Appendix A

BUDD INLET MUSSEL BIOEXTRACTION DATA SHEET *(Monthly Sampling)*

Questions? Contact PSI staff at 360-754-2741

Site (BHM, [✓ STM], POH/HF, WBM): BW **Sample ID:** (e.g. 13BHM-0615-1)

Date: 7/28/15 **Arrival Time:** 11:48 **Leave Time:** 12:45 **Tide:** low

Mussel Collectors: SB & AC **Depth:** no gun

Data Recorder: AC **Secchi:** 2.7 m (B) 4.2

SITE DESCRIPTION

Water Temp. (celcius): (S) 18.6 (2.5') 18.4 (B) 16.3 **DO:** (S) 80% (2.5) 79.8 **Salinity:** (S) 17.38 (2.5) 18.4 (B) 28.8

B: 6" off bottom **pH:** (S) 6.9 (2.5) 7.04 (B) 7.32 **ORP:**

Site Description: rained a little 2 days ago. Sunny + nice ~80° F

LINE DESCRIPTION

Line #1

Location: (*See Site Map Attached for Reference*) **Position #** (*e.g. 9B*): ①

Top	Mussel set (heavy, medium, light, none)	Fouling Community Description
1 ft	5-10% babe	lots of slimy brown
2 ft	10% top	algae, some porphyra
3 ft	10%	lots tunicates + orange/gray colonial ascidian?.
4 ft	30%	Strap is overall slimy
5 ft	30%, better at bottom	

Bottom

Notes:

don't see many

jellies, water cloudier

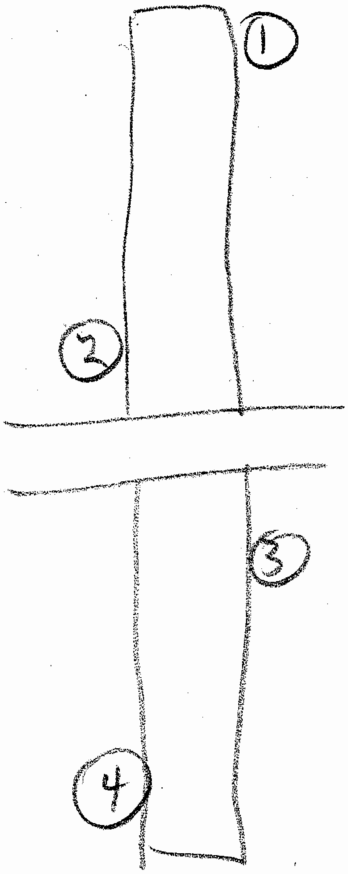
more fuzzy brown algae at surface depth

Appendix B

Sample Data Sheet

BUDD INLET MUSSEL BIOEXTRACTION DATA SHEET *(Monthly Sampling)*

Site (BHM, STM, POH, [✓ WBM]) **Sample ID:** (e.g. 13BHM-0615-1)
Date: 7/28/15 **Arrival Time:** 12:48 **Leave Time:** 1:23
Mussel Collectors: SB + AC
Data Recorder: AC



	Line # 1 Length (mm)	Line # 2 Length (mm)	Line # 3 Length (mm)	4
1	19	24	12	19
2	17	15	22	16
3	15	18	7	22
4	17	21	17	21
5	16	13	12	15
6	14	14	20	20
7	18	10	12	12
8	18	17	21	12
9	17	18	11	18
10	18	17	9	16
11	17	15	13	18
12	15	11	10	25
13	8	17	16	20
14	21	9	12	17
15	9	15	20	18
16	12	18	12	19
17	16	21	12	17
18	13	15	13	14
19	18	12	16	20
20	18	14	20	18
21	21	8	11	15
22	14	19	19	18
23	21	16	12	19
24	14	20	8	15
25	18	12	8	22
26	14	17	11	24
27	18	9	17	22
28	23	13	14	16
29	16	20	16	17
30	15	17	21	11
Composite wt + fouling (g):				
Fouling wt (g):				
Composite wt - fouling (g):				
BIOMASS OF ENTIRE LINE (30)	11.5	10.8	8.5	15.3

Jellies + Shalleback

Appendix C

9 - Flow through Exp.

1X

2015 NEP Phytoplankton

	Ref	N	C	S	Ref S	
Centric Diatoms						
Actinoptychus senarius						
Asteromphalus heptactis						
Aulacodiscus kittoni				2		
Cerataulina pelagica	12			4	6	
Chaetocreros spp.	40	38	12	32	28	
Corethron criophilum						
Coscinodiscus spp.		10	4	2		
Dactyliosolen						
Detonula pumila						
Ditylum brightwellii	6	8	2	12	14	
Eucampia						
Grammatophora						
Guinardia						
Hemiaulus						
Lauderia						
Leptocylindrus	88	48	8	98✓	96	
Melosira						
Odontella						
Plagiogramopsis						
Proboscia alata						
Rhizosolenia						
Skeletonema	36	20		30	44	
Stephanopyxis spp.						
Thallassiosira spp.	36	16	8	68	38	
Unidentified centric						
Pennate Diatoms						
Achnanthes						
Asterionellopsis						
Cylindrotheca	6	4	2	14	2	
Fragilaria						
Fragillariopsis						
Licmophora						
Navicula spp.	8	2				
Nitzschia acic + other	4				2	
Petrodictyon						
Pleurosigma					2	
Pseudo-nitzschia	1	4	2	6	2	
Striatella						
Thalassionema	6					
Tropidoneis						
Unidentified pennate	2			6	4	
Dinoflagellates						
Akashiwo sanguinea	68	28	12	66	22	
Alexandrium spp.	6*	28*	2*	19*	16	
Amphidinium	26	36	14	62	4	
Amylax triacantha						
Ceratium spp.	76	58	16	76	76	
Dinophysis spp. ϟ	7	8		4	11	
Gonyaulax spp.						
Gymnodinium						
Gyrodinium spp.	14	6		2		
Heterocapsa triquetra	34	40	16	40	60	
Kofoidinium velleloides	1					
Minuscula bipes						
Nematodinium						
Noctiluca scintillans				1	2	
Oxyphysis oxytoxoides						
Polykrikos				1		
P. gracile *Prorocentrum spp.*	66	40	16	46	86	
Protoceratium						
Protoperidinium spp.				6	4	
Pyrophacus						
Scrippsiella		2			4	
Unidentified Dinos ∞	30	30	18	34	52	
Dictyoca spp.						
Heterosigma akashiwo						
Zooplankton						
Tintinnids ✓✓	30	16	8	48	10	
copepoda						
barnacle nauplii						
crustacean nauplii						
rotifers						
tiarina	2	2	1	1		
Urochordata/Oikopleura						
Gastropod/bivalve larve						
Polychaete larvae (trochophore)						
other (No. different species)		1				
Euglenoid				1		
Eggs				3	2	

