SUMMARY REPORT
Task Title: Assessment of Juvenile Dungeness crab Abundance

Project Partners:
Snohomish County Marine Resources Committee
Stef Frenzl, Robyn Redekopp, Morgan Neal, Wendy Fisher

Washington Department of Fish and Wildlife (WDFW)
Don Velasquez

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Project Background

Dungeness crab is an important species ecologically and economically in the Puget Sound region. However, little is known about juvenile Dungeness crab habitat preferences and duration of settlement along the nearshore environment in Snohomish County. Two years ago, Don Velasquez, WDFW Biologist, approached the MRC requesting help in determining where juvenile Dungeness crabs prefer to settle along the nearshore. Due to skyrocketing harvest rates over the past few years, Dungeness crab stewardship had been prioritized as a primary goal of the MRC since 2003, so the MRC readily agreed to work on the project. The Juvenile Dungeness Crab Habitat Project was developed to collect data to assist WDFW biologists in applying conditions, specific to reducing negative impacts on Dungeness, on hydraulic project approvals.

Project Objectives

The Juvenile Dungeness crab Habitat Project investigated the extent, condition and productivity of marine nearshore habitat for juvenile Dungeness crab in Snohomish County. The initial research questions were as follows:

- What are the habitat preferences of juvenile Dungeness crab?
- When do juveniles settle and reside in this habitat?
- How does growth proceed in this habitat and when do most juveniles move to habitat characteristic of adults?

Project Implementation

The 2005 pilot project included just two sites along the Snohomish County shoreline: Mukilteo Beach (Barge/Rail Site) and Kayak Point Park. Two hundred and five samples were documents during the 12 sampling trips on six dates from July to September. Armed with lessons from the pilot and increased volunteer power supplied by WSU Beach Watchers and Edmonds Community College, plans were laid for the 2006 expanded Juvenile Dungeness crab study.

On site volunteer training for the intensive 2006 effort occurred in mid-April. 2006 sampling sites included Kayak Point Park, Hermosa Beach, Mukilteo Beach (Barge/Rail Site), Picnic Points and Edmonds Beach. Each site was assigned one or two sites leads.

Sampling occurred biweekly from May through September (with the exception of Hermosa, which had limited volunteers). It was determined that winter sampling would not be done by volunteers due to the fact that low tide in the winter is at night and might compromise volunteer safety. Tulalip Tribes has agreed to do benthic sampling in winter months.

667 samples were documented, photographed and processed from five sites on nine dates over the summer (36 total sampling trips). Over 65 different people participated in one or more of the 2006 samplings.

Discussion

Results indicate that juvenile Dungeness crabs prefer mixed substrates with a silt/sand component mixed with courser material or vegetation. The silt/sand component is likely desirable for the crab to burrow into for refuge. Burrowing into the substrate is a behavior which persists in Dungeness crab through adulthood. The coarse material and vegetation may be preferred because these tend to stabilize substrate and prevent wave energy from exposing the juveniles. These components may also provide additional cover.

We found no consistent settlement preference patterns among tide elevations between the categories of habitat sampled. Juvenile Dungeness crab settlement occurred continuously throughout the study period after June 14th. The most attractive habitats for juvenile Dungeness crab have a silt/sand component mixed with coarser material or vegetation. Other habitat types are much less attractive to juvenile crab.

Larger juveniles were less prevalent in 2006 than in 2005; one reason for this might be that the larger juveniles were affected by the heat and desiccation of the unusual summer of 2006, forcing them to lower tide heights. The presence of somewhat larger molt shells (recent) at the water's edge suggests that at least some of these larger juveniles survived but moved out of our intertidal sampling area.

Washington Department of Natural Resources (1997) estimates that 52% of the shoreline in Central Puget Sound has already been substantially modified by people. Economic pressures to develop along shorelines and armor the upper intertidal in Snohomish County are enormous. These activities have great potential to alter and degrade the intertidal habitats which are critical to Dungeness crab and other species. Results of the Juvenile Dungeness crab Habitat Project are being further analyzed and incorporated into a Priority Habitat and Species Management Recommendations document to be supplied to the WDFW habitat program for evaluating Hydraulic Projects Applications. Habitat biologists typically apply conditions on approved projects so negative impacts on key habitats and species are reduced or avoided; these involve timing of work, construction methods, and mitigation.

