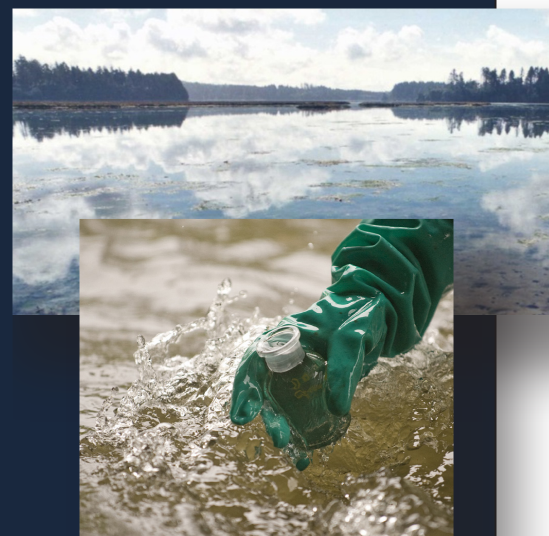
Water Quality in the Coos Estuary and Lower Coos Watershed: Other Pollutants

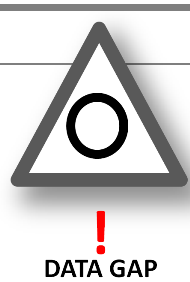
Summary:

- *Previously problematic point sources of pollution may still pose threats to water quality.*
- *Outside of some known "pollution pockets" in the Coos estuary, it appears that concentrations of dissolved pollutants generally meet USEPA standards.*
- *Many streams in the study area are listed under Section 303d of the Clean Water Act for insufficient information.*
- *More comprehensive monitoring is needed to fully assess the status of other pollutants in the Coos estuary.*



Evaluation

We do not have enough data to fully evaluate the status of other pollutants in the Coos estuary.



What's happening?

Organic Carbon in the Water Column

Total Organic Carbon

Total organic carbon (TOC) is an indicator of the presence and abundance of organic compounds in the environment and is found naturally in estuary waters and sediments. High TOC levels are often associated with the presence of other pollutants, including the toxic by-products of organic decomposition (ammonia and sulfide)(Hyland et al. 2005). Additionally, dissolved organic matter binds with metals such as mercury (Swett 2010) and other pollutants, including pesticides and herbicides (Wijayaratne and Means 1984), as well as polychlorinated biphenyls (PCBs) (Brownawell and Farrington 1986). Consequently, TOC (more specifically the dissolved organic carbon (DOC) component of TOC - see below) may facilitate pollutant transport between sediments and the water column (Swett 2010). TOC may also result in harmful byproducts (i.e., trihalomethanes) during the water treatment process (Fleck et al. 2007). The presence and abundance of TOC is often used as an indirect measure of water quality and sediment contamination.

The Oregon Department of Environmental Quality (ODEQ) has monitored total organic carbon (TOC) in the South Slough, Isthmus Slough, and Coos River subsystems (Figure 1) (ODEQ 2001, 2007a, 2007b, 2009a, 2009b). TOC sampling is sporadic, with the most recent data coming from 2009 (Table 1). The highest TOC levels were recorded in the South Slough subsystem near the Joe Ney Landfill (closed in 2013 and most recently used exclusively for construction debris)(see sidebar).

The Coos Bay/North Bend Water board monitored TOC from 2010-2012 in the Pony Slough (Pony Creek and Merritt Lake) and Lower Bay (North Spit) Subsystems as part of their drinking water program (Water Board 2012). TOC levels in Pony Slough and the Lower Bay were 3-4 mg/L on average over these years (Table 2). These levels are similar to the mean observed concentrations at ODEQ sites at South Slough, Isthmus Slough, and Coos River.

Joe Ney Landfill

The Joe Ney Construction and Demolition Landfill is located near Crown Point in the South Slough Subsystem (Figure 1). The facility is owned and was operated by Coos County from 1981 to 2013. Past landfill practices have likely contributed to groundwater contamination. For example, a complaint was filed in 1986 by a man who allegedly saw a "truck dumping 55-gallon drums" into the Joy Ney dump "which were immediately covered." The Oregon Department of Environmental Quality (ODEQ) monitors groundwater at the site with semi-annual sampling/analyses using a network of 18 monitoring wells, and 4 residential wells. Surface water is also monitored on a semi-annual basis with samples collected from 5 locations. These monitoring points were established between 1989 through 1999 during the course of several environmental investigations conducted at this site. Based on groundwater monitoring results, landfill activities have affected groundwater, and for that reason, Coos County has prepared a remedial investigation work plan for this site which led to the County's closure of the dump.

