A rapid survey method for native blue mud shrimp (*Upogebia pugettensis*) and its associated parasitic isopod, *Orthione griffenis*, in Alsea Bay, Oregon and alternative applications of this methodology.

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Submitted to:

Marine Resource Management Program
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In partial fulfillment of the requirements for the degree of:

Master of Science

June 1, 2012

Master of Science project of Cameron S. Carter presented on June 1, 2012

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I understand that my project will become part of the permanent collection of Oregon State University libraries. My signature below authorizes the release of my project paper to any reader upon request.

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my major advisor, Dr. John Chapman, for his unwavering support in this endeavor. Thank you for giving me direction in the infancy of this project, when I was searching for a research focus to apply to a small grant provided by The Nature Conservancy. You provided all the resources and encouragement I needed to turn a small project into something comprehensive, substantive, and meaningful. Thank you for being a true inspiration, and for giving me a profound appreciation for intertidal mudflats and the things that live there. Thanks to my other committee members: Flaxen Conway for giving me perspective on the implications of my research and continued support throughout my MRM academic career, and Tracy Crews for her input on the class curriculum portion of this paper. I thank Sara Mae Thoma and Erin Bruce for their help in data collection.. Lastly, I thank my parents for their unconditional love and support, and my friends for helping me find the humor in the work that I do.

CONTRIBUTION OF AUTHORS

Dr. John Chapman provided much of the advice I needed to portray the complete story of *Upogebia pugettensis* and the importance of my research in chapter 2, and provided comments throughout the paper. Flaxen Conway and Tracy Crews reviewed and provided comments for chapters 1 and 4, and chapters 1, 2, 3, and 4, respectively.

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Chapter 1: The Mud Shrimp Story

INTRODUCTION

This paper is to partially fulfill the requirements for my Masters of Science degree in Marine Resource Management from Oregon State University. This research was focused on developing: a new rapid-survey methodology to assess declining populations of an intertidal burrowing mud shrimp, and translating the methods used into a suitable 7^{th} grade math and science curriculum.

Chapter 2 concerns a new methodology we developed to assess the population dynamics of a burrowing mud shrimp, *Upogebia pugettensis*, and it's invasive parasitic isopod, *Orthione griffenis,* in Alsea Bay, Oregon and is intended for submission to a peer reviewed journal covering marine biology or ecology. The isopod is responsible for dramatic declines of all populations of *Upogebia* along the western United States and up to 18% annually in Yaquina Bay (Chapman et al., 2012). I estimated total mud shrimp abundance and biomass, infestation rate, and lost reproductive potential due to infestation by this invasive isopod in Alsea Bay. This work adds to knowledge about this understudied species, and it presents a new method of rapidly surveying static biological populations as an alternative to current practices. This project was funded by a small grant from The Nature Conservancy due to their interest in preserving and prioritizing important Oregon coastal mudflat environments for conservation or restoration.

Chapter 3 presents the 7^{th} grade math and science curriculum that I developed from the methodology shared in chapter 2, and intend to submit to a marine education journal. The curriculum is intended to help students practice scientific inquiry and methodology by collecting, organizing, and analyzing data, and reaching a conclusion while addressing scientific error. Students are enabled to use simple arithmetic calculations, a global positioning system (GPS), Microsoft Excel®, and data collection to answer scientific questions, such as "how many earthworms are present in our school's courtyard?" The goals of this curriculum satisfy 7th grade mathematics and science objectives as defined by the Oregon State Department of Education's Oregon Common Core State Standards.

Chapter 4, includes lessons learned during this project beyond the academic articles in chapters 2 and 3 including, how my results fit in more broadly with marine resource management and among various stakeholders surrounding the management of burrowing mud shrimp.

BACKGROUND AND PROJECT RATIONALE

The burrowing blue mud shrimp, *Upogebia pugettensis*, is native to western North America and ranges from British Columbia, Canada, to Morro Bay, California. The term "keystone species" applies to *Upogebi*a because of their effects on the estuary ecosystems and the communities of organisms that can coexist with them (Aller and Dodge, 1974; Ronan, 1975; Peterson, 1977; Peterson, 1979; Bird, 1982; Murphy, 1985; Posey, 1986, 1990; Weitkamp, 1991). *Upogebia* build permanent Y-shaped burrows in intertidal mudflats, and congregate together in massive "beds" that once covered thousands of hectares, included thousands of tons of shrimp biomass and dominated intertidal ecosystems (Hornig et al., 1989; DeWitt et al., 2004; Griffen et al., 2004). The nearly permanent burrows of *Upogebia* directly and indirectly provide a wide range of ecosystem functions including the amplification of carbon, nitrogen, and oxygen cycling, and the creation of critical habitat for several species of commensal shrimp, clams and polychaetes. *Upogebia* are also important prey for a wide range of marine fish and birds and their massive suspension feeding activities can significantly impact overall intertidal estuary water quality.

Infestations by the parasitic bopyrid isopod, *Orthione griffenis*, introduced via ship ballast water from Asia, first appeared among eastern Pacific *Upogebia* in the 1980's and 1990's (Chapman et al., 2012). The isopod attaches to the inner carapace lining of the shrimp and feeds on hemolymph, which energetically castrates the host (Smith et al., 2008). Marine parasitic castrators, like *Orthione,* are particularly likely to affect host populations because they can reduce host fitness to zero without increasing host mortality. Castrated hosts may thus compete with uninfested hosts while increasing potential for new infestations on a broader scale (Lafferty and Kuris, 2002; McCallum et al., 2004). Large portions of *Upogebia* populations have been unable to reproduce, and local populations appear to be decreasing by 18% or more annually in all estuaries in its native range (Chapman et al., 2012). Populations of *U. pugettensis* have disappeared in some estuaries where they were once abundant (Chapman, personal observations). Many populations of *U. pugettensis* remain unstudied or understudied, and the largest remaining populations are in estuaries along the central Oregon coast.