An overview of the project is also being presented at the 2007 Georgia Basin Puget Sound Research Conference.

Recommendations

Tracking growth of juveniles after the first 3 instars may require a different sampling strategy. Review of average size over this summer indicates larger individuals are leaving the sampling area as new recruits settle. Early settlers do not seem to remain in the intertidal long, particularly under stressful conditions.

This ambitious 2005-2006 effort was possible due to an extensive number of partnerships and over 70 highly-trained college students and volunteers. This study can serve as a model for those interested in developing collaborations among various agencies, organizations, and institutions to implement sound, applied science.

Resources/References

Velasquez, Don. (2006). Snohomish County Juvenile Dungeness Crab Survey 2005 and 2006 PowerPoint Presentation. velasdev@DFW.WA.GOV

Attachments

- Juvenile crab survey protocol and QA/QC
- 2007 Georgia Basin/Puget Sound Research Conference- project abstract
- 2007 Georgia Basin/Puget Sound Research Conference- conference sheet
- PowerPoint Presentation: Juvenile Dungeness Crab Habitat Survey
- Juvenile Dungeness Crab Habitat Survey- Field Data
- Supply List
- Juvenile Dungeness Crab habitat “Story”

Dungeness Crab Survey Abstract Draft Ideas

Abstract Title: Juvenile Dungeness Crab Habitat Study: Obtaining Best Available Science through Partnerships & High-Endurance Volunteer Power.

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Dungeness crab is an important species ecologically and economically in the Puget Sound region. Little is known about juvenile Dungeness crab habitat preferences and duration of settlement along the nearshore environment in much of the region. The Washington Department of Fish & Wildlife (WDFW) and the Snohomish County Marine Resources Committee investigated juvenile Dungeness crab preferences for habitat type and tide elevation at five sites along the Snohomish County nearshore environment from May through September 2006. Additionally, we investigated the duration of settlement and residence. Sampling occurred every two weeks at each site. Results indicate that juvenile Dungeness crabs prefer mixed substrates with a sand component, and secondarily, vegetated sand habitat. We found no consistent settlement preference patterns among tide elevations between the categories of habitat sampled. Juvenile Dungeness crab settlement occurred continuously throughout the study period after June 14th. WDFW will use study results to develop rules for Hydraulic Project Approval applications in Snohomish County. This ambitious effort was possible due to an extensive number of partnerships and over 70 highly-trained college students and volunteers. This study can serve as a model for those interested in developing collaborations among various agencies, organizations, and institutions to implement sound, applied science.

Juvenile Dungeness Crab Habitat Study: Obtaining Best Available Science through Partnerships & High-Endurance Volunteer Power

Stef Frenzl, Marine Resources Committee Lead Staff, Snohomish County
Don Velasquez, Shellfish Biologist, Washington Dept. of Fish & Wildlife

Abstract
Dungeness crab is an important species ecologically and economically in the Puget Sound region. Little is known about juvenile Dungeness crab habitat preferences and duration of settlement along the nearshore environment in much of the region. The Washington Department of Fish & Wildlife (WDFW) and the Snohomish County Marine Resources Committee investigated juvenile Dungeness crab preferences for habitat type and tide elevation at five sites along the Snohomish County nearshore environment from May through September 2006. Additionally, we investigated the duration of settlement and residence. Sampling occurred every two weeks at each site. Results indicate that juvenile Dungeness crabs prefer mixed substrates with a sand component, and secondarily, vegetated sand habitat. We found no consistent settlement preference patterns among tide elevations between the categories of habitat sampled. Juvenile Dungeness crab settlement occurred continuously throughout the study period after June 14th. WDFW will use study results to develop rules for Hydraulic Project Approval applications in Snohomish County. This ambitious effort was possible due to an extensive number of partnerships and over 70 highly-trained college students and volunteers. This study can serve as a model for those interested in developing collaborations among various agencies, organizations, and institutions to implement sound, applied science.

