***EVOS PROPOSAL SUMMARY PAGE***

***(Trustee Council Use Only)***
***Project No.*** ***G-030647***
***Date Received*** ***9/3/02***

Project Title: ***INVESTIGATING THE RELATIVE ROLES OF NATURAL AND SHORELINE HARVEST IN ALTERING THE COMMUNITY STRUCTURE, DYNAMICS, AND DIVERSITY OF THE KENAI PENINSULA'S ROCKY INTERTIDAL Submitted Under the BAA***

Project Period: FY 03 & FY 04

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Study Location: Kenai Peninsula

Trustee Agency: NOAA

Abstract:
The rocky shores of the outer Kenai Peninsula are the home of three Sugpiaq native villages where the black chiton, *Katharina tunicata*, remains an important traditional subsistence food source. This benthic invertebrate is also a competitively dominant herbivore known to have dramatic impacts on the structure, dynamics and diversity of the rocky intertidal. In collaboration with tribal members, we will evaluate the relative roles of natural factors (predation, grazing & natural variability) and anthropogenic impacts (*Katharina* harvest) in altering intertidal community structure. The project addresses the core GEM hypothesis of human versus natural impacts on the structure and productivity of coastal ecosystems. It will also provide 2 field seasons (2003 & 04) of valuable baseline monitoring in the intertidal zone that could be continued in the future. Local tribes will be involved in both developing and carrying out research which will match the GEM commitment to community based science.

## *I. INTRODUCTION*

The Black chiton, *Katharina tunicata*, is a dominant herbivore known to affect intertidal community structure along rocky shorelines of the Pacific Northwest (Dethier and Duggins 1984, Duggins and Dethier 1985, Markel and DeWreede 1998, Paine 2002) and southeast Alaska (Dethier and Duggins 1988). Its range spans surf swept rocky shores from Oregon to Alaska (Kozloff 1973, O'Clair and O'Clair 1998). Known as 'Bidarki' in Chugach Aluutiq and "Ohuduck" in Sugcestun, *Katharina* also represents an important component of coastal native diets and culture (Russell 1991, Chugachmiut 2000). Because of its central role in both the ecological and cultural dynamics of coastal Alaska, *Katharina* should be a focal species for investigating natural and anthropogenic change in the rocky intertidal zone.

We propose to investigate the relative roles of natural factors (predation, grazing, wave force and recruitment) and anthropogenic impacts (*Katharina* harvest) in altering the community structure, dynamics and diversity of the rocky intertidal. This research will be conducted at the northern most tip of the Kenai Peninsula, home of the Sugpiaq people of Port Graham, Nanwalek and Seldovia. We will determine the ecological ramifications of traditional native subsistence harvest of *Katharina* by comparing the algal and invertebrate species assemblages of heavily harvested shores close to the native villages (ecological "treatments") with more distant, unharvested shores (ecological "controls"). Because these treatments and controls are not randomly assigned, a large-scale manipulation of *Katharina* densities will allow us to test the effects of intertidal harvest directly. Other factors that could influence *Katharina* are predation by sea otters (Nickerson 1989), differential recruitment of planktonic larvae, and removal of adults by waves (Denny 1995). Whatever the cause, variation in *Katharina* density is likely to cause "domino effects" in the rest of the biotic community. In smaller-scale studies in other coastal areas, herbivory by *Katharina* alters the dominant space occupant and reduces intertidal productivity by up to an order of magnitude (Paine 1992, 2002). We will link this research to resource management by measuring *Katharina* survival, growth and length-specific fecundity. These demographic values will inform estimates of sustainable harvest, as well as allow us to test for density-dependent responses that could promote recovery of exploited populations.

Pilot work on this project was initiated by academic researchers, resource managers, and tribal members in the summer of 2002. Primary personnel include Anne Salomon, a graduate student in the Zoology Department at the University of Washington, Paul McCollum from the Chugach Regional Resource Council, Lydia McMullen, the Senior Fish Culturist at the Port Graham Hatchery, and Jim Miller, Port Graham's Natural Resource Specialist. In June and July 2002, baseline surveys were carried out at eight sites to document *Katharina* population size structure and density and the composition of intertidal assemblages. Results show that *Katharina* becomes increasingly common at sites that are less visited for subsistence harvest. The gradient applies mainly to larger individuals, whereas small *Katharina* are more evenly distributed across sites (Figure 1A&B). Due to the current extent of native community involvement with this project (Figure 2 & 3), this proposed research can serve as a pilot study to inform Project 03575, 'Designing a Community Involvement / Community Based Monitoring Plan for GEM'. Biodiversity surveys will use protocols compatible with those developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and the Kachemak Bay National Estuarine Research Reserve (KBNERR), which GEM may be adopting (http://www.oilspill.state.ak.us/events/Nearshore_2002). This proposed project could also be

used to ground-truth larger scale, lower resolution remote sensing / aerial video imaging projects 02584, 02613, and 02619.

## *II. NEED FOR THE PROJECT*

### *A. Statement of Problem*

Human activities now alter most of the earth's ecosystems, including coastal regions (Vitousek et al. 1986, Pauly & Christensen 1995). This ever-increasing anthropogenic impact accompanies a growing recognition that natural forcing functions are also dynamic (Francis, R. C. and S.R. Hare. 1994). Thus, a key challenge in understanding and predicting ecosystem productivity and resilience is to disentangle natural and anthropogenic change. Although long-term monitoring is appropriate for detecting change, shorter-term process studies must be used to explore the causes of this change. Indeed, baseline biological monitoring programs designed to serve as sentinel systems against which future change can be measured must incorporate the extent and magnitude of current anthropogenic impacts.