Source: ODEQ 2014b

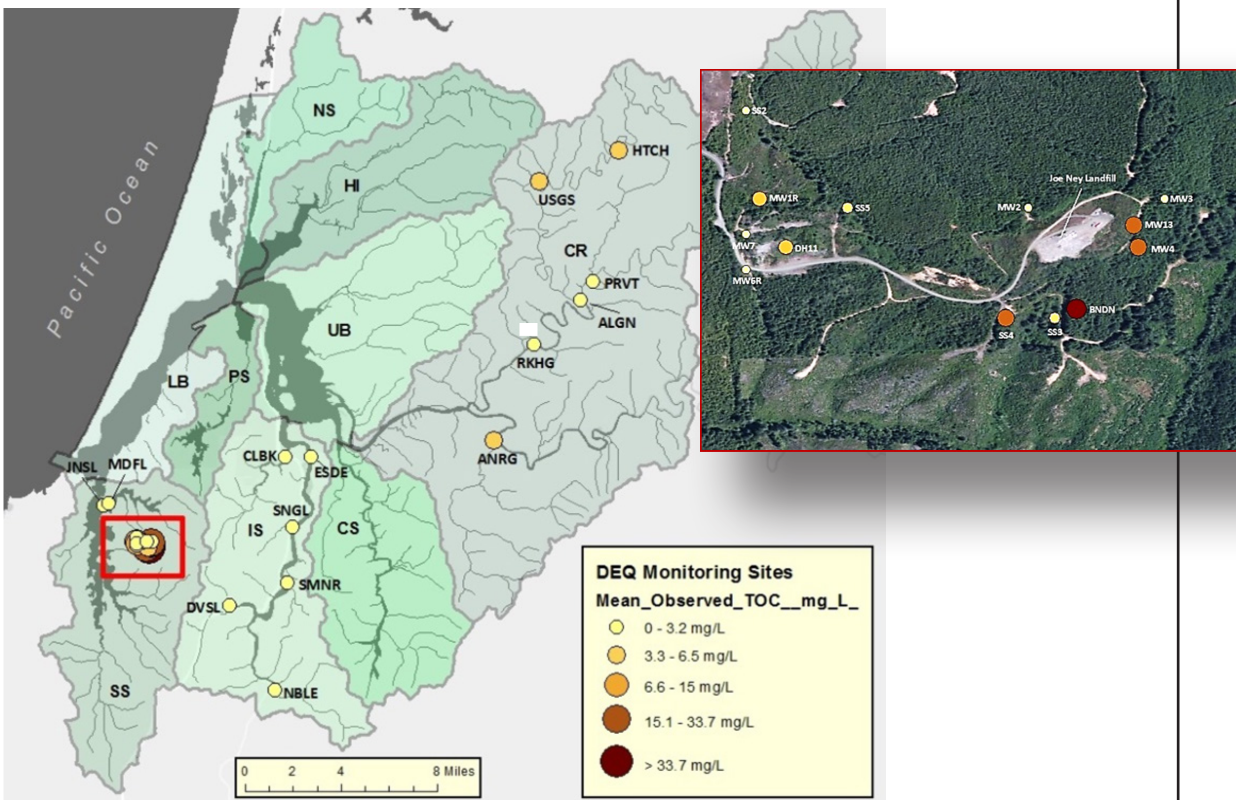


Figure 1. Location of ODEQ TOC monitoring sites and range of mean observed TOC concentrations at each site. Data: ODEQ 2001, 2007a, 2007b, 2009a, 2009b. Color aerial photo insert shows the number and location of TOC monitoring sites at or near the former Joy Ney dump site. Subsystem codes: SS-South Slough, LB-Lower Bay, PS-Pony Slough, IS-Isthmus Slough, UB-Upper Bay, NS-North Slough, HI-Haynes Inlet, CR-Coos River, CS-Catching Slough.

Table 1. Mean observed TOC and summary of all ODEQ observations (1995-2009). Data: ODEQ 2001, 2007a, 2007b, 2009a, 2009b

Monitoring Site	Site Code	Subsystem	TOC (mg/L)	# Obs	Sampling Dates	Source
Bandon Landfill leachate drain	BNDN	SS	60.0	1	March 1995	DEQ 2009b
SS-4	SS4	SS	33.66*	3	April 1998, May 2009	DEQ 2009b
Joe Ney Landfill Monitoring Well 4	MW4	SS	30.3	3	March 1995, April 2002, Oct. 2006	DEQ 2009b
Joe Ney Landfill Monitoring Well 13	MW13	SS	26.0	1	April 2002	DEQ 2009b
Joe Ney Landfill Monitoring Well MW-1R	MW1R	SS	15.0	2	March 1995, April 1998	DEQ 2009b
Dh-11	DH11	SS	11.3	4	April 1998, April 2002, Oct. 2006, May 2009	DEQ 2009b
Joe Ney Landfill Ss-3 surface site downstream of landfill	SS3	SS	6.5	2	March 1995, Oct. 2006	DEQ 2009b
South Fork Coos River at Anson Rogers Bridge	ANRG	CR	6.0	2	Sept. 2001, Nov. 2001	DEQ 2001
SS-5	SS5	SS	5.0	1	May 2009	DEQ 2009b
Millicoma River at USGS Gaging Station (RM 6.6)	USGS	CR	4.5	2	Oct. 2009	DEQ 2009a
West Fork Millicoma River 0.25 miles upstream of hatchery	HTCH	CR	4.5	2	Oct. 2009	DEQ 2009a
Millicoma River at Rook-Higgins boat ramp	RKHG	CR	3.2	5	Sept. 2001, Nov. 2001, Oct. 2009, Oct. 2009	DEQ 2001, DEQ 2009a
East Fork Millicoma River at Private Road	PRVT	CR	3.0	2	Oct. 2009	DEQ 2009a
West Fork Millicoma River at Allegany	ALGN	CR	3.0	2	Oct. 2009	DEQ 2009a
Davis Slough	DVSL	IS	2.5	11	April 2006, June 2006 - March 2007	DEQ 2007
Isthmus Slough at Sumner Bridge	SMNR	IS	2.5	26	April 2006 - March 2007	DEQ 2007
SS-2 Shana Creek upstream of Joe Ney Landfill north of SS-5	SS2	SS	2.5	2	March 1995, Oct. 2006	DEQ 2009b
Noble Creek tidegate	NBLE	IS	2.4	10	April 2006, July 2006 - March 2007	DEQ 2007
Shinglehouse Slough mouth	SNGL	IS	2.1	15	April 2006, June 2006 - March 2007	DEQ 2007
Coalbank Slough mouth	CLBK	IS	2.0	24	April 2006 - March 2007	DEQ 2007
Coos Bay South Slough near Joe Ney Slough	JNSL	SS	2.0	1	April 1998	DEQ 2009b
Isthmus Slough at Eastside Bridge	ESDE	IS	1.8	26	April 2006 - March 2007	DEQ 2007
Joe Ney Landfill Monitoring Well 3	MW3	SS	1.75*	2	March 1995	DEQ 2009b
Joey Ney Landfill Monitoring Well 6R	MW6R	SS	0.875*	4	March 1995, April 1998, Oct. 2006, May 2009	DEQ 2009b
Joe Ney Landfill Monitoring Well 7	MW7	SS	0.5	1	March 1995	DEQ 2009b
Joe Ney Landfill Monitoring Well 2	MW2	SS	0.5*	1	March 1995	DEQ 2009b
Joey Ney Slough at mudflat east of boatyard (JNMFE)	MDFL	SS	0.5*	1	April 1998	DEQ 2009b

* Mean was calculated by substituting a value of 0.5 mg/L for observations that were recorded as "< 1 mg/L."

Table 2. Mean observed TOC at three Pony Slough and Lower Bay sites. Data: Water Board 2012

Year	Mean Annual TOC (mg/L)	Minimum TOC (mg/L)	Maximum TOC (mg/L)	Std. Error	Number of Observations
2010	3.44	2.5	4.3	0.18	11
2011	3.05	1.12	4.75	0.28	19
2012	3.96	3.58	4.52	0.11	7

Dissolved Organic Carbon

Dissolved organic carbon (DOC) is a component of TOC, the measurement of which allows for particularly accurate TOC assessments in the water column. Unfortunately, little is known about the level of DOC in the Coos estuary.

What we do know comes from Pregnall (1983) who studied primary production in South Slough to help quantify DOC produced by Coos estuary biota. His findings suggest that photosynthesis of South Slough intertidal algae (*Enteromorpha prolifera*) releases 0.13-0.57 mg of DOC per gram of dry weight biomass per hour. This rate was shown to increase in response to changes commonly associated with estuarine environments such as daily salinity fluctuations.

More research is needed to fully understand estuarine DOC dynamics in the Coos estuary and how measuring DOC concentrations can be used to improve water quality assessments.