The Nexus-Partners, Volunteers & Field Research
This project was a good example of a collaborative effort among partners and volunteers to obtain credible data at a minimal expense for each partner. We recruited, trained and managed over 70 dedicated volunteers & students who contributed over 1,770 hours to implement this project. For examples of materials that we used to recruit, train and track volunteers, please visit the following website:
http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/SWM/Work_Areas/Habitat/ Marine/DungenessCrabStudy.htm

Or Google: "Snohomish juvenile crab study" and click on the first link

MRC Juvenile Dungeness Crab Survey

Supplies used (for each site):

- 2 shovels
- 2 large buckets
- 3 crates
- 3quadrates
- Calipers
- At least 6 small plastic containers (butter tub type—for storing uncounted crabs)
- Clipboard
- Parking passes
- Paperwork (Right of Entry, Volunteer sign-in, sampling forms, random number chart, Crab ID sheets)
- Pencils
- Measuring tape (at least 10 meters)
- Digital camera
- Signs with transect height and replicate letter
- Handheld GPS?

Extras:

- Knee pads/Kneeling pads
- Hand trowels (proved to be very useful)

Winter equipment:

- 2 lanterns with hanging posts
- Per person:
    - Gloves
    - Head lamp
    - Hip waders and/or rain gear

Playing in the Sand….With a Purpose!
Juvenile Dungeness Crab Habitat Study
Snohomish County Marine Resources Committee

They speak of strengthening friendship, building a stronger community and connection to the nearshore, becoming a part of the democratic process, and improving their own stewardship practices.

"They are bright, hard working and a dedicated group to helping preserve our marine life in the Salish Sea," asserted Chris Betchley, WSU Beach Watcher and one of the project's site leads. "They have toiled through rain, wind and sunshine over barnacle encrusted rocks, sunk to their knees in mud and hauled 70 lbs buckets of water for hours at a time."

Who are these devoted individuals and what exactly are they up to?

They are among the 70 plus volunteers involved in the second year of the Snohomish County Juvenile Dungeness Crab Habitat Study. The project goal is to identify and map preferred juvenile Dungeness crab habitat along the Snohomish County shoreline.

Two years ago, Don Velasquez, Shellfish Biologist at Washington Department of Fish & Wildlife (WDFW), approached the Snohomish County Marine Resource Committee (MRC) to request help for WDFW and the Tulalip Tribes in determining where juvenile Dungeness crabs prefer to settle along the nearshore. Due to skyrocketing harvest rates over the past few years, the MRC prioritized Dungeness crab stewardship as a primary goal since 2003. Although Dungeness crabs are an important resource, very little is known about their life history and habitat preferences in Snohomish County.

The MRC thus agreed to partner on this project, and received a grant of over $8,000 from the Northwest Straits Foundation in 2005, and over $20,000 in funds from the Marjorie Mosher Schmidt Foundation to coordinate the project. Stef Frenzl, County Public Works Department, MRC Lead Staff, expanded the project partnership to include WSU Beach Watchers Skagit/Snohomish Counties, Edmonds Community College, and a number of other volunteers to make the project as expansive as possible.

In 2005, volunteers began digging in the sand, gravel and cobble at Kayak Point County Park and in Mukilteo near the old tank farm, looking for tiny Dungeness crabs about the size of a pea. After fully digging in one squared-off area, a volunteer begins speaking for the data recorder, "Dungeness crab, 5mm across the carapace, first instar stage," and then puts it back in a small plastic bucket. She counts and measures all crabs found in that quadrat, and then returns all the tiny crabs back to the sand.

In 2006, the project expanded to five sites: Kayak Point County Park, Hermosa Point near Tulalip Bay, the Mukilteo site, Picnic Point County Park and Edmonds Marina Beach. Over 70 volunteers and students kneeled on their hands and knees every other week for four months to count the little Dungeness crabs. By the end of the 2006 field season, volunteers throughout the community contributed over 1,770 hours of volunteer service,

and counted and measured 894 juvenile Dungeness crab. This information will help ensure that WDFW uses this new best available science to protect juvenile Dungeness crab and improve Dungeness crab stewardship.

Yet this project isn't only about obtaining credible data to assist in Dungeness crab stewardship. Over the course of two years, many volunteers have experienced something more than scientific results from searching for and identifying juvenile crabs. Clearly, this project goes beyond numbers and leveraging partnerships and touches the intangible – the practice of living a healthy, whole life connected to community and place.

Volunteer Wendy Fisher speaks of her experience by explaining, "I have found that working on the juvenile Dungeness project is a way to connect with many different people who are out digging in the sand for such a wide range of reasons. This study is so great, I think, because it has given me a reason to be outside on the beach, rather than sitting at a computer, which I do a lot of as a graduate student. Everyone at the site gets so excited when we find the little 'juvis' and, since we've been searching so diligently for them, we can't help but care about their survival!"

