Liberty Bay Tributaries Fecal Coliform TMDL

Technical Overview

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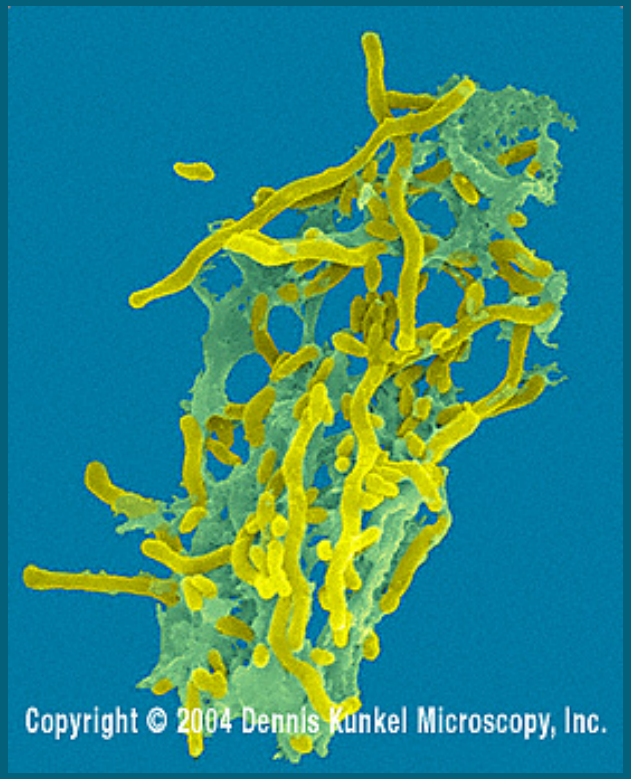
Sally Lawrence, TMDL Lead

WA State Department of Ecology presentation. Do not cite or quote.

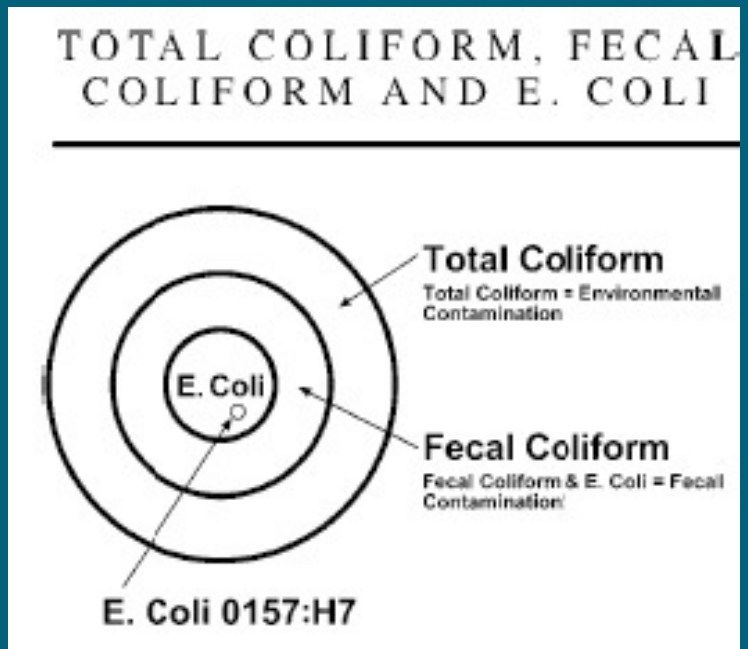
Parameter addresed in this study

Fecal Coliform bacteria



Coliform bacteria

- Total coliform = environmental contamination
- Fecal coliform = warm blooded animal waste
- E. Coli = subgroup of FC
  - Fecal Coliform and E. coli are generally not harmful to humans (except 0157:H7)
  - FC is an indicator species, meaning that it indicates the potential for pathogenic organsims.



Potential Sources of FC bacteria

- Failing on-site septic/sewage systems
- Point Sources (WWTPs, illicit discharges)
- Boater waste (liveaboard & transient)
- Warm blooded wildlife (waterfowl, deer, racoons, seals etc)
- Stormwater runoff
  - Pet wastes
  - Road runoff
  - Farm runoff (cows, horses, etc.)

303 (d) listings NOT addressed in study

Waterbody	Parameter	Medium	WASWIS	Listing ID	Latitude/Longitude or Section, Township, Range	Marine Grid Cell
Liberty Bay	D.O.	Water	390KRD	23537 23541 10268 38682	47.715 122.625 47.725 122.645 47.735 122.645 47.735 122.655	47122H6B2 47122H6C4 47122H6D4 47122H6D5
Liberty Bay	Multiple toxics	Sediment	390KRD	Multiple listings	Multiple locations, mostly southern	See comment to left
Dogfish Creek	D.O.	Water	OQ62QE	23529	26.0N - 01.0E - 14	
Dogfish Creek, East Fork	D.O.	Water	AE23TW	38539	26.0N - 01.0E - 11	
Johnson Creek	D.O.	Water	VD71BW	38662	26.0N - 01.0E - 22	
Big Scandia Creek	D.O.	Water	CC82SQ	38443	26.0N - 01.0E - 27	
Little Ck.	D.O.	Water	II47ZW	23672	26.0N - 01.0E - 27	
Daniels Creek	D.O.	Water		52977	26.0N - 01.0E - 35	
Sam Snyder	pH	Water	YL66GE	23715	26.0N - 01.0E - 36	
Lemolo Creek	D.O.	Water	AO74VW	23671 48043	26.0N - 01.0E - 25 26.0N - 01.0E - 24	
Bjorgen Creek	D.O.	Water	IS22QB	23673 48045	26.0N - 01.0E - 25 26.0N - 01.0E - 24	
Barrantes Creek	D.O.	Water		48046	26.0N - 01.0E - 26	

Goals

- Improve water quality in Liberty Bay by attaining WA state WQ standards for FC bacteria in tribs to Liberty Bay.
- Collect high quality data.
- Increase public awareness on the level of FC bacteria reductions required and how they can assist with solutions.
- Manage resources to control point and nonpoint pollution.

Objectives

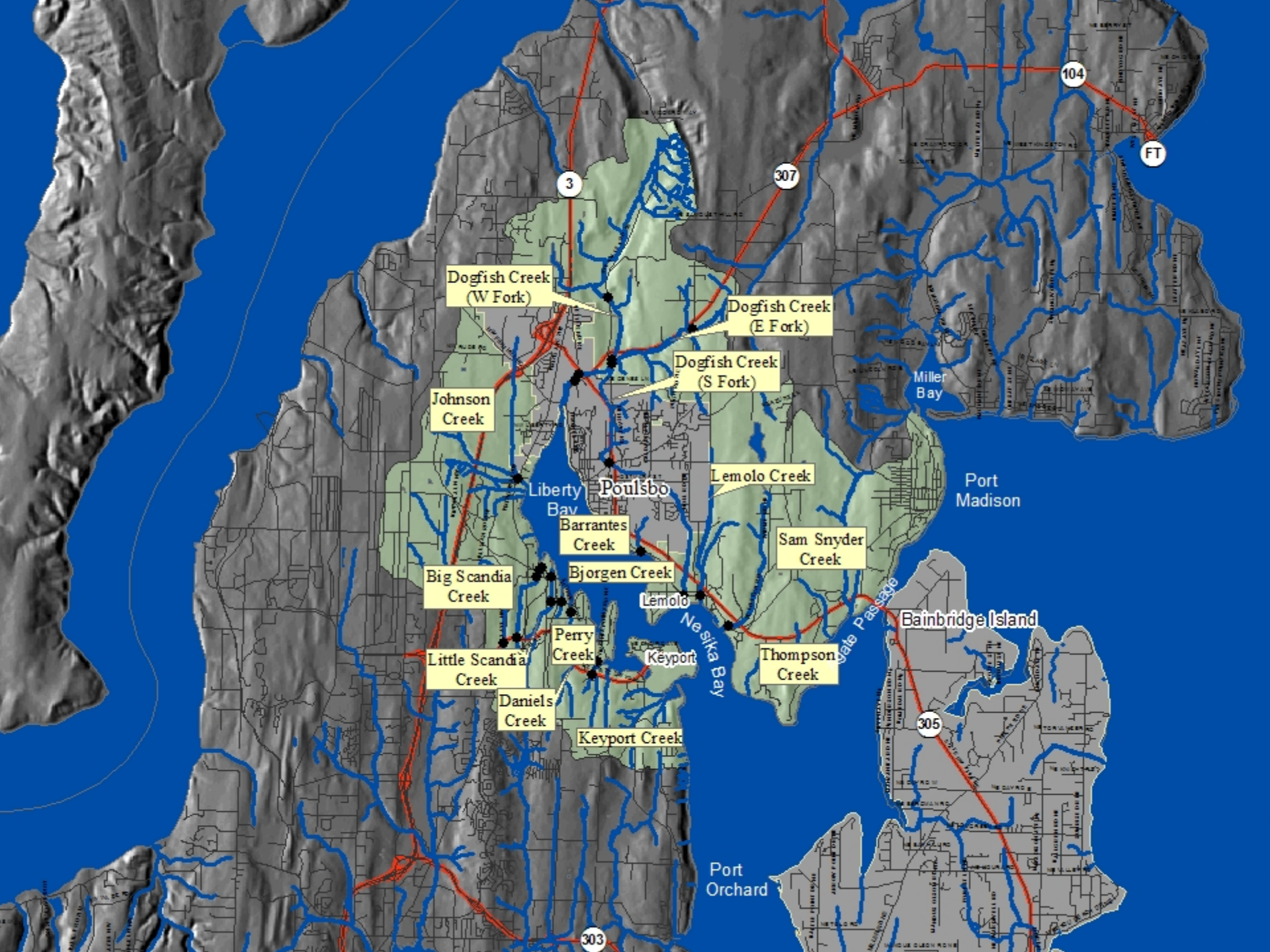
- Identify FC bacteria concentrations (#/100mL) and loads (concentration x streamflow) from all major tributaries, point sources, and drainages to Liberty Bay.