Quantitative estimates of *Upogebia* declines are based only a few populations in Willapa Bay, Washington and Tillamook Bay, and Yaquina Bay, Oregon in 2002, 2008 and 2010 (Dumbauld et al., 2011, Chapman et al., 2012). More populations have not been surveyed extensively due to the enormous time and effort they require. Our survey goals were:

1) To develop a rapid survey method to assess basic population parameters of local *Upogebia pugettensis* populations.
2) To establish a baseline population structure assessment of the *Upogebia pugettensis* population in Alsea Bay, Oregon.
3) To develop a middle-school curriculum emphasizing math and biology based on our rapid survey method.

As global human populations continue to rise, increasing pressure on marine resources for food, energy, climate mitigation, shoreline protection, and recreation is inevitable, and reliance on marine-based ecosystem functions like those provided by *Upogebia* becomes exacerbated. Over half the world's population lives and works in a coastal strip just 200 km (120 miles) wide, while a full two-thirds live within 400 km of a coast (Hinrichsen, 1998). Marine resources therefore face tremendous challenges in the coming decades, and sound management is more important now than ever before.

Protection and management of these critical resources requires managers and policy makers able to approach these difficult problems with creative, ecologically based approaches. I hope the story of these mud shrimp will increase awareness of ecosystem functions supplied by our marine resources, and the importance of thoughtful conservation.

REFERENCES

Aller, R. C. and Dodge, R. E. 1974. Animal-sediment relations in a tropical lagoon Discovery Bay, Jamaica. *Journal of Marine Research* 32: 209-232.

Bird, E. M. 1982. Population dynamics of thalassinidean shrimps and community effects through sediment modification. Ph. D. dissertation, University of Maryland, College Park, MA.

Chapman, J. W., Dumbauld, B. R., Itani, G., and J. C. Markham. 2012. An introduced Asian parasite threatens northeastern Pacific estuarine ecosystems. Biological Invasions 14 (6): 1221-1236.

DeWitt, T. H., D'Andrea, A. F., Brown, C. A., Griffen, B. D., and P. M. Eldridge. 2004. Proceedings of the Symposium on Ecology of Large Bioturbators in Tidal Flats and Shallow Sublittoral Sediments –from Individual Behavior to Their Role as Ecosystem Engineers. University of Nagasaki, Japan. pp. 107-118.

Dumbauld, B. R., Chapman, J. W., Torchin, M. E., and A. M. Kuris. 2011. Is the collapse of mud shrimp *(Upogebia pugettensis)* populations along the Pacific coast of North America caused by outbreaks of a previously unknown bopyrid isopod parasite *(Orthione griffenis)*? Estuaries and Coasts 34: 336-350.

Griffen, B. D., DeWitt T. H., and C. Langdon. 2004. Particle removal rates by the mud shrimp *Upogebia pugettensis,* its burrow, and commensal clam: effects on estuarine phytoplankton abundance. *Marine Ecology Progress Series* 269: 223-236.

Hinrichsen, Don. *Coastal Waters of the World: Trends, Threats, and Strategies.* Washington D.C. Island Press, 1998.

Hornig, S., Smith, S. D., and A. Sterling. 1989. *Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): Ghost shrimp and blue mud shrimp. Biological report,* 1-14. Washington, D. C.: Fish and Wildlife Service.

Lafferty, K. D., and A. M. Kuris. 2002. Trophic strategies, animal diversity and body size. Trends in Ecology and Evolution 17: 507-513.

McCallum, H. I., Kuris, A., Harvell, C. D., Lafferty, K. D., Smith, G. W., and J. Porter. 2004. Does terrestrial epidemiology apply to marine systems? Trends in Ecology and Evolution 19: 585-591.

Murphy, R. C. 1985. Factors affecting the distribution of the introduced bivalve, *Mercenaria mercenaria,* in a Californian lagoon: the importance of bioturbation. *Journal of Marine Research* 43: 673-692.

Peterson, C. H. 1979. Predation, competitive exclusion, and diversity in the soft-sediment benthic communities of estuaries and lagoons. In *Ecological Processes in Coastal and Marine Systems*, ed. R. J. Livingston, pp. 233- 264. Plenum Press, New York.

Peterson, C. H. 1977. Competitive organization of the soft-bottom macrobenthic communities of Southern Californian lagoons. *Marine Biology* 43: 343-359.

Posey, M. H. 1990. Functional approaches to soft-substrate communities: How useful are they? *Reviews in Aquatic Sciences* 2: 343-356.

Posey, M. H. 1986. Changes in a benthic community associated with dense beds of a burrowing deposit feeder, *Callianassa californiensis. Marine Ecology Progress Series* 31: 15-22.

Ronan, T. E. 1975. Structural and paleo-ecological aspects of a modern soft-sediment community: an experimental field study. Ph. D. dissertation, University of California, Davis, CA.

Smith, A. E., Chapman, J. W., Dumbauld, B. R. 2008. Population structure and energetics of the bopyrid isopod parasite *Orthione griffenis* in mud shrimp *Upogebia pugettensis.* Journal of Crustacean Biology 28 (2): 228-233.

Weitkamp, L. A. 1991. Disturbance in an intertidal sandflat community: the effects of small- and large-scale natural and artificial perturbations. M.S. Thesis, University of Washington, Seattle, WA.