↑ maybe larvae on its side

Entered
1/8/15

☺ one
C. divaricatum

✓ minimus +
L. danicus

A-like
* either
A. Tamarense or
Protoceratium

ϟ even mix
fortii +
acuminata

∞
most small dinos

✓✓ some ciliates,
mesodinium,
tintinnids

Δ
Some D. fortii;
but mostly
D. acuminata

Appendix D

US Composting Council ®
STA Certified Lab

soiltest
farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

Client: **Pacific Shellfish intitute**
Attn: Aimee Christy
120 State Ave NE 1056

360-754-2741

Product: **WB-Mussel 1**
Date Sampled: 12/16/15
Date Received: 12/17/15

Date Reported: 01/08/16
Laboratory # C15-744
Reveiwed by Brent Thyssen, CPSSc

Amount: $ 120.00

Nutrients

	Method	As Rcvd.	Dry Wt.	Units	Low	Normal	High	Typical Range
Moisture	70 C	**47.3**		%	**************************			15 to 40
Solids	70 C	**52.7**		%	***********			60 to 85
pH	1:5	**6.7**	**NA**	SU	*************			5.5 to 8.5
E.C	1:5	**3.26**	**6.18**	mmhos/cm	********************			below 5.0
Total N	TMECC 04.02D	**0.63**	**1.20**	%	*************			1 to 5
Organic C	TMECC 04.01A	**17.0**	**32.2**	%	*****************			18 to 45
Phosphorus	TMECC 04.12B/04.14A	**0.12**	**0.22**	%				
P_2O_5		**0.27**	**0.51**	%	*********			1 to 8
Potassium	TMECC 04.12B/04.14A	**0.39**	**0.73**	%				
K_2O		**0.46**	**0.88**	%	****			3 to 12
Calcium	TMECC 04.12B/04.14A	**2.14**	**4.1**	%	*****************			0.5 to 10
Magnesium	TMECC 04.12B/04.14A	**0.14**	**0.27**	%	****************			0.05 to 0.7
Sodium	TMECC 04.12B/04.14A	**0.16**	**0.30**	%	****************			0.05 to 0.7
Sulfur	TMECC 04.12B/04.14A	**0.11**	**0.20**	%	****************			0.1 to 1.0
Boron	TMECC 04.12B/04.14A	**6**	**12**	mg/kg	************			25 to 150
Zinc	TMECC 04.12B/04.14A	**25**	**47**	mg/kg	***			100 to 600
Manganese	TMECC 04.12B/04.14A	**161**	**306**	mg/kg	************			250 to 750
Copper	TMECC 04.12B/04.14A	**12**	**23**	mg/kg	***			100 to 500
Iron	TMECC 04.12B/04.14A	**4469**	**8479**	mg/kg	*****************			1000 to 25000
C/N ratio			**27**	ratio	****************************			18 to 24

WAC 173-350-220

	Method	Dry Wt.	Units	Low	Normal	High	WAC Limit
Arsenic	TMECC 04.12B/04.14A	**3.5**	mg/kg	****			20
Cadmium	TMECC 04.12B/04.14A	**0.1**	mg/kg	****			10
Chromium	TMECC 04.12B/04.14A	**15.6**	mg/kg				-
Cobalt	TMECC 04.12B/04.14A	**4.4**	mg/kg				-
Copper	TMECC 04.12B/04.14A	**23**	mg/kg	****			750
Lead	TMECC 04.12B/04.14A	**5.3**	mg/kg	****			150
Mercury	TMECC 04.12B/04.14A	**0.04**	mg/kg	****			8
Molybdenum	TMECC 04.12B/04.14A	**2.2**	mg/kg	**************			9
Nickel	TMECC 04.12B/04.14A	**11.8**	mg/kg	****			210
Selenium	TMECC 04.12B/04.14A	**0.2**	mg/kg	****			18
Zinc	TMECC 04.12B/04.14A	**47**	mg/kg	****			1400
		Pass					

Sample was received, handled and tested in accordance with TMECC procedures

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farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

