

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

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

Introduction

Recent declines in adult Dungeness crab populations throughout Puget Sound prompted the formation of the Pacific Crab Research Group (PCRG) in late 2018, led by treaty tribes and supported by state and federal agency biologists, university scientists and non-profit organizations to provide science-based information for adaptive planning and management of this species in the face of climate change. Pacific Shellfish Institute supports the South Sound sampling team at Nisqually Reach in its weekly light trapping efforts for larval Dungeness crab from April – September each year (Fig. 1). Impacts of climate change, including warming temperatures and low pH, are among the stressors reducing the survival of juvenile Dungeness crab that are very vulnerable to changing ocean conditions. Reduced survival of juvenile crab in a single year has a direct effect on the number of healthy adult Dungeness crab in the following years. Dungeness crab are considered a key stone species, critical for the health and function of the Puget Sound ecosystem. The Dungeness crab fishery in Washington is valued at \$12.5M: an essential commercial, recreational and tribal shellfishery for the overall health, wellbeing and resilience of our local communities. This important shellfishery is co-managed by Washington state treaty tribes and state biologists. These experts determine each year where, when and to what extent crab can be fished in Puget Sound. By collaboratively monitoring this species, shellfish managers will be able to ensure we get to keep fishing and eating tasty Dungeness crab for many years to come!



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

Student Activities

You 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:** You will familiarize yourself with field collected data of larval Dungeness (megalopae) crab counts and daily mean water temperature (°C) through time for the 2019 and 2020 season. You will interpret provided graphs and answer discussion questions.
- **Task 2:** In the second activity, you will calculate average carapace or shell size 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:** You will review a recent article by WDFW about the management of the South Puget Sound Dungeness crab population and possible factors affecting survival. Apply information learned to answer follow up questions. If you were on the research team, what additional information would you like to know? How would we measure that? Bring your ideas for a final discussion with the group to wrap up what you’ve all learned!



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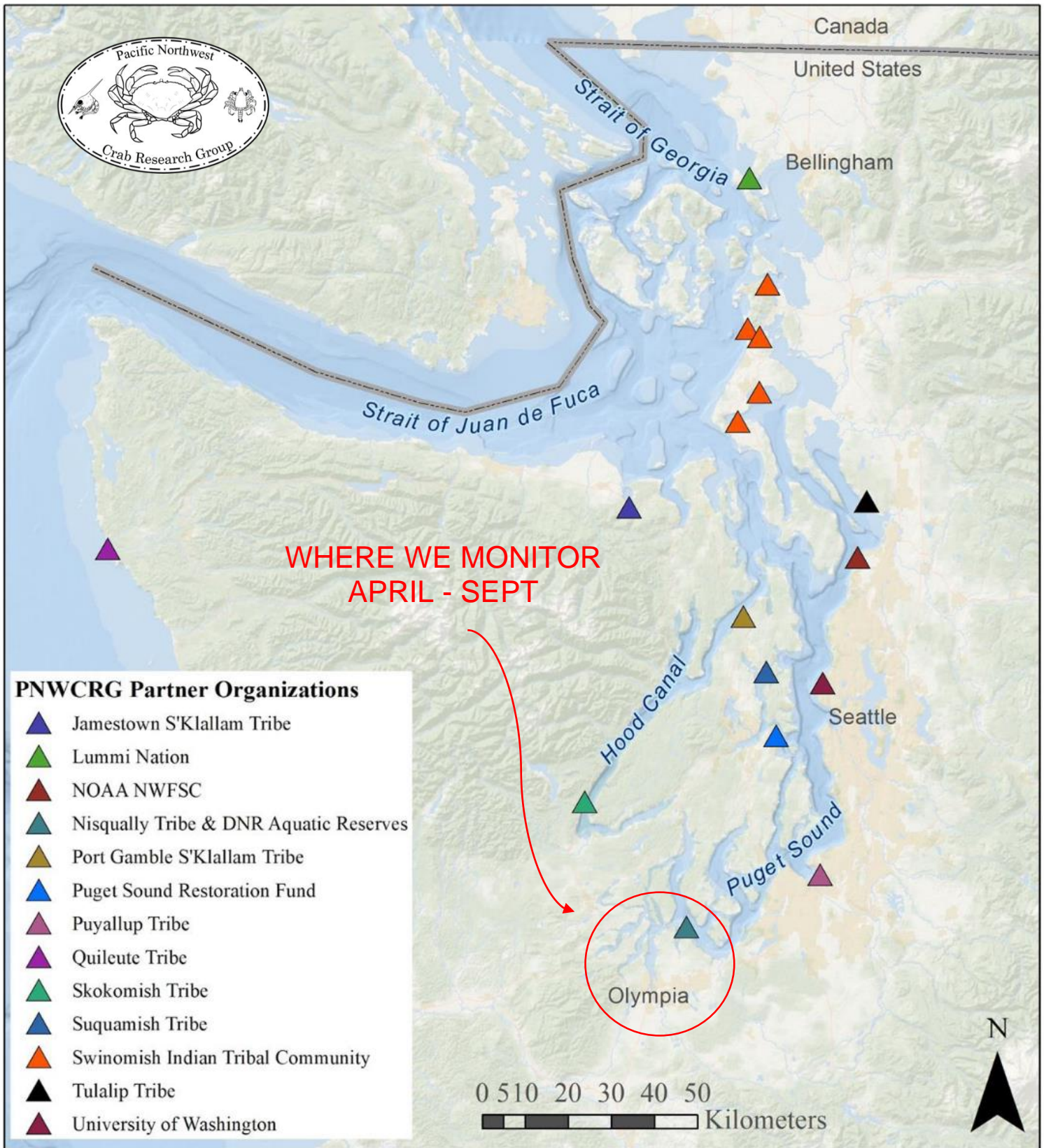