Chapter 2: A rapid survey method applied to the native blue mud shrimp *Upogebia pugettensis* and its introduced parasite *Orthione griffenis* in Alsea Bay, Oregon

A RAPID SURVEY METHOD APPLIED TO THE NATIVE BLUE MUD SHRIMP *UPOGEBIA PUGETTENSIS* AND ITS INTRODUCED PARASITE, *ORTHIONE GRIFFENIS* IN ALSEA BAY, OREGON.

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To be submitted to J. Crustacean Biology

ABSTRACT

Declines or extinctions of the native intertidal estuary blue mud shrimp, *Upogebia pugettensis*, have been observed or are suspected in all of its populations over the species' range. These declines are associated with the introduced Asian bopyrid isopod parasite, *Orthione griffenis*, which effectively castrates females. Baseline estimates of population abundances and distributions to measure overall change over their entire species ranges however, are lacking, in part, due to the massive efforts such large surveys require. We partially tested a simple rapid method for estimating total numbers and the structures of *U. pugettensis* and *O. griffenis* populations in Alsea Bay, Oregon that can be applied to many more populations and may more times per population than was previously possible.

Key Words: mud shrimp, population, survey, Alsea Bay, parasite, *Orthione griffenis, Upogebia pugettensis,* Oregon, bopyrid.

INTRODUCTION

The native blue mud shrimp, *Upogebia pugettensis* (Dana, 1852) (*Upogebia* from here on) occur exclusively on intertidal estuary mudflats where they construct individual Y-shaped burrows (MacGinitie, 1930; Chapman et al., 2012). Their extensive, conspicuous beds permit reliable qualitative distinctions of the relative sizes of populations among mudflats and estuaries by direct inspection (Chapman et al., 2012). All *Upogebia* populations between Morro Bay, California and British Columbia are verified or suspected to have declined to extremely low densities or to extinction since its Asian bopyrid isopod parasite, *Orthione griffenis* (Markham, 2004) (*Orthione* from here on) was introduced to the eastern Pacific in the mid 1980s (Chapman et al., 2012). *Orthione* effectively castrates *Upogebia* females (Smith et al., 2008; Dumbauld et al., 2011) due to hemolymph loss. No increasing *Upogebia* populations have been discovered in the last decade and all known remaining populations are recruitment limited and intensely infested by *Orthione* (Dumbauld et al., 2011; Chapman et al., 2012). The remaining large *Upogebia* populations are confined to the central Oregon coast between Tillamook Bay and Alsea Bay, Oregon (Chapman et al., 2012).

Estimates of changing abundance over entire species ranges require large population samples to compensate for the potentials of unequal changes within or among populations. However, replicated surveys of *Upogebia* in Willapa Bay in Washington and Tillamook Bay, Oregon, include only two local populations (Dumbauld et al., 2011) and only the Yaquina Bay, Oregon *Upogebia* surveys of 2002, 2008 and 2010 (Dumbauld et al., 2011) include a majority of populations in a single estuary. Thus, quantitative surveys of *Upogebia* for testing whether widespread declines are occurring have been completed in only three estuaries and only extensively in Yaquina Bay.

Conservation of tidal estuary habitats of the Alsea watershed critical for wild juvenile Coho salmon has been a management priority of The Nature Conservancy (Carter, 2011), The Wetlands Conservancy, the U.S. Fish and Wildlife Service, the Oregon Watershed Enhancement Board, and the Doris Duke Charitable Foundation (Anonymous, 2012). Brophy (1999) prioritized vegetated tidal wetlands for restoration within this estuary, but information on non-vegetated tidelands that should also be candidates for restoration has been lacking. Chapman et al. (2012) ranked the Alsea Bay *Upogebia* population among the largest of all remaining populations. *Upogebia* provide critical ecosystem services within intertidal mudflats of their estuaries, dominating oxygen, carbon and nitrogen cycling, water filtration, and sediment dynamics (DeWitt et al., 2004; D'Andrea and DeWitt, 2009). Additionally, *Upogebia* are prey for juvenile salmon, sturgeon, and shorebirds, and their burrows provide critical habitats for a multitude of commensal species (Chapman et al., 2012). Information on the overall abundances, bed surface areas, size structures, sex ratios, infestation intensities, and likely lost reproduction to infestations among the Alsea Bay populations and many other populations in other bays is lacking. We applied a rapid survey method to *Upogebia* and *Orthione* populations in Alsea Bay to obtain these data, and to qualify the importance of these shrimp on estuary function and the critical role they fill for estuarine scale conservation.

The 8.68 km^2 area Alsea Bay estuary includes 3.96 km^2 of tideland, 4.73 km^2 of submerged subtidal, and is the ninth largest of the 15 coastal estuaries in Oregon

(Hamilton, 1973). Large mudflats are exposed on tides below +0.4 m on the north and northeast side of the estuary, and in a large "stand-alone" area in the center of the estuary. Nearly all Alsea Bay *Upogebia* remain in these areas. The sand flats of the southern and western-most intertidal areas of Alsea Bay and the low salinity eastern most areas of Alsea River are unsuited for *Upogebia*.

Upogebia are gonochoristic and live at least 5 years (Bird, 1982; Dumbauld et al., 1996, 2011). Females produce a single brood of eggs between October and late March that hatch between February and late April. The stage-1 zoea emigrate from the estuary into the nearshore coastal ocean on night ebb tides (Dumbauld and Feldman, unpublished data; Chapman personal observations) where they develop through three zoea stages in three or more weeks (Hart, 1937) and then become post-larvae. The post-larvae return to the estuary and settle between late April and early June (Dumbauld et al., 1996, and personal observations). Post-larval settlement is aggregated almost exclusively among adult populations (Dumbauld et al., 2011).