Background

TOC can be thought of as the sum of particulate organic carbon (POC) and dissolved organic carbon (DOC). While POC settles in the sediment (see Chapter 10: Sediment Contamination in the Coos Estuary), DOC is transported from the sediment to the water column by a variety of natural and human activity-related processes (e.g., diffusion, bioturbation, bioirrigation, pore water advection, sediment resuspension)(Burdige 2006). Swett (2010) explains that estuarine sediments release significant amounts of DOC due to highly active microbial communities. He adds that, due to its ability to bind to metals such as mercury, DOC is a water quality concern, because it can effectively transport pollutants into the water column. Research suggests that organic carbon may also transport pesticides and herbicides (Wijayaratne and Means 1984) as well as biphenyls (PCBs)(Brownawell and Farrington 1986) into the water column from contaminated sediments. Additionally, high TOC levels in source waters have been shown to result in harmful water treatment byproducts (e.g., trihalomethanes)(Fleck et al. 2007).

Bauer and Bianchi (2011) explain that estuaries are complex systems involving the exchange of carbon between terrestrial, marine, and atmospheric sources. They point out that the complexity of biogeochemical processes in estuaries is compounded by temporal variability. For example, estuarine biogeochemical processes respond to twice daily tidal flooding, daily or weekly storm events, seasonal or monthly changes in temperature and precipitation, and multi-year to decades-long changes in long term climatic regimes (e.g., El Niño Southern Oscillation and Pacific Decadal Oscillation). In addition to these natural processes, estuarine carbon cycling is carried out against a backdrop of human land use activities, which can further complicate an already intricate process (Bauer and Bianchi 2011). Consequently, we have a limited understanding of the role of DOC in governing the flux of organic matter and trace metals in coastal and estuarine systems (Martin et al. 1995).

Guideline Values for Assessing Aquatic Life Dissolved Metals Standards:

Acute Criterion (CMC) - *The highest concentration to which aquatic life may be exposed briefly without resulting in adverse effects.*

Chronic Criterion (CCC) - *The highest concentration to which aquatic life may be exposed indefinitely without resulting in adverse effects.*

Source: USEPA 2012

Dissolved Metals

Metals can readily dissolve in water, and can find their way into estuarine waters from various sources including manufacturing, mining and farming activities (the latter featuring land-applied herbicides and pesticides), and air pollution from fossil fuel combustion (USEPA 2007a). Many metals (e.g., iron, copper) are also naturally abundant elements found in coastal watersheds (Shacklette and Boerngen 1984; USEPA 2007b). Table 3 summarizes the dissolved metals discussed below.

Water quality criteria for dissolved metals have been developed for both aquatic life and human health (ODEQ 2014a; USEPA 1993, 2007a, 2007b, 2009). For aquatic life criteria, dissolved metal standards are evaluated using an acute criterion (CMC) and a chronic criterion (CCC)(see sidebar). For human health, standards are classified into categories for the safe consumption of 1) water and aquatic organisms, and 2) aquatic organisms only. Figure 2 summarizes the organizational structure of dissolved metal standards for each pollutant.

Data describing dissolved metal concentrations are available in the Pony Slough, Sough Slough, Coos River, and Isthmus Slough subsystems (Figure 3 and Table 4)(ODEQ 1995, 1998a, 2002, 2006a, 2006b, 2006c, 2007a, 2007b, 2009a, 2009b; Water Board 2012).

From 1998 to 2012, 13 sites in the study area (including the subsystems listed above)(Figure 4 and Table 3) were listed under the Clean Water Act for insufficient data or as sites of “potential concern”. These listings reinforce the fact that we don’t yet have enough information to form a comprehensive understanding of the status of dissolved metals in the Coos estuary.

Pollutant	What is it?	Industrial Uses and Sources	EPA National WQ Criteria Listing Aquatic Life	Human Health
Aluminum	Light-weight, mallable metal comprised of mostly bauxite	Transportation, construction, packaging, machinery	Not Listed	Not Listed
Antimony	Metalliod, toxic	Discharge from petroleum refineries, fire retardants, ceramics, electronics, solder	Not Listed	Priority
Arsenic	Metalloid, toxic	Marine building material, logging, erosion of natural deposits, runoff agriculture and glass/electronics	Priority	Priority
Barium	Alkaline metal	Discharge of drilling wastes, discharge from metal refineries, erosion of natural deposits	Not Listed	Not Listed
Beryllium	Alkaline metal	Discharge from metal refineries and coal-burning factories, discharge from electrical, aerospace, and defense industries	Not Listed	Priority
Boron	Metalloid	Heat resistant alloys	Non-Priority	Not Listed
Cadmium	Transitional metal, mallable, conductor	Corrosion of galvanized pipes, erosion of natural deposits, discharge from metal refineries, runoff from waste batteries and paints	Priority	Priority
Chromium	Transitional metal, mallable, conductor	Discharge from steel and pulp mills, erosion of natural deposits	Priority	Priority
Cobalt	Transitional metal, mallable, conductor, magnetic	Metal alloys, chemicals, colorant, nuclear power, radiactive waste	Not Listed	Not Listed
Copper	Transitional metal, mallable, condutor	Corrosion of household plubing systems, erosion of natural deposits	Priority	Priority
Iron	Transitional metal, mallable, conductor, magnetic	Component in steel, naturally abundant in geological materials	Non-Priority	Not Listed
Lanthanum	Lanthanide series, rare earth elements	LED and other lighting applications	Not Listed	Not Listed
Lead	Other metal, solid, dense	Corrosion of household plumbing systems, erosion of natural deposits, paints	Priority	Not Listed
Lithium	Alkali metal, soft, mallable, conductor	Ceramics and glass, batteries, lubricating greases, powders for molding/casting metal, dehumidifying	Not Listed	Not Listed
Magnesium	Alkaline metal	Component in titanium and other alloys, metal casting, wrought products	Not Listed	Not Listed
Manganese	Transitional metal, sulfur-fixing, deoxidizing, alloying for metal production	Metal production, gasoline additive, colorant, fertilizer	Not Listed	Priority
Mercury	Transitional metal, mallable, conductor	Erosion of natural deposits, discharge from refineries and factories, runoff from landfills and croplands	Priority	Priority
Molybdenum	Transitional metal, mallable, conductor	Metal alloys, steel, cast iron	Not Listed	Not Listed
Nickel	Transitional metal, mallable, conductor, magnetic	Metal alloys, steel, electroplating	Priority	Priority
Selenium	Non-metal	Petroleum refineries, erosion of natural deposits, discharge from mining lead, copper, and nickel	Priority	Priority
Silver	Transitional metal, mallable, conductor	Jewelry, photography and electronics, dental products, solder, brazing alloys, batteries	Priority	Not Listed
Thallium	Other metal, solid, dense, toxic	Leaching from ore-processing sites, discharge from electronics, glass, and drug factories	Not Listed	Priority
Vandium	Transitional metal, mallable, conductor	Metal alloys	Not Listed	Not Listed
Zinc	Transitional metal, mallable, conductor	Galvanizing, metal alloys	Priority	Priority

Table 3. Dissolved metals found in aquatic systems.