Figure 2. Light trap locations of the Pacific Northwest Crab Research Group larval Dungeness crab study. We are located at the southern most site at Zittel's marina in Nisqually Reach, South Puget Sound. Map courtesy of PCRG.



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

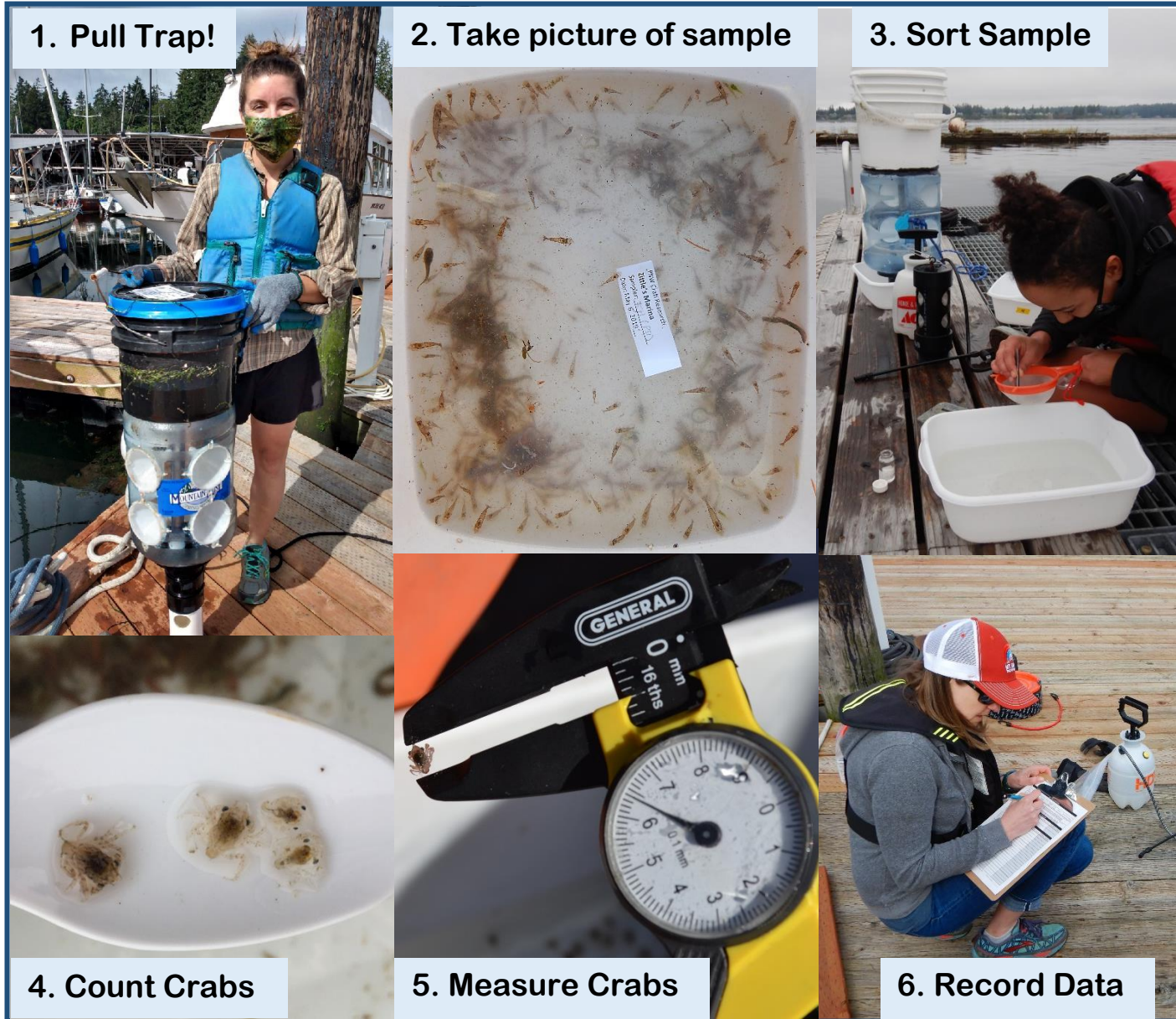


Figure 3. The light trap is fished for two nights. When the trap is pulled up (1), the sample concentrates down at the cod end of the trap. The cod end has fine mesh that captures small organisms, but lets the water drain through. The sample is then transferred to a bin and photographed (2), passed through 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