Client: **Pacific Shellfish intitute**
Attn: Aimee Christy
120 State Ave NE 1056

360-754-2741

Product: **WB-Mussel 2**
Date Sampled: 12/16/15
Date Received: 12/17/15

Date Reported: 01/08/16
Laboratory # C15-745
Reveiwed by Brent Thyssen, CPSSc

Amount: $ 120.00

Nutrients

	Method	As Rcvd.	Dry Wt.	Units	Low	Normal	High	Typical Range
Moisture	70 C	**47.3**		%	**************************			15 to 40
Solids	70 C	**52.7**		%	***********			60 to 85
pH	1:5	**6.8**	**NA**	SU	*************			5.5 to 8.5
E.C	1:5	**3.39**	**6.44**	mmhos/cm	********************			below 5.0
Total N	TMECC 04.02D	**0.61**	**1.15**	%	*************			1 to 5
Organic C	TMECC 04.01A	**14.3**	**27.1**	%	*****************			18 to 45
Phosphorus	TMECC 04.12B/04.14A	**0.14**	**0.26**	%				
P_2O_5		**0.31**	**0.59**	%	*********			1 to 8
Potassium	TMECC 04.12B/04.14A	**0.39**	**0.74**	%				
K_2O		**0.47**	**0.88**	%	****			3 to 12
Calcium	TMECC 04.12B/04.14A	**2.48**	**4.7**	%	*****************			0.5 to 10
Magnesium	TMECC 04.12B/04.14A	**0.17**	**0.31**	%	***********************			0.05 to 0.7
Sodium	TMECC 04.12B/04.14A	**0.15**	**0.29**	%	****************			0.05 to 0.7
Sulfur	TMECC 04.12B/04.14A	**0.11**	**0.20**	%	****************			0.1 to 1.0
Boron	TMECC 04.12B/04.14A	**6**	**11**	mg/kg	************			25 to 150
Zinc	TMECC 04.12B/04.14A	**27**	**51**	mg/kg	*******			100 to 600
Manganese	TMECC 04.12B/04.14A	**199**	**378**	mg/kg	************			250 to 750
Copper	TMECC 04.12B/04.14A	**14**	**27**	mg/kg	***			100 to 500
Iron	TMECC 04.12B/04.14A	**5577**	**10580**	mg/kg	*****************			1000 to 25000
C/N ratio			**24**	ratio	***********************			18 to 24

WAC 173-350-220

	Method	Dry Wt.	Units	Low	Normal	High	WAC Limit
Arsenic	TMECC 04.12B/04.14A	**4.0**	mg/kg	****			20
Cadmium	TMECC 04.12B/04.14A	**0.1**	mg/kg	****			10
Chromium	TMECC 04.12B/04.14A	**17.4**	mg/kg				-
Cobalt	TMECC 04.12B/04.14A	**5.2**	mg/kg				-
Copper	TMECC 04.12B/04.14A	**27**	mg/kg	****			750
Lead	TMECC 04.12B/04.14A	**6.0**	mg/kg	****			150
Mercury	TMECC 04.12B/04.14A	**0.04**	mg/kg	****			8
Molybdenum	TMECC 04.12B/04.14A	**1.7**	mg/kg	**********			9
Nickel	TMECC 04.12B/04.14A	**13.8**	mg/kg	****			210
Selenium	TMECC 04.12B/04.14A	**0.2**	mg/kg	****			18
Zinc	TMECC 04.12B/04.14A	**51**	mg/kg	****			1400
		Pass					

Sample was received, handled and tested in accordance with TMECC procedures

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2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

Client: **Pacific Shellfish intitute**
Attn: Aimee Christy
120 State Ave NE 1056

360-754-2741

Product: **WB-Mussel 3**
Date Sampled: 12/16/15
Date Received: 12/17/15

Date Reported: 01/08/16
Laboratory # C15-746
Reveiwed by Brent Thyssen, CPSSc

Amount: $ 120.00

Nutrients

	Method	As Rcvd.	Dry Wt.	Units	Low	Normal	High	Typical Range
Moisture	70 C	**43.4**		%	**************************			15 to 40
Solids	70 C	**56.6**		%	***********			60 to 85
pH	1:5	**6.7**	**NA**	SU	*************			5.5 to 8.5
E.C	1:5	**4.14**	**7.31**	mmhos/cm	********************			below 5.0
Total N	TMECC 04.02D	**0.68**	**1.20**	%	*************			1 to 5
Organic C	TMECC 04.01A	**15.3**	**27.0**	%	*****************			18 to 45
Phosphorus	TMECC 04.12B/04.14A	**0.14**	**0.25**	%				
P_2O_5		**0.33**	**0.58**	%	*********			1 to 8
Potassium	TMECC 04.12B/04.14A	**0.43**	**0.75**	%				
K_2O		**0.51**	**0.90**	%	****			3 to 12
Calcium	TMECC 04.12B/04.14A	**2.81**	**5.0**	%	*****************			0.5 to 10
Magnesium	TMECC 04.12B/04.14A	**0.19**	**0.33**	%	***********************			0.05 to 0.7
Sodium	TMECC 04.12B/04.14A	**0.18**	**0.32**	%	***********************			0.05 to 0.7
Sulfur	TMECC 04.12B/04.14A	**0.12**	**0.21**	%	****************			0.1 to 1.0
Boron	TMECC 04.12B/04.14A	**7**	**12**	mg/kg	************			25 to 150
Zinc	TMECC 04.12B/04.14A	**29**	**52**	mg/kg	*******			100 to 600
Manganese	TMECC 04.12B/04.14A	**213**	**376**	mg/kg	************			250 to 750
Copper	TMECC 04.12B/04.14A	**15**	**27**	mg/kg	***			100 to 500
Iron	TMECC 04.12B/04.14A	**6126**	**10820**	mg/kg	*****************			1000 to 25000
C/N ratio			**23**	ratio	***********************			18 to 24

