MONITORING FOR INVASIVE CRAB IN PADILLA BAY, SKAGIT COUNTY, WASHINGTON, IN 2011

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TABLE OF CONTENTS

INTRODUCTION

Non-native species arrive in the Pacific Northwest by various vectors: aquaculture, aquarium trade, biological control, channels/canals/locks, live bait, nursery industry, scientific research, schools, ships and boats, recreational fisheries enhancement, restaurants/seafood retail/processing (Washington Sea Grant, 1998). Not all non-native species are invasive, but the ones that are may have huge impacts on ecosystems and local economies (Ray, 2005).

Padilla Bay NERR has a number of invasive marine species and this list may not be inclusive (see Table 1). Some of these were introduced with oyster culture before shell was certified and some were introduced later (Ray, 2005). We have a native bamboo worm (*Axiothella rubrocincta*) in Padilla Bay but a similar non-native bamboo worm (*Clymenella torquata*) has been observed in Samish Bay just to the north. Others, like the Purple Varnish Clam, *Nuttallia obscurata*, are more recent arrivals. *Nuttallia* probably arrived in ballast water in British Columbia and has since moved down the coast.

Padilla Bay NERR has been monitoring certain invasive species for a number of years. We have monitored the shorelines for *Spartina* species since 1987 and have controlled *Spartina* since 1996. We participated in a monitoring effort from 2001 – 2007 for European green crab (*Carcinus maenas*) funded by Washington Department of Fish & Wildlife (WDFW) and coordinated by Nahkeeta Northwest (a local consulting firm). Even though green crab are making their way up the outer coast of Washington State and have been noted on the west coast of Vancouver Island, the inland waters are still free of green crab.

In an effort to expand the program to include more marine invasive species than just green crab, the protocol was revised and the program was then called "Marine Invasive Species Monitoring" or MISM (Nahkeeta Northwest, 2008). It included 32 species (algae, emergent plants, seagrass, clams, crabs, snails, tunicates, etc.) and a number of ways to monitor: 1) strandline surveys, 2) shoreline grid, 3) green crab trapping, and 4) tunicate sampling. Volunteers were trained and then chose the method that best suited their skills or habitat.

In the past, we used minnow traps (n=3) at three sites in Padilla Bay (Sullivan Minor, Bay View State Park, and the mouth of Indian Slough) and recorded sex, carapace width and species of all grapsid crab by-catch. In six years of monitoring (2001-2007), we did not catch any European green crab.

Larval green crab (*C. maenas*) settle out in a variety of habitats including seagrass beds, filamentous algae, mussel beds, along *Spartina* banks, muddy areas next to dikes, and gravel in the upper intertidal zone (Yamada, 2001). First year green crab generally live in the intertidal zone. The next age group spends most of their time in the subtidal but forage in the intertidal. The oldest age groups live permanently in the subtidal (Yamada, 2001). Chinese mitten crab (*Eirocheir sinensis*) has not been noted on the Washington coast except for one unconfirmed sighting in the Columbia River, but could survive in estuaries. They live most of their lives in freshwater, returning to saltwater only to breed. Japanese shore crabs (*Hemigrapsus sanguineus*) have invaded some east coast estuaries, probably arriving via ballast water. They prefer rocky areas with cobble bottoms and low- to mid-tidal zones. So, there is a potential for invasive crabs to be introduced to--and gain a foothold in--Padilla Bay.

The MISM program lost its funding, but we chose to continue monitoring for invasive crab in Padilla Bay using WDFW's folding fish traps. Starting in 2008, we set traps at only one of the three sites we have used in the past and will rotate between sites each year (i.e. we will sample each site once in 3 years). In 2008 we set traps at Sullivan Minor, in 2009 at Bay View State Park, at the mouth of Indian Slough in 2010 and at Sullivan Minor again this year. Next year we will set traps at Bay View State Park.

MATERIALS AND METHODS

<u>Location</u>. Sullivan Minor is located about a half mile north of the Breazeale Interpretive Center, which is located at 10441 Bayview-Edison Road on the eastern shore of Padilla Bay in Skagit County (Fig. 1). This site was chosen because of its proximity to salt marsh and native shore crab habitat.