2019 ZM Light Trap - Dungeness Megalopae Counts/Mean Daily Temp (°C)

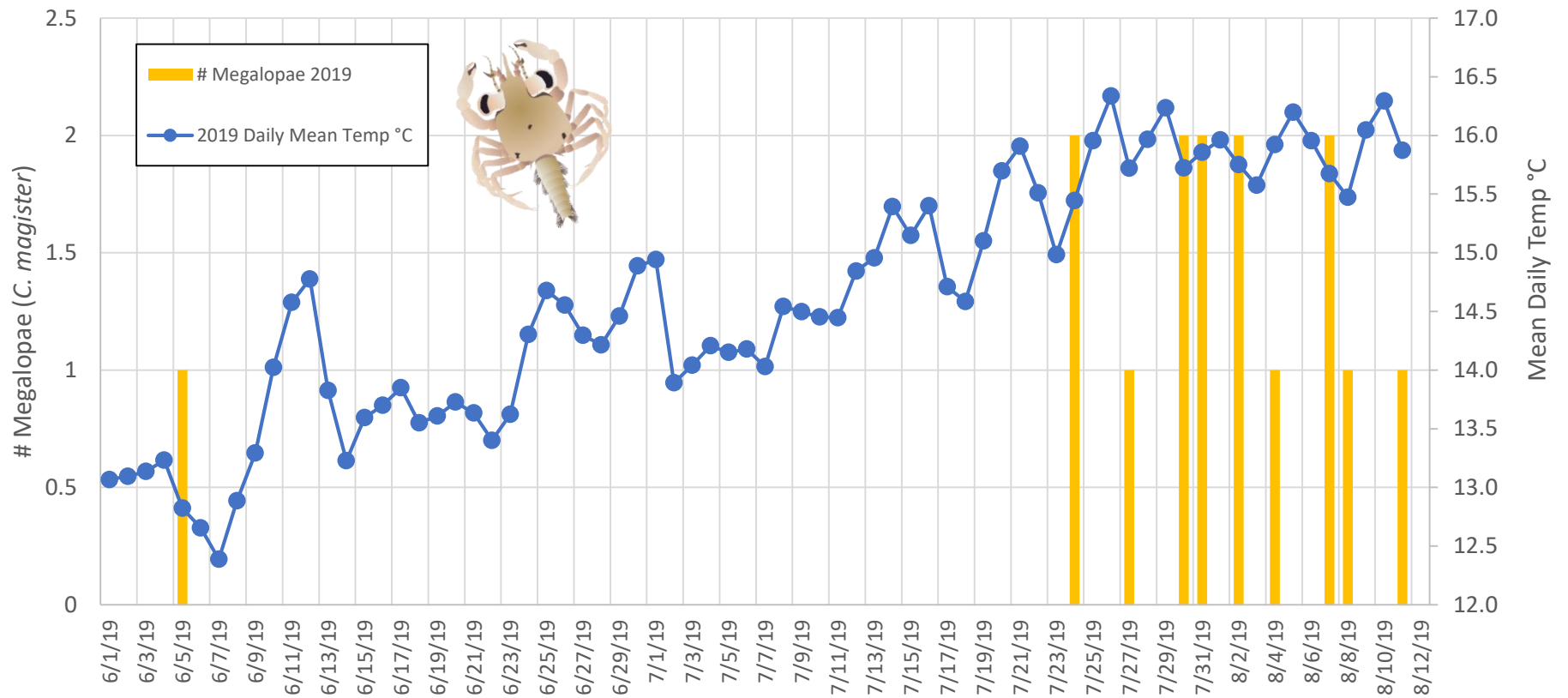


Figure 4. Larval Dungeness counts and mean daily water temperature (°C) from the Zittel’s marina light trap 2019 season.



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Task 