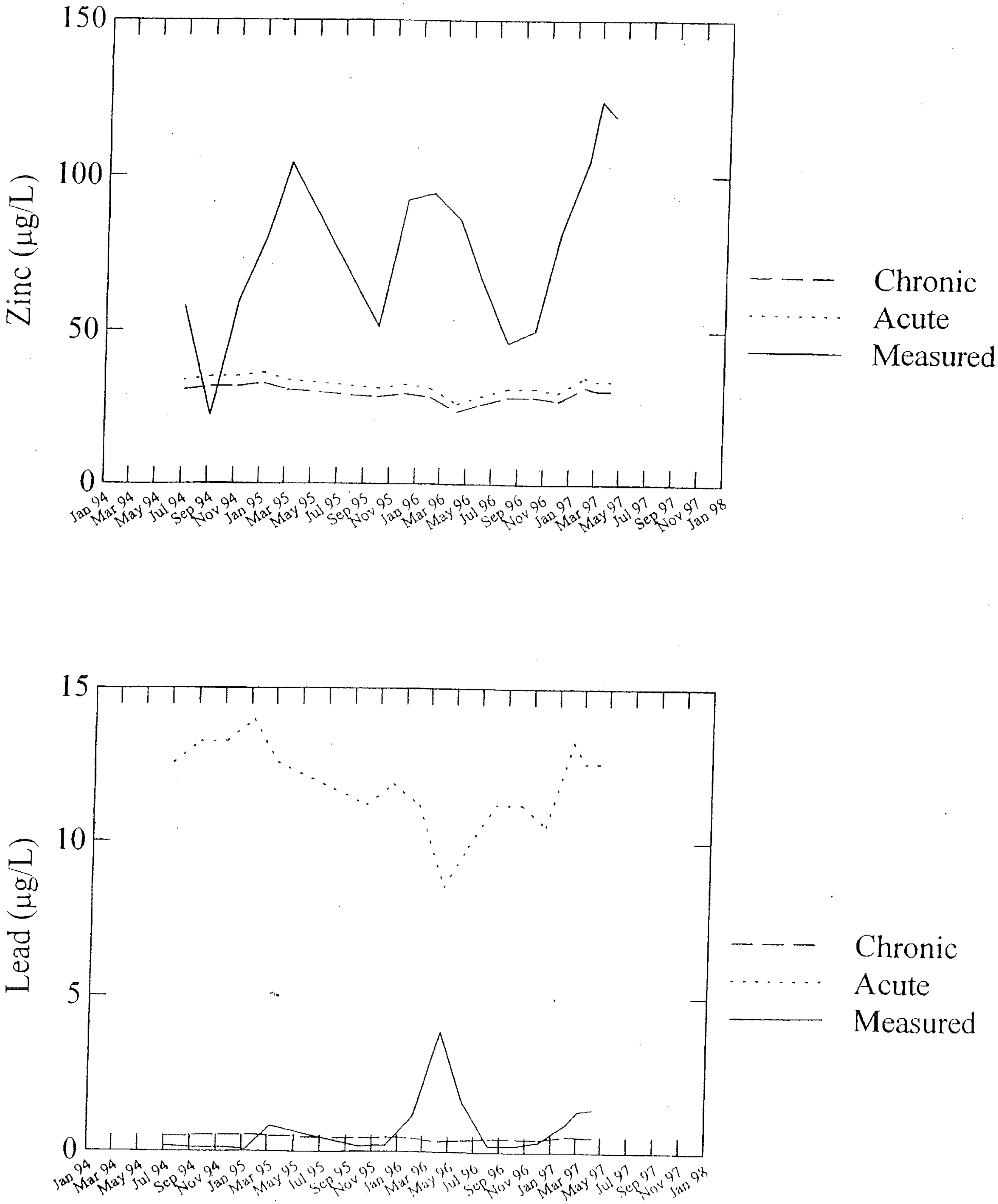

Figure 1. Dissolved Zinc and Lead Concentrations in the Spokane River @ Stateline Bridge, May 1994 - April 1977 (showing EPA water quality criteria)

Table 1. Sources of Toxics Data (continued)