<u>Monitoring for Invasive Crab</u>. A checklist was developed to help prepare for trap deployment (Appendix A). The invasive crab monitoring protocol is included in Appendix B. In 2008, we deployed five folding fish traps (Fukui) once a month from

August - October and let them soak for a 24-hour cycle, using 2 chopped frozen herring per bait box. The traps were set parallel to the shoreline at a +5 tide, 25 m apart (see Fig. 2). In 2011, we sampled from May–September, using fish traps baited with 2 chopped frozen herring per bait box. We set the traps perpendicular to the shoreline at Sullivan Minor, each about 10 meters apart in the same area where we set traps from 2001-2007. The location of the traps as set this year is shown in Fig. 3. The data was recorded on field sheets (see Appendix C).

RESULTS

Trapping for Invasive Crab. The results are shown in Table 2. This shows species of crabs caught, male or female, and carapace widths for each month the traps were set. We did not trap any invasive crab this year. The scientific name for *Cancer magister* was changed to *Metacarcinus magister* and that change is reflected in this report.

Two species of native crab were found in the by-catch: *Hemigrapsus oregonensis* (107) and *Metacarcinus magister* (1). In addition, we caught snails (665 *Batillaria attramentaria and 166 Nassarius fraterculus*). Neither snail is native to the Pacific Northwest.

DISCUSSION

A comparison of data collected at the Sullivan Minor site over time is shown in Table 3. The data from 2001 - 2007 was obtained using 3 minnow traps, while the data collected in 2008 and 2011 was obtained using 5 folding fish traps. All traps were set in the same general location, although the arrangement of the traps was slightly different. The minnow traps were set 10 meters apart in a triangular set, while the folding fish traps were set 25 meters apart at a +5 tide parallel to the beach in 2008 and set 10 meters apart perpendicular to the beach in 2011 in the same location as the 2001-2007 sets. The reason we switched to folding fish traps is that they were made part of the MISM protocol.

The greatest numbers of male *H. oregonensis* were caught in 2007 (191) using minnow traps and in 2008 (545) using fish traps. The greatest numbers of female *H. oregonensis* were caught in 2004 (56) using minnow traps and in 2008 (43) using fish traps. Total numbers of *H. oregonensis* caught at this site vary over time and were as follows: 588 (2008), 289 (2004), 209 (2005), 200 (2007), 183 (2006), 162 (2003), 107 (2011), 73 (2002), 69 (2001). Total numbers peaked in 2004-2005 when using minnow traps. Total numbers were higher in 2008 than 2011 when using fish traps.

No *H. nudus* were caught from 2001-2007 using minnow traps at this site. Two male *H. nudus* were caught in 2008 using the fish traps. Generally, in our sampling at this site, fewer *H. nudus* are caught than *H. oregonensis* probably because *H. nudus* tend to live higher in the intertidal than the trap sets are located.

M. magister were only caught at this site in four of the nine years of trapping (2002, 2006, 2008, 2011). The greatest numbers of males were trapped in 2002 (15) using minnow traps. The greatest numbers of males were trapped in 2008 (102) using fish traps. No females were trapped with minnow traps and only one female was trapped in 2008 using fish traps. None were trapped in 2011.

We will continue to monitor for invasive crab. It is a low commitment of time, is a good project for interns and/or volunteers and yields some information on native crabs in addition to the primary purpose of monitoring for the arrival of invasive crabs.