WAC 173-350-220

	Method	Dry Wt.	Units	Low	Normal	High	WAC Limit
Arsenic	TMECC 04.12B/04.14A	**4.3**	mg/kg	****			20
Cadmium	TMECC 04.12B/04.14A	**0.1**	mg/kg	****			10
Chromium	TMECC 04.12B/04.14A	**19.1**	mg/kg				-
Cobalt	TMECC 04.12B/04.14A	**5.5**	mg/kg				-
Copper	TMECC 04.12B/04.14A	**27**	mg/kg	****			750
Lead	TMECC 04.12B/04.14A	**6.1**	mg/kg	****			150
Mercury	TMECC 04.12B/04.14A	**0.03**	mg/kg	****			8
Molybdenum	TMECC 04.12B/04.14A	**2.1**	mg/kg	**************			9
Nickel	TMECC 04.12B/04.14A	**14.5**	mg/kg	****			210
Selenium	TMECC 04.12B/04.14A	**0.1**	mg/kg	****			18
Zinc	TMECC 04.12B/04.14A	**52**	mg/kg	****			1400
		Pass					

Sample was received, handled and tested in accordance with TMECC procedures

Appendix E: Environmental Education Photo Montage

Students from Marshall Middle School's Citizen Science Institute program visit a nutrient bioextraction site to observe live plankton, collect mussel growth data, measure water quality parameters, measure biodiversity on mussel straps and create an underwater Go-Pro video, October 2015.

Recent graduate student assisting with data collection and mussel harvest at West Bay Marina, October 2015.

Students from TESC's Organic Farm mixing ingredients to make mussel compost, October 2015.

Evergreen State College students touring the Organic Farm and learning about the mussel compost project.

Komachin Middle School students observe mussels improving water clarity by filtering plankton from the water.

Komachin Middle School students collect mussel length and weight data.

Komachin Middle School students observe and sketch live phytoplankton.

Students learn about various water quality equipment including depth gauges, secchi disks, plankton nets, and YSI probes.

Young scientists collecting plankton during the What's Blooming in Budd program, Summer 2016.

Kids observing live plankton during the What's Blooming in Budd program, Summer 2016.

Community members measuring water depth in Budd Inlet.

Community members learning about nutrient pollution sources including dog waste at the Great Yards Get Together Event, September 2016.

One of the lovely giveaway items offered to responsible dog owners at the Great Yards Get Together - Rice Crispies Treat Doggie Doos.

Appendix F

Eutrophication = Nutrients → → $\downarrow O_2$

✓

Budd Inlet Water Quality

Heidi Kirk
Environmental Studies
September 13, 2013

Station A. Mussel Filtration Display

1. What do mussels filter out of the water column?

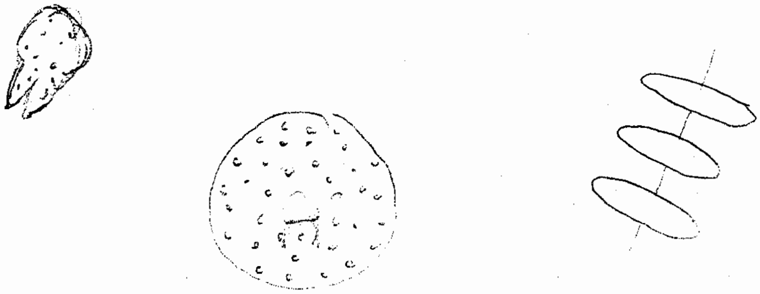
Planktonic plants and animals for a food source.

2. How does mussel filtration impact the surrounding marine environment?

They impact their surroundings by processing & recycling natural materials. clears the water so other things can grow.

Station B. Phytoplankton

3. Draw 1-2 phytoplankton species from the Budd Inlet water sample.



4. Which dinoflagellate is blooming right now?

akashiwo

Station C. Nutrient Sources

This station displays various sources of nutrients that can flow into lakes, streams, groundwater and ultimately Puget Sound where they fuel phytoplankton growth. As blooms die, bacterial decomposition leads to depleted oxygen levels which can be stressful to marine life.

5. Which products contain phosphates?

Miracle-Gro

6. Which product is phosphate-free?

Dishwashing liquid

7. List at least 2 nutrients found in Miracle Grow.

Nitrogen & phosphate

Station D. Mussel Growth Measurements (work in small groups)

This strap contains thousands of native blue mussels from Boat Works Marina in Budd Inlet. Randomly select 5 mussels and record their lengths in cm.

Mussel 1 2.1 cm
Mussel 2 3.2 cm
Mussel 3 2.6 cm
Mussel 4 2.7 cm
Mussel 5 3.0 cm

8. What is the average mussel length?

2.72 cm

9. Compare your length to the graph. Are the mussels still growing?

No.

Station E. Seasonal Water Quality Data

The following graphs depict seasonal water quality data (temperature, salinity, pH and dissolved oxygen) from the 4 sites: BHM = Boston Harbor Marina, WBM = West Bay Marina, HF = Hearthfire Restaurant, STM = Swantown Marina

10. Which station is the coldest and saltiest?

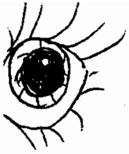
Boston Harbor Marina

11. Does pH and oxygen tend to increase or decrease as the summer progresses? Why?

It decreases, because the plankton begin to decay.

Bonus Question!!!!

Department of Ecology is offering $100,000 to the organization with the best plan for reducing nutrient levels in the Deschutes River/Budd Inlet watershed. What's your plan?



✓

[redacted]

Per. 3, Sept. 13th 2013

Budd Inlet Water Quality

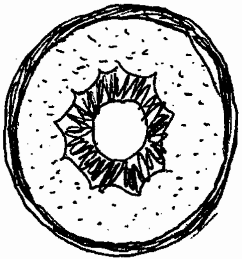
Heidi Kirk
Environmental Studies
September 13, 2013

Station A. Mussel Filtration Display

1. What do mussels filter out of the water column?
small and freefloating plants and animals for food
2. How does mussel filtration impact the surrounding marine environment?
Filter feeding shellfish process and recycle natural materials which make them available for other living things.