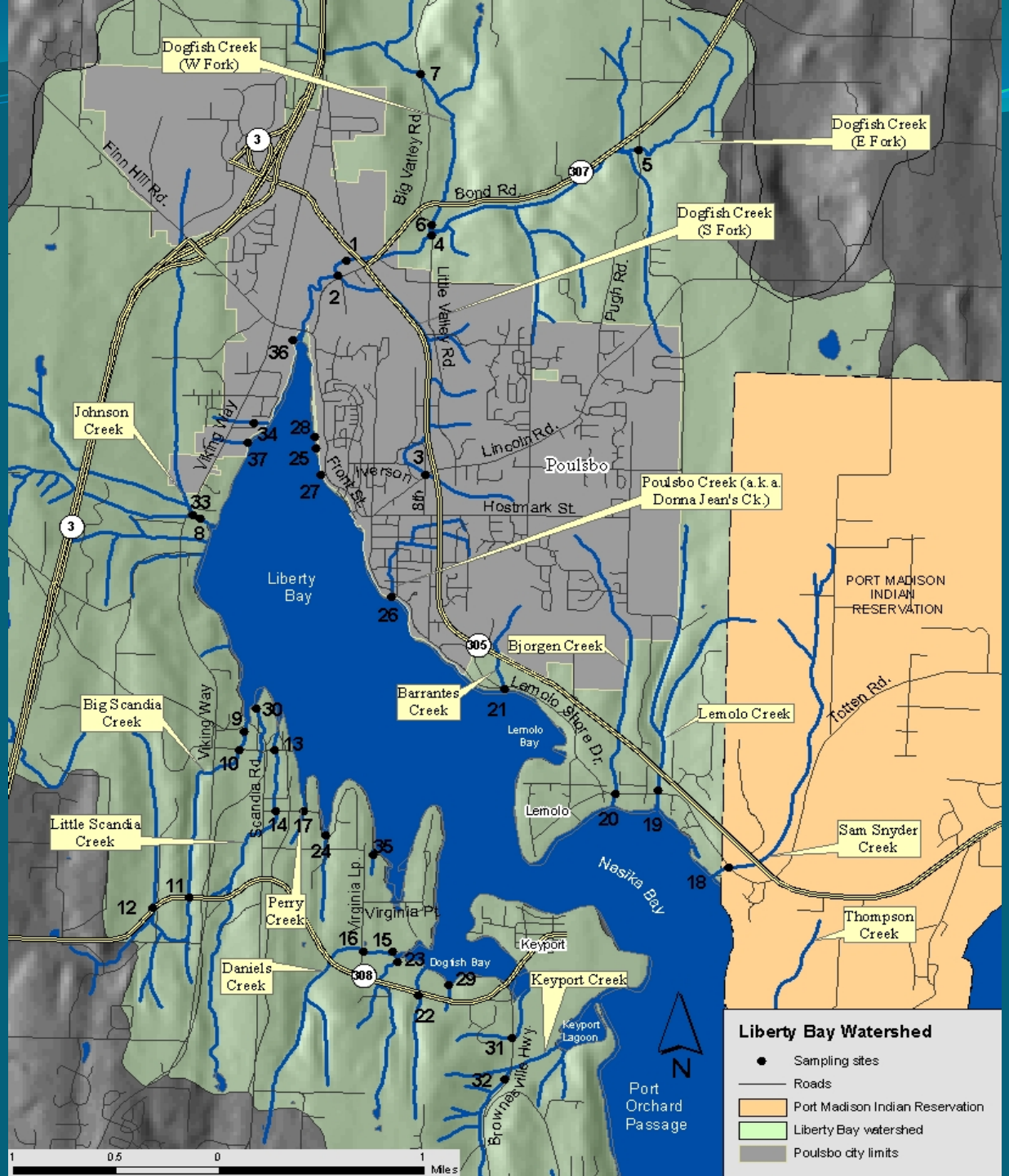
- Recommend FC pollution limits for point and nonpoint sources to protect beneficial uses
  - water recreation
  - shellfish harvesting

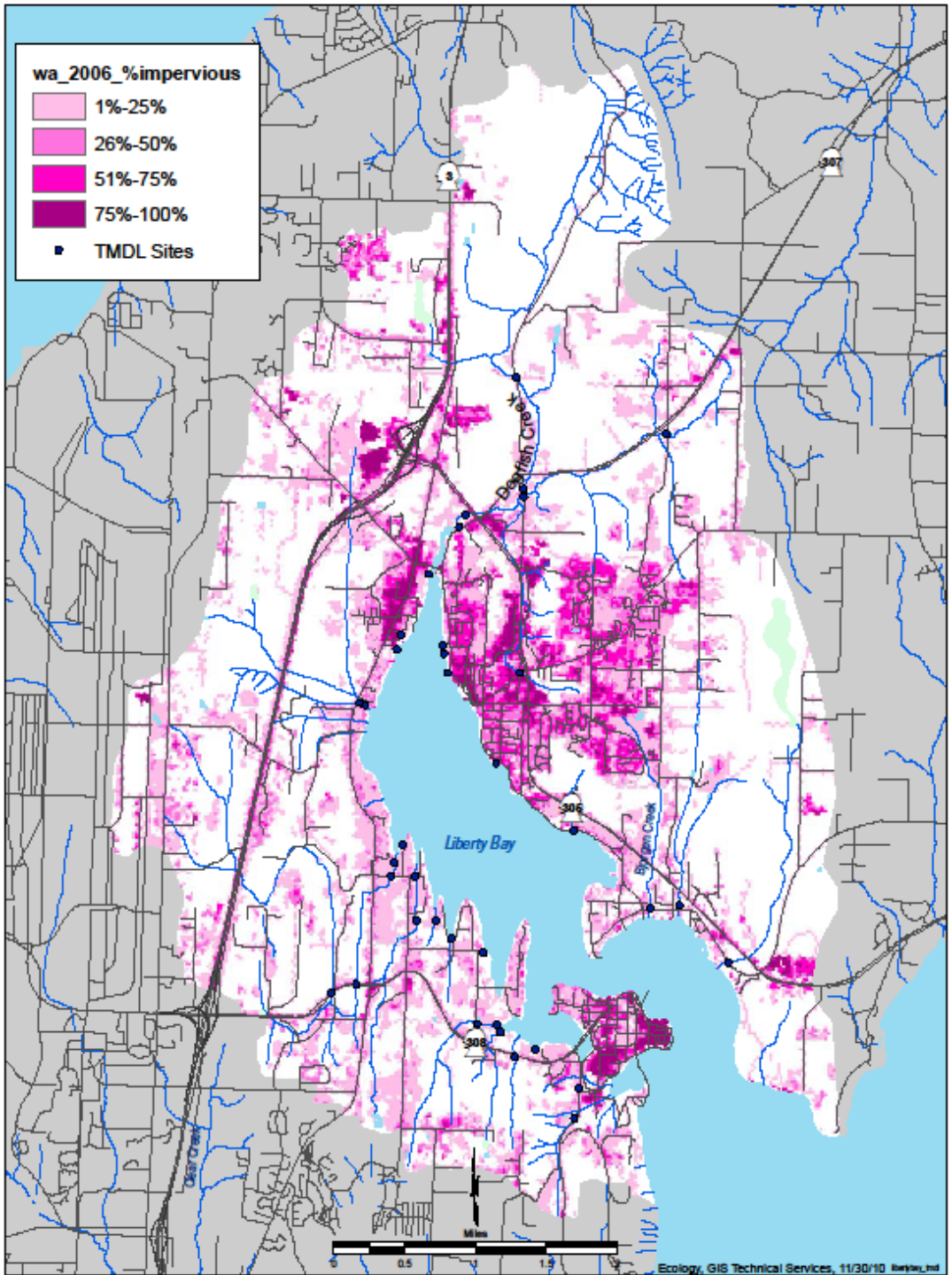
- Identify priority areas for clean-up.

Sampling accomplishments

- Sampled up to 26 times at 37 sites (2X per month for 13 months)
- Investigated and sampled all major streams and most small streams/drains to bay.
- Assessed seasonal variation
  - storm events and dry periods
  - critical periods for concentrations and loads
- Measured flows at all sites to calculate loading to bay (how many FC organisms flow into the bay per day).
- Followed QA Plan procedures and met quality objectives.


104
FT
3
307
Dogfish Creek
(W Fork)
Dogfish Creek
(E Fork)
Dogfish Creek
(S Fork)
Miller
Bay
Johnson
Creek
Lemolo Creek
Liberty
Bay
Poulsbo
Port
Madison
Barrantes
Creek
Sam Snyder
Creek
Big Scandia
Creek
Bjorgen Creek
Lemold
Nesika Bay
Bainbridge Island
Perry
Creek
Keyport
Thompson
Creek
Little Scandia
Creek
Daniels
Creek
Keyport Creek
305
Port
Orchard
303


Dogfish Creek (W Fork)
Dogfish Creek (E Fork)
Dogfish Creek (S Fork)
Johnson Creek
Poulsbo Creek (a.k.a. Donna Jean's Ck.)
Bjorgen Creek
Barrantes Creek
Lemolo Creek
Big Scandia Creek
Little Scandia Creek
Perry Creek
Daniels Creek
Keyport Creek
Sam Snyder Creek
Thompson Creek
Liberty Bay
Poulsbo
Lemolo Bay
Lemolo
Nasika Bay
Dogfish Bay
Keyport
Keyport Lagoon
Port Orchard Passage
PORT MADISON INDIAN RESERVATION
Finn Hill Rd.
Big Valley Rd.
Little Valley Rd.
Bond Rd.
Pugh Rd.
Lincoln Rd.
Hostmark St.
Iverson
Front St.
8th
Viking Way
Scandia Rd.
Virginia Lp.
Virginia Pl.
Lemolo Shore Dr.
Totten Rd.
Brownsville Hwy.
N
Liberty Bay Watershed
Sampling sites
Roads
Port Madison Indian Reservation
Liberty Bay watershed
Poulsbo city limits
1 0.5 0 1 Miles


wa_2006_%impervious
1%-25%
26%-50%
51%-75%
75%-100%
TMDL Sites
Liberty Bay
Deafish Creek
Ecology, GIS Technical Services, 11/30/10

Water Quality Standards

Liberty Bay (Primary Contact)

Criteria:

90th percentile (10% cannot exceed): <43 FC cfu/100mL

Geometric Mean: <14 FC cfu/100mL

All Tributaries to Liberty Bay (Extraordinary Primary Contact)

Criteria:

90th percentile (10% cannot exceed): <100 FC cfu/100mL

Geometric Mean: <50 FC cfu/100mL

Regularly sampled sites (annual stats)