Volunteer Melissa McKay finds the project to be a fresh breath of air as well. She says, "I have been reassured over and over again that there are many people that care about the environment and the aquatic/intertidal zone environment in particular," she said. "I can only say thank you for giving me this opportunity to have a great time while doing something worthwhile and meet wonderful people too!"

The Snohomish County Marine Resources Committee's juvenile Dungeness Crab Project has reached many successes, both measurable and those beyond measurement. Not only does the Committee help provide the best available science to marine resource users and managers to improve stewardship, but it also strives to strengthen our community's relationship with our marine resources, and the land and waters in which they live. The Snohomish County Marine Resources Committee helps us reconnect with *why* we love living in the Puget Sound, and why it's important to steward our resources for future generations.

Joan Douglass, one of the project site leaders, may have captured this best when she exclaimed, "I admit, at first, I wasn't sure I could really do it all, the many dates, the math (calculators? random numbers? What?), the species identification, and the tiny-ness of what we were being asked to search for!!! We all felt like we were doing important work, with a purpose and a greater meaning than many of our jobs, obligations and tasks. And, knowing how our work connected with our friends and peers also working along the shoreline, we became part of a much greater effort. Very motivating stuff!

As for the beach, could we have asked for a more perfect spot? It is one of the most beautiful and interesting beaches in Snohomish County, and I now want to both hide it and share it!!! For sure I am now much more connected to it, and my town of Mukilteo..."

QA/QC FORM
Juvenile Dungeness Crab Preferred Habitat Study
October 13, 2005

Protocol

Methods:

Pilot Study

A pilot study will be implemented in the summer-fall of 2005 to record how Dungeness crab use two sites along the Snohomish County shoreline. This sampling effort will be less intensive than the intensive effort beginning in summer-fall of 2006, will save sampling time and costs, and will supply much needed information to focus the 2006 intensive effort. Specific information gained from sampling in this fashion will be useful information regarding early life history abundance and size frequency for juvenile crab as well as presence and absence. Study area results can then be compared to existing information for the northern reaches of Puget Sound and used to derive the more intense Phase III effort.

The two pilot study sites include Edgewater Beach, located north of the National Marine Fishery Service laboratory in Mukilteo, and Kayak Point Park, a Snohomish County park located near the Tulalip Tribes reservation. These sites will be sampled bimonthly throughout this time period during the summer-fall 2005. The methods used to collect this data represent a combination of those used for transect surveys by the Island County Beach Watchers and those used by McMillan et al. (1995). The latter study described densities of juvenile crabs in different habitat types and times of the year for sites in North Puget Sound. Similar information is currently lacking for Snohomish County.

Establishing Transects- Pilot Study

At each site at least one transect will be established and divided into 1 foot tide height intervals with flagged stakes (dGPS marked). The pilot study will include two sites: Edgewater Beach in Mukilteo and Kayak Point. Transects will run from about –2 ft to +4 feet with the lower boundary stake located using an estimate generated from "Tides and Currents" software. The stakes above –2 ft will be located using tide poles as described in the Island County/WSU Beach Watchers manual "Beach Monitoring Procedures". Once transects are established and properly marked, samplers should need minimal time to locate and process samples during the low tides. Coordinates for stakes will be recorded.

Sampling Transects- Pilot Study

Both transect sites will be sampled every two weeks from May 1st through September 30th and once a month at other times of the year. The target time frame for the Pilot study will be June 2005 through September 2005, and Phase III will begin in November 2005 and end in September 2006, with an understanding to collect samples the following year if staff and funds allow it. Before placing quadrats, digital photos may be taken at each stake to document changes in available cover (at least through the summer but if feasible at other times of the year). At each tide height, three .25 m^2 (50 cm by 50 cm) quadrat placements will be randomly located along a 10 m segment ending on the transect. Exact placements will be determined using the random number table. This will

result in about 21 samples per transect per date. A typical transect sampling is depicted in Figure 1.