Data sources: ODEQ 2014a, USEPA 1993;

Industrial Uses and Sources data: Buszka et al. 2007, CDC 2004, ODEQ 2008, RSC 2014, USEPA 2009, USGS 2014, Wilburn 2012, Winter 1993;

Water Quality Criteria Listing data sources: USEPA 1993

Priority Pollutant Status

The USEPA has developed a list of 126 priority pollutants. Priority status is assessed based on the following criteria:

1. Must be included on USEPA's list of toxic pollutants

2. Must have chemical standards and published testing methods

3. Must be frequently found in water

4. Must have been produced domestically in substantial quantities

Source: USEPA 2014

Of the 13 sites mentioned, only three were listed as potential water quality threats to both aquatic life and human health due to elevated concentrations of dissolved metals (Coos Bay in 1998 and Day and Storey Creeks in 2004). The remaining 10 sites were listed due to informational gaps (Table 3)(ODEQ 1998b, 2004, 2012).

The status of specific dissolved metals in the Coos estuary and surrounding area is detailed below. This inventory presents USEPA standards for both aquatic life and human health. However, the toxic effects of exposure focus on human health, because the effects on

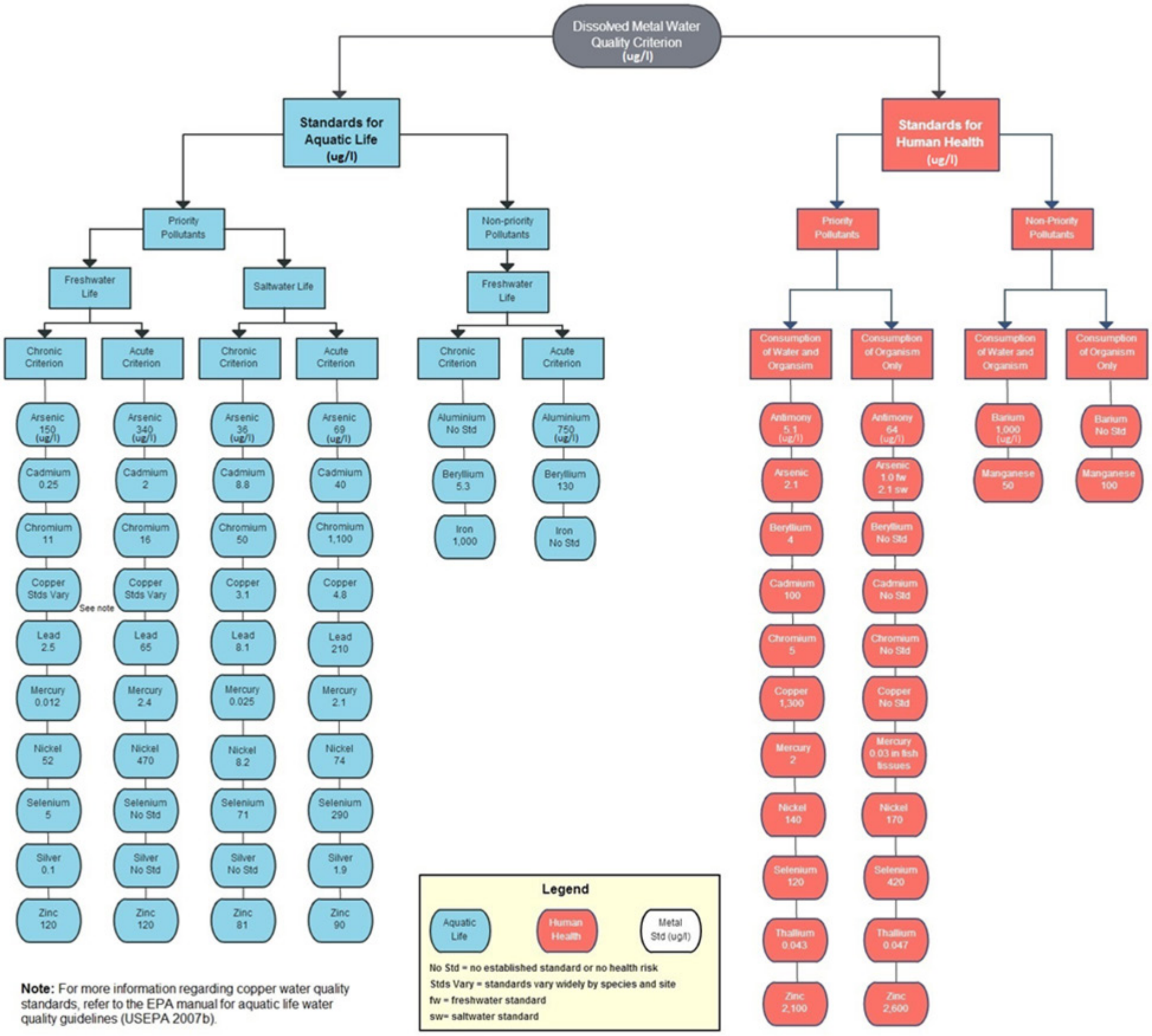


Figure 2. Dissolved metals standards in micrograms per liter (ug/l). Source: ODEQ 2014a; USEPA 1993, 2007a, 2007b, 2009

aquatic life can vary significantly by species and environmental conditions (e.g., pH, organic content, sediment characteristics, conductivity, etc.)(USEPA 1980; USEPA 2007b).

Aluminum

Dissolved aluminum (1995-2009) concentrations appear to be higher in Isthmus Slough than in South Slough or Pony Slough.

Aluminum is a non-priority pollutant for aquatic life standards (see sidebar)(USEPA 1993).

Antimony

Antimony concentrations (2005-2009) in South Slough at the former Joe Ney Landfill Disposal Site (JNDS) meet USEPA standards for human consumption of both water and aquatic organisms (Table 4).