Site ID w/ stream mile	Map #	Site description	n	Min	Max	Geo-metric mean	90th percen-tile
Dogfish Creek							
15-DOG-0.6	1	Mainstem behind dental office on Bond Rd., downstream of HWY 305 crossing	26	11	390	56	218
15-SFD-0.0	2	South fork at Bond Rd. and 1st Ave., 50 ft. downstream of culvert	26	9	1000	83	447
15-SFD-1.3	3	South fork at 8th Ave. and Iverson, upstream side of culvert	26	1	640	68	467
15-EFD-0.0	4	East fork at Little Valley Rd., downstream side of culvert	26	2	890	47	405
15-EFD-1.2	5	East fork off Bond Rd. at Pugh Rd.,upstream side of culvert	26	3	300	28	151
15-WFD-0.0	6	West fork at Little Valley Rd., downstream side of culvert	26	3	1300	45	229
15-WFD-0.9	7	West fork at first Big Valley Rd. crossing near Living Waters Farm, up of culvert	26	1	510	24	188
Johnson Creek							
15-JOH-0.1	8	Mainstem south of Norfin Ln., 200ft. downstream of tributary	26	1	220	18	165
Big Scandia Creek							
15-BSC-0.0	9	Mainstem at mouth near the end of Scandia Ct. at private property. Trail to ck.	26	2	380	55	351
15-BSC-0.1	10	Mainstem at Scandia Rd, upstream side of bridge	26	2	340	48	340
15-BSC-1.1	11	Mainstem at HWY 308 between Viking Way and Cox Ave., downstream of culvert	26	1	500	28	300
15-BSC-1.6	12	Mainstem at HWY 308 just west of Cox Ave., upstream side of culvert	26	1	340	31	245
Little Scandia Creek							
15-LSC-0.1	13	Mainstem at Scandia Rd. behind church, upstream side of culvert	26	3	2600	224	1545
15-LSC-0.4	14	Mainstem at Blomster Way, upstream side of culvert	26	3	920	73	643
Daniels Creek							
15-DAN-0.0	15	Mainstem off HWY 308, near residence at 14510, upstream side of culvert	26	9	1200	102	775
15-DAN-0.2	16	Mainstem at Virgina Loop Rd., approximately 30ft. below culvert	26	1	940	40	556
Perry Creek							
15-PER-0.1	17	Mainstem at 90 deg. right turn in Thorpe Rd. upstream side of culvert	26	3	8000	102	996
Sam Snyder Creek							
15-SAM-0.1	18	Mainstem at Lemolo Shore Dr., downstream side of culvert (dry during dry season)	14	1	54	9	54
Lemolo Creek							
15-LEM-0.1	19	Mainstem at Lemolo Shore Dr. east of Delate Rd. Access from first private drive east of creek, 75 ft. upstream of culvert	26	1	960	32	448
Bjorgen Creek							
15-BJO-0.1	20	Mainstem at Lemolo Shore Dr. by market, downstream side of culvert	26	4	6700	77	1070
Barrantes Creek							
15-BAR-0.0	21	Mainstem at Lemolo Shore Dr. downstream of culvert. Sample at low tide	24	1	810	48	450
Unnamed Tributaries to Liberty Bay							
15-UNN-0.1	22	Trib. east of Daniels Ck. at Hwy 308 near "Support Our Troops" sign. 30ft.upstream of culvert	24	1	240	20	178
15-UNN-0.0	23	Trib. flowing into bay right next to Daniels Ck. mouth. Sample at low tide.	21	1	9700	60	1803

Investigatory sites

Site ID w/ stream mile	Map #	Site description	n	Min	Max	Geo-metric mean	90th percen-tile
Investigatory sites							
15-PET-0.0	24	Trib. east of Perry Ck. at Thorpe Rd. Sample at low tide above culvert. Dry during dry season	13	3	190	43	199
15-JEA-0.0	25	Small, unnamed stream flowing into the bay near American Legion Park. Poulsbo outfall ID is PSW31	20	1	2900	84	1163
15-DON-0.0	26	Poulsbo Creek (aka Donna Jean's Creek) at Poulsbo Yacht Club. Poulsbo ID PSW25	17	1	5200	74	1206
15-STORM-1	27	Storm drain at the south end of American Legion Park. Below the Gran Kirk, Martha and Mary, and Front St. Poulsbo outfall ID PSW30.	4	160	1500	-	-
15-STORM-2	28	Next storm drain north of STORM-1 (metal culvert)	4	32	2100	-	-
15-UN3-0.0	29	Small, unnamed stream flowing into Dogfish Bay, east of 15-UNN-0.1	1	27	27	-	-
15-BST-0.0	30	Small unnamed seasonal stream flowing into Liberty Bay ~300 feet east of Big Scandia Creek.	12	8	2900	134	1109
15-KE1-0.2	31	Small, unnamed ck. near Keyport Ck (1st trib. at Brownsville Hwy, traveling south)	10	1	1600	162	3156
15-KE2-0.3	32	Keyport Creek (2nd trib. at Brownsville Hwy, travelling south)	10	2	970	60	729
15-JOH-T	33	Trib. to Johnson Creek above 15-JOH-0.1, at Viking Way. Sample down of culvert	4	1	150	-	-
15-BOV-0.0	34	Trib to Liberty Bay between Bovela St. and Bay St. Flows under Viking Way	10	23	900	174	799
15-LMK-0.0	35	Small, intermittent stream off Virginia Lp. Rd. NE at private prop.	5	45	6000	439	6700
15-NEL-0.0	36	Nelson Park bioswale at beach. Poulsbo outfall ID is PSW37	10	46	3300	714	4273
15-RET-0.0	37	Small, unnamed ck. flowing through assisted living facility property off Viking Way in Poulsbo, near Bovela St. Sample at beach.	10	54	2300	461	1698

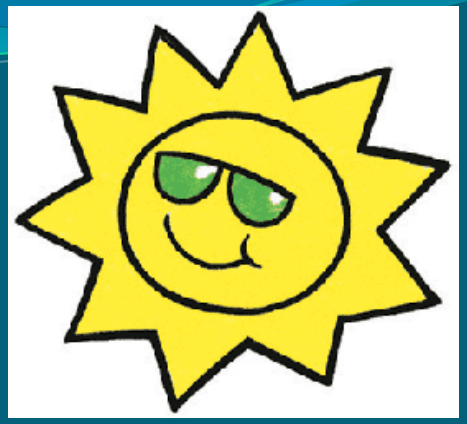
Individual FC results

Site ID w/ stream mile	Map #	Aug 12	Aug 26	Sept 10	Sept 24	Oct 8	Oct 22	Nov 11	Nov 24	Dec 10	Dec 29	Jan 14	Jan 28	Feb 11	Feb 25	Mar 11	Mar 24	Apr 8	Apr 29	May 6	May 20	Jun 9	Jun 17	July 8	July 22	Aug 12	Sept 1	n	Min	Max	Geo-metric mean	90th percen-tile
Dogfish Creek																																
15-DOG-0.6	1	65	110	43	66	88	32	63	52	21	390	17	19	24	31	12	15	13	11	280	130	250	92	120	84	330	92	26	11	390	56	218
15-SFD-0.0	2	360	120	26	31	84	12	65	9	290	540	31	180	190	280	18	32	11	1000	830	160	54	140	51	130	54	31	26	9	1000	83	447
15-SFD-1.3	3	61	72	170	71	140	46	41	8	330	340	29	66	130	170	3	6	1	140	640	130	110	380	96	69	92	140	26	1	640	68	467
15-EFD-0.0	4	180	80	51	34	220	92	51	4	10	68	5	2	30	15	30	5	18	3	180	140	890	110	180	240	830	150	26	2	890	47	405
15-EFD-1.2	5	60	67	16	29	9	4	3	12	51	130	9	5	51	7	4	10	31	14	170	75	61	61	120	56	300	120	26	3	300	28	151
15-WFD-0.0	6	75	180	110	31	18	18	43	45	23	270	9	14	10	33	10	25	3	44	51	140	74	40	80	120	1300	150	26	3	1300	45	229
15-WFD-0.9	7	57	80	19	28	13	18	37	30	17	170	4	1	4	6	6	8	1	7	35	140	60	510	180	170	62	71	26	1	510	24	188
Johnson Creek																																
15-JOH-0.1	8	8	120	4	140	220	2	11	1	1	87	190	3	15	17	6	2	1	15	120	27	24	53	47	57	74	69	26	1	220	18	165
Big Scandia Creek																																
15-BSC-0.0	9	180	110	14	40	80	40	56	3	31	230	5	17	44	43	13	56	2	23	380	180	240	210	200	170	210	280	26	2	380	55	351
15-BSC-0.1	10	79	110	36	35	88	20	6	2	44	260	9	6	24	56	80	52	2	9	250	250	340	200	88	86	290	300	26	2	340	48	340
15-BSC-1.1	11	35	110	6	10	28	7	11	2	1	55	14	5	12	110	9	5	4	3	340	140	200	400	77	320	500	280	26	1	500	28	300
15-BSC-1.6	12	84	72	32	31	88	7	3	9	1	340	14	40	11	41	24	4	2	4	170	200	74	110	75	150	290	85	26	1	340	31	245
Little Scandia Creek																																
15-LSC-0.1	13	1600	660	410	670	77	140	46	250	55	320	40	110	340	270	3	34	120	92	920	380	160	240	700	2600	770	2500	26	3	2600	224	1545
15-LSC-0.4	14	920	150	260	640	180	160	41	3	6	100	6	99	28	67	4	9	15	40	760	180	120	17	680	220	300	180	26	3	920	73	643
Daniels Creek																																
15-DAN-0.0	15	590	62	540	450	450	100	29	15	23	23	17	10	20	120	18	280	20	9	550	130	110	1200	500	600	480	350	26	9	1200	102	775
15-DAN-0.2	16	420	92	940	200	80	65	10	44	18	51	2	8	1	6	1	5	7	6	62	30	96	670	390	520	550	140	26	1	940	40	556
Perry Creek																																
15-PER-0.1	17	530	550	69	77	80	9	71	3	17	220	23	26	29	74	77	200	20	7	500	200	84	520	310	8000	770	870	26	3	8000	102	996
Sam Snyder Creek																																
15-SAM-0.1	18	-	-	-	-	-	-	20	3	13	54	1	1	22	21	3	6	2	47	32	24	-	-	-	-	-	-	14	1	54	9	54
Lemolo Creek																																
15-LEM-0.1	19	84	77	3	7	18	22	2	6	5	150	21	6	7	5	1	6	14	190	960	800	120	150	280	900	670	23	26	1	960	32	448
Bjorgen Creek																																
15-BJO-0.1	20	3000	140	49	190	140	21	120	6	5	1100	14	6	27	53	6	7	4	17	490	80	280	230	6700	240	220	730	26	4	6700	77	1070
Barrantes Creek																																
15-BAR-0.0	21	450	190	810	190	270	20	110	13	3	90	4	27	8	11	12	1	24	62	240	48	51	170	210	270	-	-	24	1	810	48	450
Unnamed Tributaries to Liberty Bay																																
15-UNN-0.1	22	29	40	-	-	29	15	100	3	4	110	14	1	11	8	4	7	1	7	9	6	83	240	84	230	230	230	24	1	240	20	178
15-UNN-0.0	23	-	-	-	-	-	77	180	63	330	180	10	3	9	39	2	1	1	1	420	150	270	240	180	3300	750	9700	21	1	9700	60	1803