1: Larval Dungeness Crab Counts and Water Temperature Data

2020 ZM Light Trap - Dungeness Megalopae Counts/Mean Daily Temp (°C)

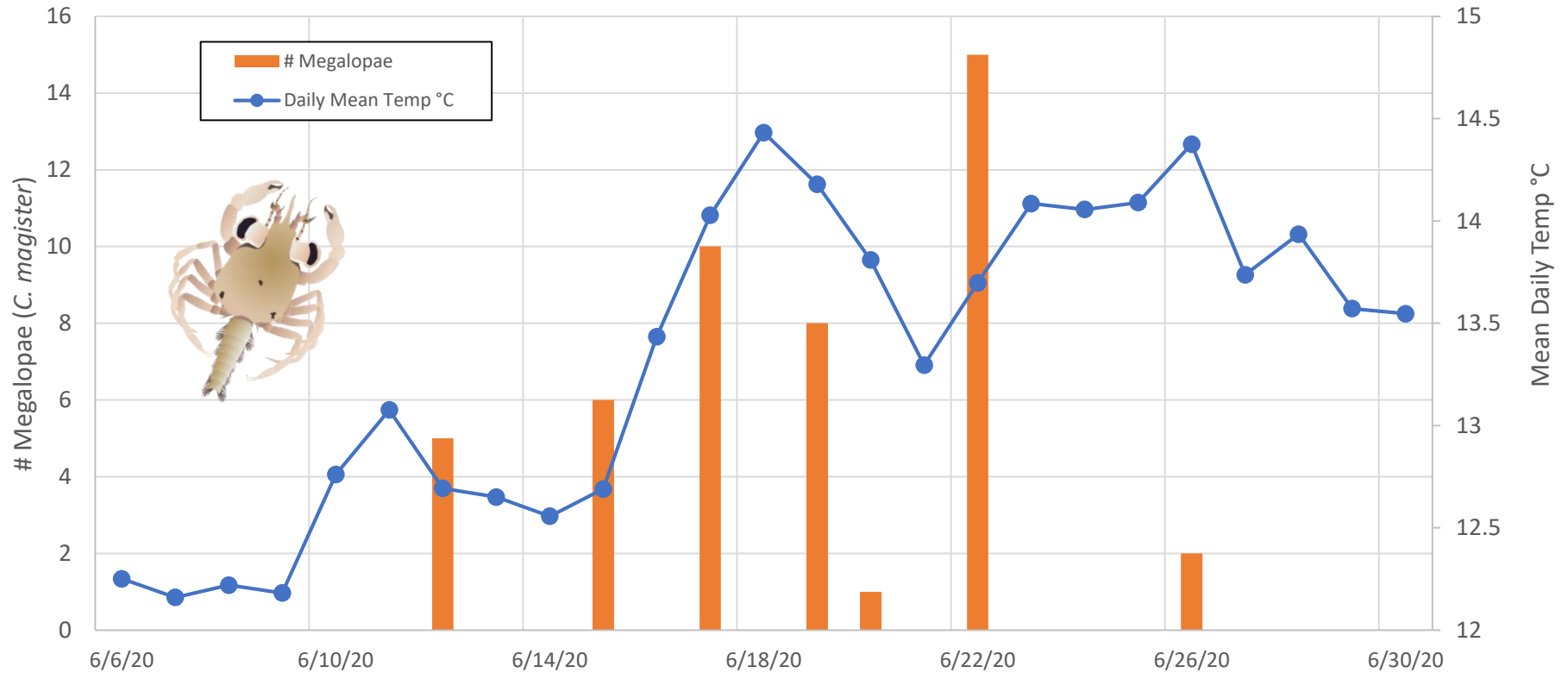


Figure 5. Larval Dungeness counts and mean daily water temperature (°C) from the Zittel’s marina light trap 2020 season.