Subsystem	Number of Observations	Dectection Rate A (%)	Estimated Average B (µg/l)	Max Observed Value C (µg/L)	Data Source
Aluminium					
SS	39	26	36	300	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	48	1,382	2,550	ODEQ 2006b, 2006c, 2007a, 2007b
CR	11	0	25	25	ODEQ 2009b
Antimony					
SS	31	3	2.2	3.4	ODEQ 1995, 1998, 2002, 2006a, 2009a
Arsenic					
SS	39	15	38	21	ODEQ 1995, 1998, 2002, 2006a, 2009a
PS	10	30	1.97	4	Water Board 2012
Barium					
SS	39	87	267	1,720	ODEQ 1995, 1998, 2002, 2006a, 2009a
Beryllium					
SS	38	11	1.13	0.029	ODEQ 1995, 1998, 2002, 2006a, 2009a
Boron					
SS	38	82	668	5,230	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	95	2,380	4,170	ODEQ 2006b, 2006c, 2007a, 2007b
CR	11	55	136	1,260	ODEQ 2009b
Cadmium					
SS	38	0	1.78	N/A	ODEQ 1995, 1998, 2002, 2006a, 2009a
Chromium					
SS	38	24	3.78	3.91	ODEQ 1995, 1998, 2002, 2006a, 2009a
Cobalt					
SS	39	56	11	31	ODEQ 1995, 1998, 2002, 2006a, 2009a
Copper					
SS	37	25	9.03	62	ODEQ 1995, 1998, 2002, 2006a, 2009a
PS	10	100	102.1	250	Water Board 2012
Iron					
SS	38	74	5,026	41,900	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	51	1,398	2,680	ODEQ 2006b, 2006c, 2007a, 2007b
CR	11	45	54	178	ODEQ 2009b
Lead					
SS	12	0	0.37	N/A	ODEQ 1995, 1998, 2002, 2006a, 2009a
PS	10	100	6.7	11	Water Board 2012
Lanthanum					
SS	16	50	15	25	ODEQ 1995, 1998
Lithium					
SS	38	26	11	22	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	47	428	750	ODEQ 2006b, 2006c, 2007a, 2007b
CR	11	18	14	50	ODEQ 2009b
Magnesium					
SS	39	100	23,663	61,900	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	47	698,268	1,210,000	ODEQ 2006b, 2006c, 2007a, 2007b
CR	11	100	62,427	384,000	ODEQ 2009b
Manganese					
SS	40	95	679	4,890	ODEQ 1995, 1998, 2002, 2006a, 2009a
IS	259	51	146	290	ODEQ 2006b, 2006c, 2007a, 2007b
CR	5	80	31	79	ODEQ 2009b
Mercury					
SS	26	19	0.63	0.01	ODEQ 1995, 1998, 2002, 2006a, 2009a
Molybdenum					
SS	38	21	6	18	ODEQ 1995, 1998, 2002, 2006a, 2009a
Nickel					
SS	38	42	6.1	10.3	ODEQ 1995, 1998, 2002, 2006a, 2009a
Selenium					
SS	35	0	2.35	----	ODEQ 1995, 1998, 2002, 2006a, 2009a
Silver					
SS	39	3	1.34	0.26	ODEQ 1995, 1998, 2002, 2006a, 2009a
Thallium					
SS	20	0	0.64	N/A	ODEQ 1995, 1998, 2002, 2006a, 2009a
Vanadium					
SS	39	8	4	0.66	ODEQ 1995, 1998, 2002, 2006a, 2009a
Zinc					
SS	11	27	1.74	4.8	ODEQ 1995, 1998, 2002, 2006a, 2009a

A- Percent of all observations above detectable limits.
B - In order to estimate the average concentration, observations that are below dectable limits take on an assumed value (see Chapter Summary).
C - Maximum observed value refers to the highest value in the subset of observations that are above dectectable limits.

Table 4. Summary of dissolved metal concentrations in the lower Coos Watershed. Data: ODEQ 1995, 1998a, 2002, 2006a, 2006b, 2006c, 2007a, 2007b, 2009a, 2009b; Water Board 2012

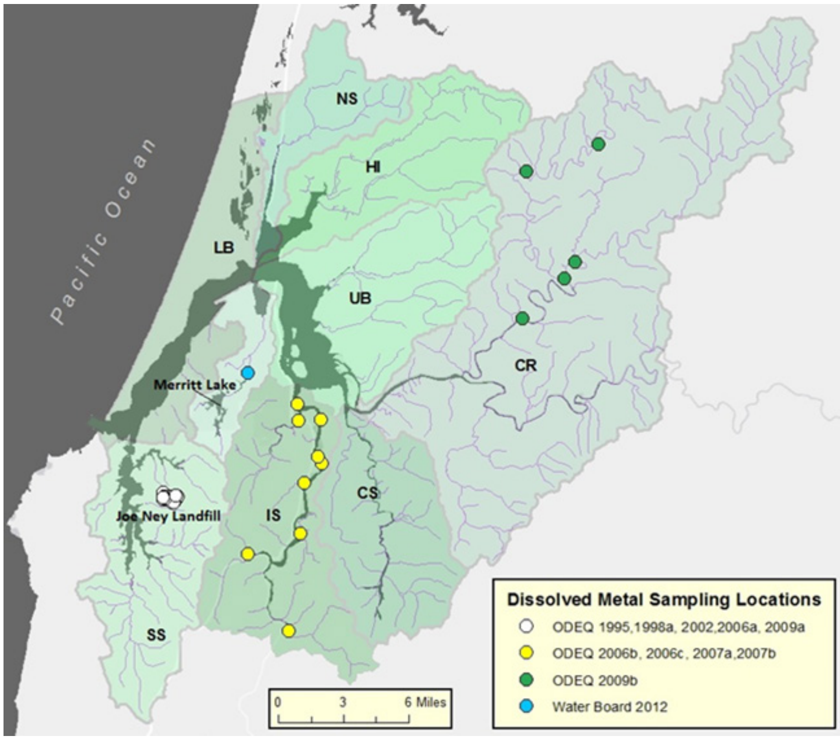


Figure 3. Sampling Locations of Dissolved Metals. Source: ODEQ 1995, 1998a, 2002, 2006a, 2006b, 2006c, 2007a, 2007b, 2009a, 2009b, Water Board 2012. Subsystem codes: SS-South Slough, LB-Lower Bay, PS-Pony Slough, IS-Isthmus Slough, UB-Upper Bay, NS-North Slough, HI-Haynes Inlet, CR-Coos River, CS-Catching Slough

In 2004, Day Creek (South Slough), Mettman Creek (Upper Bay), as well as Morgan Creek and the West Fork of the Millicoma River (Coos River) were all listed due to insufficient information (Table 3)(ODEQ 2004).

Antimony is a priority pollutant, meaning that it is a toxic pollutant with established chemical standards that is frequently found in water (USEPA 1993, 2014). Human exposure to antimony can affect the cardiovascular (heart and blood vessels) and respiratory (breathing) systems, but is not known to have any cancer effects (CDC 2014).

Arsenic

At South Slough's JNDS, arsenic concentrations (1995-2009) may be harmful to saltwater aquatic life. Elevated arsenic concentrations at South Slough's JNDS may not meet USEPA recommended concentrations for the safe human consumption of both water and aquatic organisms. In 2012, arsenic concentrations in the Pony Slough subsystem at Merritt Lake met USEPA guidelines (Table 4).