Orthione infestations are conspicuous due to the large bulge they create in the carapaces of the shrimp they infest (Dumbauld et al., 2011). Like all bopyrid isopods, *Orthione* effectively castrate their decapod crustacean hosts (Kuris, 1974; Walker, 1977; O'Brien and Van Wyk, 1985; Smith et al., 2008) without greatly increasing host mortality (Dumbauld et al., 2011). Thus, the fitness of infested *Upogebia* is zero while the low host mortality permits competition between the castrated hosts and uninfested hosts (Dumbauld et al., 2011; Chapman et al., 2012). Moreover, continued *Orthione* reproduction is possible for at least one *Upogebia* generation, permitting extreme host population declines previous to *Orthione* declines (Dumbauld et al., 2011). We therefore surveyed to the Alsea Bay *Upogebia* population to establish a second major population baseline for measuring changes in *Upogebia* abundances with time, in addition to the population surveys of Yaquina Bay in 2002, 2008, and 2010.

Although quantitative surveys over time are required for precise estimates of population change, we examined statewide and Alsea Bay commercial catch records provided by the Oregon Department of Fish and Wildlife for changes in *Upogebia* landings since the mid-1980s. We interviewed local burrowing shrimp harvesters to identify historical high-density *Upogebia* areas in Alsea Bay for comparisons with present *Upogebia* bed distributions, and to assess the importance of commercial efforts on total landings over the last three decades.

METHODS

We surveyed the areas of the beds and the densities of *Upogebia* per area and *Orthione* infestations per *Upogebia* relative to shrimp size and sex. To measure the bed areas, the *Upogebia* bed perimeters were circumnavigated between 13 and 27 June 2011 with a Garmin GPSMAP 76CSx model global positioning system (GPS) with the "track" function in UTM projection coordinate points enabled. Coordinate points were collected every several seconds as each bed was circumnavigated (Fig. 1).

Coordinate points marking the bed perimeter were exported via Garmin® software to Excel spreadsheets. Each contiguous *Upogebia* bed was subdivided into polygons that permitted multiple, non-overlapping triangles to be plotted between the polygon center and all adjacent perimeter coordinates of the polygon. The center of each polygon was based on its average UTM northerly and westerly coordinates (Eq. 1).

$$\text{Centroid coordinate (N, W)} = \frac{\sum \text{northerly coordinates}}{\text{n}}, \frac{\sum \text{westerly coordinates}}{\text{n}} \quad (1)$$

We calculated the areas (A) of each perimeter to center triangle of the survey polygons by Heron's formula (Eq. 2) which, computes the areas of a triangles from their side lengths (a, b, and c) and semiperimeter (s). Total polygon area is thus the sum of all triangles that define each polygon where:

$$\text{Triangle area (A)} = \sqrt{(\text{s} * (\text{s} - \text{a}) * (\text{s} - \text{b}) * (\text{s} - \text{c}))} \quad (2)$$

$$\text{Semiperimeter (s)} = \frac{(\text{a}+\text{b}+\text{c})}{2}$$

We estimated *Upogebia* densities between June 28 June and July 1, 2011 from burrow and shrimp samples collected at 63 evenly dispersed stations spanning transects of the previously marked *Upogebia* beds (Fig. 1); the densities of burrow openings m^{-2} were noted at all 63 stations and quantitative core samples were collected at 32 of the 63 stations. Additionally, yabby gun samples were collected in evenly spaced transects across the marked beds, and a large excavation sample core was taken on July 29, 2011.

Burrows formed by *Upogebia* and co-occurring burrowing "ghost shrimp", *Neotrypaea californiensis* (*Neotrypaea* from here on) and *N. gigas* within a 0.25 m^2 area were counted at all stations. *Upogebia* burrows are round and have constricted diameter openings and distinctive, smooth linings. *Neotrypaea* and *N. gigas* construct the most similar of all co-occurring burrows to those of *Upogebia,* but they can be distinguished from *Upogebia* by their unconstricted openings and course linings.

Two to four 0.127 m diameter by 0.8 m depth cores collected at odd numbered stations. Each core sample was collected to depth from the surface and then a second core was collected from the bottom of the hole produced by the first core. Each core sample was thus to an excess of 0.8 m. No less than two core samples were collected at each coring station and one or two additional cores samples were collected if no shrimp were found in the first two core samples from within and next 0.25 m^2 quadrat.

Upogebia or *Neotrypaea* were recovered from 80 individual core samples from the 32 coring stations. Due to the different numbers of core samples collected among areas, shrimp densities were estimated from the total number of shrimp collected (n=123) divided by the total core area sampled ("bulk density"), and by averaging shrimp density among all sample stations ("average density"). Shrimp densities were also estimated from the number of shrimp per burrow opening corrected for the ratio of shrimp to burrow opening densities. We used Dumbauld et al.'s (2008) and DeWitt's (2002) relationships between *Upogebia* and *Neotrypaea* burrow counts and actual population density (Eq. 3 and Eq. 4, respectively) for our estimates of shrimp to burrow density which, when multiplied by total bed area provided a second estimate of total population sizes as follows:

Upogebia m^{-2} = (0.59*burrow count m^{-2}) +1.33 (Dumbauld et al., 2008, r^2 = 0.883) and (0.41*burrow count m^{-2}) – 0.43 (DeWitt, 2002, r^2 = 0.901); (3)

Neotrypaea m^{-2} = (0.66*burrow count m^{-2}) + 9.73 (Dumbauld et al., 2008, r^2 = 0.777) and (0.64*burrow count m^{-2}) – 0.62 (DeWitt, 2002, r^2 = 0.725) (4)

Twenty-nine *Upogebia* were collected from cores, 71 from yabby gun samples, and 24 from the excavation. *Upogebia* sex and carapace length (CL from here on; from the tip of the rostrum to the back edge of the carapace), as well as presence and dimensions of *Orthione* were recorded. Size, sex and infestation frequencies of *Upogebia* collected from small core samples, yabby gun samples, and the large excavation on 7/29/2011 were not significantly different and therefore were combined for all additional analyses. Size frequencies were estimated in 1 mm increments of the 7 to 35 mm size range of the population.