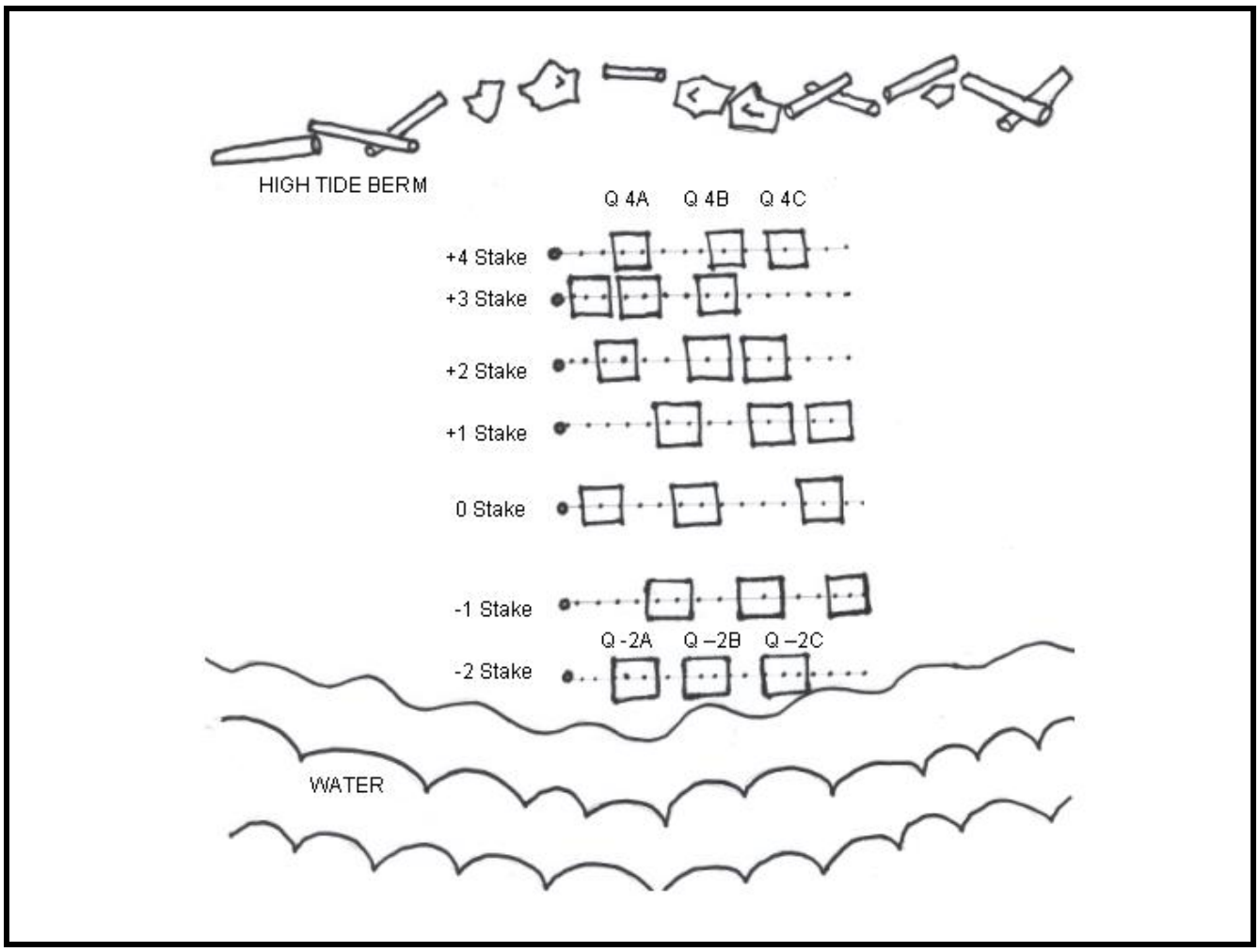

Figure 1. Example of Pilot Transect Sampling for Juvenile Dungeness Crab

Each quadrat placement (sample location) will have all substrate and vegetation excavated down to a depth of 3-5 cm. The cover will be confirmed with existing mapping efforts. Larger cobble and macrophytes are removed from the sample and examined for the presence of megalops larvae and juvenile instars. The remainder is wet sieved through a 3 mm mesh screen table. All juvenile Dungeness crabs are counted and measured immediately anterior to the 10^{th} antero-lateral spine with calipers. Larger material and juvenile crabs are returned to the beach after measuring, preferably where they were sampled.

Intensive Sampling

Results from the Pilot Study will enable us to develop changes to the methodology as necessary. Possible changes could include a stronger focus on habitat-type in relation to

tide height. The methodology will be updated in November 2005 after results from the Pilot Study are analyzed.

