Pacific Shellfish Institute (PSI) – Light Trap Data Module (Grades 6-8)

Tiny Crabs, Big Impacts: Long-Term Monitoring for Healthy Dungeness Crab Populations

By: Katie Houle

Acknowledgements

Data collection methods and light trap design were standardized by the Pacific Northwest Crab Research Group (PCRG). Data shared herein is for educational purposes only with permission from the South Puget Sound monitoring team: Pacific Shellfish Institute (PSI), Nisqually Indian Tribe, Nisqually Reach Nature Center, & WDNR Aquatic Reserves Program. Funding to support PSI monitoring and involvement in PCRG during 2019 and 2020 was provided by Squaxin Island Tribe, educational resources and curriculum design supported by the Keta Legacy Foundation.

Learning Standards (NGSS)

MS-LS2-1 Ecosystems: Interactions, Energy and Dynamics

- *Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.*
- ***Disciplinary Core Ideas:*** *Interdependent relationships in ecosystems (LS2.A)*

MS-ESS3 Earth and Human Activity

- *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment (ESS3-3).*
- ***Disciplinary Core Ideas:*** *Natural Resources (ESS3.A), Human Impacts on Earth Systems (ESS3.C), Global Climate Change (ESS3.D)*

Figure 1. Light traps are deployed April-September sound-wide to monitor larval Dungeness crab called megalopae (top left, Photo: Jamestown S'Klallam). Biologists, Margaret Homerding (Nisqually Indian Tribe), Katie Houle (PSI) and Jamie Kilgo (DNR Aquatic Reserves Program) check the trap at Zittel's marina, South Puget Sound, Washington in 2019. Photo: Debbie Preston

Summary & Learning Outcomes

Students will learn how to graph, analyze and interpret data from two datasets (Tasks 1 & 2), complete discussion questions and think critically about solutions to a current natural resource issue (Task 3); maintaining healthy Dungeness crab populations for a thriving recreational, commercial and tribal fishery in Washington State.

- Task 1: Students will work through the process of creating their own graph of larval Dungeness (megalopae) crab counts and daily mean water temperature (°C) through time for the 2020 season. Students will interpret provided graphs and compare with their graphed 2020 data to answer discussion questions.
- Task 2: In the second activity, students will calculate average carapace size (mm) of Dungeness megalopae using size metric data from 2019 and 2020. The difference in carapace size and percent change will be calculated to compare between the two years.
- Task 3: Students will review a recent article by WDFW about the management of the South Puget Sound Dungeness crab population and possible factors affecting survival. As a group, students will discuss what they learned, what interested them the most and key take home messages about Dungeness crab in Puget Sound.