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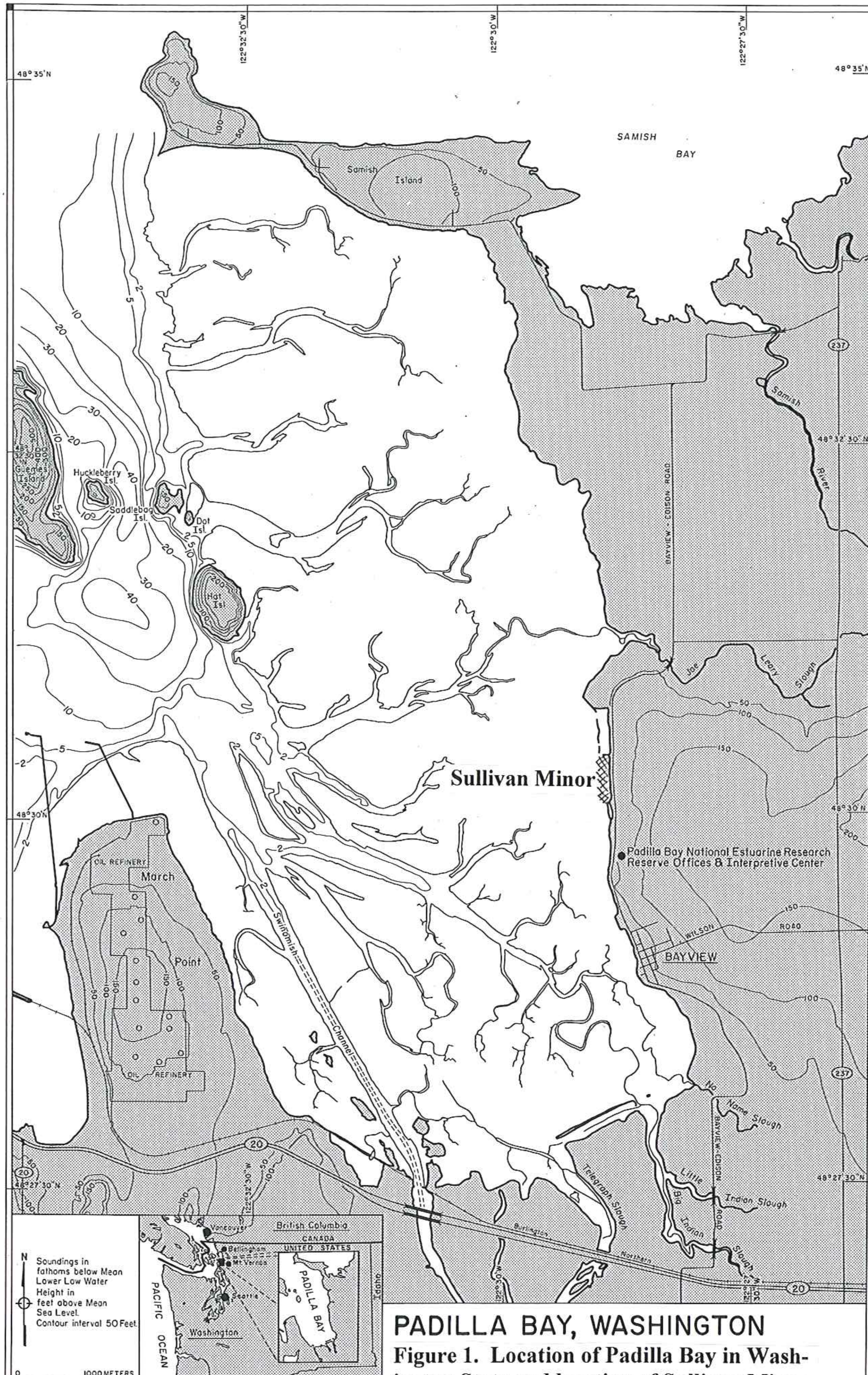

Figure 1. Location of Padilla Bay in Washington State and location of Sullivan Minor.

Figure 2. Location of folding traps on the tide flat (tide height: +5 feet) at the Sullivan Minor location in Padilla Bay, Washington, in 2008.

Figure 3. Location of folding traps on the tide flat at Sullivan Minor in Padilla Bay, Washington, on May 16, 2011.

Table 1. Non-native species identified on Padilla Bay NERR's species listing, place of origin and method of introduction.

Common name	Scientific name	PBNERR Species List	Place of Origin	Vector
INVERTEBRATES				
Amphipod	*Ampithoe valida*	X	Atlantic	Atlantic oysters
Barnacle, Striped	*Balanus amphitrite amphitrite*	X	SW Pacific	ship fouling
Clam	*Mysella tumida*	X	Japan	Pacific oysters
Clam, Japanese littleneck	*Venerupis philippinarum*	X	Japan	Pacific oysters
Clam, Japanese purple varnish	*Nuttallia obscurata*	X	Japan	ballast water
Clam, Soft-shell	*Mya arenaria*	X	Atlantic	Atlantic oysters
Drill, Atlantic oyster	*Urosalpinx cinerea*	X	NW Atlantic	Atlantic oysters
Drill, Japanese	*Ocenebra japonica*	X	Japan	Pacific oysters
Oyster, Pacific	*Crassostrea gigas*	X	Japan	aquaculture
Snail, Slipper shell	*Crepidula fornicata*	X	Atlantic	Atlantic oysters
Snail, Nassa mud	*Nassarius fraterculus*	X	Japan	Pacific oysters
Snail, Japanese false cerith	*Batillaria attramentaria*	X	Japan	Pacific oysters
Snail, Mouseear mud	*Phytia (Ovatella) myosotis*	X	Europe	ship fouling
Worm	*Pseudopolydora kempi*	X	Japan	Pacific oysters
Worm, Bamboo	*Clymenella torquata*		western Atlantic	Atlantic oysters
Worm, Polydora mud	*Polydora ligni*	X	Atlantic	Atlantic oysters
Worm, tube	*Spirorbis sp.*	X	Japan	Pacific oysters
VASCULAR PLANTS				
Eelgrass, Japanese	*Zostera japonica*	X	Japan	Pacific oysters
Cordgrass, smooth	*Spartina alterniflora*	X	Atlantic coast	Atlantic oysters
Cordgrass, common	*Spartina anglica*	X	Britain/U.S.	erosion control
MACROALGAE				
Brown - Wire weed, Japanese	*Sargassum muticum*	X	Japan	Pacific oysters

Table 2. Crabs caught in fish traps on the tideflat at Sullivan Minor salt marsh in Padilla Bay, May-Sept 2011.