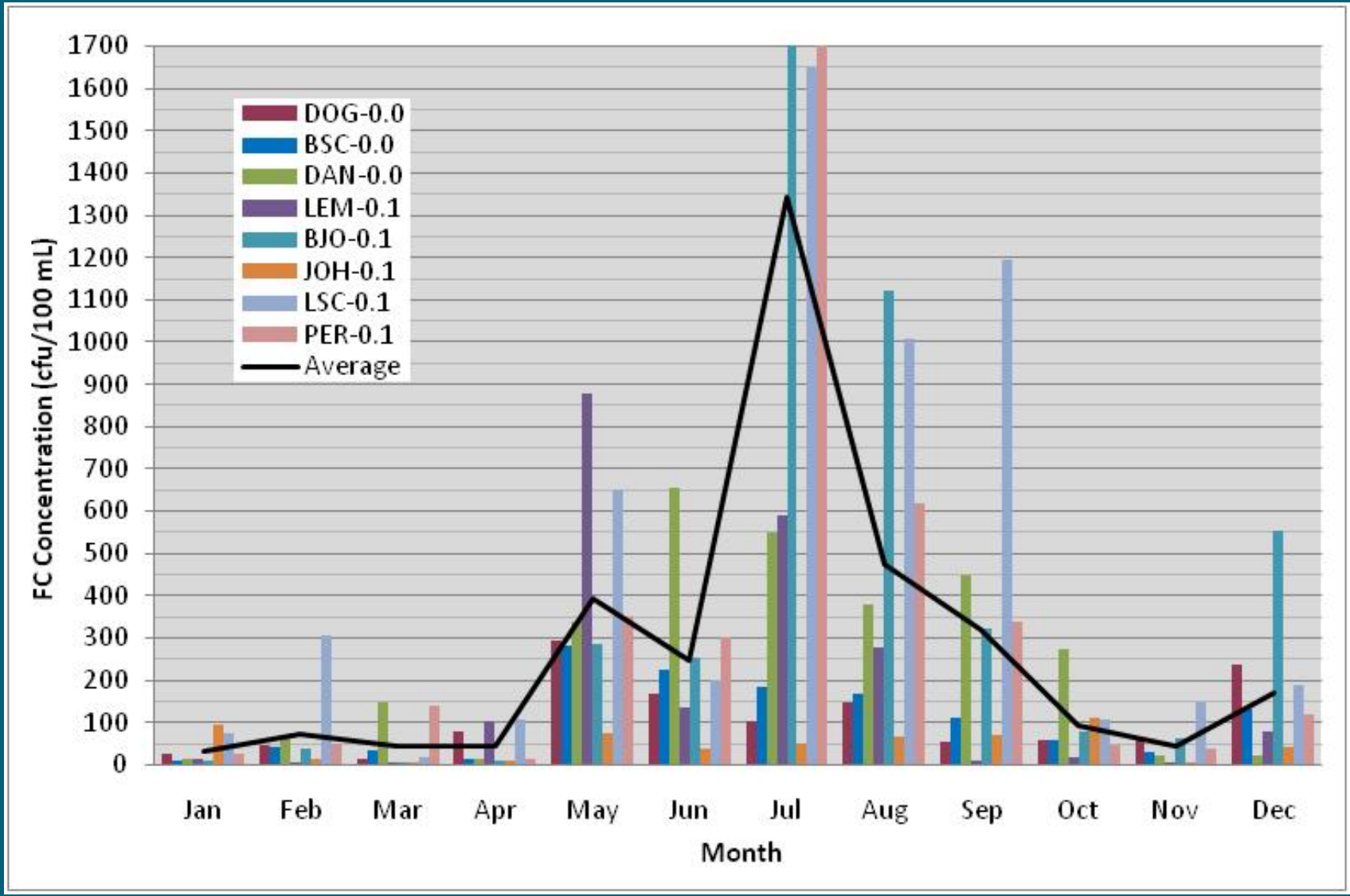
FC Results, cont'd

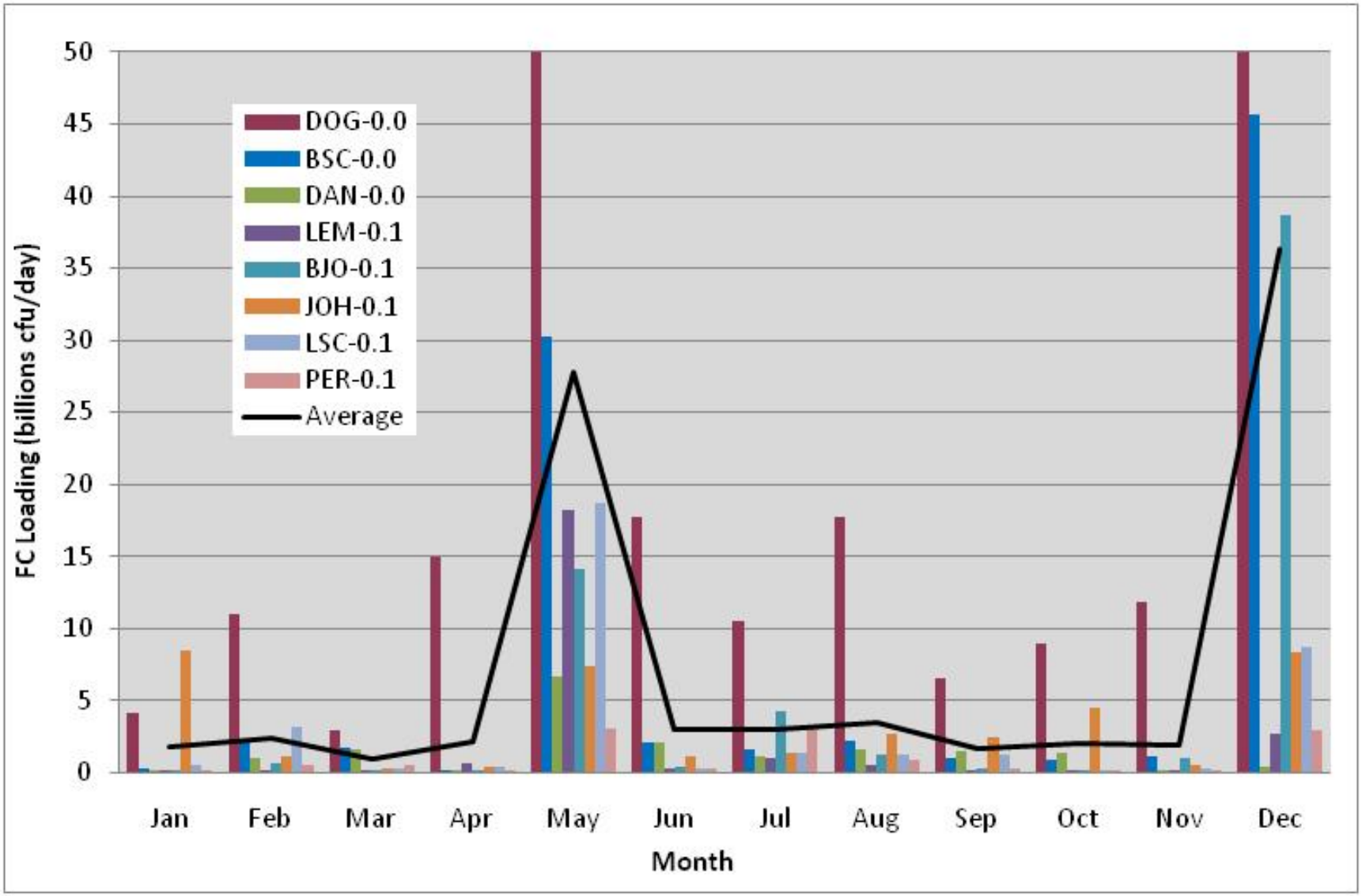
Site ID w/ stream mile	Map #	Aug 12	Aug 26	Sept 10	Sept 24	Oct 8	Oct 22	Nov 11	Nov 24	Dec 10	Dec 29	Jan 14	Jan 28	Feb 11	Feb 25	Mar 11	Mar 24	Apr 8	Apr 29	May 6	May 20	Jun 9	Jun 17	July 8	July 22	Aug 12	Sept 1	n	Min	Max	Geo-metric mean	90th percen-tile
Investigatory sites																																
15-PET-0.0	24	-	-	-	-	-	89	-	-	160	110	8	86	26	190	3	64	22	21	57	59	-	-	-	-	-	-	13	3	190	43	199
15-JEA-0.0	25	-	-	-	-	-	-	150	75	82	1300	3	220	69	1000	1	7	6	34	2900	370	200	49	52	200	530	69	20	1	2900	84	1163
15-DON-0.0	26	-	-	-	-	-	-	-	-	-	370	11	1	21	140	8	13	14	12	5200	71	92	840	710	180	700	110	17	1	5200	74	1206
15-STORM-1	27	-	-	-	-	-	-	1500	-	-	880	-	-	-	160	-	-	-	-	1300	-	-	-	-	-	-	-	4	160	1500	-	-
15-STORM-2	28	-	-	-	-	-	-	-	-	-	1100	-	-	32	2100	-	-	-	-	1600	-	-	-	-	-	-	-	4	32	2100	-	-
15-UN3-0.0	29	-	-	-	-	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	27	27	-	-
15-BST-0.0	30	-	-	-	-	-	-	-	-	760	200	60	11	110	230	88	8	130	100	2900	510	-	-	-	-	-	-	12	8	2900	134	1109
15-KE1-0.2	31	-	-	-	-	-	-	-	-	-	-	23	-	-	51	-	1	-	-	-	380	640	1600	610	930	50	970	10	1	1600	162	3156
15-KE2-0.3	32	-	-	-	-	-	-	-	-	-	-	2	-	-	6	-	10	-	-	-	57	55	160	160	970	430	140	10	2	970	60	729
15-JOH-T	33	-	-	-	-	-	-	-	-	3	150	-	-	-	-	-	-	-	1	17	-	-	-	-	-	-	-	4	1	150	-	-
15-BOV-0.0	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	100	31	150	660	200	250	200	900	400	10	23	900	174	799
15-LMK-0.0	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	6000	2900	130	160	-	-	-	-	-	5	45	6000	439	6700
15-NEL-0.0	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3200	280	590	46	760	870	1700	160	3300	2400	10	46	3300	714	4273
15-RET-0.0	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	310	520	2300	700	330	54	320	290	1300	770	10	54	2300	461	1698

Seasonality



May through September has highest average FC concentrations AND loads at most sites, although loading is much higher during storms and rain events


1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
FC Concentration (cfu/100 mL)
DOG-0.0
BSC-0.0
DAN-0.0
LEM-0.1
BJO-0.1
JOH-0.1
LSC-0.1
PER-0.1
Average
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


FC Loading (billions cfu/day)
50
45
40
35
30
25
20
15
10
5
0
DOG-0.0
BSC-0.0
DAN-0.0
LEM-0.1
BJO-0.1
JOH-0.1
LSC-0.1
PER-0.1
Average
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Storms

Two rain events in May and one in December that lead to both high concentrations and high loading.