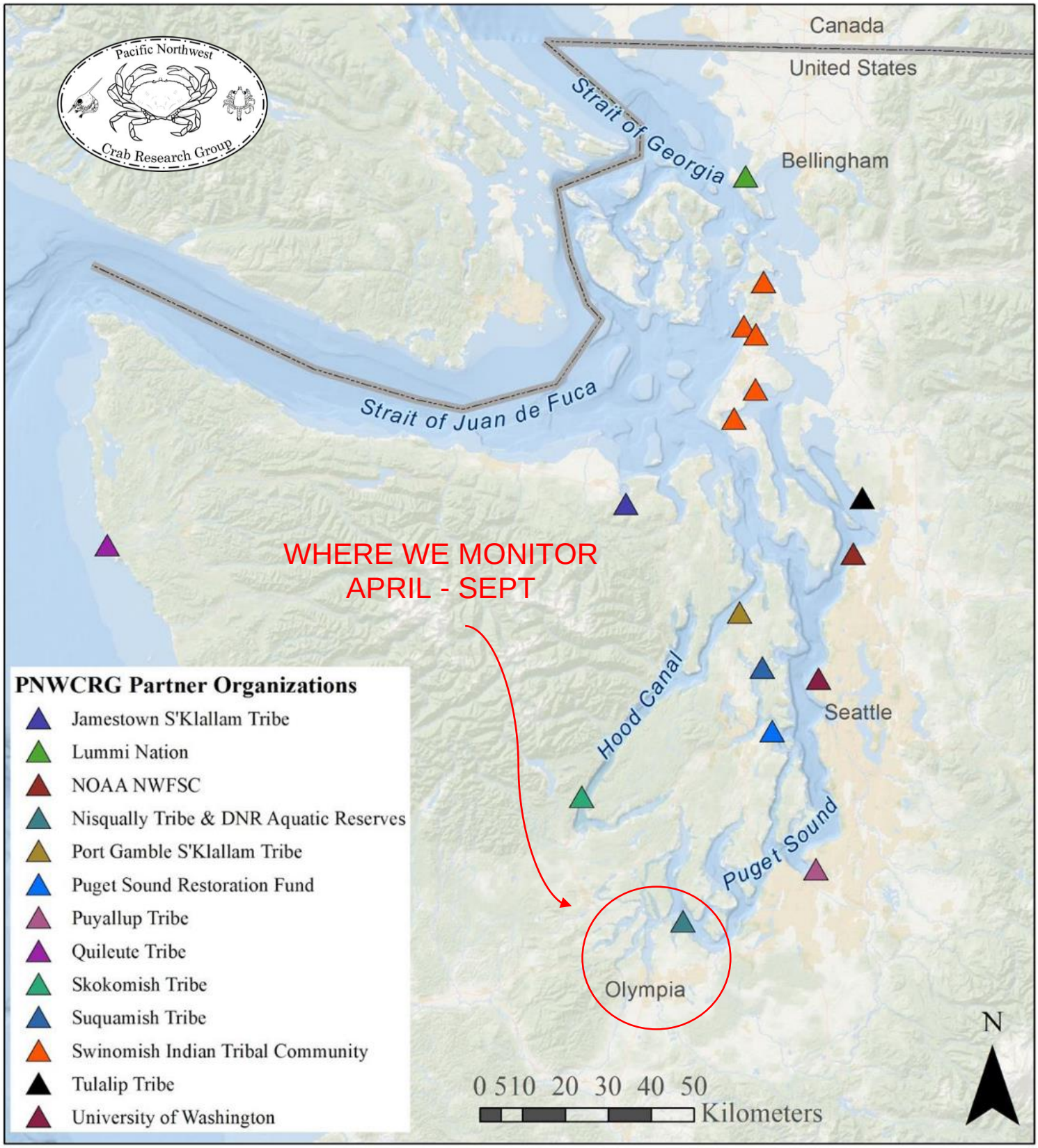

Figure 2. Light trap locations of the Pacific Northwest Crab Research Group larval Dungeness crab study. We are located at the southern most site at Zittel's marina in Nisqually Reach, South Puget Sound. Map courtesy of PCRG.

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A Step-by-Step Guide to Collecting Light Trap Data:

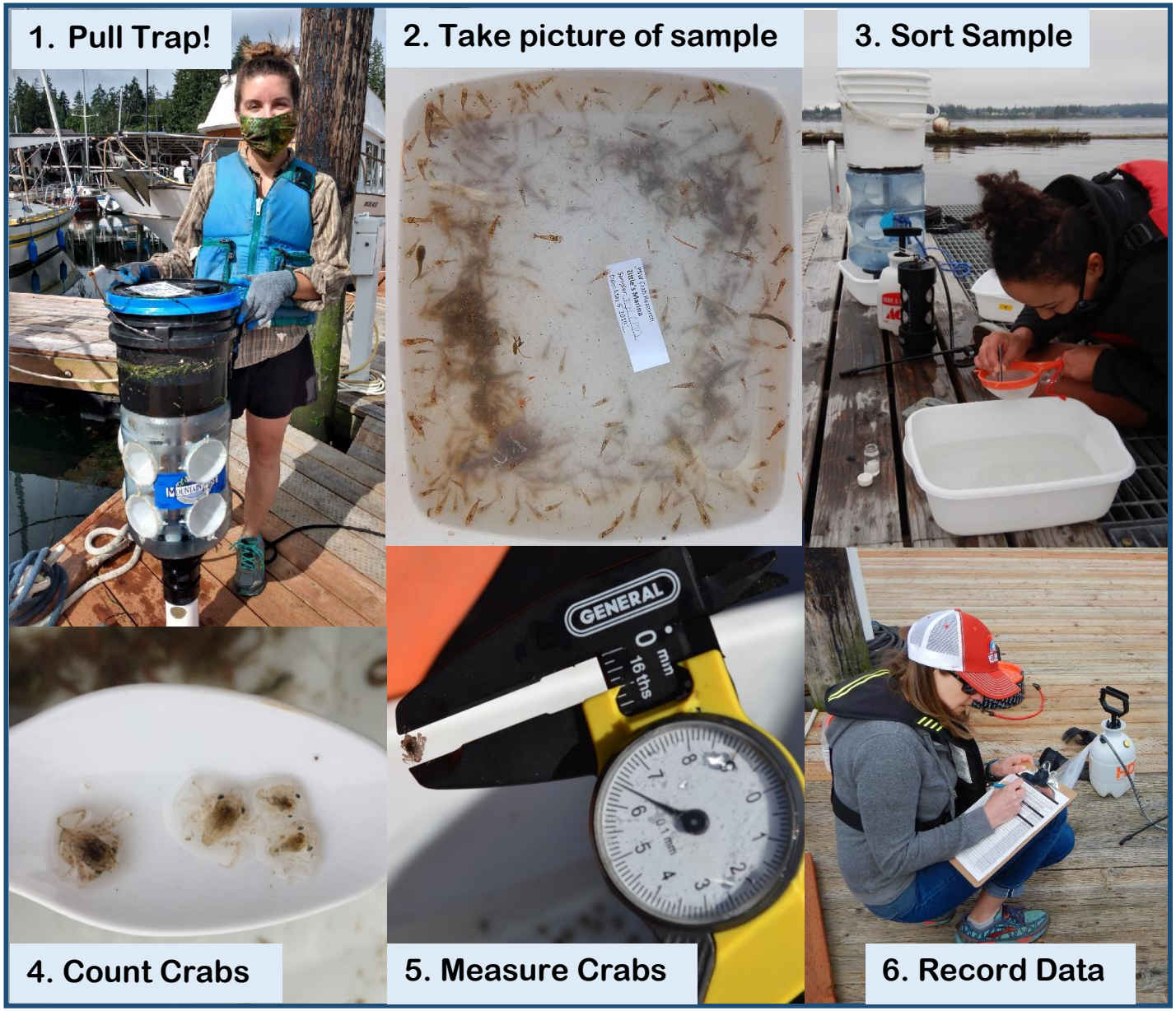

Figure 3. The light trap is fished for two nights. When the trap is pulled up (1), the sample concentrates down at the cod end of the trap. The cod end has fine mesh that captures small organisms, but lets the water drain through. The sample is then transferred to a bin and photographed (2), passed through a series of sieves to collect the tiny crab megalopae (3), removed with tweezers for enumeration (4) and measuring (5). All data of Dungeness counts, size and other species in the sample are recorded (6). Our site has a continuous device that records temperature at the light trap entrance every 30 minutes. At the end of the season it is removed and data is uploaded to a computer. Photos clockwise: Katie Houle (PSI), Rachel Hardin (PSI), bottom left Dungeness megalopae (Swinomish Tribe), Jamie Kilgo (WDNR).

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Task 1: Larval Dungeness Crab Counts and Water Temperature Data