		Carapace Width (mm)		Carapace Width (mm)		Carapace Width (mm)		Carapace Width (mm)		Carapace Width (mm)	
Scientific Name	**Common Name**	**May Male**	**May Female**	**June Male**	**June Female**	**July Male**	**July Female**	**Aug Male**	**Aug Female**	**Sept Male**	**Sept Female**
Carcinus maenas	European green crab	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Metacarcinus magister	Dungeness crab	n/a	n/a	54	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hemigrapsus nudus	Purple shore crab	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hemigrapsus oregonensis	Yellow shore crab	19.5	16	25,27,28,29	21	21,21,21,22,22,22,25,25,25,25,27,30,31	20,20,22,23,23,24,25	20,21,22,22,22,22,22,22,23,23,24,24,24,25,25,26,26,26,26,27,30	n/a	19,19,21,21,22,22,22,23,23,23,23,23,23,23,24,24,24,24,24,24,24,24,24,24,24,24,24,24,24,24,24,24,24,25,25,25,25,25,26,26,26,26,26,26,27,27,27,27,27,27,27,28,28,28,28,28,28,28,28,28,29,29,30,30,30,30,30,31,33	
Telmessus cheiragonus	Helmet crab	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pagurus spp.	Hermit crab	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	*	n/a

* One *Pagurus* caught at this site, no carapace width.

Table 3. Comparison of total numbers of *Hemigrapsus oregonensis*, *Hemigrapsus nudus*, *Metacarcinus magister, and Pagurus spp*. caught at the Sullivan Minor tideflat in Padilla Bay from April - September (2001-2007) using WDFW minnow trap protocol (n=3, baited with Friskies Salmon Dinner cat food, monthly sampling). The 2008 data collected August-October and the 2011 data was May-September using folding fish traps monthly (n=5, baited with frozen herring).

	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2011	2011
H. oregonensis	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Totals	63	6	63	10	145	17	233	56	187	22	167	16	191	9	545	43	107	0
mean/trap	12.6	1.2	12.6	2	29	3.4	46.6	11.2	37.4	4.4	33.4	3.2	38.2	1.8	109	8.6	21.4	0
H. nudus	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Totals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
mean/trap															0.4			
Metacarcinus magister	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Totals	0	0	15	0	0	0	0	0	0	0	3	0	0	0	102	1	1	0
mean/trap			3								0.6				20.4	0.2	0.2	0
Pagurus spp.																		
Totals (M + F)	0		42		25		21		39		68		38		1		0	
mean/trap			8.4		5		4.2		7.8		13.6		7.6		0.2			

APPENDIX A: Checklist

MONITORING FOR INVASIVE CRABS

Checklist for Setting Traps

___Reserve appropriate vehicle (GMC pickup or Jeep are ok)

___Black backpack (in Sharon's office)

___5 data sheets on clipboard (copied on Rite-in-the-Rain paper, see Sharon)

___Clipboard (check for laminated i.d. sheet, copy of Scientific Collection Permit, data sheets)

___Tide charts for "Swinomish Channel entrance, Padilla Bay" for set and retrieval days

___A few zip loc bags in case you find non-native crabs (mark gps location on bag, date, and your initials. Bring back, freeze and let Sharon know.) If you find crabs you're unsure of, bring back in bucket for positive i.d. Make sure you note which trap you found crab in.

___Rot cord or nylon zip ties (12 pieces)

___Wire cutters, knife or scissors

___Mechanical pencils (2)

___Calipers (for measuring carapace width)

___Prep bait (2 frozen herring per bait box, frozen herring in lab freezer, may need to zap in microwave for a minute so you can get them apart)

___Bucket with 5 rocks

___5 metal stakes (top is curved)

___5 folding fish traps

___Mud shoes, if you think you might need them.

___Fill out Fieldwork Contact Sheet and leave with Linda in front office

___GPS unit (if you take readings, be sure to note which unit you're using (there's a number on the side on lab tape) and write down the GPS # of the point.

