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### **3.3 POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN YALE RESERVOIR (WAQ 3)**

In response to an issue raised by the Lewis River Aquatic Resource Group (ARG), PacifiCorp and Cowlitz PUD developed a study plan to assess levels of Polycyclic Aromatic Hydrocarbons (PAHs) in Yale Lake. The study, conducted to determine the need for adaptive management and future monitoring, was approved by the Steering Committee in June 2001.

#### **3.3.1 Study Objectives**

Very low levels of PAHs can be toxic to fish. The objective of WAQ 3 was to provide a baseline description of the PAH concentrations in Yale Lake. Sampling was conducted only on Yale Lake because previous recreational surveys showed maximum recreational use of this reservoir (PacifiCorp 1999). As discussed in the WAQ 3 Study Plan (PacifiCorp and Cowlitz PUD 1999, as amended), the objective in terms of timing was to conduct this study during a period of peak summer use of 2-stroke gasoline engines, those deemed largely responsible for PAH output. Additionally, this study was conducted to determine the need for future sampling and adaptive management.

#### **3.3.2 Study Area**

Field samples for PAH analysis were collected in the vicinity of 4 boat ramps at Yale Lake: Saddle Dam, Yale Park, Cougar Park, and Beaver Bay. These are depicted on Figure 3.3-1.

#### **3.3.3 Methods**

At each boat ramp, 5 1-liter samples were collected at approximate clock positions 10, 11, 12, 1, and 2; with the boat ramp located at 12:00. Samples were collected approximately 50 to 60 meters from the boat ramp, and approximately 10 to 20 meters apart. All samples were collected August 11, 2001.

Using scuba gear, a diver collected each sample at a depth of 3 meters. Labeled, laboratory-prepared bottles were first rinsed 3 times just under the water surface, then capped and brought to a depth of 3 meters. At a depth of 3 meters, the diver slowly removed the cap and filled the bottle, slowly swimming forward to ensure that it was in contact with “new” water as it was filled. Filling of the bottle took approximately 2 minutes. It was then capped, brought to the surface, and placed in a cooler on ice. Samples were collected from an aluminum boat with no outboard motor; and no residue from previous use of an outboard.

Air temperature and surface water temperature were recorded at each of the 4 boat ramps. Observations of boat use throughout the preceding day (August 10) and on the day of the study were recorded by camp hosts at each boat ramp (with the exception of Saddle Dam on August 10). This information included separate counts of personal watercraft (PWC; e.g., jetskis) and other motorized craft brought to the particular ramp.

All samples were analyzed at Alta Analytical, El Dorado Hills, CA. Following receipt at the lab, the 5 samples from each boat ramp were composited into a single 5-liter sample; thus, a total of 4 5-liter samples were analyzed. No compositing of samples was done in the field. Each sample was analyzed using a modified California Air Resources Control Board Method 429 for low level PAH analysis. Detection limits were near 1 ppt (part per trillion) for most analytes.

### 3.3.4 Key Questions

No key questions were identified during the Lewis River cooperative watershed studies meetings that pertain to this study.

### 3.3.5 Results

Conditions on the day of sampling were ideal; air temperatures were warm (about 26°C) and skies were clear. Conditions were similar on the day preceding the study. Surface water temperatures averaged 22°C throughout the day. Winds were calm in the morning and increased slightly in the afternoon.

Total PAH values for all 4 boat ramps ranged from no detectable levels at Saddle Dam, to 7.28 nanograms per liter (ng/l; parts per trillion) at Yale Park (Table 3.3-1). Of the 19 component analytes measured in each sample, 2 were measurable at Cougar Creek and Beaver Bay (fluoranthene and pyrene), none at Saddle Dam, and 3 at Yale Park (fluoranthene, pyrene, and anthracene). Toxicity of these 3 compounds increases in the presence of sunlight (i.e., they are photo-toxic) (Oris et al. 1998). Pyrene was present in the method blank at 1.03 ng/l; no other blank values were detectable.

Results of boat counts are shown below for August 11 (Table 3.3-2). Numbers of both PWC and motor boat put-ins were highest at Saddle Dam on August 11 (no data were recorded there on August 10).