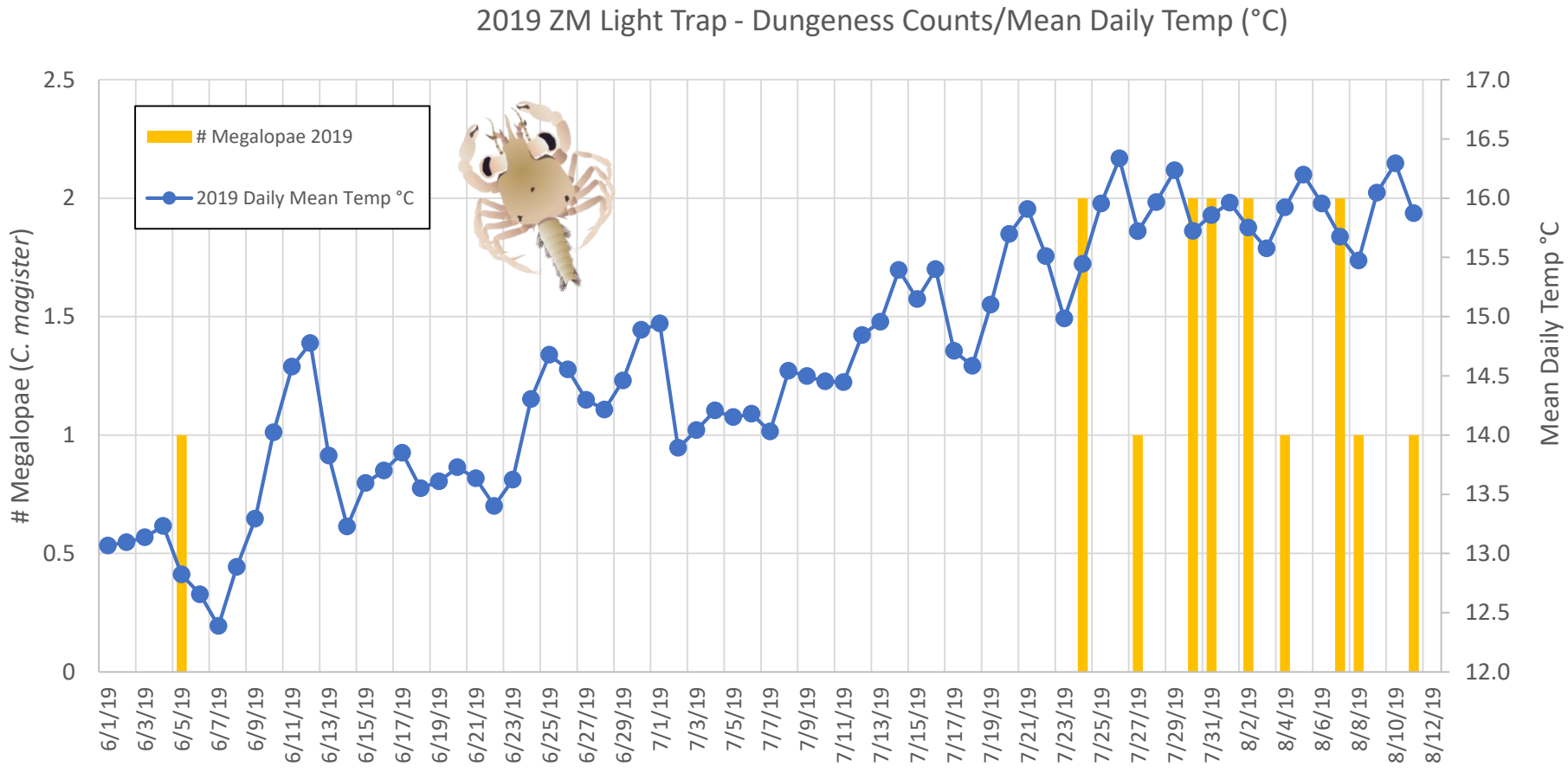

Figure 4. Larval Dungeness counts and mean daily water temperature (°C) from the Zittel's marina light trap 2019 season.

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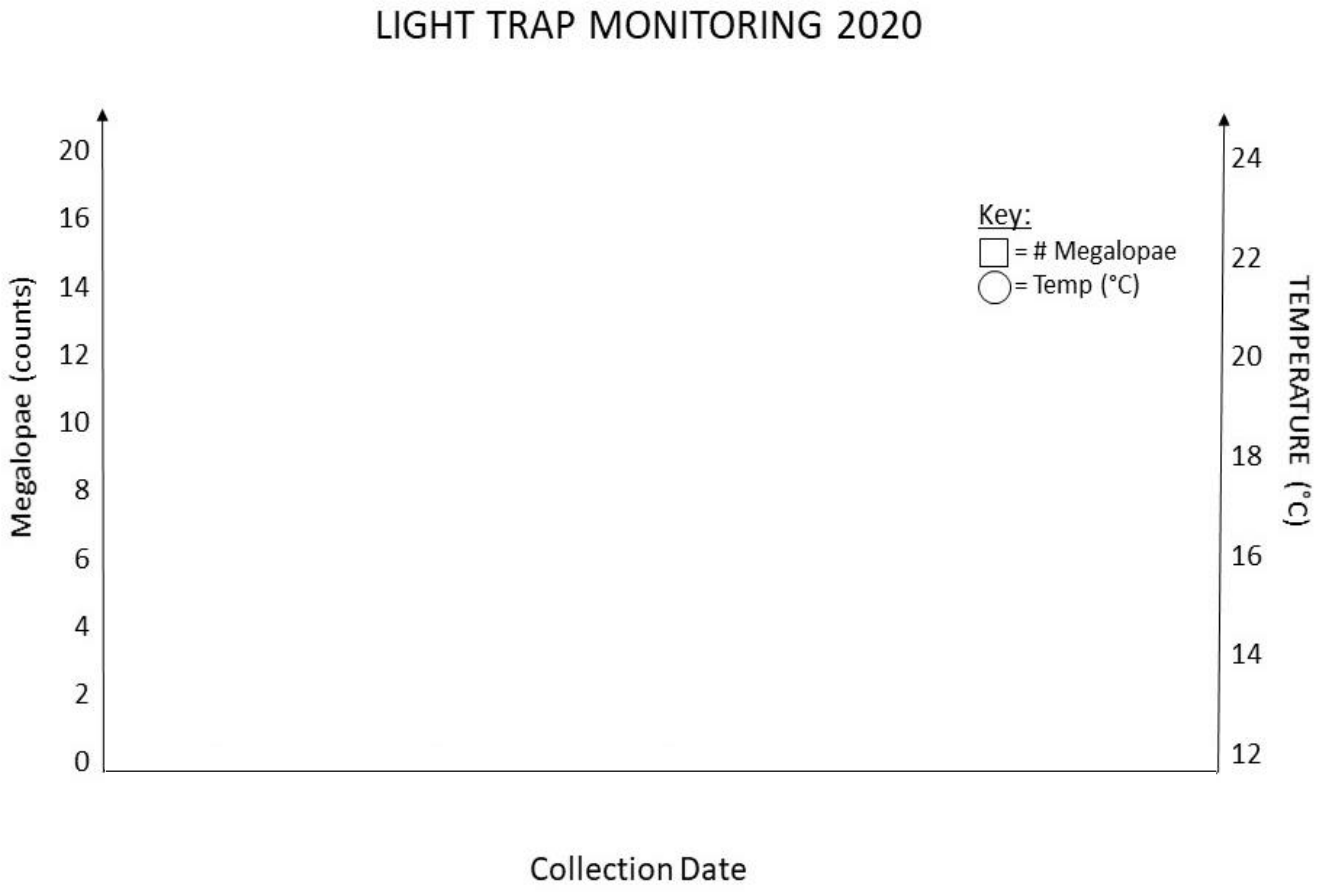
Task 1: Larval Dungeness Crab Counts and Water Temperature Data