___Cell phone

___Let Linda know when you return

Checklist for Retrieving Traps

___Fill out Fieldwork Contact Sheet and leave with Linda in front office

___Black backpack with above contents

___Empty bucket (for rocks)

___Bin (to empty crabs into)

___Cell phone

___Empty bait boxes out on tideflat

___Collect rocks

___Collect all metal stakes

___Carefully fill out all of the data requested on data sheet (incorrect data sheets invalidate our collection).

___Let Linda know when you return

Checklist for Finishing Trap Set/Retrieval

____Clean all gear (bait boxes, traps, stakes, bucket, bin) with fresh water and store under sink in wet lab. Spigot by barn is best.

____Thoroughly clean wire cutters/knife/scissors & calipers and dry before returning to backpack

____Carefully enter data in spreadsheet. Have someone else check your entries (QA/QC) and initial the data sheet.

European Green Crab Monitoring - Methods

This section provides detailed instructions for monitoring European green crab using two types of traps 1) Minnow or Crayfish Trap and 2) Fukui Fish Trap. Please read this in full before setting any traps.

INTRODUCTION

Monitoring for green crab in Puget Sound In 2008 methods for trapping green crab in Puget Sound have changed. Modification to trapping methods are based on research conducted in Oregon and British Columbia where green crab occur. To date, no green crabs have been found in Puget Sound. Modifications in methodology will increase our chances of catching green crab if they are present and provide greater confidence in collected data.

VOLUNTEER REGISTRATION AND TIME RECORD

Prior to participating in the Puget Sound Marine Invasive Species Volunteer Monitoring Program, you must register as a volunteer using the volunteer registration form and mail the signed form to Nahkeeta Northwest. Volunteer timesheets are also required and must be filled out and submitted on a monthly basis. All participants in the program must fill out and submit these forms, there are no exemptions. Please find the needed forms and instructions in your volunteer packet.

SAFETY

Please be aware that coastlines can be hazardous areas to work in. If your monitoring site is potentially hazardous and are uneasy about accessing it please find an alternate access point, similar beach nearby or contact your coordinator to be relocated. Be mindful of the tides and conduct your surveys during low tides. It is useful to trap with a partner, friend or family member. If you are monitoring alone, be sure to let someone know where you are going and when you plan to return. Be careful when traversing uneven ground, especially slippery surfaces such as wet rocks or seaweed. Also, be cautious when accessing mud flats, certain areas can be very soft, so test your footing and do not go out too far on soft mud flats.

In Washington State tidelands are of mixed ownership and at various tide levels. Much of Puget Sound's shorelines are privately owned. When choosing a site to monitor, please respect private property boundaries and simply ask the owner for permission to access their tidelands. Explain your project and how it will help protect our marine resources, including those on their own property, most owners are quite cooperative and may even want to volunteer their help!

SCIENTIFIC COLLECTION PERMITS

A scientific collection permit is updated each year and the permit number is required for trap identification and data submittal. The permit is required to trap live organisms (bycatch) and to collect and/or transport any live green crab in Washington State. As an active volunteer, your name will be listed as a sub-permitee on the program permit. If you are working under a local group coordinator, their name will be listed as the sub-permitee.

Each trap will need a red ID tag. Please make sure the permit number is on this tag along with your contact information. These tags are required on each trap for enforcement. Also, write clearly on the back of each tag "Research – Do Not Disturb". If you have any questions please email Nahkeeta Northwest <u>nnw2@fidalgo.net</u>

COMMUNICATION, QUESTIONS and UPDATES

Most communication for this program is conducted via Email. Forms, permits and other items will be mailed to you at the onset of each season or upon request. Equipment replacement or transfer will be conduced at regional centers, so please refer to the list included or ask. The green crab monitoring project is a large program supported by minimal staff so please keep this in mind. If you have any questions regarding the monitoring process, beach access, trapping or data collection methods, please contact your local volunteer coordinator or the Puget Sound Green Crab Monitoring Coordinator.

HOW TO CONDUCT THE SURVEY

EQUIPMENT LIST

The following list of equipment is necessary for conducting green crab survey using traps.