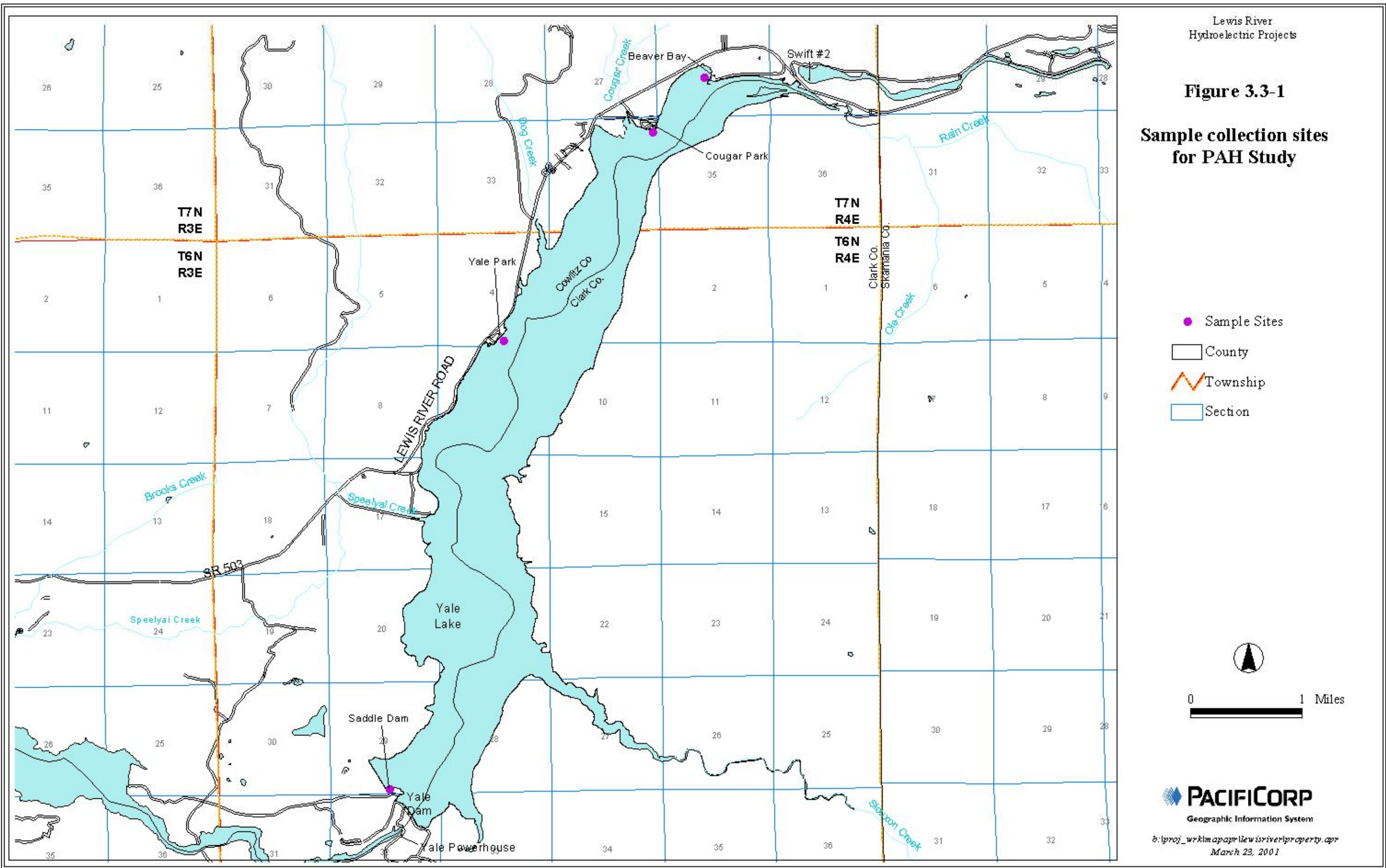
### 3.3.6 Discussion

Based on effluent toxicity testing on zooplankton (*Ceriodaphnia dubia*) and fish larvae (*Pimephales promelas*) conducted by Oris et al. (1998), No Observable Effects Concentrations (NOECs) were developed that serve as useful comparisons for this study. However, differences in water quality and limnology between Lake Tahoe and Yale Lake must be taken into account when comparing Oris' data to Yale Lake data.

Oris' NOECs are toxicity thresholds, above which measurable effects were observed on zooplankton survival and reproduction, and on fathead minnow growth. Oris's NOECs for *Ceriodaphnia* survival and reproduction (6.5 ng/l and 3.4 ng/l., respectively) were exceeded at Yale Park, where total PAH measured 7.28 ng/l. Oris' NOEC for fathead minnow growth (9 ug/l) was not exceeded. However, correspondence with Dr. Oris indicates that the NOECs developed for Lake Tahoe are from 2 to 5 times lower than would be necessary for Yale Lake (pers. comm., J. Oris, 9/16/2001). Reasons for the more conservative NOECs relate to greater water clarity at Lake Tahoe, which increases phototoxicity of PAHs, as well as the short retention time of Yale Lake in contrast to

Figure 3.3-1

Sample collection sites  
for PAH Study



- Sample Sites
- County
- ▬ Township
- Section



0 1 Miles

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Geographic Information System

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March 23, 2001

Lake Tahoe. Key determinants of toxicity of PAH in aquatic systems are the degree of UV penetration, very high in Lake Tahoe, and dissolved organic carbon (DOC) which can block and filter incoming radiation (pers. comm., J. Oris, 9/16/2001).