Station B. Phytoplankton

3. Draw 1-2 phytoplankton species from the Budd Inlet water sample.



Coscinodiscus

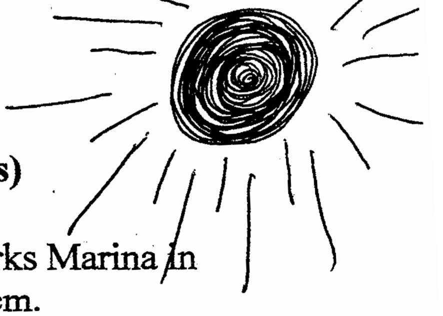
Thalassionema

4. Which dinoflagellate is blooming right now?
Acoshuo

Station C. Nutrient Sources

This station displays various sources of nutrients that can flow into lakes, streams, groundwater and ultimately Puget Sound where they fuel phytoplankton growth. As blooms die, bacterial decomposition leads to depleted oxygen levels which can be stressful to marine life.

5. Which products contain phosphates?
Miracle-gro ~~and FINISH~~ and FINISH tablets
6. Which product is phosphate-free?
Dishwashing ~~and FINISH~~ soap
7. List at least 2 nutrients found in Miracle Grow.
Nitrogen and zinc



Station D. Mussel Growth Measurements (work in small groups)

This strap contains thousands of native blue mussels from Boat Works Marina in Budd Inlet. Randomly select 5 mussels and record their lengths in cm.

Mussel 1 3½cm
Mussel 2 4½cm
Mussel 3 3cm
Mussel 4 1.8cm
Mussel 5 2.3cm

8. What is the average mussel length?
   3.02cm
9. Compare your length to the graph. Are the mussels still growing?
   Yes they are growing.

Station E. Seasonal Water Quality Data

The following graphs depict seasonal water quality data (temperature, salinity, pH and dissolved oxygen) from the 4 sites: BHM = Boston Harbor Marina, WBM = West Bay Marina, HF = Hearthfire Restaurant, STM = Swantown Marina

M:
tonharbor
arina

10. Which station is the coldest and saltiest?
    BHM is the coldest ~~[illegible]~~ and saltiest
11. Does pH and oxygen tend to increase or decrease as the summer progresses? Why?
    PH levels decrease, while water temperature rises. ~~Bacteria de~~

Bonus Question!!!!

Department of Ecology is offering $100,000 to the organization with the best plan for reducing nutrient levels in the Deschutes River/Budd Inlet watershed. What's your plan?

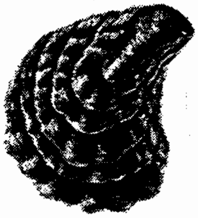
[redacted]

P.1

✓ D

4.12.14

Budd Inlet Water Quality Worksheet

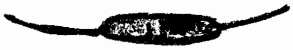


Pacific Shellfish Institute
Olympia, WA
www.pacshell.org

Station A. Phytoplankton

1. Draw 1-2 phytoplankton species from the Budd Inlet water sample.

Akashiwo sanguinea



ceratium fusus

2. Can you tell which are zooplankton or phytoplankton? Diatoms or dinoflagellates? Species? If so, label as such.

Station B. Mussel Growth Measurements (work in small groups)

3. Select 5 mussels and record their lengths in cm. What is the average mussel length?

Mussel 1 4cm

Mussel 2 4 1/2cm

Mussel 3 3.2 cm

Mussel 4 3.4 cm

Mussel 5 4.6cm   Average Mussel Length 3.94 (cm)

Press the tare button on the scale. Place the 5 mussels in the dish and record their weight in grams. Divide the weight by 5 to obtain the weight per individual mussel.

Weight of 5 mussels 28.5 (g)   Weight per Mussel 5.7 (g)

4. Compare your data to the graphs. To maximize the amount of nitrogen removed, we want the average mussel length to be at least 3 cm (or 30 mm) and the weight per mussel to be at least 1.5 grams. Is it time to harvest or should we wait longer?

I think it's to harvest because all of our measurements are big.

Station C. Water Quality Sampling

5. What do you think each piece of sampling equipment (A-D) is used for?

A. Depth
B. temp.
C. Filter
D. water samples

6. Use the YSI probe (or refractometer) to measure the salinity in each jar. Which jar contains seawater and which is fresh?

Fresh water	Brackish water	Saline water	Brine
< 0.5 ppt	0.5 – 30 ppt	30-50 ppt	>50.0 ppt

A B

Station D. Solutions to Nutrient Pollution

This station displays various nutrient sources that can travel from our neighborhoods into lakes, streams, and ultimately Puget Sound where they fuel phytoplankton (algae) growth. As algae die, the process can rob bottom waters of oxygen placing stress on marine life.

7. Name one product that contains phosphates and one that is phosphate free.

Phosphates: Fertilizer
No Phosphate: Mussle Compost

8. List several actions that you can take to prevent nutrients from flowing into Puget Sound?

Changing the fertizer people use. pick up dog poop. using soap w/o phosphate.

Nutrient Bioextraction is the process of growing and harvesting shellfish to remove nutrients from natural water bodies. Pacific Shellfish Institute has been testing this idea as a way to improve water quality in Budd Inlet. The mussels are then harvested and turned into nutrient rich, organic compost.

9. What are these mussels filtering out of the water?

Nitrogen from the algea.

10. How can shellfish filtration impact the surrounding marine environment?

Cleaner water and more oxygen.