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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							
2020	5/15/2020	9/30/2020							

➤ 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? _____

Interpreting Data Map - PCRG 2019 Peak Abundance (Figure 6)

1. How does our South Sound site compare to the other PCRG light trap sites? _____
2. What sites receive peak larval abundance in the spring before we see our first megalopae in June? _____
 - a. What part of Puget Sound are they located? _____
 - b. How are these locations different from the South Sound site? _____
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? _____



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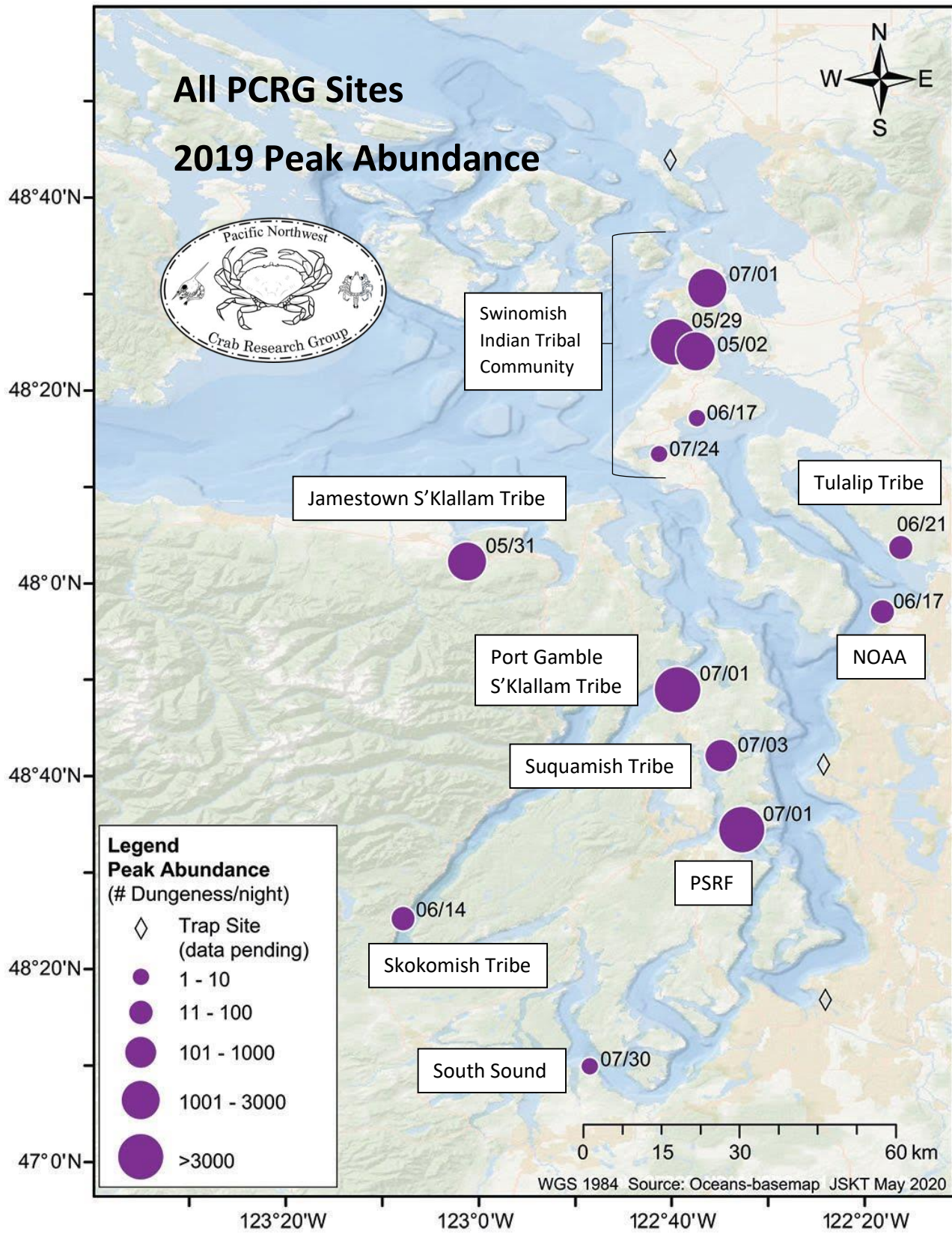


Figure 6. Dates of peak larval Dungeness crab catches for the PCRG 2019 pilot season of light trap monitoring. Data and map courtesy of PCRG.