Because of the legacy of Exxon Valdez, it is easy to think of oil spills as the primary anthropogenic factor influencing intertidal assemblages. However, intertidal systems in many areas have been subject to – and coexisted with – tribal harvest of resources for thousands of years. Thus, another key anthropogenic factor to consider as it influences system productivity is direct exploitation in the intertidal zone. The black chiton *Katharina tunicata* is the primary invertebrate harvested in the rocky intertidal by coastal Alaskan Natives. Large individuals (≥ 6cm) are harvested during spring, summer and fall low tides and are eaten steamed, raw or incorporated into other traditional dishes. The tribes of Port Graham and Nanwalek have recently observed a decline of this benthic resource around their villages and consequently have had to move farther a field to harvest large individuals (Nick Tanapee, Simeon Kvasnikoff personal communication).

In pilot research in 2002, we documented lower densities of large *Katharina* at accessible, harvested sites vs. less-accessible, less-harvested sites (Figure 4). These results are consistent with strong negative impacts of humans on this dominant intertidal herbivore. However, natural factors undoubtedly also play into *Katharina* distributions. Some of the most likely include current patterns that influence larval delivery, predation by sea otters, and dislodgement by waves. Although we cannot manipulate these natural factors experimentally, we will monitor them at all study sites to determine how much of the variation in *Katharina* density can be explained by these natural factors.

Anthropogenic effects on *Katharina* are unlikely to be restricted to that species. As it grazes, this chiton can selectively remove species of algal sporelings, and it also "bulldozes" small invertebrates. Previous research on the impact of *Katharina tunicata* has revealed that this species can alter both the abundance and size structure of intertidal kelp (Duggins and Dethier 1985, Paine 1992, Markel and DeWreede 1998, Paine 2002) and invertebrate species (Dethier and Duggins 1984, Dethier and Duggins 1988). Research carried out by a member of the project team revealed a significant relationship between *Katharina* abundance and intertidal biodiversity in British Columbia (Salomon 2000). Indeed, *Katharina* is likely to structure intertidal communities in a manner well-documented in marine systems: When dominant consumers are removed from a system, direct and indirect community-level effects may ensue (Castilla and Duran 1985, Castilla and Bustamante 1989, Jackson et al. 2001). Their food sources, once

released from consumption, may increase, which can cause other species to decline. Jackson et al. (2001) propose that the removal by humans of top predators in marine systems has been a major contributor to altered community structure and collapse of productive natural resources.

Because of its cultural and ecological roles, *Katharina* should be the focus of process-oriented research on what factors influence its distribution and on how it in turn affects system structure and function as a whole. Changes in *Katharina* density may have "domino effects" on other intertidal species, which may cause dramatic spatial or temporal variation in long-term monitoring.

### *B. Rationale/Link to Restoration*

Although the black chiton *Katharina tunicata* is ecologically and culturally important in coastal Alaska, it was not reported as an injured resource after the Exxon Valdez oil spill. This may be due to the fact that it tends to occur on more wave-exposed shorelines and lower in the intertidal zone than where most of the oil landed. However, *Katharina* does serve as a prey item for species that were injured by the oil spill, including sea otters and black oystercatchers (Wootton 1997). The primary rationale for a focus on *Katharina* is to increase "critical ecological information" about natural and anthropogenic drivers of intertidal structure and function. Furthermore, the Bidarki has been identified as an important subsistence species needing further study at the Tribal level through the Tribal Natural Resource Management planning process.

### *C. Link to GEM Program Document*

In the intertidal zone, the GEM program document poses the question of how natural and anthropogenic factors influence community structure and function. In locations where it has been studied, *Katharina* plays a central ecological role in the lower intertidal zone, influencing both species composition and productivity (Paine 1992, 2002).

To DETECT change, this project will provide a three year time series of *Katharina* population and community assemblage / biodiversity data, which local tribal members are involved in designing and implementing. The two years proposed here will complement data collected in 2002, and local citizens could pursue monitoring over the longer term. To UNDERSTAND causes of change, this project focuses on the impacts of direct exploitation of a strongly-interacting intertidal species while accounting for natural variation in the species that could be due to recruitment, predation, or physical constraints. PREDICTING the status of natural resources in the future is a difficult task, but many models require parameter values for demography and species interactions. The research we propose will provide demographic information on *Katharina*'s survival, growth, and reproduction. In particular, we will examine whether these parameter values increase at low density, which could aid recovery of exploited populations. By involving tribal members in the design and implementation of this research, we will INFORM coastal communities about scientific methods and results. This information will be valuable to the native coastal Alaskans who use this resource and to the scientific community interested in understanding how food webs are altered by exploitation.

The information collected throughout this project will be georeferenced and made available to the public and interested agencies and scientists through a regularly updated web site.

## *III. PROJECT DESIGN*

### *A. Objectives*

1. Determine and compare the spatial variation of *Katharina* density and size structure and intertidal biodiversity / community structure at sites within traditional subsistence harvest areas and unharvested control sites. (Note some sites already chosen and described in section III D)

2. Quantify the ecological role of *Katharina* in structuring intertidal communities through experimental removals of *Katharina*.

3. Estimate the fecundity, survival and growth of *Katharina tunicata* to compare demography at exploited and unexploited densities.

4. Promote community involvement in practical, applied research that will provide useful information to both the native and scientific communities through education and hands on experience.

### *B. Procedural Methods*

#### *1. Spatial Variation of Katharina Density and Size Structure and Intertidal Biodiversity / Community Structure*

*Null Hypothesis #1: There is no difference in Katharina density or population size structure between harvested and unharvested sites.*

*Null Hypothesis #2: There is no difference in invertebrate and algal assemblage between harvested and unharvested sites.*

A total of 10 rocky intertidal, low angle sites, characteristic of *Katharina* habitat will be selected for study. These sites will fall along a gradient of exploitation from heavily harvested to relatively pristine. Highly articulated coastline will be avoided to reduce within site variability. In order to restrict between site variability to wave exposure, care will be taken to maintain slope consistency among sites. Each site will be approximately 50 m in length.