We estimated population wet and dry weights from the correlations of CL to weight reported by Smith et al. (2008) (Wet weight = $0.0004*CL^{3.1414}$ and dry weight = $0.0003*CL^{2.7185}$, respectively). We estimated *Neotrypaea* wet weight by sex using Dumbauld's (1994) derivations (where: Male wet weight = $0.00025*CL^{3.67722}$ and Female wet weight = $0.001604*CL^{2.96552}$, respectively). Population weight is equal to average shrimp weight multiplied by total abundance.

Every shrimp was inspected for *Orthione,* and the length, width, and development of each recovered female *Orthione* was noted. *Orthione* only infest greater than 12 mm CL *Upogebia* and increasingly infest the larger shrimp (Smith et al., 2008; Dumbauld et al., 2011; Chapman et al., 2012). The effective *Upogebia* population available to *Orthione*, *N*, is therefore a function of length-class susceptibility above 12 mm CL times the numbers of shrimp per length class. Dumbauld et al. (2011) summarized this variable probability distribution for *Upogebia* infestations by *Orthione* with size by the relation:

$$c = \frac{0.1363CL^4 - 14.777CL^3 + 560.67CL^2 - 8340.3CL + 42373}{1000} \qquad (5)$$

Equation 5 is an estimated maximum infestation probability that we used to normalize our infestation distribution for comparisons among populations by length frequencies, n_i, to length dependent vulnerabilities, c_i as follows:

$$N = \sum_{i=12}^{35} c_i n_i \qquad (6)$$

The effective host population sample size, *N,* is thus also a maximum expected prevalence when *Orthione* are at maximum frequency among all host size classes (Chapman et al., 2012). Comparisons among populations require normalized *Orthione*, ρ, relative to the expected number of infested shrimp, I, and effective vulnerable population, *N*, where:

$$\rho = I/N \qquad (7)$$

Infestation data were combined with the size frequency distribution from all collected shrimp, and measured infestation rate compared to expected infestation rate. Expected infestation rate per carapace length bin size is equal to the probability of infestation multiplied by the number of individual *Upogebia* collected for each carapace length bin.

We used Dumbauld et al.'s (2011) infestation probability index to compare Alsea Bay infestation with other areas:

$$pDetection = 1 - (1 - pInfestation)^{Frequency} \qquad (8)$$

RESULTS

Nearly all of the Alsea Bay *Upogebia* are in the northeastern intertidal of the Alsea Bay estuary, in a single 908,700 m^2 bed that is incised only by intermittent shallow channels (Fig. 1). The bed covers 23% of the total 3,961,872 m^2 tideland area of Alsea Bay (Hamilton, 1973). The southern and western boundaries of the bed (Fig. 1) are defined by the major river channel, and exposed tideflats of sandier sediments dominated by *Neotrypaea*, and the eastern and northern most boundaries of the bed are predominantly sand or extremely fine mud sediments contained within large areas of periodically low salinity marshland.

Upogebia carapace length frequency distributions and average carapace length were similar among small cores yabby gun and mega-core samples (26.5 mm, 26.9 mm and 25.8 mm average, respectively) (Fig. 2). Therefore, we consolidated the 81 female and 42 male *Upogebia* collected from all collection methods for size analyses (Fig. 3). The mode CL bin size and mean of this distribution was 30 mm ± 1 mm, and 26.6 mm for both males and females. Average carapace lengths of males and females were 25.0 mm and 27.5 mm, respectively, and females are twice as abundant as males (81:41).

Total *Upogebia* and *Neotrypaea* abundance was estimated by: 1) averaging shrimp density among sample stations and multiplying by total bed area; 2) multiplying average bulk shrimp density (total shrimp collected divided by total core area) by total bed area, and; 3) by converting shrimp burrow openings to density using the conversion factors of Dumbauld et al. (2008) and then DeWitt (2002), and multiplying average shrimp density by total bed area (Table 1). We used the weight to CL relationship reported by Smith et al. (2008) for Yaquina Bay *Upogebia* for our estimates of biomass (Table 1).

Forty-four (35.7%) of the 123 *Upogebia* collected were infested by *Orthione.* Of the infested shrimp, 32 (73%) were females and 12 (27%) were males. Of reproductive size *Upogebia* (CL>17mm), 33.3% of males and 40.5% of females were infested. The maximum expected infestations in this population (Equation 5) was 83. Thus, overall prevalence (ρ) was 44/83= 53.1% of maximum expected. Percent infestations and deviations from the expected infestations with CL were bi-modal and higher than expected for the 18 mm and 20 mm carapace length size classes and lower than expected among 14 mm to 16 mm and 22 mm to 34 mm size classes (Fig. 4).