Supplies: Graph paper, pencil, ruler

Data Table:

Date	Daily Mean Temp °C	# Megalopae
6/6/20	12.3	0
6/7/20	12.2	0
6/8/20	12.2	0
6/9/20	12.2	0
6/10/20	12.8	0
6/11/20	13.1	0
6/12/20	12.7	5
6/13/20	12.7	0
6/14/20	12.6	0
6/15/20	12.7	6
6/16/20	13.4	0
6/17/20	14.0	10
6/18/20	14.4	0
6/19/20	14.2	8
6/20/20	13.8	1
6/21/20	13.3	0
6/22/20	13.7	15
6/23/20	14.1	0
6/24/20	14.1	0
6/25/20	14.1	0
6/26/20	14.4	2
6/27/20	13.7	0
6/28/20	13.9	0
6/29/20	13.6	0
6/30/20	13.5	0

Graph Template an example of how the graph will be set up with data on each y-axis: megalopae counts and water temperature. Collection date is on the x-axis. Use solid bars to represent # of megalopae and circles to represent mean daily water temperature. Plot the data in the **Data Table** to your left on your graph paper using a ruler and pencil.



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Task 1: Larval Dungeness Crab Counts and Water Temperature Data

Interpreting Your Data:

Year	Deployed	Date Pulled	Date First Megalopae	Date Last Megalopae	Max Daily Count	Total # Megalopae	Water Temp Range (°C)	Max Daily Temp (°C)	Date of Max Daily Temp (°C)
2019	4/24/2019	8/25/2019	6/5/2019	8/11/2019	2	15	12.4-16.3	16.3	7/24
2020	5/15/2020	9/30/2020	6/12/2020	6/26/2020	15	47	12.2-14.4	14.4	6/18, 6/26

- *Please record your answers to the questions below in the table above.*

1. When was the first and last Dungeness megalopae caught in 2019, in 2020?
2. What was the maximum number of megalopae caught on a single day in 2019, in 2020?
3. What is the total number of megalopae caught in 2019, in 2020?
4. What was the temperature range when the light trap was catching Dungeness megalopae in 2019, in 2020?
5. What was the maximum daily temperature during the sample period in 2019? In 2020? On what day(s) did this occur?

Discussion Questions:

1. Referring to your completed table and graphs, what observations can you make about the two seasons? Are there any similarities? How are they different? If you were monitoring next season, would you do anything differently? In addition to water temperature, would you measure any other variables? Is there any other information that would be helpful to know? First catch dates similar, early June. In 2019, megalopae were caught over a longer duration compared to 2020, however nearly 3x the number of megalopae were caught in 2020 within a 2-week window.

Interpreting Data Map - PCRG 2019 Peak Abundance (Figure 5)

1. How does our South Sound site compare to the other PCRG light trap sites? Low counts, late season peak abundance, no spring cohort
2. What sites receive peak larval abundance in the spring before we see our first megalopae in June? Refer to Figure 2 for site names. Swinomish and Jamestown
    a. What part of Puget Sound are they located? North Puget Sound & Sequim Bay
    b. How are these locations different from the South Sound site? Closer to Strait of Juan de Fuca, larvae from coastal populations
3. What inferences can we make about South Sound larval crab populations based on this information? What about adult crabs? Do we need more information?