[redacted]

11-21-16

What I learned today was very intresting, First, we learned about how nutriens go to the Oceans, lakes, and ponds. Then we got to observe many fastinating animals. For example, the jelly-fish, it was very soft, and it was clear.

Now that I heared you talk about that, I will try to be more aware of my sorroundings. For example, I will always pick up my dogs poo.

[redacted] 11-21-16

Today I learned about entrophication. Eutrophication is when too much nutrients gets into the water. Then, the plankton feast on the nutrients. Once they're done, they die. Next, bacteria comes in and clean up the dead plankton -and the oxygen. These places with no oxygen are called dead zones. When the weather gets cold, and storms happen, the water mixes up, and the oxygen returns.

w/ Harry & Aimee

[redacted]

11-21-2016

Today I learned about the planktons and the life cycle of planktons. I also learned that too much nutrients in the water also called eutrophication.

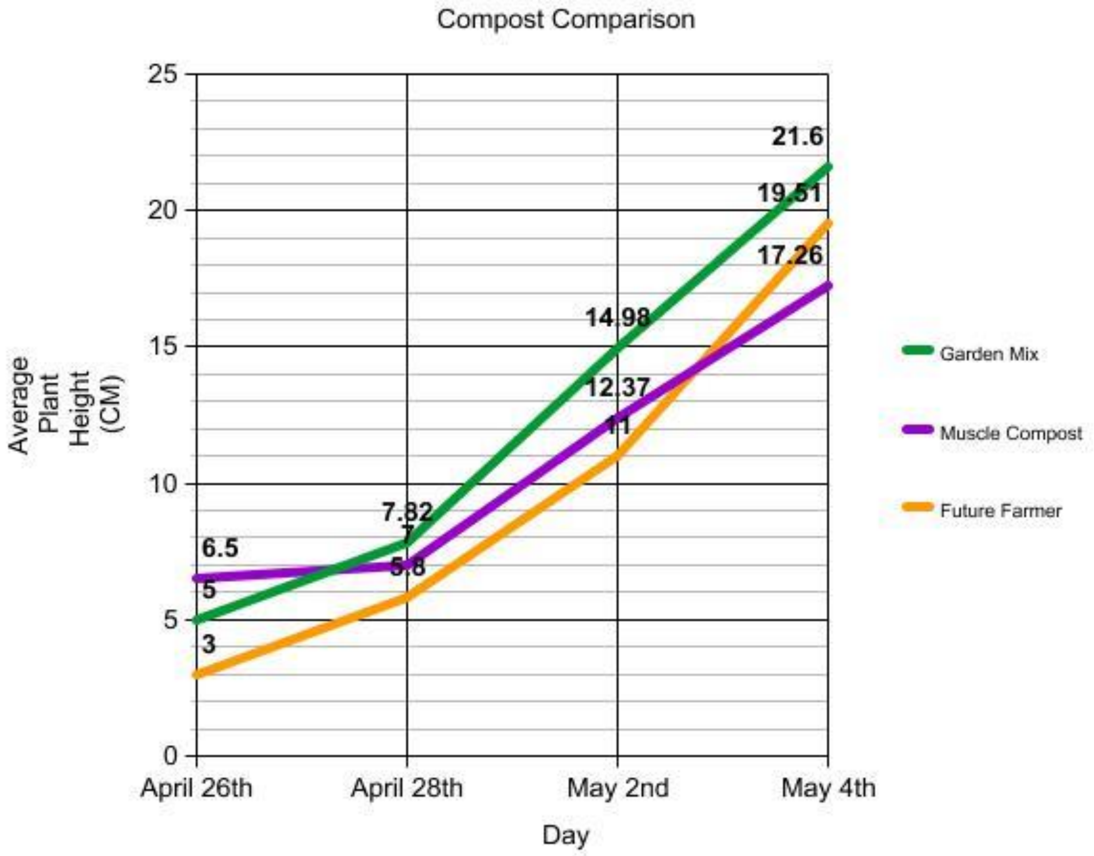
One way I could help the enviroment is to fertilize on the lawn and not get any on the sidewalk.

[redacted] 11/21/16

I learned that there are different kinds of plakton, like plakton that grow into plants and plakton that grow into sea animals. Like clams for example. I also leared that etrophication means extra nutrients. Another thing that I learned is that bioextraction means to remove extra nutrients. One thing I can do to keep extra nutrients is when I walk my aunts dog I can pick up its poop.

Appendix G

Marshall Middle School Mussel Compost Growth Trials Spring 2016



As one can see from this graph, by the end of the experiment, the Mussel Compost produced the shortest plant height average. Although, there is only a 4.34 CM difference between Garden Mix, the compost that produced the tallest plant average, and Muscle Compost. In the beginning of the experiment, the Muscle Compost had the tallest plant average, but later it was overtaken by the Garden Mix and the Future Farmer composts.

Although the Mussel Compost proved least effective by the end, it can still be used as a reliable compost material. All plants need nitrogen for growth and photosynthesis. Nitrogen is something this compost has a lot of. However, different plants consume different amounts of nitrogen. This compost would be very useful for plants that are particularly heavy nitrogen consumers such as roses, corn, lettuce, tomatoes, squash, cucumbers and cabbage. There is such a thing as too much nitrogen, which can be just as harmful to a plant as to little. The amount of nitrogen that is too much varies from plant to plant. This compost will be beneficial to plants like mentioned before but not to others.

All in all, this compost works pretty well but will really thrive with gardens that are in need of lots of nitrogen. It could however be too much for certain gardens. A nitrogen heavy compost can be harmful to plants that do not need as much nitrogen. More experiments could be done to find the perfect amount of nitrogen that could be used on a larger variety of plants. Making this compost material is a great way to use the excessive amount of muscles in the Puget Sound.