During winter months or when sampling is not able to coincide with a low tide, the option to use a suction-style benthic sampler will be employed. In this fashion, samples can be taken when the habitat is submerged and the tide stage becomes less relevant and limiting. Nightime sampling during the winter months won't be necessary as a result. A description of the methods and equipment previously employed using scuba samplers can be found in Dinnel and Hora (1998). Another boat-based system using a centrifugal pump for benthic sampling is described in Stark et al. (2000). A personal discussion with Paul Dinnel indicated that the results from sampling juvenile crab using either of these methods when habitats are submerged would be comparable to low-tide sampling. However, a comparative analysis in September 2005 will be conducted to understand whether submerged sampling methods are quantitatively comparable to the transect sampling method.

Volunteers
Phase III sampling will involve a considerable amount of volunteer effort. Each sampling team will be comprised of at least one biologist and one technician with the hopes of having one or two volunteers on site to assist with sampling and sample processing for every day in the field. Minimum training will be required to allow full assistance to the project from volunteers. Field equipment needed to work on the beach and the boat will be supplied by the Tribes and WDFW to allow all interested in participating to be successful participants. Due to some sampling being conducted by diver operated biological dredging – no volunteers will be used for any in-the-water sampling. The Tulalip Tribes Dive Team will operate all dredge sampling equipment to maintain dive operation safety.

Study Locations:
Sites for Phase III may include Edmonds Underwater Park, Picnic Point, Howarth Park, Mission Beach and Kayak Point. Sampling feasibility will be taken into consideration, as numerous volunteers are needed to obtain data from all quadrats while the tide is low.

How Samples Are Processed: A data collection form is included in this QA/QC report. Samples are processed initially by taking photographs of each quadrat before excavation. Then, the first two-inches of substrate are within the 1/4m2 quadrat are excavated, and all material is strained through a filter to catch all Dungeness crabs located inside the quadrat. Crab carapace width and determination of molt is recorded (J1 or J2). Other species are also identified and presence recorded. All species (including Dungeness crabs) are returned relatively unharmed to their habitat after sampling.

If data will be analyzed, what Statistics will be used?
Non-parametric statistical procedures will be employed to test hypotheses of whether Dungeness crab density varies significantly across habitat type, location, tide height, or time of year. Carapace width frequency distributions will be constructed of all juveniles sampled at the transect sites. The arrival and departure of settling cohorts can be tracked

over time. Because the methods employed are very similar to those used in previous studies further north, some interesting comparisons should be possible. Ultimately, an estimate of juvenile production capacity for Snohomish County shorelines could be made based on mapped intertidal habitats and the density of juveniles residing in these habitats.

Quality Assurance/Quality Control: Intensive Sampling

Who is going to collect the data?
Project leads with alternates will be identified for each project site. WDFW and Snohomish County will supply one project lead for one site for the entire sampling season in 2006. Edmonds Community College has tentatively agreed to finding a project lead and managing all volunteers for the Edmonds Underwater Park site. Two Project Leads currently remain. We hope to obtain a number of additional project lead/alternates from the first WSU Beach Watcher class. Project Leads will find and manage volunteers to collect samples for their individual site, with oversight and assistance from Stef Frenzl.

What are their qualifications?
Project leads and interested volunteers will undergo a half-day training in the spring of 2006. Many potential project leads and volunteers have already volunteered numerous hours in the pilot study, and are well qualified to run sampling efforts.

How will they ensure the data collection is as per the protocol?
Protocol sheets will be supplied for each site. Project leads and interested volunteers will undergo a half-day training in the spring of 2006. Don Velasquez will serve as the Project Manager and will travel to different sampling sites throughout the summer to ensure that all teams are following protocol.

Who is going to compile the data? Don Velasquez
What are their qualifications? Shellfish Biologist, WDFW
How will it be compiled? Spreadsheet
How will you ensure the data is accurate?
Data sheet information will be cross-referenced with quadrat photographs.

Where will the data be stored?
WDFW and Snohomish County will store the data on Disk, on hard copy in the MRC library, and will post data on the MRC website.

Who will analyze the data? Don Velasquez
What are their qualifications? Shellfish Biologist, WDFW

How will the data be used? WDFW will use the data to update mitigation requirements for development applications. Snohomish MRC will use the data to give more specific recommendations to the County, and to better understand how to incorporate preferred Dungeness crab habitat types in future restoration/protection projects.

By whom? WDFW, Snohomish MRC