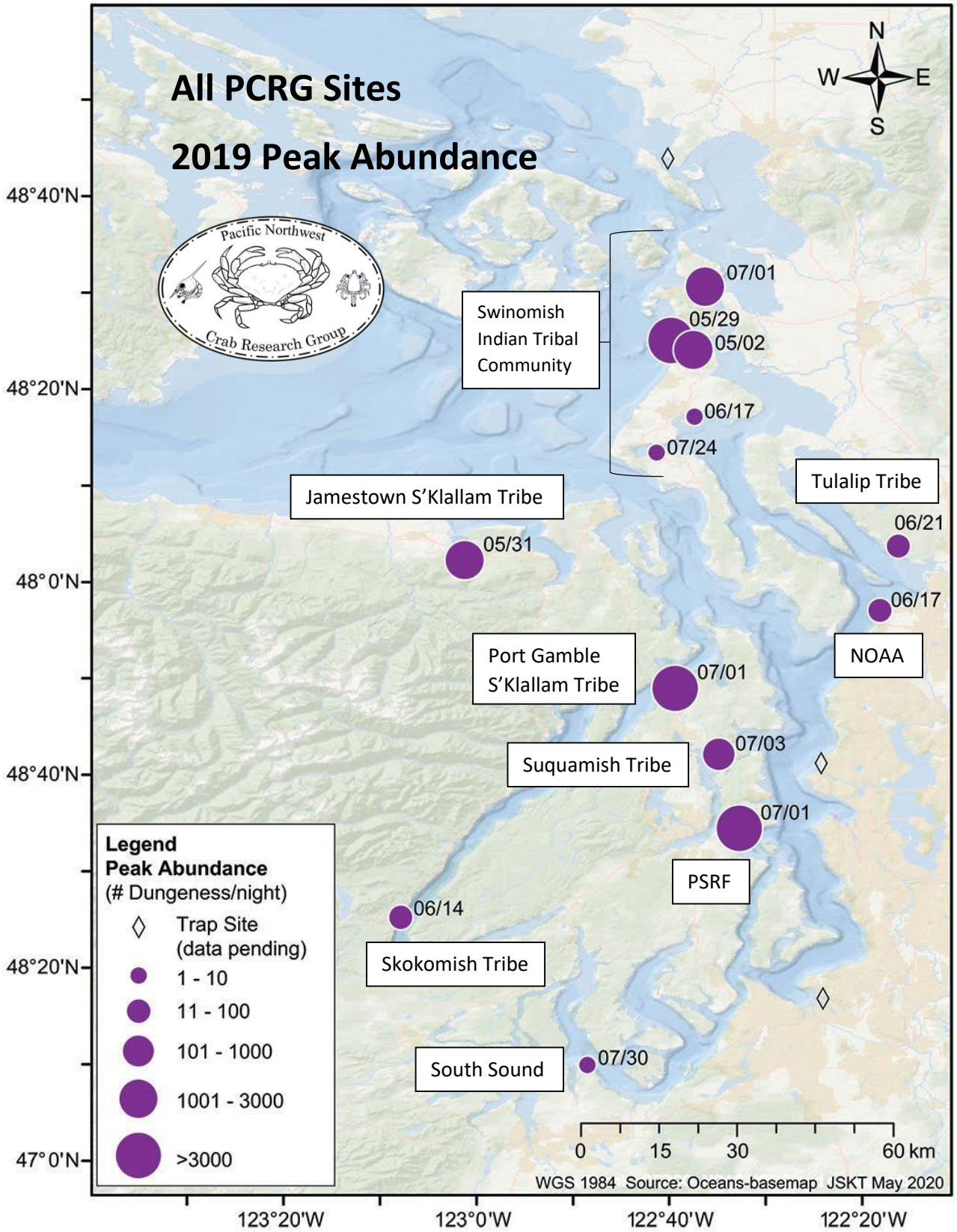

Figure 5. Dates of peak larval Dungeness crab catches for the PCRG 2019 pilot season of light trap monitoring. Data and map courtesy of PCRG.

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Task 2: Calculating Larval Dungeness Carapace Size

Supplies: Notebook, pencil, calculator

How to Measure a Dungeness Crab Megalopae:

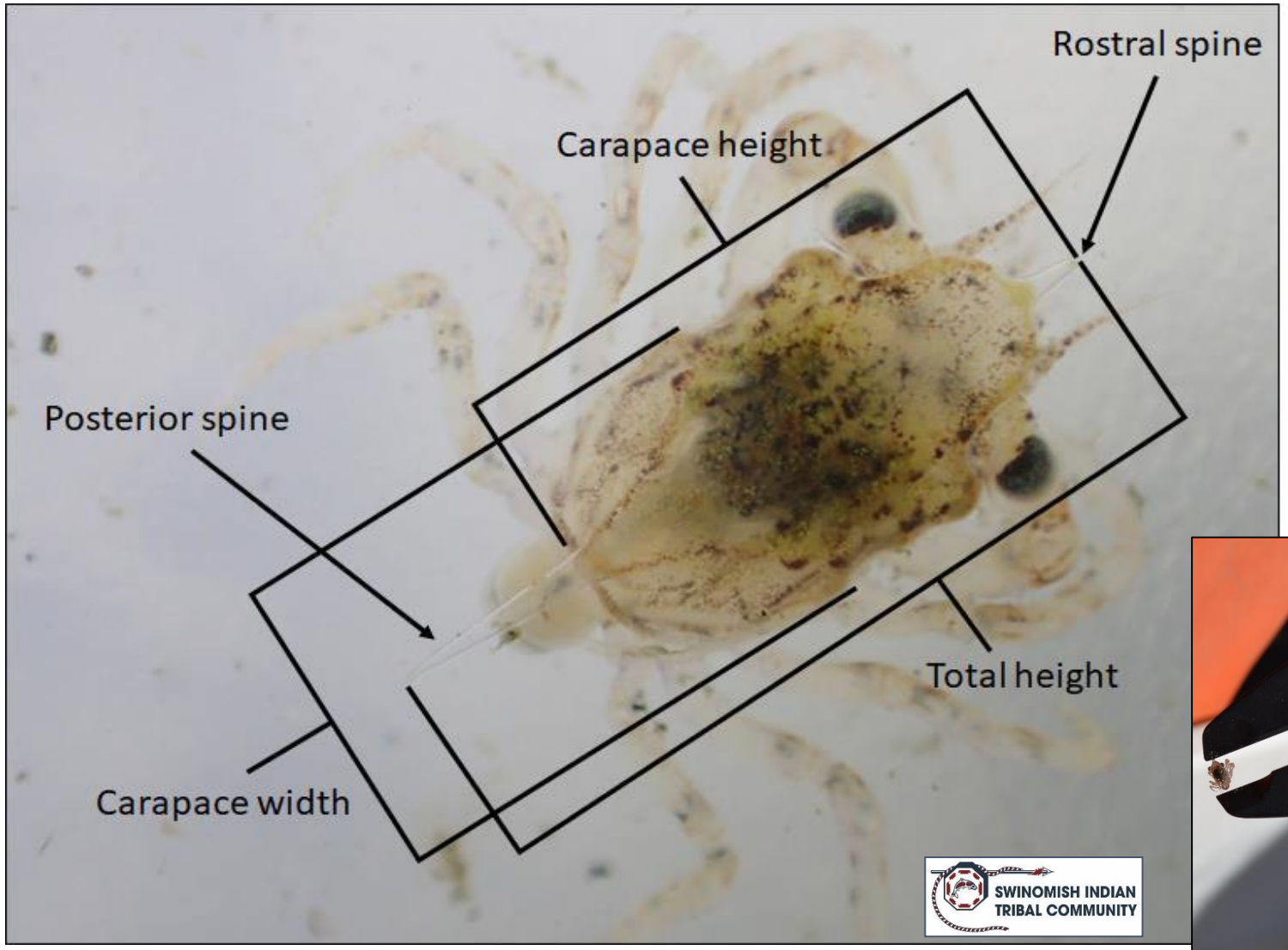
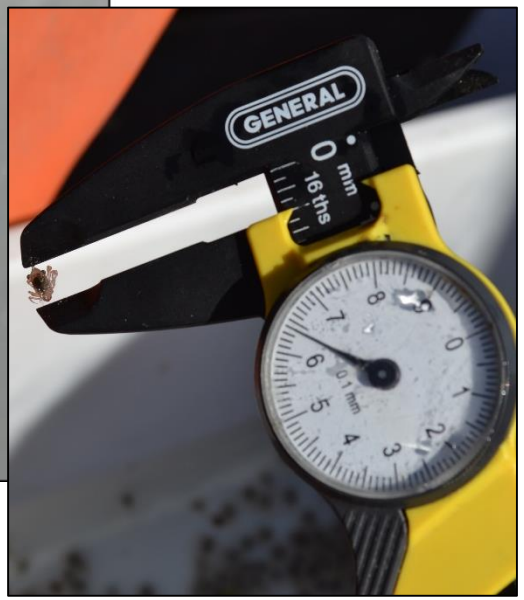


Figure 6. Measurement locations for carapace width, carapace height, and total height on Dungeness megalopae to nearest 0.1mm. Each week a subset of 30 megalopae are measured at each site. Methods standardized for PCRG (SITC 2020). Megalopae carapace width and height are used to differentiate between early and late cohorts (Dinnel *et al.* 1993). Photos: SITC



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Task 2: Calculating Larval Dungeness Carapace Size

Supplies: Notebook, pencil, calculator

Data Tables 2019 & 2020:

#	Date	CW	CH	TH
	M/D/YYYY	Carapace Width (mm)	Carapace Height (mm)	Total Height (mm)
1	6/5/2019	3.9	5.2	6.8
2	7/24/2019	2.5	4.7	6.2
3	7/24/2019	2.7	4.8	6.5
4	7/27/2019	2.7	5.8	6.8
5	7/30/2019	3.8	5.0	6.6
6	7/30/2019	4.0	6.6	7.2
7	7/31/2019	2.6	4.1	6.6
8	7/31/2019	3.1	4.8	7.2
9	8/2/2019	2.9	4.9	6.3
10	8/2/2019	2.7	5.2	6.6
11	8/4/2019	2.8	5.0	6.7
12	8/7/2019	2.7	5.0	6.3
13	8/7/2019	2.7	5.0	6.3
14	8/8/2019	3.1	4.8	6.8
15	8/11/2019	2.5	5.0	6.1
	Means	**2.98**	**5.06**	**6.6**