Appendix H

What's Blooming in Budd?

With the onset of spring comes blooming crocus, Indian plum and red-flowering currant. Did you know Puget Sound blooms as well? Spring marks a time of plentiful nutrients, sunshine and good mixing conditions in Puget Sound—perfect ingredients for fueling the microscopic plants of the sea, phytoplankton.

Last year marked the fourth year of Stream Team's plankton monitoring events in Budd Inlet near downtown Olympia. Between June and September, volunteers gathered at the Port Plaza dock to collect weekly information about the weather, tides, temperature, salinity and water clarity. Plankton samples were taken to the LOTT WET Science Center where they were projected onto a large screen for viewing, analyzed for species composition, and screened for harmful algal bloom (HAB) species. This ongoing data set allows the tracking of seasonal changes as well as the detection of changes over time.

Why study plankton?

Besides being fascinating to observe under the microscope, plankton are the life force of the ocean. Phytoplankton and zooplankton, the microscopic plants and animals of the sea, are the basis of the marine food web. The food web, which is a delicate balance between species and the environment, responds to human pollution and pressures in ways we are only beginning to understand. For example, Christopher Krembs, Washington Department of Ecology (WDOE), hypothesizes that Noctiluca, the bioluminescent dinoflagellate responsible for painting surface waters bright orange, may be blooming more frequently and intensely than in the past. The voracious appetite of this organism for phytoplankton, protozoans, copepods and fish eggs may be having an impact on important species such as diatoms and copepods. Copepods are not only a critical food source for many fish and invertebrates, but their sinking fecal pellets transfer nutrients to deposit-feeding organisms below. As you can see, a simple shift in plankton composition could have profound and unexpected impacts on the surrounding environment.

Volunteers collect phytoplankton samples and view under microscopes to discover what's blooming in Budd.

Phytoplankton also influence dissolved oxygen levels in seawater. They produce oxygen while photosynthesizing and are believed to be responsible for over half of the oxygen that we breathe today. However, in late summer and early fall, bacterial decomposition of plankton that have settled to the bottom can cause dissolved oxygen levels to plummet to dangerously low levels. This is especially true in lower Budd Inlet, where excess nutrients from a multitude of sources result in plankton-rich waters. Oxygen is critical to the health of all marine organisms and, when concentrations are low, fish and invertebrates become stressed. Moderation is key—too little or too much phytoplankton are both cause for concern.

Finally, phytoplankton is monitored because several species are capable of producing harmful biotoxins that can accumulate in filter feeding organisms such as shellfish. Washington Department of Health regularly tests shellfish for biotoxins to ensure that those harvested commercially and recreationally are safe to eat. Sound Toxins, a phytoplankton monitoring program managed by NOAA and Washington Sea Grant, relies on volunteers to collect weekly water samples throughout Puget Sound, screening them for HAB species that produce biotoxins. The "What's Blooming in Budd?" program participates in this program by entering weekly data onto the Sound Toxins database.

Noctiluca bloom captured by WDOE's Eyes Over Puget Sound program.

Did you know?

The weight of all the plankton in the oceans is greater than that of all the dolphins, whales and fish put together. Amazing when you consider that most plankton are microscopic in size!

Citizen Plankton Monitoring

Don't Feed the Phytoplankton!

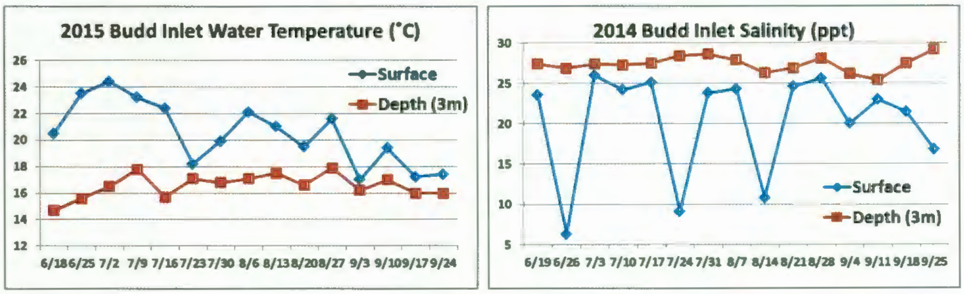
Phytoplankton are critical to the marine world, but too many nutrients can fuel large blooms that negatively impact water clarity and dissolved oxygen levels. Keep excess nutrients out of Puget Sound with these easy steps!

1. Minimize your use of synthetic lawn fertilizers. Use slow-release organic options instead.
2. Properly dispose of pet waste. Scoop It, Bag It, Trash It....every poop, every time.
3. Have your septic system inspected every year and pumped every 3–5 years.

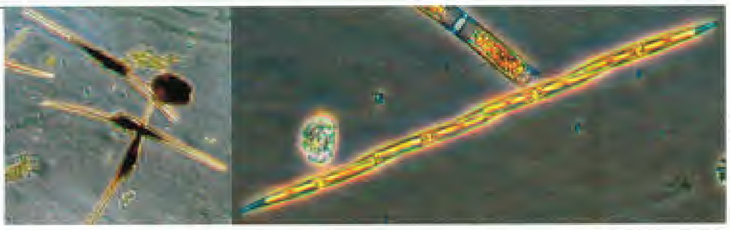
What have we discovered?

Over the past four years, volunteers have observed several interesting findings. First, it was hard not to notice the unusually warm surface water temperatures in Budd Inlet during the summer of 2015. Since 2014, researchers have identified a persistent warm water mass, nicknamed "the blob", in northeast Pacific waters. Extending into Puget Sound, "the blob" has raised water temperatures by 1.5–2.0°C. Since "What's Blooming in Budd?" was initiated, volunteers recorded peak surface temperatures reaching a high of around 21°C (70°F). Last summer, however, temperatures reached 24.4°C, or 75.2°F, by early July!