A series of community meetings will be held with interested tribal members, tribal natural resource specialists and local researchers to exchange traditional, local and western information on *Katharina* ecology, discuss relevant questions, and identify high and low harvest areas. This was successfully initiated in the summer of 2002 through one on one meetings with tribal elders and a community potluck organized by the Port Graham Natural Resource Specialist Jim Miller held on July 19$^{th}$ 2002 (Figure 2 & 3). As such, data has already been collected from 4 harvested and 4 unharvested sites (Figure 4). Two more unharvested sites will be selected based on further discussion with local Tribes.

The size frequency and density of *Katharina* will be estimated in the field by counting and measuring all individuals found within five 0.5 m wide belt transects running vertically to the shore and spanning *Katharina* habitat. Belt transects will be randomly stratified along a 50 meter transect. Calipers will be used to measure the maximum length of each individual found to the nearest 0.5 cm. Size-frequency relationships will then be derived as one site indicator of

adult growth, survival and juvenile recruitment. This vertical band sampling procedure is suggested to account for the spatial variation in of size classes as larger *Katharina* tend to be found at lower tidal elevations. Density estimates will also be made by counting the number of individuals per quarter meter square at the zero low tide level.

The percent cover of dominant algal species (ex: *Alaria* spp., *Hedophyllum sessile*) and sessile invertebrates plus counts of dominant mobile invertebrates (ex: *Katharina, Maragrites*, *Lacuna*, *Lottia*) will be quantified in ten 50cm X 50cm quadrats randomly stratified along a 50 m transect placed horizontally to the shore at the 0 low tide (chart datum will be estimated based on a corrected local tide and current charts). Percent cover categories used will be 0, 1, 5, 15, 25, 50, 75, 85, 95, 99, & 100. To account for extensive species overlap and the three-dimensional nature of the community, the canopy, understory and substrate will be surveyed allowing for greater than 100% cover per quadrat. This will be carried out once per year in June 2003 and June 2004. This methodology was chosen to be consistent with Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and Kachemak Bay National Estuarine Research Reserve (KBNERR) protocol. All data collected will be georeferenced using hand-held GPS.

Wave force at each site will be estimated with maximum wave force recorders and dissolution blocks (Denny 1985). Sea otter presence will be monitored at each site to estimate natural predation pressure. Shore and 'on water' observations will be made each time a site is visited for monitoring and experimental research. Pilot observations made in the summer of 2002 indicate that there is differential otter presence among the 8 sites visited.

***2. Experimental Removal of Katharina***

*Null Hypothesis #3: Katharina has no effect on invertebrate and algal community structure or algal productivity.*

*Katharina* will be harvested experimentally in the early spring (April 2003) from a 5 x 5m area at 3 traditionally unharvetsed sites. These sites will be randomly chosen from among the 5 possible unharvested sites. The remaining 2 unharvested sites will be left unharvested. Based on the size that is traditionally harvested, all individual *Katharina* greater than 6 cm will be removed. After the removal experiment, algal and invertebrate species, in particular algal sporelings, will be quantified in the experimental plots and control areas once a month from April to August. Experimental plots will be maintained / harvested throughout the year by local project field assistants.

***3. Katharina Demography at Exploited and Unexploited sites***

*Null Hypothesis #4: There is no difference in Katharina fecundity, survival and growth between sites.*

Because *Katharina* alters the composition and productivity of prey items, it may experience substantial intraspecific competition at high densities. Indeed, large individuals could even remove new recruits by "bulldozing." Consequently, the harvest of large individuals could actually improve the growth and survival of smaller individuals or increase reproductive output of remaining adults. If such compensatory density dependence occurs, then populations may recovery more rapidly than expected after exploitation, as long as recruitment is unimpaired.

To estimate fecundity, we will measure length-specific gonad weight of individuals collected by locals for consumption or removed during experimental manipulations. Gonads will be excised, dried and measured following protocols in Salomon (2000).

Survival and growth will be determined through mark-recapture experiments. We will mark up to 200 individual *Katharina* spanning four size classes at low-density and high-density sites. Chitons will be double-marked with epoxy putty on their dorsal plates, and a numbered tag will be embedded in the epoxy on one plate. Marking will occur in June 2003, and chitons will be resampled in August 2003 and April 2004. Length and weight will be measured for all marked individuals to determine summer (June-August) and winter (August-April) growth. It may be possible to estimate actual survival rates using Jolly-Seber methods, however, because we only have time to do two recaptures, survival at low- and high-density sites is likely to be a relative rather than absolute measure.

***4. Current and Future Tribal Involvement***

Although the Trustee Council is not emphasizing community-based science in this round of proposals, it is important to point out that this project meets a central goal of GEM by involving tribal members in both design and implementation of research. Summer field assistants will be hired from the villages of Port Graham and/or Nanwalek. As in July 2002, community meetings organized in collaboration with the local Natural Resources Specialists, Fisheries and Environmental staff will be held with the goal of documenting traditional ecological knowledge of *Katharina* and its nearshore ecosystem following the Trustee Council's TEK protocols. This documentation will be spear headed and completed by Henry Huntington, the project's Traditional Ecological Knowledge expert, working closely with local traditional knowledge holders of the Port Graham or Nanwalek communities. At these meetings scientific, natural history and cultural knowledge of *Katharina* will be shared.

***C. Statistical Methods***

One anthropogenic (harvest) and three natural (wave force, recruitment, predation) factors may contribute to spatial variation in density of *Katharina*. To analyze our observational data, we will determine how much of the variation in density of large *Katharina* (>6 cm) can be accounted for by each of these factors, using multiple regression. Harvest pressure will be estimated from interviews with local subsistence harvesters. Wave force will be measured with dynamometers, and predation pressure will be based on observations of sea otters. Recruitment of *Katharina* will be based on densities of small individuals (<2 cm).