**Table 3.3-1. Results of PAH analysis at Yale Lake boat ramps, August 11, 2001.**

Analyte	Cougar Park		Beaver Bay		Saddle Dam		Yale Park	
	Conc. (ng/l)	RL (ng/l)	Conc. (ng/l)	RL (ng/l)	Conc. (ng/l)	RL (ng/l)	Conc. (ng/l)	RL (ng/l)
Napthalene	ND	2.61	ND	2.63	ND	2.67	ND	2.68
2-Methylnapthalene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Acenaphthylene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Acenaphthene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Fluorene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Phenanthrene	ND	2.61	ND	2.63	ND	2.67	ND	2.68
Anthracene	ND	1.04	ND	1.05	ND	1.07	1.59	1.07
Fluoranthene	1.46	1.04	1.25	1.05	ND	1.07	2.59	1.07
Pyrene	1.22	1.04	1.11	1.05	ND	1.07	3.10	1.07
Benz(a)anthracene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Chrysene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Benzo(b)fluoranthene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Benzo(k)fluoranthene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Benzo(e)pyrene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Benzo(a)pyrene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Perylene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Indeno(1,2,3-c,d)pyrene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Dibenz(a,h)anthracene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
Benzo(g,h,i)perlene	ND	1.04	ND	1.05	ND	1.07	ND	1.07
<b>Total PAH/l (ng)</b>	<b>2.68</b>		<b>2.36</b>		<b>ND</b>		<b>7.28</b>	

RL: reporting limit      ND: not detected

**Table 3.3-2. Boat counts on August 10 and 11, 2001 at Yale Lake boat ramps.**

Boat Ramp	Day	No. of people	No. of Watercraft	
			PWC	Motor Boats
Saddle Dam	11-Aug	592	27	50
Yale Park	10-Aug	106	11	27
	11-Aug	72	8	21
Cougar Camp	10-Aug	40	2	9
	11-Aug	81	12	17
Beaver Bay	10-Aug	105	7	16
	11-Aug	180	15	28

Levels of PAH observed near Cougar Park and Beaver Bay campgrounds were very low, near the method detection limit. The existence of pyrene in the method blank for all of these samples (1.03 ng/l) must be considered in these data, although no detections of any

of the PAH compounds was observed at Saddle Dam. Discussion with the laboratory regarding potential contamination indicates that the presence of a nanogram per liter of pyrene is quite common in blank samples, and very difficult to eliminate completely.

Field methods used for these samples eliminated potential contamination from atmospheric drift of exhaust fumes, or from field sampling equipment, such as tubing or plexiglass. Subsurface sampling using scuba gear, as well as rinsing sample bottles with surface water, was discussed with and recommended by the U.S. Geological Survey (USGS) (pers. comm., Joe Rinella, July 2001). As far as sample depth, PAH levels in the surface microlayer may be higher than at 3 meters. However, it was felt that deeper sampling would be more indicative of potential biological effects, less prone to short-term variation, and in general more replicable than surface sampling.

A direct influence of boating activity on PAH levels was not apparent from this study. PAH levels at Saddle Dam were lowest, and boat numbers there were highest. Boat counts at the other 3 ramps were similar, although total PAH at Yale was approximately 3 times higher than either Cougar Park or Beaver Bay. Cougar Creek enters Yale Lake in the immediate vicinity of the sampled area, and a velocity gradient was observed at about 3 meters, which was near the reservoir bottom at this location. Spent fuel from PWC and outboard motors near Cougar Park is more quickly dissipated than at the other ramps, including Saddle Dam. Duration of boating near the ramps may have been higher at Yale Park but cannot be determined from the boat count data.

The existence of a PAH problem at Yale Lake cannot be ruled out by this study. However, cause for concern is greatly reduced given that 2 of the 3 sites with measurable levels had total PAH of less than 3 parts per trillion, with pyrene detected in the method blank at just over 1 part per trillion. PAH at Yale Park was well above the detection limit, and, if future monitoring is considered, may warrant re-sampling.

### 3.3.7 Schedule

This study is complete.

### 3.3.8 References

Oris, J.T. et al. 1998. Toxicity of ambient levels of motorized watercraft emissions to fish and zooplankton in Lake Tahoe, California/Nevada, USA. *Poster presented at the 8th Annual Meeting of the European Society of Environmental Toxicology and Chemistry, April 1998, Bordeaux, France.*

PacifiCorp. 1999. Yale Hydroelectric Project – Recreation Resources Final Technical Report. Portland, OR. April 1999.

PacifiCorp and Cowlitz PUD. 1999, as amended. Study Plan Document for the Lewis River Hydroelectric Projects. Portland, OR and Longview, WA. October 29, 1999, as amended.

### 3.3.9 Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

<b>Commenter</b>	<b>Volume</b>	<b>Page/ Paragraph</b>	<b>Statement</b>	<b>Comment</b>	<b>Response</b>	<b>Response to Responses</b>
J. Sampson, Technical Advisor to the Conservation Groups	1	WAQ 03-1 para 3	"Field samples for PAH analysis were collected in the vicinity of 4 boat ramps at Yale Lake:..."	The map in Figure 3.2-3 should include these sampling locations, and the figure should be referenced in the text.	Comment noted, Figure 3.2-3 will be revised to indicate sampling locations for the PAH study.	



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