Volunteers were also fascinated by the enormous fluctuations in surface salinity occurring after rain events or Capitol Lake dam releases. While salinity remains fairly constant at depth (27–29 ppt), surface values can drop as low as 6 ppt during dam releases. Volunteers have also witnessed interesting changes in water clarity throughout the summer using an instrument called a Secchi disk. Water clarity is influenced by the amount of particulates in the water column such as suspended sediments and plankton. Too many particles can restrict light availability and visibility for submerged vegetation and marine life. Poor water clarity can also represent an overabundance of plankton, which could lead to subsequent drops in dissolved oxygen upon decomposition. According to the data collected, water clarity typically ranges from 2–5 meters in depth in lower Budd during the summer, but at times dropped to less than 1 meter, when Akashiwo and Ceratium were blooming!



Graphs displaying water temperature and salinity collected from the surface and depth.



Akashiwo sanguinea and Ceratium fusus—two of the most common dinoflagellates found in south Puget Sound Inlets during summer (left) and Pseudo-nitzschia, the diatom responsible for amnesic shellfish poisoning (right).

Finally, volunteers have detected HAB species such as the diatom Pseudo-nitzschia (responsible for amnesic shellfish poisoning) and dinoflagellate Dinophysis (responsible for diarrhetic shellfish poisoning) over the past several years. This is not unusual, and their presence does not necessarily indicate that they are producing toxins. However, one unusually large bloom of Dinophysis was detected in July of 2013. Simultaneously, Washington Department of Health posted the first closure to recreational shellfish harvesting in Budd Inlet's history based on elevated DSP toxins in tested mussel tissue.

Akashiwo sanguinea bloom in lower Budd Inlet, September 2014. Photo by Kelsey Browne, LOTT Clean Water Alliance.

How can I get involved?

Join Stream Team and biologists from Pacific Shellfish Institute at the dock this summer, starting June 23, to collect water quality data and discover what's blooming in Budd. Join us and be amazed as a drop of water comes to life right before your eyes! For more information, check the Stream Team website at www.streamteam.info

Additional Resources

WDOE's Eyes Over Puget Sound: www.ecy.wa.gov/programs/eap/mar_wat/surface.html Learn more about algal blooms, "the blob," jellies, and Puget Sound water quality.

SoundToxins: http://www.soundtoxins.org/ Learn about this Puget Sound-wide HAB monitoring program.

Stream Team: www.streamteam.info/actions/lawncare/ Learn ways to keep your lawn healthy while keeping nutrients out of Puget Sound.

Pacific Shellfish Institute: www.pacshell.org Discover what's blooming in Budd. Also learn how PSI is removing nutrients in Budd Inlet by growing mussels and turning them into surf-to-turf compost.

Article courtesy of Aimee Christie, Pacific Shellfish Institute

Appendix I

SUNDAY SEPTEMBER 11 2016
THEOLYMPIAN.COM
The Olympian

AMELIA DICKSON adickson@theolympian.com

The West Central Park Project demonstrated a gardening style called hugelkultur at the Great Yards Get Together on Saturday. The process involves layering wood and other organic matter to create a spongy, nutrient-rich soil.

GREAT YARDS GET TOGETHER

Event guides gardeners to eco-friendly approach

BY AMELIA DICKSON
adickson@theolympian.com

Where in Olympia can you find compost made from ground-up Budd Inlet mussels?

At the Great Yards Get Together, of course.

The Pacific Shellfish Institute gave away the surprisingly-not-stinky compost by the tubful at the Saturday event, hosted at Heritage Park on Capitol Lake.

The event was devoted to providing gardeners with yard solutions that aren't harmful to humans, animals or the water supply, said organizer Susan McCleary, who works as a senior program specialist for the city of Olympia. The event was hosted by Stream Team, Thurston County and the cities of Lacey, Olympia and Tumwater.

She said her best advice is for people to practice integrated pest management — using solutions other than pesticides and fertilizers to improve a plant's health. These options include proper pruning techniques, placing plants in the right place and using good-quality soil.

Mussel compost is an example of a healthy solution.

Mary Middleton said the Department of Ecology-funded project is a version of nutrient bioextraction. The live mussels removed excess nutrients from Budd Inlet, and turning them into compost allows them to be used in other parts of the watershed.

SEE GARDEN, 9A

FROM PAGE 3A

GARDEN

The process of creating the compost was relatively simple, she said. The organization hung seatbelts in Budd Inlet and mussels attached themselves to the fabric.

Five months later, the mussels were harvested and put through a wood chipper. The concoction, mixed with wood chips, makes a great compost.

Aimee Christy tested the compost and said the plants grown in it did as well as those grown in a commercial, store-bought compost — but without the harmful chemicals.

After the compost was left outside and tended to by worms, it worked even better.

"No other compost compared," Christy said.

Dave Humphries and Alicia Elliott, of the West Central Park Project, also provided examples of healthy yard solutions.

Elliott said the park, located at the corner of Harrison Avenue and Division Street, features several sample gardens — including an example of hugelkultur. Humphries explained hugelkultur, in German, means "mound culture."

He said gardeners start by building a trench, whic they then fill with rotting wood. Maple, alder and fruit woods work well — but gardeners should stay away from cedar.

On top, they place stra compost, soil and other organic materials. Plants are grown on top of the layers.

"It creates a spongy effect," Humphries said. "It adds nutrients to the soil for up to 20 years."

McCleary said gardene who missed the Great Yards Get Together can learn more about yard solutions through the Ma ter Gardeners Foundatio of Thurston County.