Changes in *Katharina* density following their large-scale experimental removal will be analyzed by repeated measures analysis of variance, with sites nested within treatment (rarely harvested vs. experimentally harvested).

Size-specific growth and survival data will be collected at two low-density and two high-density sites [ideally the low-density sites would be post-experimental removal]. We will analyze results using analysis of variance (low-density vs. high-density sites) or analysis of covariance (using density as the covariate). Size-specific fecundity will be analyzed similarly.

Community structure / biodiversity data will be analyzed using non-metric multidimensional scaling to look at community-level differences among sites.

Given that we will have 10 sites, 10 quadrats per site, an alpha value/significance level of 0.05 and an estimate of *Katharina* density variance within each site to be 7.62 /.25m$^2$ (this is based on data collected in Port Graham in July 2002 Figure 3), where k = 10, n = 10, $\alpha$ = 0.05, $s^2$ = 7.62 /.25m$^2$ and $U_i$ = 1.9,1,.4,5.8,6.6,4.6,5.6,7.8,6,6, and using $\Phi = \sqrt{n \Sigma(u_i-u)^2 / ks^2}$ (Zarr 1999), $\Phi$ = 1.658. Based on Appendix Figure B1 in Zar (1999) for $v_1$= (k-1) = 8 (*note, no graph exists for $v_1$ = 9), $\Phi$ = 1.658, and $v_2$= k(n-1) = 81; ***power = 0. 96***. Thus we there will be a 4% chance of committing a Type II error in the proposed *Katharina* density analysis.

### *D. Description of Study Area*

This project will be conducted at the northern most tip of the Kenai Peninsula, home of three small native villages; Port Graham, Nanwalek and Seldovia (59.4833, -152.0000, 59.1667, -151.6667 lat/long coordinates). Tribal members have already been involved in site selection and pilot data collection. They will benefit from ecological study of *Katharina* because it remains an important subsistence resource that is apparently declining in some areas.

### *E. Coordination and Collaboration with Other Efforts*

This project will be conducted in collaboration with the Center for Alaskan Coastal Studies (Marilyn Sigman) and the Chugach Regional Resource Council (Paul McCollum). Due to the degree of tribal participation in this project, it is closely linked to Project 03575; 'Designing a Community Involvement / Community Based Monitoring Plan for GEM'. As Project 03575 is focused on identifying strategies and approaches to provide meaningful community involvement in GEM research and monitoring activities, the proposed research acts as a demonstration project that may illustrate what works and what could be improved upon in terms of tribal involvement in the future.

There is a strong need for developing and nurturing alliances between Tribal Natural Resource research, scientists, educators, and non Tribal natural resource management. Increasing meaningful tribal involvement in nearshore research and monitoring activities will help facilitate stewardship, an awareness of local natural resources and ecosystems and will allow tribal and community derived research questions and hypotheses to be addressed.

This project will help bring about an increased amount of communication and cooperation between scientists and local communities. Researchers are recognizing more and more that Native people have traditional knowledge that can help answer otherwise unanswerable questions, obtain a clearer understanding of the local behavioral / ecological issues, or even raise entirely new questions. Both Port Graham and Nanwalek have been working with CRRC in developing their Tribal Natural Resource Management Programs. These programs are developed at the local level to ensure long-term ecological health, sustainability of important subsistence resources, and responsible management of lands in proximity to their villages and traditional use areas. CRRC will work closely with the PI to help optimize interaction and communication between the research efforts and the participating villages. Because the Bidarki has been identified as an important subsistence species needing further study at the Tribal level through the Tribal Natural Resource Management planning process, this project will have a high degree of relevance and local interest from the communities involved.

This proposed research complements the Washington, Oregon and California intertidal monitoring initiative of PISCO and the KBNERR intertidal monitoring of Kachemak Bay because it uses the same intertidal monitoring protocol.

## *IV. SCHEDULE*

### *A. Project Milestones*

Objective 1. Determine the spatial variation of *Katharina* density and size structure and monitor intertidal biodiversity / community structure at sites within traditional subsistence use areas and unharvested control sites.
To be met by July 2003 and once again in July 2004

Objective 2. Quantify the ecological role of *Katharina* in structuring intertidal communities through experimental removals of *Katharina*.
To be met by August 2003 and once again in August 2004

Objective 3. Estimate the fecundity, survival and growth of *Katharina* to compare demography at exploited and unexploited densities
To be met by May 2004

Objective 4. Promote community involvement in practical, applied research that will provide useful information to the Native communities through education and hands-on experience.
To be met throughout this project

### *B. Measurable Project Tasks*

FY 03, 1st quarter (October 1, 2002-December 31, 2002)
November 25: Project funding approved by Trustee Council

FY 03, 2nd quarter (January 1, 2003-March 31, 2003)
January 13-17: Annual EVOS Workshop (joint symposium with GLOBEC and NMFS)

FY 03, 3rd quarter (April 1, 2003-June 30, 2003)
April 31: Community meeting to discuss project and select remaining sites
April 31: Experimental *Katharina* harvest complete
May 30: 200 Individual *Katharina* marked, measured and released
June 30: Length-fecundity relationship estimated from regularly harvested individuals

FY 03, 4th quarter (July 1, 2003-September 30, 2003)
July 30: Baseline *Katharina* population survey & biodiversity/ Community structure survey complete

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| August 30: | Native community meeting / potluck in Port Graham and Nanwalek |
| September 30: | Recapture, measure and re-release tagged *Katharina* |
| September 30: | Present findings to date to Native villages |
| September 30: | Preliminary TEK report based on community meetings to date – to be completed by September 30, 2004 |