Example – Poulsbo Creek

Dry season loading to bay ~ 0.7 billion FC per day
Annual average (including dry and wet events) ~ 17 billion FC per day
May 6, 2009 Storm event loading to bay ~ 260 billion FC per day

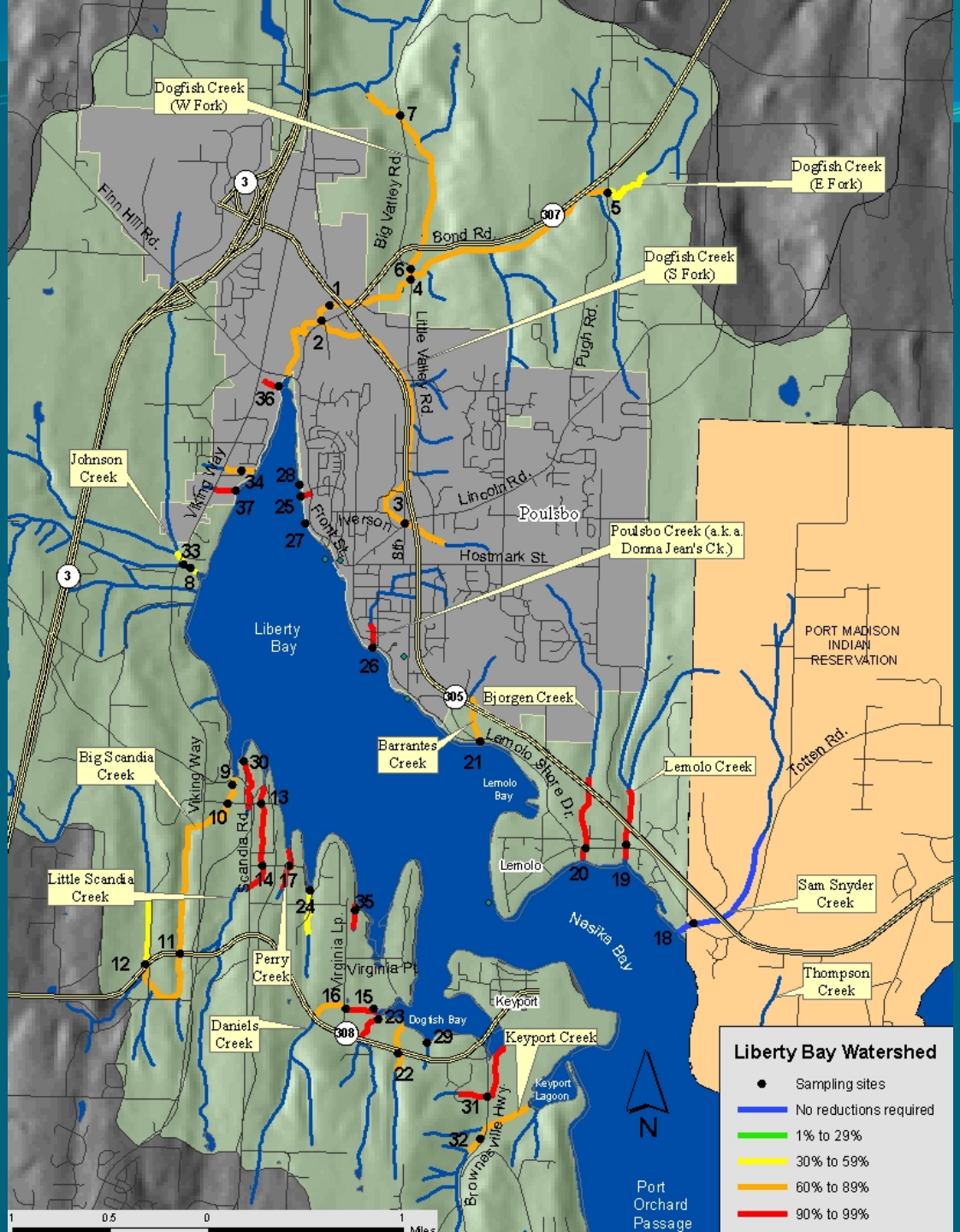
Example – Dogfish Creek

Dry season loading to bay ~ 10 billion FC per day
Annual average (including dry and wet events) ~ 33 billion FC per day
December 29, 2008 Storm event loading to bay ~ 360 billion FC per day

This is probably indicative of most places in watershed… more storm sampling may be helpful to prioritize ditches and other small drains that pollute creeks and bay.

Site ID w/River Mile	Site Location Summary	Current Load (billions cfu/day)	Load Allocation (billions cfu/day)	Target FC Reduction	NPDES Municipal Stormwater Permittee
Dogfish Creek					
15-DOG-0.6	Dogfish off Bond Rd. at dental office	22	8.0	64%	Poulsbo, KC, WSDOT (HWY 305, 307)
15-SFD-0.0	South Fork at Bond Rd. and 1st Ave.	11	2.5	78%	Poulsbo, WSDOT (HWY 305)
15-SFD-1.3	South Fork at 8th Ave. and Iverson	2.0	0.43	79%	Poulsbo, WSDOT (HWY 305)
15-EFD-0.0	East Fork at Little Valley Rd.	4.0	0.67	83%	KC, WSDOT (HWY 307)
15-EFD-1.2	East Fork at Pugh Rd.	2.0	1.1	47%	KC, WSDOT (HWY 307)
15-WFD-0.0	West Fork at Little Valley Rd.	13	3.3	76%	KC, WSDOT (HWY 307)
15-WFD-0.9	West Fork at Big Valley Rd.	6.8	2.5	63%	KC
Johnson Creek					
15-JOH-0.1	400 ft. south of Norfin Rd.	3.2	1.9	40%	Poulsbo, KC
Big Scandia Creek					
15-BSC-0.0	Scandia Ct. at private res.	7.0	1.7	76%	KC
15-BSC-0.1	Scandia Rd.	6.7	1.8	73%	KC, WSDOT (HWY 308)
15-BSC-1.1	HWY 308, between Viking and Cox	3.4	0.62	82%	KC, WSDOT (HWY 308)
15-BSC-1.6	HWY 308, west of Cox Ave.	4.2	1.8	57%	KC
Little Scandia Creek					
15-LSC-0.1	Scandia Rd.	2.9	0.14	95%	KC
15-LSC-0.4	Blomster Way	1.8	0.18	90%	KC
Daniels Creek					
15-DAN-0.0	Off HWY 308	1.5	0.15	90%	KC
15-DAN-0.2	Virginia Loop Rd.	0.52	0.06	89%	KC, WSDOT (HWY 308)
Perry Creek					
15-PER-0.1	At 90 deg. right turn in Thorpe Rd.	1.0	0.04	96%	KC
Sam Snyder Creek					
15-SAM-0.1	Lemolo Shore Dr.	0.31	0.31	no reduction required	KC, Suquamish Tribe (no action required)
Lemolo Creek					
15-LEM-0.1	Lemolo Shore Dr.	1.8	0.16	91%	KC, WSDOT (HWY 305)
Bjorgen Creek					
15-BJO-0.1	Lemolo Shore Dr.	4.7	0.23	95%	Poulsbo, KC, WSDOT (HWY 305)
Barrantes Creek					
15-BAR-0.0	Lemolo Shore Dr.	0.18	0.03	83%	Poulsbo, KC, WSDOT (HWY 305)
Unnamed Tributaries to Liberty Bay					
15-UNN-0.1	East of Daniels Ck. at HWY 308	0.20	0.06	70%	KC, WSDOT (HWY 308)
15-UNN-0.0	Trib. flowing into bay next to Daniels	0.76	0.04	95%	KC, WSDOT (HWY 308)