- 5 or more traps per site
- one permit tag per trap – secured to trap with zip tie
- one bait box per trap
- raw or frozen fish for bait
- rock anchor and pencil rod (flagged) - line for securing traps to shore may be used
- thermometer
- bucket
- calipers
- crab and intertidal identification guide
- digital camera (optional)

About Traps and Their Application

Research in Oregon and British Columbia has indicated that two trap types, the Fukui and crayfish or minnow, are useful for trapping and collecting green crab. These two trap types differ in shape, mesh size and application. While crayfish/minnow traps have been used in Puget Sound since 1999, the Fukui fish trap have proved effective in capturing green crab in coastal regions where they are known to occur.

The Fukui Fish baited with raw or frozen fish is the preferred method for trapping green crab. Fukui traps capture green crab of a broad age range and not exclude larger or older crabs. The Crayfish or Minnow traps that have been used in Puget Sound are useful for capturing first year recruits or young crab and exclude larger-older crab due to the size of the opening. The crayfish/minnow traps are useful in areas where young crab may concentrate particularly vegetated saltmarsh, such as spartina habitats.

Fukui Fish traps are light-weight folding traps, that are easy to use, transport and store. They have a metal frame covered by ½ inch mesh netting and slot openings. They anchor easily with a single rod and a rock. The rock also serves as cover for crab and other organisms. Due to the larger opening, there is a greater potential for large or abundant bycatch. Please do not leave these traps exposed too long following 24 soaking - if possible create a shallow depression large enough for the trap to provide a pool for the bycatch

Crayfish or Minnow traps are cylindrical metal mesh traps that are in two halves and fit together with a hinged rim. These traps come with a 5cm tunnel opening at both ends (check the size with your calipers) and should be modified to about 6cm or 2¼ inches. This can be done with wire cutters or tin snips. These traps are easily set and secured with one or two pencil rods or rebar.

Beginning in 2008 we recommend using Fukui Fish Traps for most sites and crayfish/minnow traps only in saltmarsh and upper intertidal with shoreline vegetation. If your site has a mix of habitats including saltmarsh and protected intertidal area, you may consider using both types of traps and placing them according to habitat type e.g. 2-3 traps along the saltmarsh-shoreline interface and 2-3 traps within the intertidal area.

TRAPPING PROCEDURES

TRAP PREPARATION:

1) Obtain five traps, ID tags, bait boxes and anchors (pencil rod, rebar).
2) Fill out a red plastic WDFW research trap identification tag with a permanent ink pen (use a Sharpie pen) and be sure to include the permit number. If you are monitoring independently, please place your phone number and address on the tag. If you are associated with an organization, put your organization coordinator's phone number on the tag, not the surveyor's. If the trap becomes lost, the finder of the trap will be more likely to reach someone at an organization's number. Also write on the back of the tag **"Research – Do Not Disturb."** Attach the tag to the trap.
3) For minnow traps attach a bait container to the edge of one half of the trap using a zip tie, so that it will hang in the center of the trap when both sides are joined. Make sure that the bait container doesn't block either one of the tunnel openings

SECURING TRAPS.

These traps are light weight and need to be anchored or secured to the beach.

Intertidal

1) For minnow traps use one or two pencil rods or rebar to anchor the closed trap in place by wedging trap under the curved end of rod driven into the beach or run the rod through the metal clip loop and drive the stake into the ground using the curved rod end to hold the trap in place.
2) For Fukui traps, place a medium sized rock on the inside bottom of the trap, then bait box, close the trap and use a single stake and drive it from the top of the trap down through the center of the trap into the beach substrate.
3) Use extra rod if your site is exposed to wave action.

Subtidal

1) For sites that require that traps be deployed by boat at high tide, off a dock or in deeper water, tie a line to the trap and with a float and use some type of anchor in the trap (chain, metal ball, rocks, etc.) with a float as a marker. Please do not use lead for weight.

PLEASE avoid loosing your traps – lost traps can kill organisms for a very long time.

BAIT.

BAIT

WDFW has not yet scientifically tested bait preference by green crab, however other research indicates that fresh and frozen fish is the preferred bait. Fresh marine fish parts are best. Frozen herring, salmon or mackerel chucks are recommended for ease of storage and use. Fish parts can be obtained from seafood retailers, fish processors and sport fishers. We will be attempting to obtain bait for volunteer use, but we urge you to seek local sources and request a donation from that source if possible.

Canned catfood containing a fish product (Friskies salmon dinner is recommended) has been been the bait of choice for ease of use and acquisition. This should be only be used if fish is not available or difficult to obtain.

LOCATION/SITE SELECTION.