In 2004, arsenic was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004). Arsenic is a priority pollutant for both aquatic life and human health (USEPA 1993). Human exposure to arsenic can affect the dermal (skin), gastrointestinal (digestive), hepatic (liver), neurological (nervous system), and respiratory (breathing) systems. It is a known carcinogen (CDC 2014).

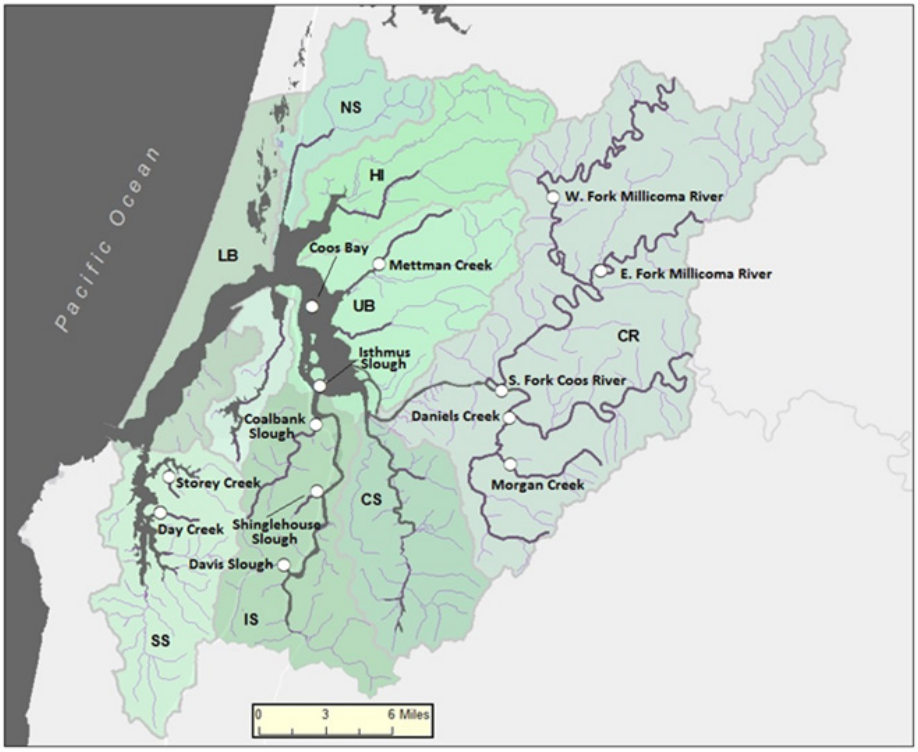


Figure 4. Location of 303d-listed sites (1998-2012). Source: ODEQ 1998, 2004, 2012.

Subsystem codes: SS-South Slough, LB-Lower Bay, PS-Pony Slough, IS-Isthmus Slough, UB-Upper Bay, NS-North Slough, HI-Haynes Inlet, CR-Coos River, CS-Catching Slough

Barium

In 2004, barium was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

The data that are available suggest that average barium concentrations (1995-2009) at South Slough's JNDS appear to meet the USEPA standards for safe human consumption of water and aquatic organisms, but maximum observed concentrations do not meet these standards (Table 4).

Barium is a non-priority pollutant (USEPA 1993). However, human exposure to barium may affect the cardiovascular (heart and blood vessels), gastrointestinal (digestive), and reproductive (producing children) systems. It does not have any cancer effects (CDC 2014).

Beryllium

In 2004, beryllium was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

However, the data that are available suggest that dissolved beryllium concentrations (1995-2009) in South Slough's JNDS meet USEPA standards for both aquatic life and human health (Table 4).

Beryllium is a priority pollutant for human health (USEPA 1993). Human exposure to beryllium may affect the gastrointestinal (digestive), immunological (immune system), and respiratory (breathing) systems. It is a known carcinogen (CDC 2014).

Boron

Average boron concentrations (1995-2009) are higher in Isthmus Slough than in either Sough Slough JNDS or Pony Slough at Merritt Lake. However, the highest maximum observed concentration occurred in South Slough at JNDS (Table 4).

The USEPA has not established water quality guidelines for boron.

Cadmium

In 2004, cadmium was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

The available data suggest that cadmium concentrations in the study are low. From 1995-2009, ODEQ made 38 cadmium observations at South Slough's JNDS. All of these observations were below detectable limits, indicating that cadmium concentrations at JNDS likely meet USEPA standards for human health. USEPA standards for freshwater aquatic life, however, are much closer to detectable limits. Therefore, it's difficult to know if the JNDS cadmium concentrations meet the freshwater aquatic life standard for indefinite exposure (Table 4).

Cadmium is a priority pollutant (USEPA 1993). Human exposure to cadmium may affect the cardiovascular (heart and blood vessels), gastrointestinal (digestive), neurological (nervous system), renal (urinary and kidneys), reproductive (producing children), and respiratory (breathing) systems. It is a known carcinogen (CDC 2014).

Chromium

Chromium concentrations (1995-2009) in South Slough's JNDS meet USEPA standards for both aquatic life and human health (Table 4).

In 1998, chromium was listed as a potential concern for aquatic life in Coos Bay (Upper Bay)(ODEQ 1998b). In 2004, it was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Chromium is a priority pollutant (USEPA 1993). Human exposure to chromium may affect the immunological (immune system), renal (urinary and kidneys), and respiratory systems. It is a known carcinogen (CDC 2014).

Cobalt

About half of the cobalt observations (1995-2009) at South Slough's JNDS are below detectable limits, indicating that the accuracy of monitoring efforts could be improved by more complete information (Table 4). USEPA has not established water quality guidelines for cobalt (USEPA 1993).

Copper

Copper concentrations at South Slough's JDNS (1995-2009) as well as Pony Slough at Merritt Lake (2012) appear to meet the USEPA standard for safe human consumption. However, brief exposure to these sites may be harmful to saltwater aquatic life (Table 4).

In 1998, copper was listed as a potential concern for aquatic life in Coos Bay (Upper Bay) (ODEQ 1998b). In 2004, it was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Copper is a priority pollutant (USEPA 1993). Human exposure to copper may affect the gastrointestinal (digestive), hematological (blood forming), and hepatic (liver) systems. It does not have any cancer effects (CDC 2014).

Iron

Iron concentrations in the Coos River subsystem (2009) as well as in Isthmus Slough (2006-2007) and South Slough's JNDS (1995-2009) may be harmful to freshwater aquatic life (Table 4).