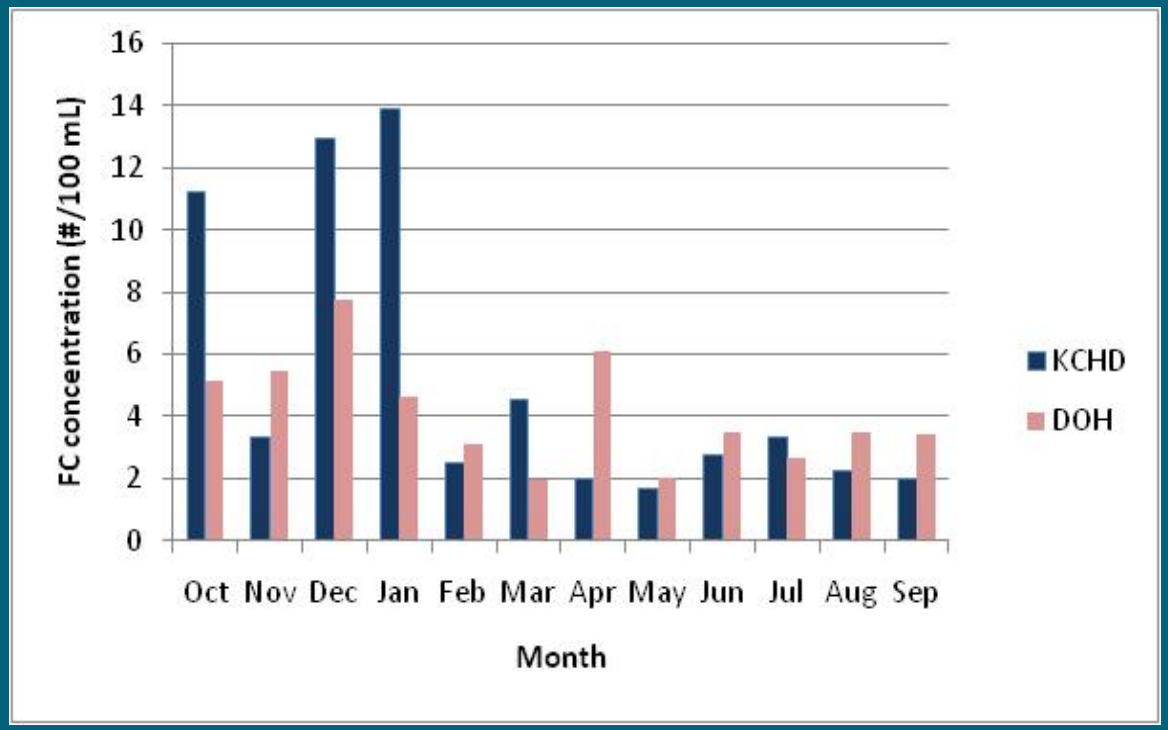
Site ID w/River Mile	Site Location Summary	Current Load (billions cfu/day)	Load Allocation (billions cfu/day)	Target FC Reduction	NPDES Municipal Stormwater Permittee
Investigatory Sites					
15-PET-0.0	East of Perry Ck. at Thorpe Rd.	0.1	0.05	50%	KC
15-JEA-0.0	American Legion Park	2.2	0.19	91%	Poulsbo
15-DON-0.0	Poulsbo Ck. at Poulsbo Yacht Club	17	1.4	92%	Poulsbo
15-BST-0.0	~300 ft. east of Big Scandia Ck.	2.8	0.26	91%	KC
15-KE1-0.2	Brownsville HWY	1.5	0.05	97%	KC, Navy
15-KE2-0.3	Brownsville HWY	1.3	0.18	86%	KC, Navy
15-BOV-0.0	Between Bovela St. and Bay St.	0.61	0.08	87%	Poulsbo, possibly KC
15-LMK-0.0	Off Virginia Lp. Rd. at private res.	0.46	0.01	99%	KC
15-NEL-0.0	Nelson Park bioswale on beach	0.93	0.02	98%	Poulsbo
15-RET-0.0	Off Viking at assisted living facility	1.1	0.06	94%	Poulsbo, possibly KC
15-STORM-1	storm drain from Poulsbo to beach	not enough data to calculate			Poulsbo
15-STORM-2	storm drain from Poulsbo to beach	not enough data to calculate			Poulsbo
15-JOH-T	Johnson Ck. tributary	not enough data to calculate			KC
15-UN3-0.0	Unnamed trib. near UNN-0.1	not enough data to calculate			KC

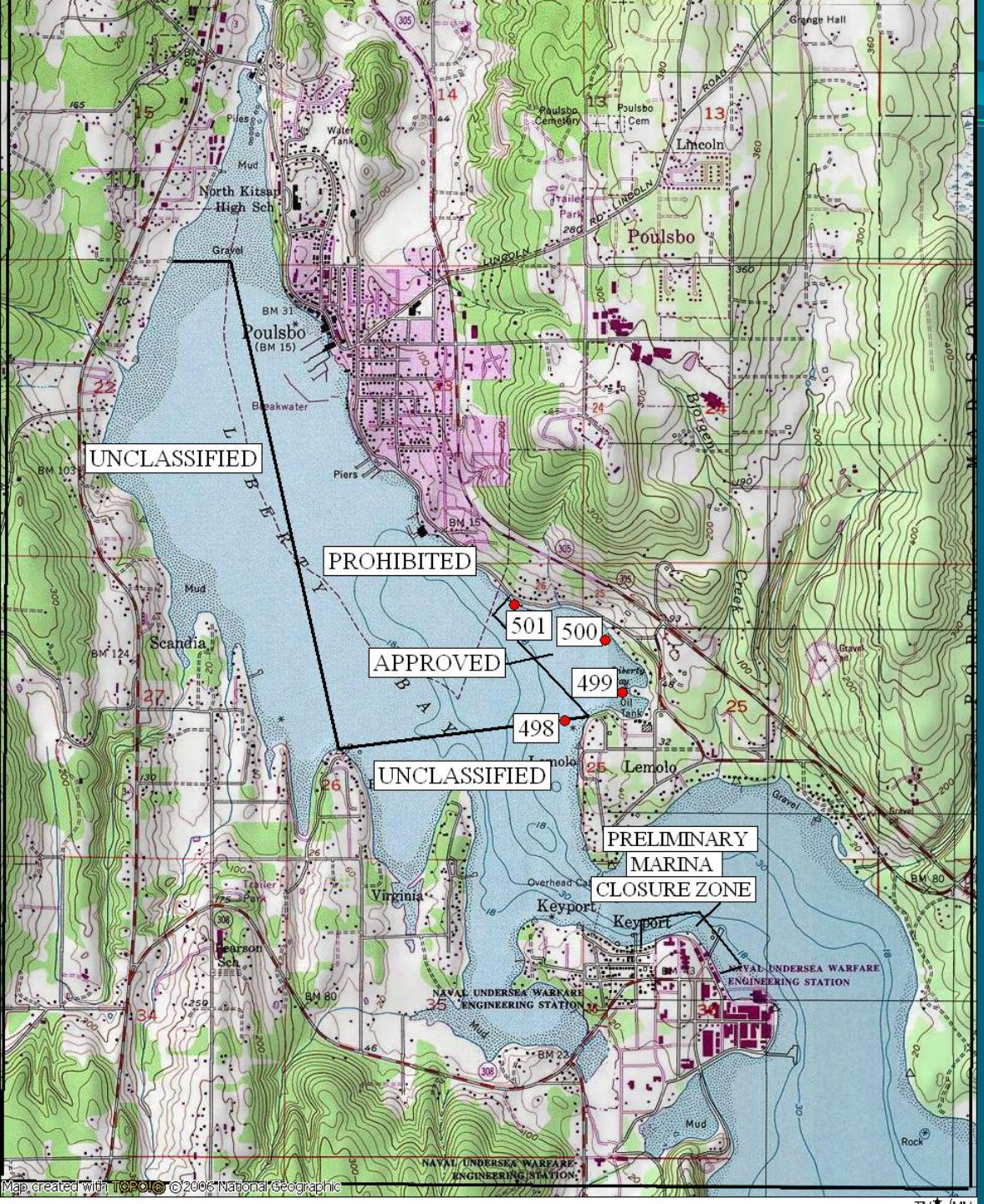

Dogfish Creek (W Fork)
Dogfish Creek (E Fork)
Dogfish Creek (S Fork)
Finn Hill Rd.
Big Valley Rd.
Bond Rd.
Little Valley Rd.
Pugh Rd.
Johnson Creek
Viking Way
Lincoln Rd.
Poulsbo
Iverson
Front St.
8th
Hostmark St.
Poulsbo Creek (a.k.a. Donna Jean's Ck.)
Liberty Bay
PORT MADISON INDIAN RESERVATION
Bjorgen Creek
Barrantes Creek
Lemolo Shore Dr.
Lemolo Bay
Lemolo
Lemolo Creek
Totten Rd.
Big Scandia Creek
Scandia Rd.
Little Scandia Creek
Perry Creek
Virginia Lp.
Virginia Pt.
Daniels Creek
Dogfish Bay
Keyport
Keyport Creek
Keyport Lagoon
Brownsville Hwy.
Nasika Bay
Sam Snyder Creek
Thompson Creek
Port Orchard Passage
N
Liberty Bay Watershed
Sampling sites
No reductions required
1% to 29%
30% to 59%
60% to 89%
90% to 99%
1 0.5 0 1 Miles

Marine Data

2 to 5 sample geometric means from KCHD (2002-09).

6 to 17 sample geometric means from DOH (1993-2009).





Right now, the bay <u>meets marine standards</u> at all DOH sampled stations.