Male *Upogebia* had higher infestation rates at shorter carapace lengths than females, and both sexes exhibited high infestation at larger carapace lengths (Fig. 5). Males had high infestation rates from 18 mm to 22 mm and 26 to 30 mm in length. Females had high infestation from 26 mm to 32 mm in length. None of the shrimp of either sex in the 24 mm CL size class were infested (Figure 5).

Based on Dumbauld et al. (1996) estimated uninfested *Upogebia* fecundity at $0.008*CL^{4.12}$, our estimated size adjusted effective castration by *Orthione* on overall natality of the Alsea Bay *Upogebia* is 42% (Fig. 6). The 30 mm size class of females had the greatest potential natality among size classes, representing 39% of total fecundity, but also had the greatest reduction in fecundity by infestation, with a reduction of 18%.

DISCUSSION

In contrast to previous surveys (Dumbauld et al., 2011; DeWitt et al., 2002), abundances of the low density Alsea Bay *Upogebia* populations (Table 1), estimated from random small core samples were not consistent with our estimates based on 0.25 m^2 quadrat samples of burrow opening densities. Our estimates of *Upogebia* per burrow opening could be low. The bivalve *Mya arenaria* is sparsely distributed throughout the

Upogebia bed in Alsea Bay, and the broadly oval burrow openings they create can be difficult to distinguish from those of *Upogebia,* making them suspect for misidentification. However, agreement between total burrow count and total shrimp density was consistent with previous estimates (Fig. 9).

The Alsea Bay *Upogebia* beds (Fig. 7) contain nearly equal densities of *Neotrypaea*. We found a non-linear *Upogebia* burrow per shrimp density increase (Fig. 10). Dumbauld et al. (2008) found a linear increase. However, Dumbauld et al.'s (2008) *Upogebia* beds contained uniformly low densities of *Neotrypaea*. The higher density *Neotrypaea* of Alsea Bay could have altered the aggregation and burrow to shrimp densities of *Upogebia*. Juvenile *Upogebia* preferentially settle with adults (Dumbauld et al., 2011), resulting in adult congregation within the beds over time. The number of burrows per shrimp increases with burrow density (Fig. 11), indicating that individual *Upogebia* exhibit affinity for each other, and are not dispersed evenly.

Within the *Upogebia* bed in Alsea Bay, the majority (22 of 32) of core sample stations had burrow densities of <80 m^{-2}. Burrow densities in this range have, on average, less than two burrows per individual shrimp (Fig. 11). This relationship is consistent with data from Dumbauld et al. (2008). However, core samples from high-density areas in the center of the *Upogebia* bed have a burrow to shrimp ratio of up to 5:1, a substantially different relationship. This distinction is manifested in our overall *Upogebia* burrow density to *Upogebia* density relationship (Fig. 8).

It is possible that, as populations of *Upogebia* in Alsea Bay continue to decline, *Neotrypaea* is settling in areas previously held by *Upogebia.* Our *Upogebia* burrow data show two distinct density relationships (Fig. 8) with actual *Upogebia* density, neither of which matches the data from Dumbauld et al. (2008). The relationship is much stronger for total shrimp and total burrows (Fig. 9), suggesting that if space becomes available for settlement within the *Upogebia* bed, *Neotrypaea* take advantage. In Willapa Bay, Washington increasing populations of *Neotrypaea* have coincided with declining *Upogebia* populations, also suggesting emigration and expansion.

Infestation rates by *Orthione* are consistent with previous surveys in Yaquina Bay. Dumbauld et al. (2011) reported that quarterly data collected for *O. griffenis* in Yaquina Bay suggested that isopod prevalence increases in summer months (x = 64% and 73% in 2005 and 2006, respectively) and declines in the winter (x = 48% and 49% in 2005 and 2006, respectively). Total infestation in Alsea Bay was 35.7% (44 of 123 infected individuals) during data collection in June, 2011, suggesting that overall infestation may be lower than observed in Yaquina Bay.

Proportions of Yaquina Bay females ranged from 42-69% between sample sites, and average 52% (Smith et al., 2008) while the proportions of Alsea Bay female were 66% (81 of 123 individuals), falling within this range. Griffen (2009) found increased infestations with CL among Yaquina Bay females. Our data support these observations (Fig. 3; Fig. 5). Female *Upogebia* compromised 73% of total infestations, and were present in greater proportions at high CL while male *Upogebia* existed in higher proportions at low CL. It is possible that female *Upogebia* grow more quickly, and thus spend a larger part of their lives at adult CL, making them more susceptible to infestation.

Reproductive loss due to infestation by *Orthione* is less than estimations for Yaquina Bay, Oregon. Dumbauld et al. (2011) reported a total reproductive loss of 68%

in Yaquina Bay due to infestation; our data suggest a total reproductive loss of 42% in Alsea Bay (Fig. 6).

Quantitative estimates of *Upogebia* declines have been made only for one population at a time in Willapa Bay, Washington and from three major surveys of Yaquina Bay, Oregon in 2002, 2008 and 2010 (Dumbauld et al., 2011). This survey serves to establish an additional baseline for *U. pugettensis* in Alsea Bay to allow measurement of change in the future. Subsequent surveys are needed to quantify changes in population with time, however the standard error in our abundance estimations limits the preciseness with which we can determine absolute changes in abundance. Our error ranges vary from ± 26.0% to 44.3% of estimated abundance. If the Alsea Bay *Upogebia* population is declining at similar rates as the Yaquina Bay population (18% annually, (Dumbauld et al., 2011)), decline over several years will be necessary to statistically differentiate abundances and quantify decline rates.