In 2004, iron was listed as a potential concern for both aquatic life and human health at Day and Storey Creeks (South Slough). In 2012, it was listed for insufficient information at Mettman Creek (Upper Bay) as well as the following waters in the Coos River subsystem: Daniels Creek, East Fork Millicoma, West Fork Millicoma, Morgan Creek, and South Fork Coos (Table 3)(ODEQ 2004). Iron is a non-priority pollutant.

Lead

Lead observations at Pony Slough Merritt Lake (2012) and South Slough's JNDS (1995-2009) seem to meet USEPA standards for aquatic life (Table 4).

In 1998, lead was listed as a potential concern for aquatic life in Coos Bay (Upper Bay)(ODEQ 1998b). In 2004, it was listed for insufficient information in Day Creek (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Lead is a priority pollutant for aquatic life (USEPA 1993). Although it is not listed as a priority pollutant for human health, lead exposure is associated with harmful health affects to the cardiovascular (heart and blood vessels), gastrointestinal (digestive), hematological (blood forming), musculoskeletal (muscles and skeleton), neurological (nervous system), ocular (eyes), renal (urinary and kidneys), and reproductive (producing children) systems. It is reasonably anticipated to be a carcinogen (CDC 2014)

Lanthanum

Only sixteen percent of lanthanum observations at South Slough's JNDS (1995-2009) are above detectable limits, indicating that accuracy of cobalt monitoring efforts could be improved by more complete information (Table 4). USEPA has not established water quality guidelines for lanthanum.

Lithium

Lithium concentrations appear to be an order of magnitude higher in Isthmus Slough (2006-2007) than at South Slough's JNDS (1995-2009) or in the Coos River (2009) subsystem (Table 4). USEPA has not established water quality guidelines for lithium.

Magnesium

Magnesium concentrations are much higher in Isthmus Slough (2006-2007) than at South Slough's JNDS (1995-2009) or in the Coos River (2009) subsystem (Table 4). USEPA has not established water quality guidelines for magnesium.

Manganese

In 2004, Manganese was listed as a potential concern for human health in both Day and Storey Creek (South Slough). It was also listed for insufficient information at Mettman Creek (Upper Bay) as well as Morgan Creek and the West Fork of the Millicoma River (Coos River) (Table 3)(ODEQ 2004). In 2012, Coalbank, Davis, Isthmus, and Shinglehouse Sloughs (Isthmus Slough subsystem) were all listed as informational gaps (Table 3)(ODEQ 2012).

The available data suggest that manganese concentrations may not meet USEPA standards. The estimated average manganese concentration does not meet the USEPA guideline for safe human consumption of either water or aquatic organisms in Isthmus slough (2006-2007); nor does it meet these standards at South Slough's JNDS (1995-2009). In the Coos River subsystem (2009), maximum observed concentrations do not meet USEPA standards for safe human consumption (Table 4).

Manganese is a non-priority pollutant (USEPA 1993). However, human exposure to manganese may affect the cardiovascular (heart and blood vessels), hepatic (liver), neurological (nervous system) and respiratory (breathing) systems. It does not have any cancer effects (CDC 2014).

Mercury

Indefinite exposure to mercury concentrations at South Slough's JNDS (1995-2009) may be harmful to both freshwater and saltwater aquatic life. However, mercury concentrations appear to meet the USEPA recommended standard for safe human consumption of water (Table 4). For a discussion of mercury in fish tissues, see Chapter 10: Sediments in the Coos Estuary and Lower Coos Watershed.

In 2004, mercury was listed for insufficient information at Day Creek (South Slough)(Table 3)(ODEQ 2004).

Mercury is a priority pollutant for both aquatic life and human health (USEPA 1993). Human exposure to mercury may affect the gastrointestinal (digestive), neurological (nervous system), ocular (eyes), and renal (urinary and kidneys) systems. It does not have any cancer effects (CDC 2014).

Molybdenum

Only 21% of molybdenum observations at South Slough's JNDS (1995-2009) were above detectable limits, indicating that the accuracy of monitoring efforts could be improved by more complete information (Table 4). USEPA has not established water quality guidelines for molybdenum.

Nickel

Dissolved nickel concentrations at South Slough's JNDS (1995-2009) easily meet USEPA standards for safe human consumption of both water and aquatic organisms (Table 4).

In 2004, nickel was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Nickel is a priority pollutant for both aquatic life and human health (USEPA 1993). Human exposure to nickel may affect the cardiovascular (heart and blood vessels), dermal (skin), immunological (immune system), and respiratory (breathing) systems. It is a known carcinogen (CDC 2014).

Selenium

In 2004, selenium was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

However, the available data suggest that selenium concentrations at South Slough's JNDS (1995-2009) meet USEPA standards for both aquatic life and human health.

Selenium is a priority pollutant for both aquatic life and human health (USEPA 1993). Human exposure to selenium may affect the dermal (skin), and reproductive (producing children) systems. It is reasonably anticipated to be a carcinogen (CDC 2014).

Silver

Indefinite exposure to dissolved silver at South Slough's JNDS (1995-2009) may be harmful to freshwater aquatic life (Table 4).

In 2004, silver was listed for insufficient information in Storey and Day Creeks (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Silver is a priority pollutant for aquatic life (USEPA 1993). Although it is not listed as a priority pollutant for human health, exposure to silver is associated with harmful health effects to the renal (urinary and kidneys) and reproductive (producing children) systems. It does not have any cancer effects (CDC 2014).

Thallium

All twenty thallium observation at South Slough's JNDS (1995-2009) are below detectable limits. However, the estimated average concentration indicates that thallium concentrations at JNDS may not meet USEPA standards for safe human consumption of either water or aquatic life (Table 4).

In 2004, thallium was listed for insufficient information in Day Creek (South Slough), Mettman Creek (Upper Bay), and Morgan Creek and the West Fork of the Millicoma River (Coos River)(Table 3)(ODEQ 2004).

Thallium is a priority pollutant for human health (USEPA 1993). Human exposure to thallium may affect the gastrointestinal (digestive), hepatic (liver), neurological (nervous system), and renal (urinary or kidneys) systems. It does not have any cancer effects (CDC 2014).

Vanadium

Only 8% of all vanadium observations at South Slough's JNDS (1995-2009) are above detectable limits, indicating that the accuracy of monitoring efforts could be improved by more complete information.

USEPA has not established water quality guidelines for vanadium. Human exposure to vanadium may affect the cardiovascular (heart and blood vessels), gastrointestinal (digestive), renal (urinary and kidneys), reproductive (producing children), and respiratory (breathing) systems. It does not have any cancer effects (CDC 2014).

Zinc

Dissolved zinc concentrations at South Slough's JNDS (1995-2009) easily meet USEPA standards for both aquatic life and human health (Table 4).