Year	General Location	Metals	PCBs	Dioxins/Furans	Pesticides	Semivolatiles	Volatiles	Water	Sediment	Fish/Biota	Reference
1990	Long Lake		x	x	x	x			x	x	Johnson (1991b) Johnson et al. (1991)
1992	Idaho	x						x			Woods & Beckwith (1996)
1992	ab.Upriver Dam	x						x			Holye-Dodson (unpub.)
1992	Long Lake	x	x		x	x			x	x	Serdar et al. (1994)
1992	Spokane Arm, Long Lake	x			x	x			x		Bortleson (1994)†
1992 - 93	Stateline, Trent Rd., Riverside Pk.	x						x			Pelletier (1994)
1993	Uppper Spokane River	x						x			Stinson (1993)†
1993	Deadman Cr. (Little Spokane R.)	x	x		x	x		x	x		Hoyle-Dodson (1994)
1993	Spokane Arm into Idaho	x	x						x	x	Johnson et al. (1991b, -94b)
1993	ab. Upriver Dam		x						x		Huntamer (1996)
1993	ab. Upriver Dam		x		x					x	Davis et al. (1995)
1994	SpokaneArm into Idaho	x	x			x		x	x	x	Johnson (1994a) TIS (1995)† Batts & Johnson (1994)†
1994	ab. Upriver Dam		x					x	x	x	HartCrowser (1995)
1994	ab. Upriver Dam		x						x		CH2MHILL (1995)
mid1990's	ab.Upriver Dam	x						x			Kaiser (unpub.)
1994	Upper Spokane River	x						x			Zheng (1995)
1994	Upper Spokane River	x						x			Miller (unpub.)
1994	Spokane Arm	x								x	Munn et al. (1995)
~1994	ab. Upriver Dam, Idaho	x								x	USFWS (in prep.)

Table 1. Sources of Toxics Data (continued)

Year	General Location	Metals	PCBs	Dioxins/Furans	Pesticides	Semivolatiles	Volatiles	Water	Sediment	Fish/Biota	Reference
1996	Little Spokane R., ab. Nine-Mile, ab. Monroe Dam, ab. Upriver Dam		x							x	Johnson (1997)
1996	Deadman Cr., Hangman Cr.				x			x			Davis (in prep.)
1997	bw. Long Lake into Idaho	x						x			Hopkins & Johnson (1997)
1997	Post Falls	x						x			Woods (personal comm.)

[†]includes bioassay data

Table 2. Summary of Recent TIS and USGS Data on Spokane River Sediments

Reach of Spokane River	Ref.	n	Metals Concentrations (mg/Kg) Zn	Pb	Cd	Bioassays showed toxicity? Hyalella	Microtox
(Guideline) SEL*			820	250	10		
LAET**			520	260	7.6		
Spokane River Arm (FDR Lake)	(1)	1	**960**	81	**7.4**	--	--
	(2)	1	**1180**	81	**9.1**	no	yes
	(3)	1	**671**	125	**11**	--	--
	(5)	1	**1540**	128	5.6	--	--
	(6)	3	**980 - 1800**	80 - 150	4.9 - **11**	no	yes
Long Lake	(1)	1	**1425**	154	**16**	--	--
	(2)	1	**520**	42	3.9	no	no
	(4)	2	**1270 - 1660**	76 - 165	**14 - 19**	--	--
Above Nine-Mile Dam	(1)	1	343	22	1.8	--	--
Above Upriver Dam	(1)	1	**3990**	**605**	**33**	--	--
	(2)	1	**4050**	**542**	**40**	yes	yes
Above Idaho Border	(1)	1	**1140**	**366**	**6.8**	--	--

Note: values in **BOLD** approach or exceed guidelines
* SEL = Severe Effects Level from Ontario guidelines (Persaud et al., 1993)
**LAET = Lowest AET value for freshwater sediments (Cubbage et al., 1997)
(1) Johnson et al. (1994)
(2) Batts & Johnson (1994); TIS (1995)
(3) Johnson (1991)
(4) Serdar et al. (1994)
(5) Johnson et al. (1988)
(6) Bortleson et al. (1994)

Table 3. Summary of Recent TIS Data on Total PCBs in Spokane River Fish (ug/Kg, wet weight)

Location	Species*	1993 mean	1994 mean	1996 mean	n**
Ab. Upriver Dam	Largescale Sucker	2780	531	520	3
	Rainbow Trout	1020	424	790	8
	Crayfish	- -	- -	ND	3
Ab. Monroe Dam	Largescale Sucker	201	--	116	3
	Rainbow Trout	- -	152	76	5
	Mountain Whitefish	--	568	381	5
	Crayfish	- -	- -	ND	3
Ab. Nine-Mile Dam	Largescale Sucker	1210	- -	345	3
	Rainbow Trout	490	371	76	8
	Mountain Whitefish	522	139	463	7
Little Spokane River	Largescale Sucker	- -	440	366	3
	Mountain Whitefish	- -	222	145	6
	Cutthroat Trout	- -	188	- -	1
Long Lake	Largescale Sucker	410	820	- -	2
	Mountain Whitefish	780	110	- -	4
	Northern Squawfish	--	235	- -	3
	Brown Trout	- -	193	- -	1
	Largemouth Bass	96	99	- -	3
	White Crappie	- -	98	- -	2
	Yellow Perch	9.4	8.0	- -	4
	Crayfish	- -	ND	- -	2
Spokane Arm	Largescale Sucker	640	- -	- -	1
	Kokanee	92	- -	- -	1
	Smallmouth Bass	28	--	- -	1
	Walleye	15	46	- -	2

*suckers analyzed whole, other fish samples are fillets, crayfish samples are tail muscle
**each sample a composite, typically 5-8 individual fish or crayfish
- - = no samples
ND = not detected