Anecdotal information from a local bait fisherman who previously harvested *Upogebia* from Alsea Bay permitted us to partially test whether *Upogebia* population changes have occurred. This harvester is still in operation and has used numerous Oregon estuaries over the last several decades but no longer harvests from Alsea Bay. He identified high-density locations in the estuary where he used to harvest. Many of his locations coincided with areas marked by our GPS survey, or could not be distinguished from marked areas. Bait fishermen target high-density areas for harvest to maximize catch per unit effort and can harvest up to at least 300 m across any tideflat adjacent to water sources and have a nearly constant market for their catches. Their catch records therefore appear to be controlled largely by changes in *Upogebia* populations.

Dense beds of *Upogebia* used to inhabit the northwestern-most channel of the estuary where harvests of up to 1,000 shrimp (21 to 28 kg., based on our size-frequency data) were possible during each ~3 hour tidal cycle. Qualitative surveying of this once dense bed revealed that *Upogebia* are still present, though in very low densities that would not provide previous shrimp harvest rates. This harvester also noted that mixed beds of *Upogebia* and *Neotrypaea* used to dominate the southern side of the primary channel at low tide that are now dominated by *Neotrypaea* beds.

These observations corroborate the *Upogebia* bait landings reported by the Oregon Department of Fish and Wildlife. Statewide which peaked in 1991 at 56,022 lbs. and then steadily declined to 2,396 lbs. by 2011 (Fig. 12). Similarly, catches in Alsea Bay have dropped from a peak in 1988 at 1,895 lbs. to 70 lbs. and 6 lbs. in 2010 and 2011, respectively (Fig. 13). Subsequent surveys of Alsea Bay are needed to more precisely quantify changes in population, but it appears that this second major population examined is declining in a similar manner to Yaquina Bay and Willapa Bay populations reported by Dumbauld et al. (2011) and Chapman et al. (2012).

ACKNOWLEDGEMENTS

I thank Sara Mae Thoma (HMSC, NSF-REU program) and Erin Bruce (Leader of the Lincoln County Community Consortium, Summer Natural Resources Crew, and the crew) for their help in field work and data collection, and Dr. John Chapman for his continued support in the development of this paper.

REFERENCES

Anonymous 2012. (http://oregonwetlands.net/index.php?option=com_content&view=article&id=16&Itemid=17)

Bird, E. M. 1982. Population dynamics of thalassinidean shrimps and community effects through sediment modification. Ph.D. dissertation, University of Maryland, College Park, Maryland, p. 150.

Brophy, L. 1999. Final Report: Yaquina and Alsea river basins estuarine wetland site prioritization project. Green Point Consulting, Corvallis, Or. Retrieved from: http://hdl.handle.net/1957/3961

Carter, C. 2011. Population structure and spatial extent of the mud shrimp *Upogebia pugettensis* in Alsea Bay, Oregon. Report to The Nature Conservancy, 12 pp. + fig.

Chapman, J. W., Dumbauld, B. R., Itani, G., and J. C. Markham. 2012. An introduced Asian parasite threatens northeastern Pacific estuarine ecosystems. Biological Invasions 14 (6): 1221-1236.

D'Andrea A. F., and T. H. DeWitt. 2009. Geochemical ecosystem engineering by the mud shrimp *Upogebia pugettensis* (Crustacea: Thalassinidae) in Yaquina Bay, Oregon: Density-dependent effects on organic matter remineralization and nutrient cycling. *Limnology and Oceanography* 54: 1911-1932.

DeWitt, T. H., D'Andrea, A. F., Brown, C. A., Griffen, B. D., and P. M. Eldridge. 2004. Impact of burrowing shrimp populations on nitrogen cycling and water quality in western North American temperate estuaries. In: A Tamaki (ed.), Proceedings of the symposium on ecology of large bioturbators in tidal flats and shallow sublittoral sediments – from individual behavior to their role as ecosystem engineers. University of Nagasaki, Japan. pp. 107-118.

Dumbauld, B. R., Chapman, J. W., Torchin, M. E., and A. M. Kuris. 2011. Is the collapse of mud shrimp *(Upogebia pugettensis)* populations along the Pacific coast of North America caused by outbreaks of a previously unknown bopyrid isopod parasite *(Orthione griffenis)*? Estuaries and Coasts 34: 336-350.

Dumbauld B. R., and J. W. Chapman. 2008. Could burrowing shrimp host populations with pelagic larval dispersal be controlled by an invading parasite? In: 37th Annual Benthic Ecology Meeting. Providence, RI April 9-13, 2008.

Dumbauld, B. R., Armstrong, D. A., and K. L. Feldman. 1996. Life-history characteristics of two sympatric thalassinidean shrimps, *Neotrypaea californiensis* and *Upogebia pugettensis* with implications for oyster culture. Journal of Crustacean Biology 16: 689-708.

Dumbauld, B. R. 1994. Thalassinid shrimp ecology and the use of carbaryl to control populations on oyster grounds in Washington coastal estuaries – Ph. D. dissertation. University of Washington. Seattle, Washington Pp. 1-192.

Griffen, B. D. 2009. Effects of a newly invasive parasite on the burrowing mud shrimp, a widespread ecosystem engineer. Marine Ecology Progress Series 391:73-83

Hart, J. L. 1937. Larval and adult stages of British Columbia anomura. Canadian Journal of Research 15: 179-200.

Hamilton, S. F. 1973. Oregon Estuaries, Division of State Lands, State of Oregon State Land Board, 48 pp.

Kuris, A. M. 1974. Tropic interactions: Similarity of parasitic castrators to parasitoids. The quarterly review of biology 49: 129-148.