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Task 2: Calculating Larval Dungeness Carapace Size

Supplies: Notebook, pencil, calculator

How to Measure a Dungeness Crab Megalopae:

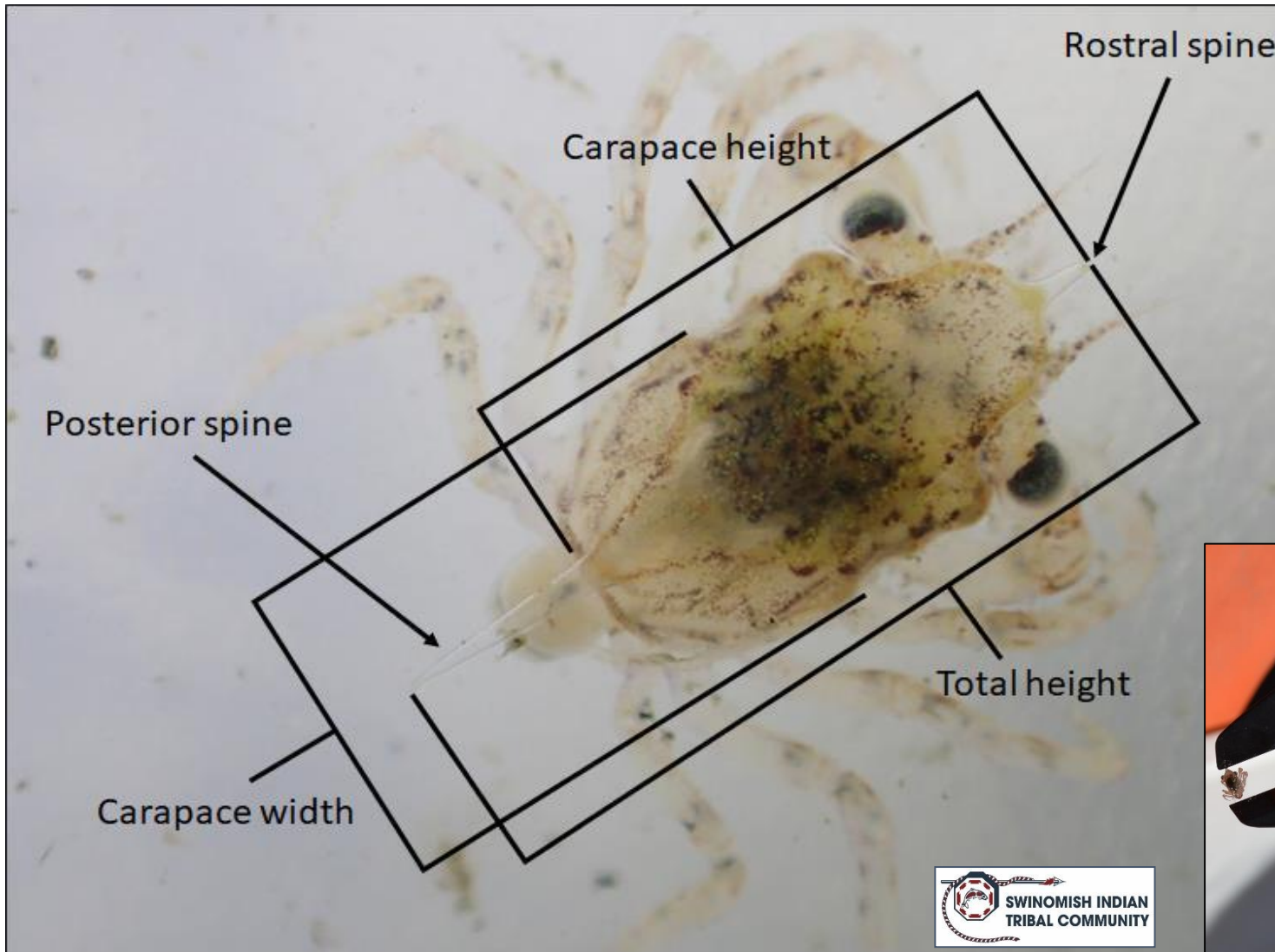
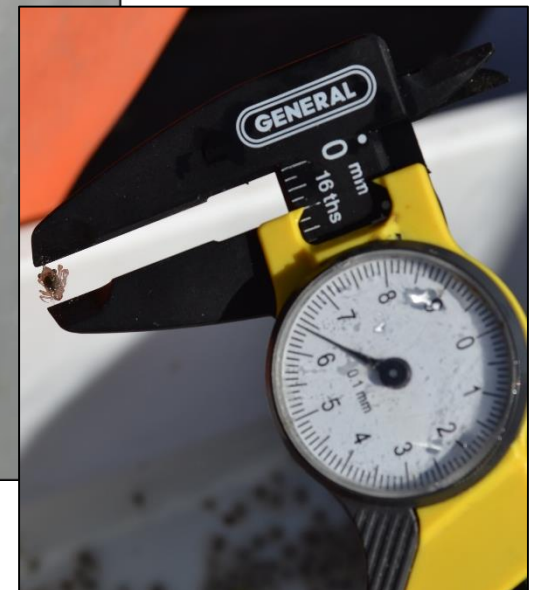