FY 04, 1st quarter (October 1, 2003-December 31, 2003)

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| December 15: | Statistical analysis of summer data |

FY 04, 2nd quarter (January 1, 2004-March 31, 2004)

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| (dates not yet known) | Annual EVOS Workshop |
| March 31: | Recapture and measure tagged *Katharina* |

FY 04, 3rd quarter (April 1, 2004-June 30, 2004)

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| April 15 | Submit final report (which will consist of draft manuscript for publication) to EVOS |

FY 04, 4th quarter (July 1, 2004-September 30, 2004)

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| July 30: | Second baseline *Katharina* population survey & biodiversity/ intertidal community structure survey complete |
| August 30: | Native community meeting / potluck |
| August (dates not yet known): | Attendance at the Society for Conservation Biology Annual meeting at Columbia University New York |
| September 30: | Present key findings and conclusions to native villages |
| September 30: | Final TEK report based on community meetings complete and made available for distribution |
| September 30: | draft manuscript complete for peer reviewed journal |

## *V. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES*

### *A. Community Involvement and Traditional Ecological Knowledge (TEK)*

This proposal involves a strong community participation component and the integration of Traditional Ecological Knowledge (TEK) with Western science. Affected and participating communities will be informed about the project and be given an opportunity to provide their input at two annual community meetings/potlucks to be held in July/August 2003 and 2004. Research findings will be communicated to the native communities at the end of the field season during September 2003 and 2004. Two field assistants will be hired from the local native villages of Port Graham, Seldovia, and/or Nanwalek. Traditional and local knowledge on *Katharina* will be documented by the project's TEK expert, Dr. Huntington, with copies made available by September 30th, 2003.

### *B. Resource Management Applications*

*Katharina tunicata* is not traditionally a state or federally managed species. As suggested earlier, community-based monitoring of this resource and the ecosystem upon which it relies would be incredibly instructive and may promote the sustainable harvest of *Katharina*. Furthermore, data collected during this study could inform marine reserve design by identifying areas of high productivity and high recruitment. This project will also allow us to investigate the utility and ecological ramifications of marine reserves and promote community involvement and awareness in the sustainable use of coastal resources.

Intertidal invertebrates and algae are often harvested with little to no management information (West 1997) and *Katharina* is no exception. As a broadcast spawner, *Katharina* is likely subject to metapopulation dynamics and like any harvested species, is vulnerable to overexploitation. Community-based monitoring of this resource and the ecosystem upon which it relies would be very instructive and may promote the sustainable harvest of *Katharina*. A well-informed and effective Tribal harvest plan would be incorporated into each of the participating villages Tribal Natural Resource Management Plans along with the information on the population dynamics and ecological role of *Katharina*, Traditional Ecological Knowledge, and Tribal involvement in the research conducted. Furthermore, biodiversity / invertebrate and algal community structure data in control areas can be used as baseline nearshore information on natural variability upon which future change, both natural and anthropogenic, can be assessed. Improved understanding of the marine and coastal ecosystems that support the resources, as well as the people of the Exxon Valdez spill region will be extremely beneficial.

Marine reserves, also known as harvest refugia, may be an appropriate fisheries management techniques to ensure the sustainable use of this benthic marine invertebrate and the conservation of intertidal and nearshore ecosystem dynamics. In an effort to promote adaptive management among coastal communities, Alaskan Natives of Port Graham and Nanwalek could experiment with spatially explicit harvest policies based on the information they gather on the population dynamics of *Katharina*. Limiting the harvest of *Katharina* to several populations while maintaining several source populations (Pulliam 1988) free from fishing effort would allow us to investigate the utility and ecological ramifications of marine reserves and promote community involvement and awareness.

## *VI. PUBLICATIONS AND REPORTS*

*Proposed Peer Reviewed Manuscripts*

1. Incorporating Local Coastal Communities and Traditional Ecological Knowledge in Conservation Research

   Submitted to Conservation Biology in Practice by December 2004

2. Impacts of Natural Factors and Shoreline Harvest on the Community Structure, Dynamics and Diversity of the Rocky Intertidal

   Submitted to Marine Ecological Progress Series by December 2004

*Proposed Report*

1. Traditional Ecological Knowledge of Bidarkis
completed by September 2003

## *VII. PROFESSIONAL CONFERENCES*

We plan to present a paper at the annual Society for Conservation Biology meeting to be held at Columbia University in New York, August 2004 (specific dates are as of yet not posted). We will discuss our current findings on the ecological impacts of traditional native harvest of *Katharina* and how to involve local coastal communities in research.

## *VIII. PERSONNEL*

### *A. Principal Investigator (PI)*

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### *B. Other Key Personnel*

***Anne Salomon***

Anne Salomon is a doctoral graduate student in the Zoology Department at the University of Washington. As the principal field researcher, she will use this proposed research in several dissertation chapters. Ms. Salomon will be responsible for collecting all of the field data in the manner described, analyzing the data, writing the quarterly reports and proposed manuscripts, and liasing with the native villages. Ms. Salomon has extensive experience working in the temperate rocky intertidal having obtained her Master's degree from the University of British Columbia investigating the relationship between population viability and intertidal biodiversity and its implication for marine reserve site selection.

***Paul McCollum***

Mr. McCollum is CRRC's Fisheries and Natural Resource Biologist as well as the owner and chief biologist of Sound Fisheries. He is a fisheries biologist with 30 years of experience in Alaskan fisheries research, enhancement and management projects. He is contractually employed by the Port Graham Village Council working on Fisheries, Natural Resources and Environmental projects. He works closely with the Port Graham Hatchery staff, providing training, education, and consulting advice for all aspects of the project. He works directly with the Nanwalek Tribal I.R.A. council providing consultation and technical assistance with their fisheries, natural resources and environmental projects and programs. He also works contractually with the Seldovia Village Tribe on their Tribal Environmental Program. He works with the Port Graham, Nanwalek and Seldovia Schools from time to time, helping to bring fisheries, natural resource and environmental issues into the classroom.