#	Date	CW	CH	TH
	M/D/YYYY	Carapace Width (mm)	Carapace Height (mm)	Total Height (mm)
1	6/12/2020	4.3	6.6	7.9
2	6/12/2020	4.2	6.1	7.5
3	6/12/2020	4	5.2	7.1
4	6/19/2020	4.4	6.8	7.5
5	6/19/2020	3.7	6.4	7.3
6	6/19/2020	3.4	5.8	7.2
7	6/22/2020	3.4	6.2	7.1
8	6/22/2020	3.2	5.8	6.5
9	6/22/2020	3.4	7.5	6.4
10	6/22/2020	3.3	5.7	6.8
11	6/22/2020	4	6.4	7.8
12	6/22/2020	3.1	6.0	7
13	6/22/2020	3.1	5.5	6.7
14	6/22/2020	3.3	6.2	7.1
15	6/22/2020	3.4	5.1	6.6
	Mean	**3.6**	**6.1**	**7.1**

Show Your Work Below:

$$\frac{\text{SUM OF ALL \#s}}{\text{TOTAL \# OF DATA PTS}} = \text{MEAN VALUE}$$

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Task 2: Calculating Larval Dungeness Carapace Size

Calculate the Mean Differences:

Year	Total Counts	n=	CW (mm)	CH (mm)	TH (mm)
2019	15	15	2.98	5.06	6.6
2020	47	15	3.6	6.1	7.1
Mean Difference			**0.62**	**1.04**	**0.5**
Percent (%) Change			**+17%**	**+17%**	**+7%**

EQUATIONS:

Mean 2020 – Mean 2019 = **Mean Difference**

$$\frac{\text{Mean Difference}}{\text{Mean 2020}} \times 100 = \textbf{Percent (\%) Change}$$

Show Your Work Below:

Interpreting Your Data:

1. Did megalopae size, across all metrics, increase or decrease from 2019 to 2020?
   Increased
   a. What was the (%) change of carapace width? Positive or negative change? +17% change
   b. What was the (%) change of total height in megalopae? +7% change
   c. What was the largest megalopae caught based on carapace width? 4.4mm On what date? 6/19/20
   d. What was the largest megalopae caught based on total height? 7.9mm On what date? 6/12/20

Discussion Questions:

1. Based on our limited dataset, what can we infer about larval Dungeness populations? Is the larval pool growing or shrinking? Based on what evidence thus far? Growing: seasonal counts and increasing size class data
2. What factors might influence mean size class differences between the two years? Genetics of adult populations, environmental stressors (water temp, DO, low pH), predation pressure, etc.
3. Do you think size class data from 15 megalopae is sufficient to determine larval health? Is data from one location a sufficient indicator of the larger, South Sound region? A larger dataset would give a more accurate depiction of larval population health, n=15 is a small sample size from any year. Sampling from multiple locations in our region could provide more information about early life stages of Dungeness crab in South Sound. It's possible that Zittel's marina is not truly representative of the larval population.
4. If you were to collect data next season, would you make any modifications to the sampling plan?

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Task 3: Management of South Puget Sound Dungeness Crab Populations

Review Article:

The following article, **"WDFW works to manage and restore Dungeness crab in Washington waters"** was written by WDFW on March 11, 2020. Access the full article here: (pdf version)

Follow up Questions:

1. What year was the South Puget Sound Dungeness crab fishery closed? 2018
2. Is overharvesting the primary factor in the decline of Dungeness crab? No
3. Besides WDFW, who co-manages the Dungeness crab fishery? Treaty Tribes
4. What strategies do shellfish biologists use to manage the Dungeness crab fishery? Describe at least one in detail as discussed in this article. Fishing closures, test fishing, Size-Sex-Season, environmental/water quality monitoring
5. What factors do WDFW biologists suggest may be responsible for the most recent decline in crab numbers? Multiple factors, including changing ocean conditions – warming surface waters, ocean acidification, pollutant levels and hypoxia
6. Did the South Sound Dungeness crab fishery open in 2020? Does our light trap data from 2019 and 2020 provide supporting evidence for this decision? Why or why not?

Group Discussion Questions:

1. If you were light trap monitoring next season would you do anything differently?
2. In addition to water temperature, would you measure any other water quality variables?
3. Is there any other information you'd like to collect that would help us learn more about Dungeness crab?
4. What did you find most interesting about this lesson and research?

Figure 7. Shellfish biologists work together to manage Puget Sound Dungeness crab fishery for recreational, commercial and tribal harvests. Photos (top) WDFW, (bottom) Nisqually Tribe biologists.