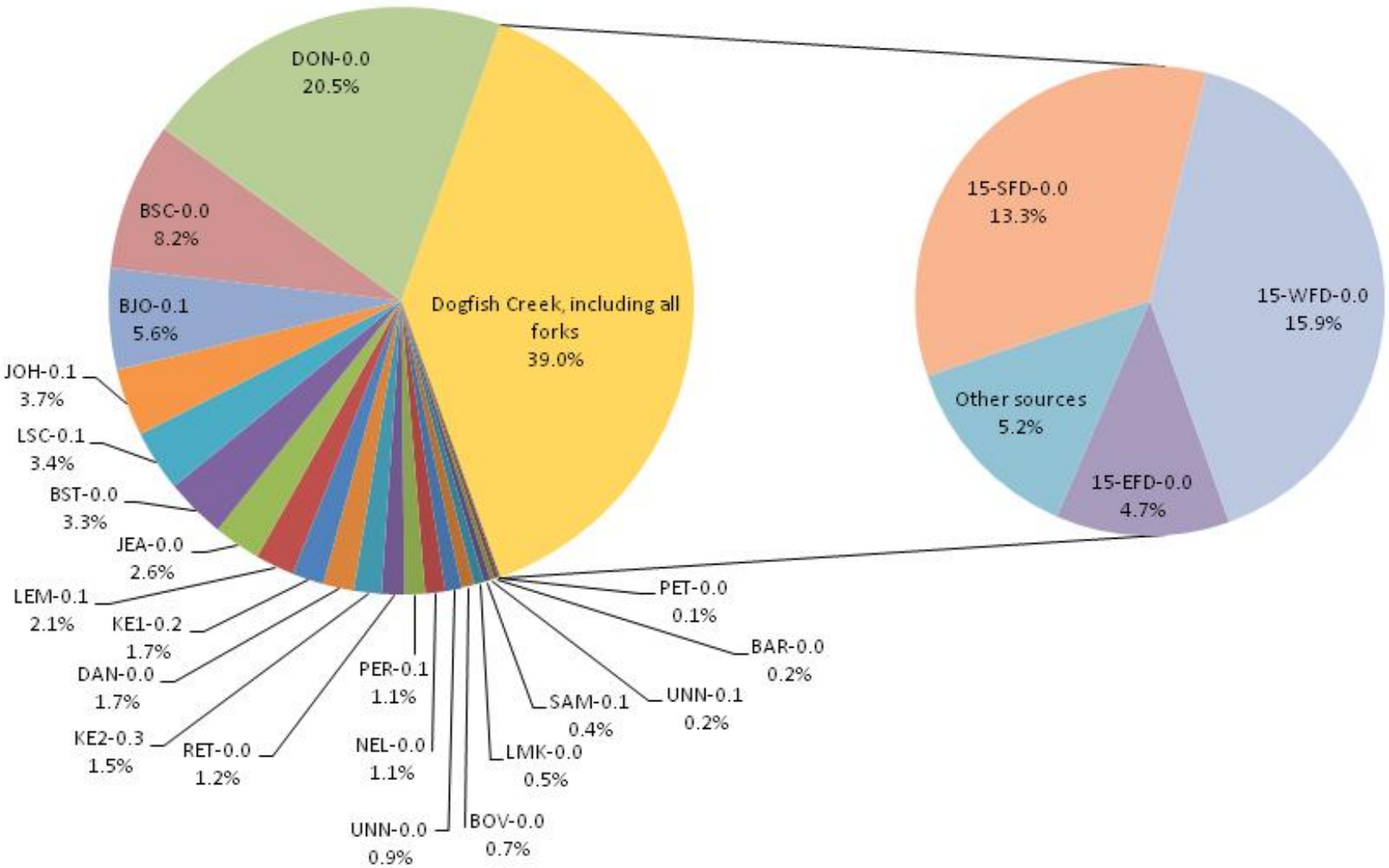
Prioritize by loading…

Site ID w/ stream mile	Load (billions cfu/day)
15-DOG-0.0*	33
15-DON-0.0	17
15-BSC-0.0	7.0
15-BJO-0.1	4.7
15-JOH-0.1	3.2
15-LSC-0.1	2.9
15-BST-0.0	2.8
15-JEA-0.0	2.2
15-LEM-0.1	1.8
15-KE1-0.2	1.5
15-DAN-0.0	1.5
15-KE2-0.3	1.3
15-RET-0.0	1.1
15-PER-0.1	1.0
15-NEL-0.0	0.93
15-UNN-0.0	0.76
15-BOV-0.0	0.61
15-LMK-0.0	0.46
15-SAM-0.1	0.31
15-UNN-0.1	0.20
15-BAR-0.0	0.18
15-PET-0.0	0.10

Site ID w/ stream mile	Geometric mean	90th percentile
15-NEL-0.0	714	4273
15-RET-0.0	461	1698
15-LMK-0.0	439	6700
15-LSC-0.1	224	1545
15-BOV-0.0	174	799
15-KE1-0.2	162	3156
15-BST-0.0	134	1109
15-PER-0.1	102	996
15-DAN-0.0	102	775
15-JEA-0.0	84	1163
15-BJO-0.1	77	1070
15-DON-0.0	74	1206
15-DOG-0.0*	69	245
15-UNN-0.0	60	1803
15-KE2-0.3	60	729
15-BSC-0.0	55	351
15-BAR-0.0	48	450
15-PET-0.0	43	199
15-LEM-0.1	32	448
15-UNN-0.1	20	178
15-JOH-0.1	18	165
15-SAM-0.1	9	54

or concentrations?

Percent of total annual loading to bay



Some thoughts…

- Smaller creeks will be easier to “fix” but larger ones (like Dogfish, Big Scandia, and even Poulsbo Creek) will make more of a difference to the bay.
- Most of the investigatory sites have worst concentrations, but may affect bay the least
- Storm drains and runoff can be a major source of FC and add most of the FC load to bay during wet season
- Marine data shows higher concentrations during storm/wet season
- More impervious surface area=more FC?…pets, septics, urban sources?

EVINRUDE
BOSTON WHALER
RESEARCH
DEPARTMENT OF ECOLOGY

Thanks!

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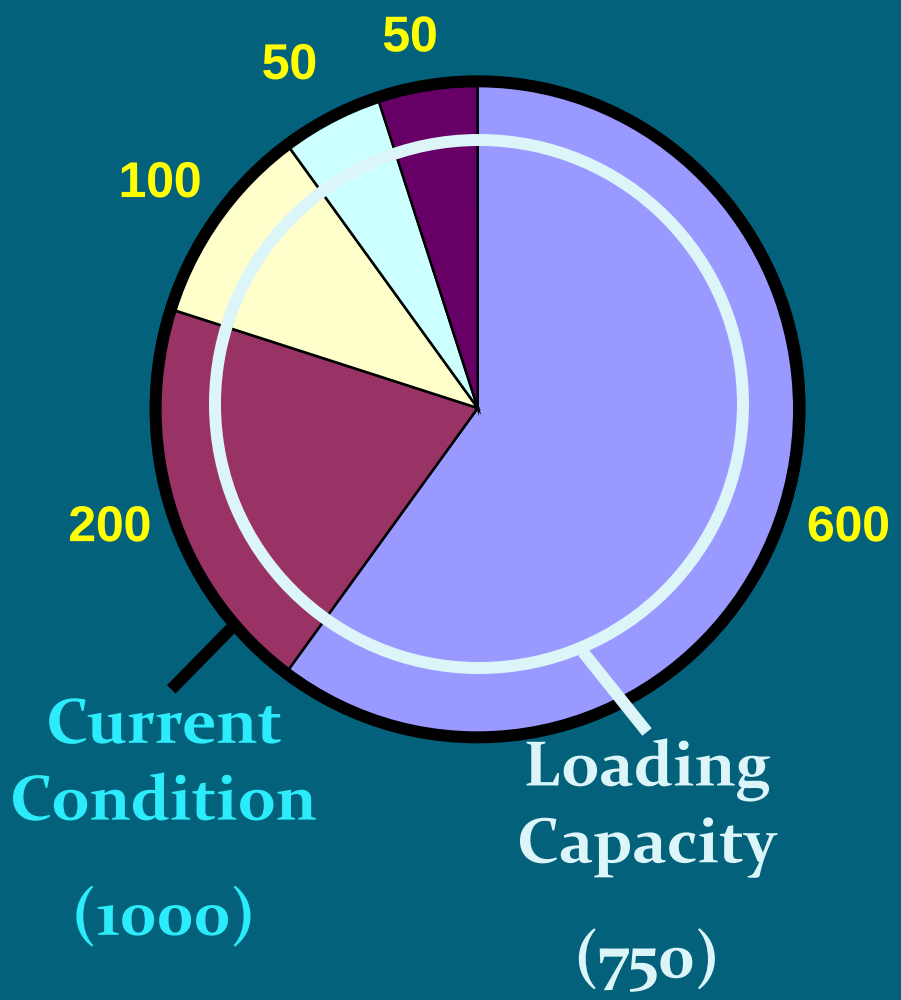
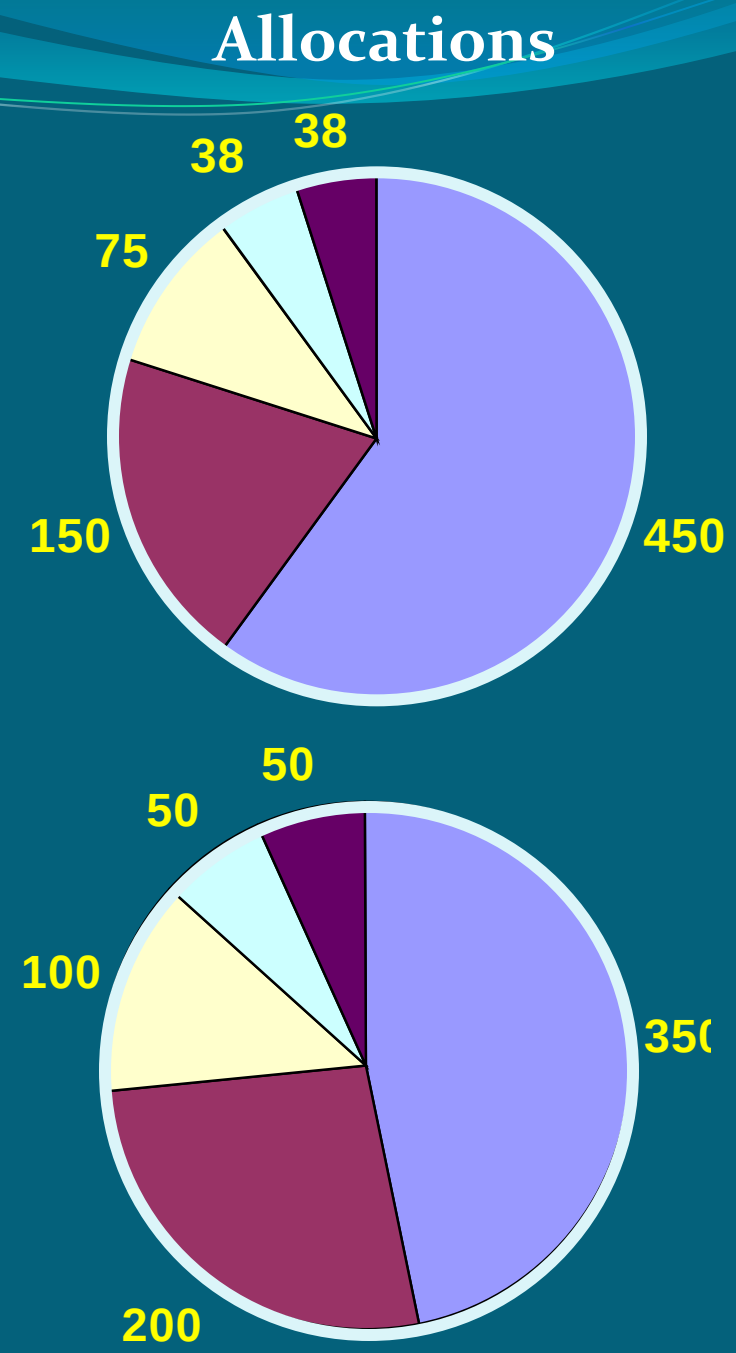
What a TMDL looks like:





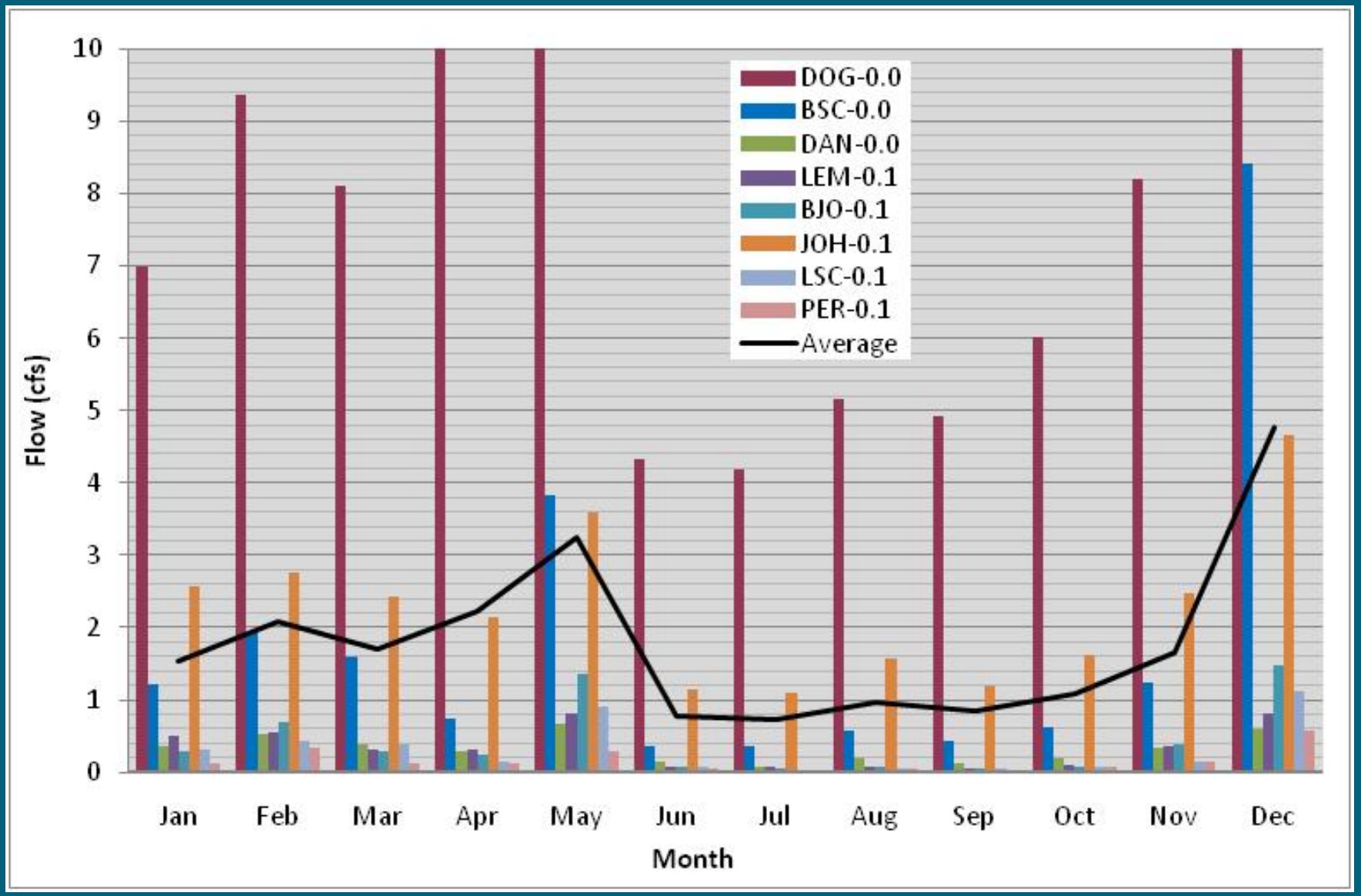
Concentration vs. Loading

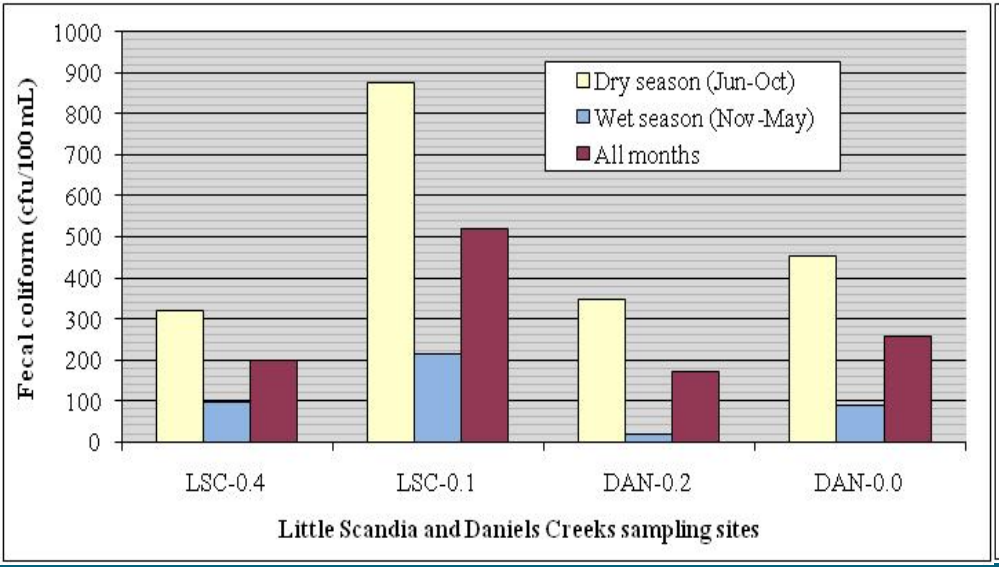
- Concentration: educated guess at whether the water is contaminated or not.

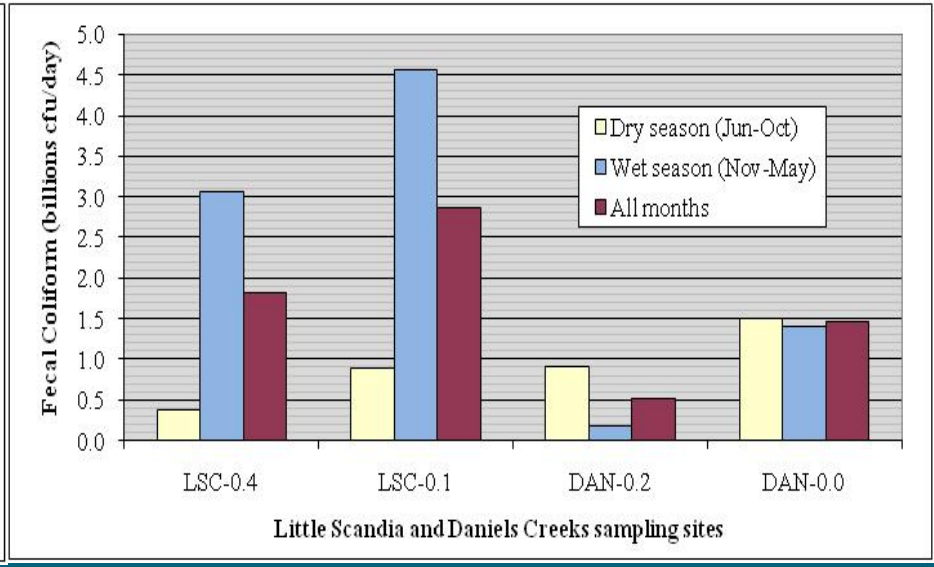
- Load: tells us how many bacteria are in water and helps us find sources.

  - May have high concentration but low loading or high loading but low concentration
  - Helpful to detect if bay will be affected or not

DOG-0.6						
flow	method	FC	load* (billions of organisms)	sci. not.	LN	ttest
4.8	EST_SW	65	7.6	7.6E+09	4.2	65
6.6	WASFLOW	110	17.9	1.8E+10	4.7	110
4.6	WASFLOW	43	4.8	4.8E+09	3.8	280
4.8	WASFLOW	66	7.8	7.8E+09	4.2	130
5.9	WASFLOW	88	12.7	1.3E+10	4.5	250
5.3	RATING	32	4.2	4.2E+09	3.5	92
8.7	WASFLOW	63	13.5	1.4E+10	4.1	120
5.4	WASFLOW	52	7.0	7.0E+09	4.0	84
6.0	EST_SW	21	3.1	3.1E+09	3.0	330
26	EST_SW	390	249.4	2.5E+11	6.0	92
7.2	WASFLOW	17	3.0	3.0E+09	2.8	43
5.3	RATING	19	2.5	2.5E+09	2.9	66
8.9	WASFLOW	24	5.2	5.2E+09	3.2	88
8.1	RATING	31	6.2	6.2E+09	3.4	32
7.4	WASFLOW	12	2.2	2.2E+09	2.5	63
7.8	RATING	15	2.9	2.9E+09	2.7	52
21	WASFLOW	13	6.6	6.6E+09	2.6	21
5.8	RATING	11	1.6	1.6E+09	2.4	390
13	WASFLOW	280	88.9	8.9E+10	5.6	17
8.7	RATING	130	27.9	2.8E+10	4.9	19
4.0	RATING	250	24.5	2.5E+10	5.5	24
4.0	RATING	92	9.0	9.0E+09	4.5	31
4.0	RATING	120	11.8	1.2E+10	4.8	12
3.9	RATING	84	8.0	8.0E+09	4.4	15
3.9	RATING	330	31.3	3.1E+10	5.8	13
3.8	WASFLOW	92	8.6	8.6E+09	4.5	11
Geomean (all)		56	May-Aug	2.4E+10	4.0	
90th %tile (all)		218	Sep-Apr	2.1E+10	1.1	
Geomean (critical)		134	All	2.2E+10	5.4	
90th %tile (critical)		274			4.9	3.5
Geomean (non)		32			0.6	0.9
90th %tile (non)		106			5.6	4.7
	90th reduction	0.64	64%	90th reduction		
	target mean	48.8	49	Geomean target		
		100	100	90th target		
are the two seasons sig. diff. (p<.05)?				**p=**	**0.0082**	**YES**
May - Aug is crit. season						


10
9
8
7
6
5
4
3
2
1
0
Flow (cfs)
DOG-0.0
BSC-0.0
DAN-0.0
LEM-0.1
BJO-0.1
JOH-0.1
LSC-0.1
PER-0.1
Average
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Fecal coliform (cfu/100 mL)
1000
900
800
700
600
500
400
300
200
100
0
Dry season (Jun-Oct)
Wet season (Nov-May)
All months
LSC-0.4
LSC-0.1
DAN-0.2
DAN-0.0
Little Scandia and Daniels Creeks sampling sites


Fecal Coliform (billions cfu/day)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Dry season (Jun-Oct)
Wet season (Nov-May)
All months
LSC-0.4
LSC-0.1
DAN-0.2
DAN-0.0
Little Scandia and Daniels Creeks sampling sites