***Marilyn Sigman***

Ms. Sigman is the Executive Director of the Center for Alaskan Coastal Studies. Ms. Sigman has an in-depth knowledge of Alaska's coastal ecosystems and resource management issues and experience in program and project management that focuses on coastal ecosystems and facilitating linkages among the scientific, education, and local communities. She was Project Director of the EPA-sponsored Tillamook Bay National Estuary Project from 1993-96 where she developed and facilitated the integration of community involvement and scientific research in the context of developing solutions to watershed management issues. She has also coordinated regional and statewide education programs for the Alaska Department of Fish and Game.

***Dr. Henry Huntington***

Dr. Huntington works with CRRC on Traditional Ecological Knowledge issues and projects and will serve as the projects TEK Specialist. Dr. Huntington received his Ph.D. at the University of Cambridge (U.K.), Scott Polar Research Institute in Polar Studies. He has served as the Environmental Coordinator for the Inuit Circumpolar Conference (ICC), coordinating ICC policy regarding the Arctic Environmental Protection Strategy (AEPS), in cooperation with indigenous organizations in Russia and Scandinavia. He was also responsible for TEK and other research projects under the auspices of the AEPS.

### *C. Contracts*

No contracting will be done

## *IX. PRINCIPAL INVESTIGATOR QUALIFICATIONS*

Dr. Jennifer Ruesink – Short Curriculum Vitae

### Education

University of Washington, Ph.D. Zoology (1996)
Cambridge University, England, M.Phil. Botany (1990)
Cornell University, B.A. Biology, Summa Cum Laude (1989)

### Employment

Assistant Professor, Department of Zoology, University of Washington (Sept. 1999-)
Post-doctoral fellow, Department of Zoology, University of British Columbia (1996-99)
*Current Responsibilities: Graduate and undergraduate student advising and teaching, marine community ecology research*

### Expertise

12 years experience studying community ecology of rocky shores of Washington, British Columbia, and Alaska
State and nationally funded research program on biodiversity, species interactions, and population dynamics
Committee service to advise the Olympic Coast Marine Sanctuary/ Olympic National Park on reserve design and intertidal monitoring; and on NRC panel to review GEM

Published record of quantitative expertise in parametric statistics, power analysis, likelihood analysis, matrix modeling, and food web/ Ecopath modeling

### Publications

Jenkins, C., M.E. Haas, A. Olson & J.L. Ruesink. Impacts of trampling on a rocky shoreline of San Juan Island, Washington. In press, Natural Areas Journal.

Driskell, W.B., J.L. Ruesink, D.C. Lees, J.P. Houghton & S.C. Lindstrom. 2001. Long-term signal of disturbance: *Fucus gardneri* after the *Exxon Valdez* oil spill. Ecological Applications 11:815-827.

Ruesink, J.L. 2000. Assessing density dependence using intraannual counts. Ecology 81:3377-3390.

Ruesink, J.L. 1997. Coral injury and recovery: matrix models link process to pattern. J. Exp. Mar. Biol. Ecol. 210: 187-208.

Paine, R.T., J.L. Ruesink, et al. 1996. Trouble on oiled waters: lessons from the *Exxon Valdez* oil spill. Ann. Rev. Ecol. Syst. 27: 197-235.

Total: 22 peer-reviewed papers, 3 published reports, 5 book reviews

## *X. LITERATURE CITED*


Castilla, J. C., and R. H. Bustamante. 1989. Human exclusion from rocky intertidal of Las Cruces, central Chile: effects on *Durvillaea antartica* (Phaeophyta, Durvilleales). *Marine* Ecology Progress Series 50: 203-214.

Castilla, J. C., and L. R. Duran. 1985. Human exclusion from the rocky intertidal zone of central Chile: the effects on *Concholepas concholepas* (Gastropoda). Oikos 45: 391-399.

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Duggins, D. O., and M. N. Dethier. 1985. Experimental studies of herbivory and algal competition in a low intertidal habitat. Oecologia 67: 183-191.

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Markel, R. W., and R. E. DeWreede. 1998. Mechanisms underlying the effect of the chiton *Katharina tunicata* on the kelp *Hedophyllum sessile*: size escapes and indirect effects. Marine Ecology Progress Series 166: 151-161.

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O'Clair, R. M., and C. E. O'Clair. 1998. Southeast Alaska's Rocky Shores. Plant Press, Auke Bay, Alaska.

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Pauly, D. and V. Christensen. 1995. Primary production required to sustain global fisheries. Nature 374: 255-257.

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A)

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Wootton, J.T. 1997. Estimates and tests of per capita interaction strength: Diet, abundance, and impact of intertidally foraging birds. Ecological Monographs 67: 45-64.