PUBLIC BEACHES. Public beaches can be good choices for monitoring because there is usually safe and easy access available and the boundaries are often well marked. The downside to monitoring at public beaches is that they are just that, public. If there is a lot of foot traffic on the beach, then it is more likely that your trap(s) will be tampered with or even stolen. Before you place traps on public beaches, try to contact the beach ranger or any site manager. Also, add a "RESEARCH - Do Not Disturb" tag on your trap.

YOUR OWN PRIVATE TIDELANDS. If you are a tideland owner, then you probably don't need to search for a site any further than your own backyard. It will be easy for you to access the site, you know where the boundaries of your property are, you may be able to keep an eye on your trap(s) from your home, and there is most likely less foot traffic there than at a public beach.

OTHER PRIVATE TIDELANDS. In the event that you would like to monitor private tidelands other than your own for optimal conditions, please obtain permission from the property owner prior to monitoring.

HABITAT. Apart from having legal, safe and convenient access, the most important things to consider when choosing a monitoring site are the environmental conditions of the tidelands and associated body of water. Habitat varies greatly from site to site, and also within a site, however, look for structures that may provide potential cover for green crab if they were to move into the area. Green crab have been found in a variety of different conditions within their native range and also in areas they have colonized. On the U.S. west coast, the European green crab has only been observed in protected embayments and estuaries. On the southwest Washington coast, the European green crab has been found primarily in the lower salt marsh zones, **particularly in *Spartina*,** a non-native invasive marine grass. However, on the east coast of North America, they are common in moderately exposed rocky areas (Grosholz and Ruiz, 1996). Recent research on the Washington and Oregon coast reveal that green crab prefer fresh water input, lower salinity and warmer temperatures >10 deg C (Yamada, 2004), they can also be found on mud flats and tidal channels. It is recommended that traps be placed in areas with any of the following characteristics:

- Protected shoreline with low wave action and low shoreline gradient (slope)
- Freshwater influence (e.g., seeps, creeks, streams or river mouths)
- Along intertidal margin at the base of rip-rap bulkheads

- Eelgrass meadows
- Low saltmarsh areas with direct intertidal connectivity
- Areas with *Spartina* infestations – unless the area has been sprayed, tilled or disturbed
- Protected tidal channels
- Large intertidal structures (e.g., boulders, rock piles, large woody debris, etc.)
- Oyster or mussel beds
- Warm water in summer months

TIDE HEIGHT. The tide heights where most green crab on the North American West Coast have been found have been in the mid- to upper-intertidal range, around 0 to plus 5- foot tide heights. Sampling should be focused within those tide heights, but you may also set traps at lower tidal elevations, especially if the habitat looks favorable.

<u>SETTING TRAPS</u> – CONFIGURATION AND DISTANCE.

It is recommended that a minimum of 5 traps be set at each monitoring site, the o~~n~~ld methods called for 3 traps per site. If you currently have 3 traps please add 2 new Fukui traps when they become available. When setting your traps set them far enough apart so they won't interfere with each others effective fishing range. The approximate effective radius of a trap is not yet known. Set traps about 25 meters apart = 5 traps per 100 meter trapping area. Set either in a row or in a configuration that optimizes habitat sampling. Spacing also depends on habitat suitability and available beach area. If the habitat you are sampling is fairly uniform, you can place the traps a set distance apart. If the habitat on the beach you're sampling varies widely, it's more important to look for suitable habitat instead of just placing the traps a uniform distance apart. Placing traps at variable tidal levels is also acceptable. For example, if *Spartina* is on the beach, it is advisable to place 2-3 traps in the *Spartina.* At sites where low saltmarsh is contiguous with the shoreline, place 2-3 minnow traps in or on the edge of the saltmarsh. Young green crab are associated with saltmarsh areas. ***Select for known green crab habitat first.***

When setting crayfish/minnow traps, use a twist tie to hold traps together instead of the metal clip, so if the trap is lost it will fall apart. Make a depression under the traps to hold water longer to increase the survival of bycatch organisms. Be sure to anchor your traps sufficiently.

<u>TRAPPING TIME PERIOD</u>.

Deploy the gear for a 24-hour soak period which encompasses both a full tidal and day/night cycle. It is crucial to check and empty your trap(s) immediately after the designated soak period, particularly during the months of April through September, when the probability of catching large quantities of crab and other animals is higher. The longer the trapped animals are unprotected from the effects of sun and air, the less likely they will survive until they can be released. Leaving large quantities of crab in this confined condition for an extended period of time also increases the number of animals that will be damaged/killed due to their interactions, including bycatch. **If you suspect the trap(s) can not be checked within a 24-hour period, reschedule your survey for a more convenient time.**

<u>TRAP RECOVERY</u>.