Zinc is a priority pollutant for both aquatic life and human health (USEPA 1993). Human exposure to zinc may affect the gastrointestinal (digestive), hematological (blood forming), and respiratory (breathing) systems. It does not have any cancer effects (CDC 2014).

<u>Persistent Organic Pollutants, Biocides, and Other Contaminants</u>

"Persistent organic pollutants" (POPs) are widely distributed herbicides, pesticides, insecticides, and other biocides that are internationally recognized for their potential to cause environmental damage (see "Stockholm Convention" sidebar). In addition to POPs, tributyltin (TBT), an anti-fouling chemical found in boat bottom paints, has historically been a concern in the Coos estuary (Wolniakowski et al. 1987). Table 5 details the properties of the most common POPs and provides their associated water quality standards.

Although little is known about dissolved POPs and TBT in the Coos estuary, what we do know comes from the Coos Bay/North Bend Water Board, which monitors Merritt Lake (Pony Slough Subsystem) for eight POPs including aldrin and dieldrin, chordane, DDT, endrin, heptachlor, HCB, PCBs, and toxaphene. Since the monitoring program began in 1985, the Water Board has not recorded any POPs observations above detectable limits (Water Board 2012).

Cornu et al. (2012) note that a wide range of pesticides, including POPs such as DDT, have been detected by ODEQ in low ("unquantifiable") amounts at 29 sites in the Coos Basin. Although the location of many these sites is undisclosed, it is clear that sampling occurred at no fewer than three Sough Slough locations, including Joe Ney Slough, Collver Point, and Brown's Cove (ODEQ 2014b).

Persistent Organic Pollutant (POP)	What is it?	Environmental and Human Health Effects	Human Health Water Quality Standard (mg/L)
Aldrin and Dieldrin	Agricultural insecticide; terminte control	Fatal to birds. Harmful to aquatic life, especially frogs and fish. Known to be fatal to humans.	No standard
Chlordane	Agric. insecticide; terminte control; home lawn and garden pesticide	Persistant in soil. Fatal to ducks, quail, and shrimp. May affect the human immune system, liver, or nervous system. Possible human carcinogen.	0.002
Chlordecone	Agric. pesticide	Highly persistant. High potential for transport over long distances and bioaccumulation/biomagnification in ecosystems. Very toxic to aquatic life. Possible human carcinogen.	No standard
1,1,1- Trichloroethane and 1,1,2-Trichloroethane (DDT)	Agric. insecticide	Egg shell thinning among birds, especially raptors. Long-term exposure associated with chronic health effects in humans including liver, kidney, immunse system, and neurological problems.	0.005-0.2 depending on properties
Endosulfan and related isomers	Agric. pesticide	Persistent in the atmosphere, sediments, and water. Toxic effects in animals. Linked with congential physical disorders, mental retardations, and death in humans.	No standard
Endrin	Agric. insecticide, rodent control	Persistant in soils. Highly toxic to fish. Associated with liver problems in humans.	0.002
Heptachlor	Agric.insecticide	Fatal to birds. Harmful to small mammals. Linked to liver damage in humans. Possible human carcinogen.	0.0004
Hexabromobiphenyl	Industrial chem.; fire retardant	Highly persistant. Bioaccumulation in ecosystems. Possible human carcinogen.	No standard
Hexabromobiphenyl ether and heptabromodiphenyl ether	Chem. manufacturing	Persistant with high likelihood of long-rang transport and bioaccumulation. Possible human carcinogen.	No standard
Hexachlorobenzene (HCB)	Fungicide; Industrial chem. in fireworks, ammunition, and synthetic rubber. Byproduct of chem. manufacturing.	Lethal to some animals. Associated with limited reproductive success in wildlife. Human effects include liver or kidney problems, reproductive difficulties, increased risk of cancer, and death.	0.001
Hexachlorocyclohexane and related isomers	Byproduct of Lindane	Highly persistant. May bioaccumulate. Possible human carcinogen.	No standard
Lindane	Agric. insecticide; human health pharmeceutical	Bioaccumulates rapidly. Toxic effects in aquatic wildlife and humans.	0.0002
Mirex	Insecticide; Industrial chem.; fire retardant.	Extremely persistant. Toxic to fish and plants. Possible human carcinogen.	No standard
Tetrabromodiphenyl ether and pentabromodiphenyl ether	Industrial chem.; fire retardant	Persistent. High potential for long-range transport and bioaccumulation. Toxic effects in widlife. Adverse human health effects.	No standard
Toxaphene	Agric. pesticide.	Extremely persistent. Toxic to fish. Related to kidney, liver, or thyroid problems in humans. Possible human carcinogen.	0.003
Pentachlorobenzene	Fungicide and industrial chem. Byproduct of combustion.	Persistant with potential for bioaccumulation and long-range transport. Moderately toxic to humans and very toxic to aquatic organisms.	No standard
Perfluorooctane sulfonic acid, its salts, and perfluorooctane sulfonyl fluoride	Industrial chem. Byproduct of chem. degradation.	Extremely persistent. Bioaccumulates rapidly. Binds to the blood and liver tissues rather than fat.	No standard
Polychlorinated biphenyls (PCB)	Industrial chem. Byproduct of combustion.	Persistance depends on chem. properties. Toxic to fish. Harmful to mammals. Severe human ealth effects to nervious and immune systems. Probable human carcinogen.	0.0005
Polychlorinated dibenzo-p-dioxins and Polychlorinated dibenzofurans (PCDD and PCDF)	Byproduct of combustion. Comtaminant in herbicides, wood preservatives, and PCBs	Persistant. Lethal to fish. Immune and enzyme disorders in humans. Possible human carcinogen.	No standard

Table 5. Properties of the most common POPs. Source: Stockholm Convention 2008.

For additional information about POPs, TBT, biocides, and other contaminants, refer to Chapter 10: Sediment Contamination in the Coos Estuary.

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Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants is a multinational agreement intended to eliminate or mitigate the production/use of harmful Persistent organic pollutants (POPs). POPs are "organic" (i.e., carbon-based) pollutants with high potential for environmental damage.

In 2001, the Convention identified 12 priority POPs, and an additional nine POPs were added in 2009. These POPs were selected based on the following properties:

- *Persistence: The ability to remain intact in the environment for many years*
- *Long-range distribution: Widely distributed throughout the environment as a result of natural processes*
- *Bioaccumulation and Biomagnification: Accumulation in fatty tissues of living organisms, with higher concentrations occurring at higher levels in the food chain*
- *Toxicity: Associated with harmful health affects in humans and wildlife*

Long-range transport of POPs is often facilitated by the migration of animals that have been exposed to them. Due to the characteristics of POPs, predatory animals that are high up the food chain, such as fish, raptors, mammals, and humans, are at elevated risk for absorbing high POP concentrations.

Source: Stockholm Convention 2008

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