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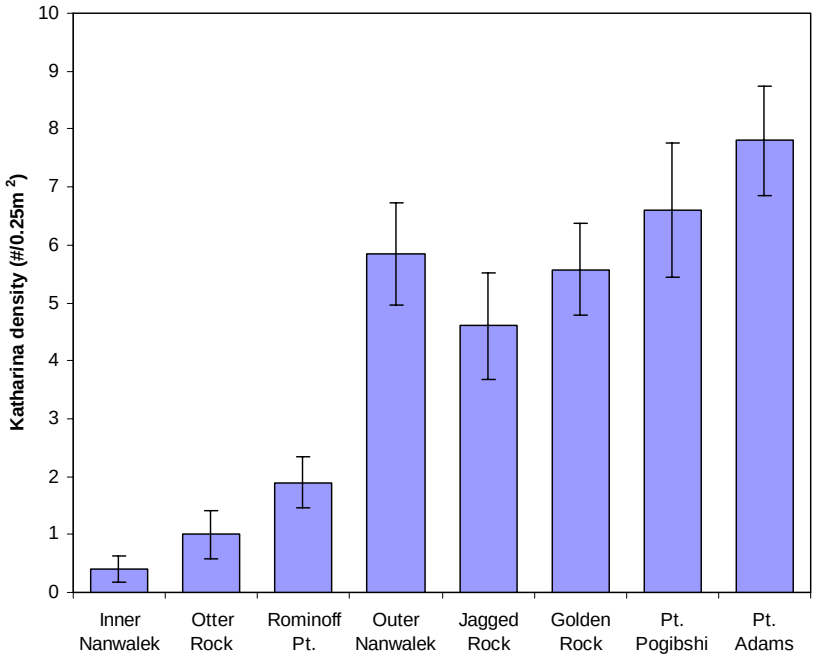


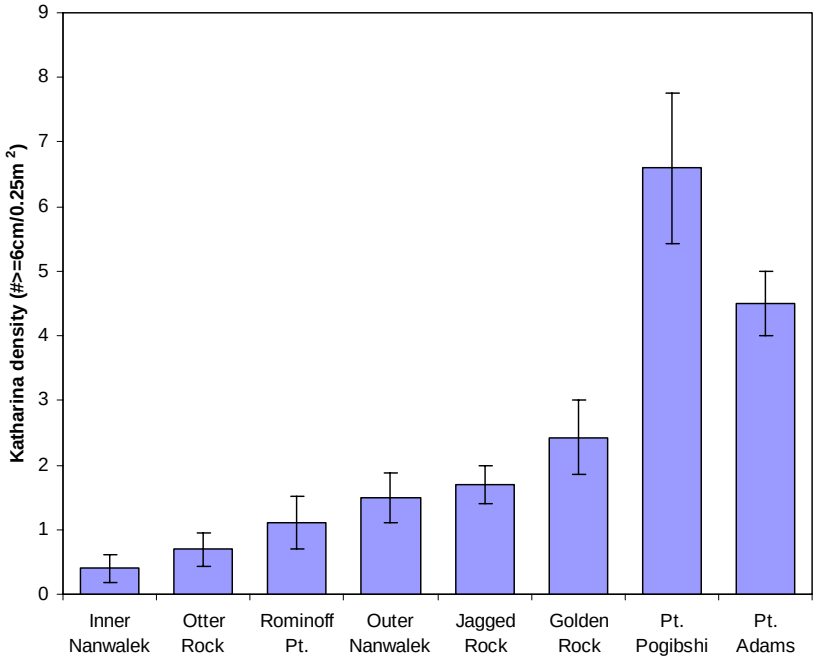


Figure 1 A&B: *Katharina* density per quarter meter square at the zero low tide level (A all individuals, B individuals ≥ 6cm) at 8 sites located at the northern most tip of the Kenai Peninsula. *Katharina* harvest occurs at the first 4 sites although most heavily at the first 3. These sites are arranged in increasing distance from Port Graham and Nanwalek. Data was collected in June and July 2002.

# Natural Resources Luncheon

**Port Graham July 19th, 2002**







Figure 2: Natural resources Luncheon July 19, 2002.

Figure 3 is too large to transmit. Please see hard copy of proposal. If you have any questions feel free to contact me.

Thanks you ,
Anne Salomon

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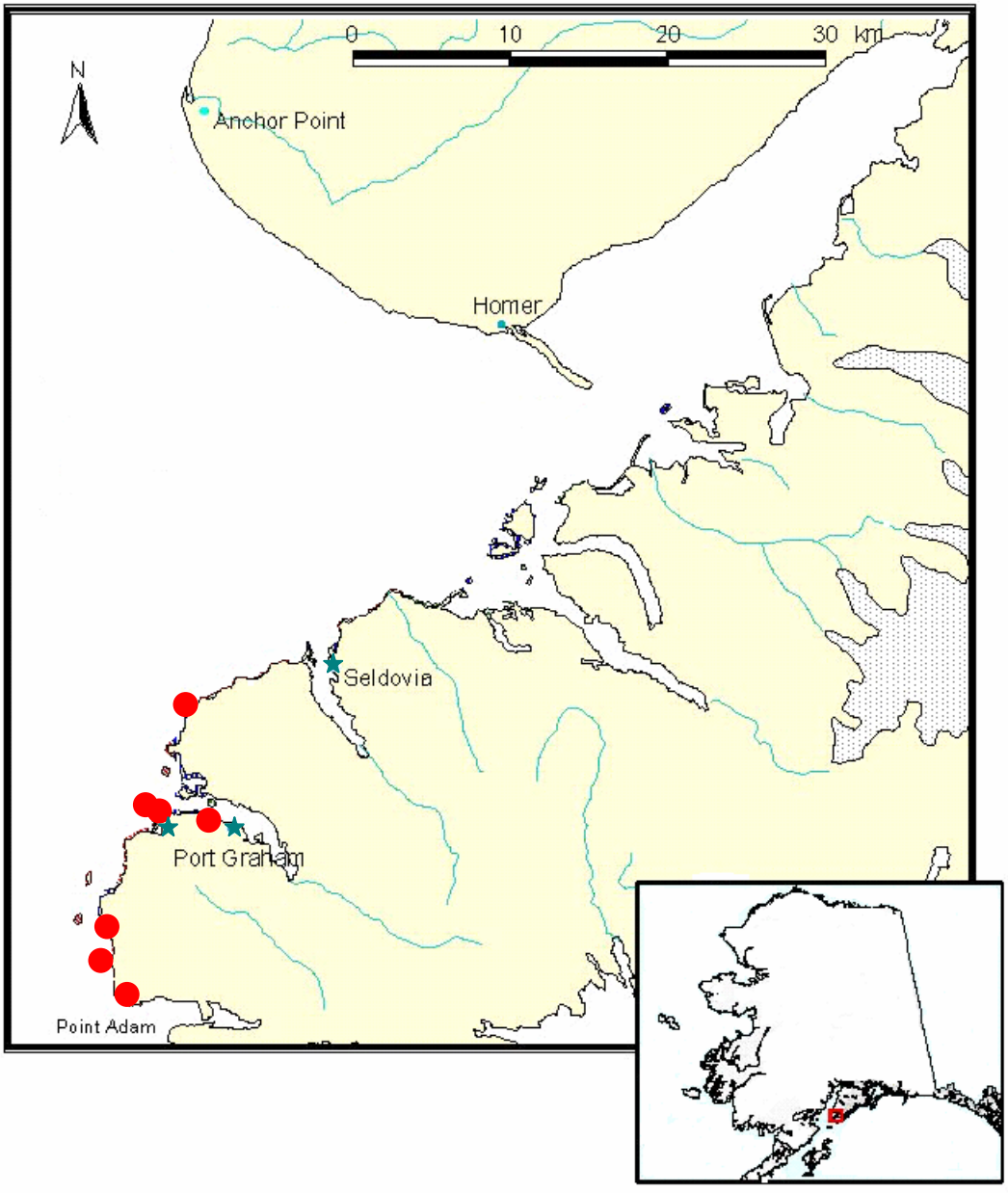