Figure 7. Measurement locations for carapace width, carapace height, and total height on Dungeness megalopae to nearest 0.1mm. Each week a subset of 30 megalopae are measured at each site. Methods standardized for PCRG (SITC 2020). Megalopae carapace width and height are used to differentiate between 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:

Show Your Work Below:

#	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			

#	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			

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



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Task 2: Calculating Larval Dungeness Carapace Size

Calculate the Mean Differences:

Show Your Work Below:

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					
Percent (%) Change					

EQUATIONS:

$$\text{Mean 2020} - \text{Mean 2019} = \text{Mean Difference}$$

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

Interpreting Your Data:

1. Did megalopae size, across all metrics, increase or decrease from 2019 to 2020? _____
 - a. What was the (%) change of carapace width? Positive or negative change? _____
 - b. What was the (%) change of total height in megalopae? _____
 - c. What was the largest megalopae caught based on carapace width? _____ On what date? _____
 - d. What was the largest megalopae caught based on total height? _____ On what date? _____

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?

2. What factors might influence mean size class differences between the two years?

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? _____

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 full article here: ([pdf version](#))

Follow up Questions:

1. What year was the South Puget Sound Dungeness crab fishery closed? _____
2. Is overharvesting the primary factor in the decline of Dungeness crab? _____
3. Besides WDFW, who co-manages the Dungeness crab fishery? _____
4. What strategies do shellfish biologists use to manage the Dungeness crab fishery? Describe at least one in detail as discussed in this article. _____

5. What factors do WDFW biologists suggest may be responsible for the most recent decline in crab numbers? _____

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?



Photo: WDFW

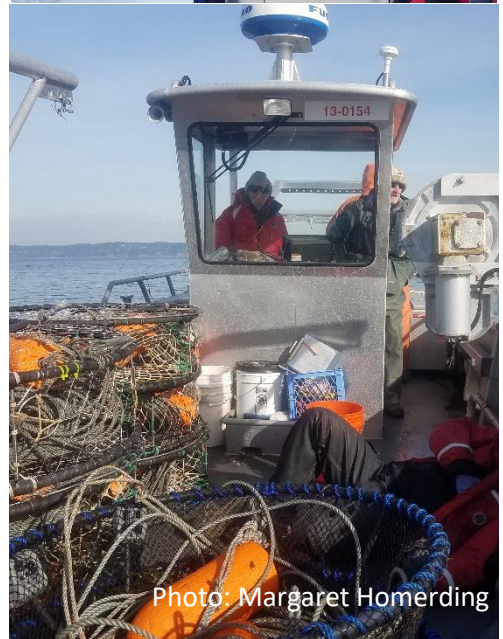


Photo: Margaret Homerding

Figure 8. Shellfish biologists work together to manage Puget Sound Dungeness crab fishery for recreational, commercial and tribal harvests. Photos (top) WDFW, (bottom) Nisqually Tribe biologists.

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