TRAP RECOVERY

After traps have soaked for 24 hours, recover each trap, open it and record the organisms captured on your data form. See WDFW's "**Data Collection Procedures - How to Fill Out the Data Sheet**" for data collection instructions. **Please record all observations, even when no crabs are caught. "Zeros" are important information.** Bycatch data is also important and needs to be recorded correctly – all organisms need to be identified and counted. Handle bycatch briefly and gently and return to suitable habitat where caught as soon as possible. Carefully check the corners of traps since organisms may crawl into hiding and shake the trap before folding. Empty contents of bait containers at the trap site. Fill trap excavations if necessary and leave site as you found it.

Be sure to clean all debris, plants and animals out/off of your traps between surveys, especially if you will be setting your traps at a different site. It is very important not to inadvertently transfer other "pest" species (e.g., oyster drills, tunicate..) from an infested site to a pest-free site through your activities. Please rinse off your trap and clean out bait containers after each trapping session.

TRAPPING FREQUENCY.

Trapping for green crab is recommended during the six month period from April through September. This period is when the marine waters have warmed sufficiently for green crab to move into intertidal areas. They require temperatures greater than 10 degrees C to grow and reproduce. The **minimum** sampling frequency is once a month per site. If you would like to survey more frequently, please do so. By sampling more often, you increase your chances of finding a European green crab if it is in the area. If a green crab is found, sampling frequency and trapping density will be increased.

NOTE: Please take time to visually scan your beach (particularly the high tide line) for green crab molts (exoskeletons) and carapaces (only the back shell). The inside of the carapace tends to be very white. Frequently, the presence of European green crab will be initially revealed through the discovery of a molt, not through a live animal sighting. This was the case in Willapa Bay, Washington.

REPORTING AND STORING GREEN CRAB

In the event you catch a European green crab, **do not throw it back**. Record the necessary data and place it in your bucket. Contact Nahkeeta Northwest IMMEDIATELY by phone (360-766-6008 or cell 360-770-6012) to go over identification. If you are unable to reach someone at the above numbers and you are certain you have a green crab you may call WDFW at (360) 902-2741. Also take a digital photo of the crab(s) both top and bottom, preferably held in the hand for size reference and email it to the Puget Sound Coordinator at: nnw2@fidalgo.net Place the crab in a zip lock bag or other suitable container and place it in your freezer. This container should be labeled with the date the trap was set, trap location (be specific – use your site code and site name), the name of the surveyor and phone number and the organization name (if applicable). ALL CAPTURED GREEN CRAB MUST BE TURNED OVER TO WDFW IN ORDER TO CONFIRM IDENTIFICATION. It is very important to get identification confirmation as soon as possible, and not talk with the press or others until the sighting is verified by WDFW.

APPENDIX C: Field Sheets

PADILLA BAY CRAB SURVEY					
NAME		PHONE		WATER BODY	Padilla Bay
COUNTY	Skagit	SITE	Sullivan Minor	TRAP # (x of x)	
			Bayview St Pk		
LAT/LONG			Indian Slough		
TYPE OF TRAP	Minnow	Folding Fish			
TYPE OF BAIT	Cat food	Frozen herring	Other (list):		
DATE (MO/DAY/YR)/TIME TRAPS SET					
TIDE HEIGHT					
COMMENTS					
DATE (MO/DAY/YR)/TIME TRAPS RET					
TIDE HEIGHT					
COMMENTS					
SHORELINE TYPE	Salt marsh	Tidal channel	Tidal Flat		
SUBSTRATE TYPE	Cobble	Gravel	Sand	Mud	Shellfish bed
VEGETATION	None	Algae	Eelgrass	Other	
COMMENTS:					
Sci. Coll. Permit #					

CATCH				
Common name	**Scientific name**	**SEX**	**CW**	**Total #**
Green crab	Carcinus maenas	M		
		F		
Comments: Do not release (Freeze)				
Dungeness crab	Cancer magister	M		
		F		
Comments:				
Red Rock crab	Cancer productus	M		
		F		
Comments:				
Helmet crab	Telmessus cheiragonus	M		
		F		
Comments:				
Yellow shore crab	Hemigrapsus oregonensis	M		
		F		
Comments:				
Purple shore crab	Hemigrapsus nudus	M		
		F		
Comments:				
Hermit crab	Pagurus sp.		Total numbers only	
Comments:				
Other catch (totals): Batillaria _____ Nassarius _____ Live sculpin _____ Dead sculpin _____ Other _____				