Figure 4: ● Location of sites surveyed in July 2002. ★ Location of Sugpiaq Native Villages.

**EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL**
**PROJECT BUDGET**

| **Budget Category:** | Proposed FY |
|---|---|
| | |
| Personnel | $38.0 |
| Travel | $5.4 |
| Contractual | $0.0 |
| Commodities | $6.2 |
| Equipment | $0.0 |
| Subtotal | $49.6 |
| Indirect Cost University of WA (26%) | $11.8 |
| Administration of Funds (9%) | $5.5 |
| **Project Total** | **$66.9** |
| | |
| | |
| | |
| Other Funds in kind donation | $12.0 |

Comments:
The CRRC Project Coordinator, Paul McCollum, will provide time and support as an in kind contribution from CRRC

**FY04**

Prepared:
11/5/2002

Project Number:
Project Title: Investigating the Relative Roles of Natural Factors and Shoreline Harvest in Altering the Community Structure, Dynamics, and Diversity of the Kenai Peninsula's Rocky Intertidal
Submitted Under the BAA
Name: Dr. Jennifer Ruesink, University of Washington

**EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL**
**PROJECT BUDGET**

| **Personnel Costs:** | | | Months | Monthly | |
|---|---|---|---|---|---|
| Name | Description | | Budgeted | Costs | Overtin |
| A. Salomon | Graduate Student/ Principal Field Researc | | 9.2 | 2.2 | 0 |
| (to be hired from 1 of the 3 participating native | Research Assistant | | 3.0 | 2.3 | |
| (to be hired from 1 of the 3 participating native | Resaecrh Assistant | | 3.0 | 2.3 | |
| Henry Huntington | TEK Specialist | | 1.0 | 4.0 | |
| Paul McCollum | Native Village Liason & Coordinator (in Kir | | 2.0 | 6.0 | |
| | Subtotal | | 18.2 | 16.8 | 0 |
| | | | | | **Personnel To** |

| **Travel Costs:** | | Ticket | Round | Total | Da |
|---|---|---|---|---|---|
| Description | | Price | Trips | Days | Per Die |
| A. Salomon | Seattle to Anchorage, Alaska for EVOS/GLOBEC workshop | 0.7 | 1 | | |
| A. Salomon | Seattle to Homer, Alaska for field season research | 0.8 | 2 | | |
| A. Salomon | Homer, Alaska to PortGraham, Alaska for field research | 0.1 | 12 | | |
| A. Salomon | Homer, Alaska to New York for Society for Conservation Bio | 1.0 | 1 | | |
| J. Reusink | Seattle, WA to Port Graham, Alaska for field work | 0.9 | 1 | | |
| | | | | | **Travel To** |

**FY04**

Prepared:
11/5/2002

Project Number:
Project Title: Investigating the Relative Roles of Natural Factors and Shoreline Harvest in Altering the Community Structure, Dynamics, and Diversity of the Kenai Peninsula's Rocky Intertidal Submitted Under the BAA
Name: Dr. Jennifer Ruesink, University of Washington

**EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL**
**PROJECT BUDGET**

| **Contractual Costs:** |
|---|
| Description |
| |
| **Contractual To** |
| **Commodities Costs:** |
| Description |
| Community involvement meetings |
| TEK Report |
| Manuscript page costs (for Marine Ecological Progress Series) |
| Fuel |
| Boat upkeep |
| Communications |
| **Commodities Tot** |

**FY04**

Prepared:
11/5/2002

Project Number:
Project Title: Investigating the Relative Roles of Natural Factors and Shoreline Harvest in Altering the Community Structure, Dynamics, and Diversity of the Kenai Peninsula's Rocky Intertidal
Submitted Under the BAA
Name: Dr. Jennifer Paci, University of Washington

**EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL**
**PROJECT BUDGET**

| **New Equipment Purchases:** | Number of Units | U Pri |
|---|---|---|
| Description | | |
| | | |
| Indicate replacement equipment purchases with an R. | | **New Equipment To** |

| **Existing Equipment Usage:** | Numb of Un |
|---|---|
| Description | |
| | |

**FY04**

Prepared:
11/5/2002

Project Number:
Project Title: Investigating the Effects of Traditional Native Subsistence Harvest of Katharina Tunicata on Intertidal Community Structure Submitted Under the BAA