MacGinitie, G. E. 1930. The natural history of the mud shrimp *Upogebia pugettensis* (Dana). Annals and Magazine of Natural History 6: 37-45.

Markham, J. C. 2004. New species and records of Bopyridae (Crustacea: Isopoda) infesting species of the genus *Upogebia* (Crustacea: Decapoda: Upogebiidae): the genera *Orthione* Markham, 1988, and *Gyge* Cornalia & Panceri, 1861. Proc Biol Soc Wash 117: 186-198.

O'Brien, J. J., and P. Van Wyk. 1985. Effects of crustacean parasitic castrators (epicaridean isopods and rhizocephalan barnacles) on growth of crustacean hosts. In Crustacean issues: Factors in adult growth, ed. A.M. Wenner, 191-218. Rotterdam: Balkema.

Smith, A. E., Chapman, J. W., Dumbauld, B. R. 2008. Population structure and energetics of the bopyrid isopod parasite *Orthione griffenis* in mud shrimp *Upogebia pugettensis.* Journal of Crustacean Biology 28 (2): 228-233.

Walker, S. P. 1977. *Probopyrus pandalicola:* Discontinuous ingestion of shrimp hemolymph. Experimental Parasitology 41: 198-205.

	Upogebia pugettensis			*Neotrypaea californiensis*			*Total (Upogebia + Neotrypaea)*	
Method	**Average (m^{-2})**	**Total Abundance**	**Wet biomass (MT)**	**Average (m^{-2})**	**Total Abundance**	**Wet biomass (MT)**	**Total Shrimp**	**Total Biomass**
Average density	33.7	30,661,465 ± 11,965,766	404.4 ± 157.8	28.4	25,840,472 ± 11,461,627	439.6 ± 194.9	56,501,937 ± 23,427,393	844 ± 352.7
Average bulk density	29.6	26,927,410 ± 11,965,766	355.2 ± 157.8	28.6	25,965,692 ± 11,461,627	441.7 ± 194.9	52,893,102 ± 12,427,393	796.9 ± 352.7
Combined (2008)	46.0	41,754,765 ± 8,511,866	550.8 ± 112.3	27.6	25,110,592 ± 6,523,629	427.2 ± 111.0	66,865,357 ± 15,035,495	978 ± 223.3
DeWitt (2002)	30.6	27,783,460 ± 5,664,152	366.5 ± 74.7	16.7	15,202,217 ± 6,325,943	258.6 ± 107.6	42,985,677 ± 11,990,095	625.1 ± 182.3

Table 1: *Neotrypaea* density and total abundance, and *Upogebia* density, total abundance, total wet biomass, and total dry biomass. Estimations are from cores and from burrow to shrimp density by regression models herein and of Dumbauld et al. (manuscript), and DeWitt et al. (2002).

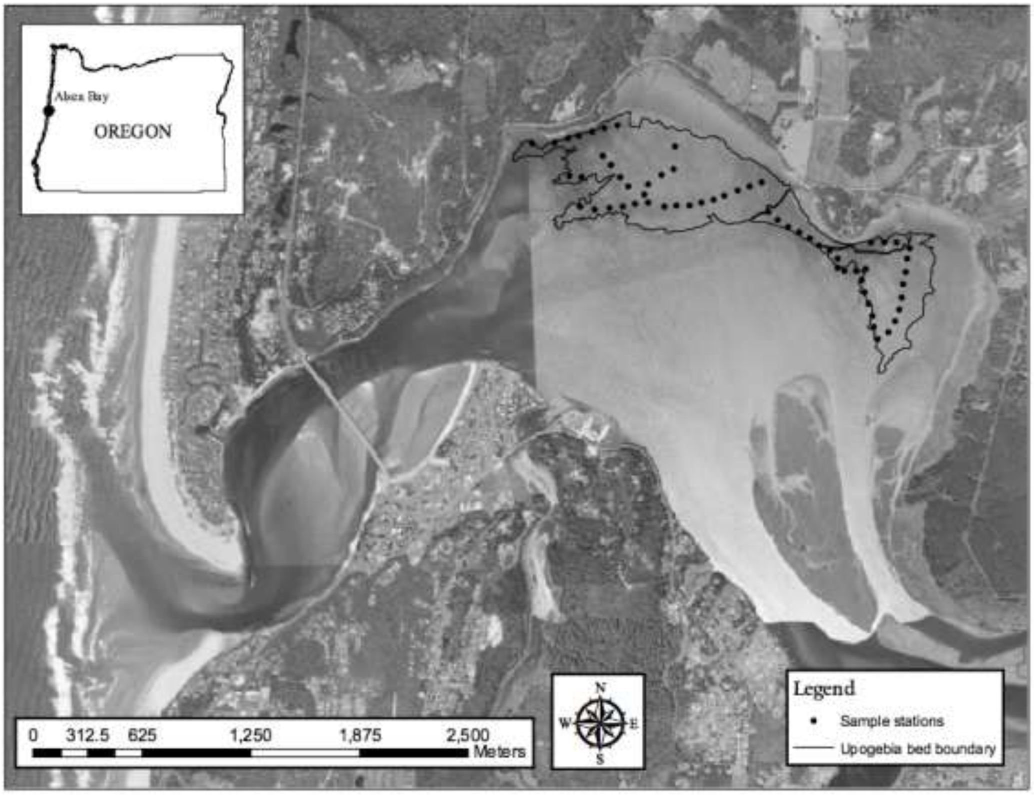


Figure 1: *Upogebia pugettensis* bed perimeters (solid lines) and sampling locations (solid circles, n=63) in Alsea Bay, Oregon.

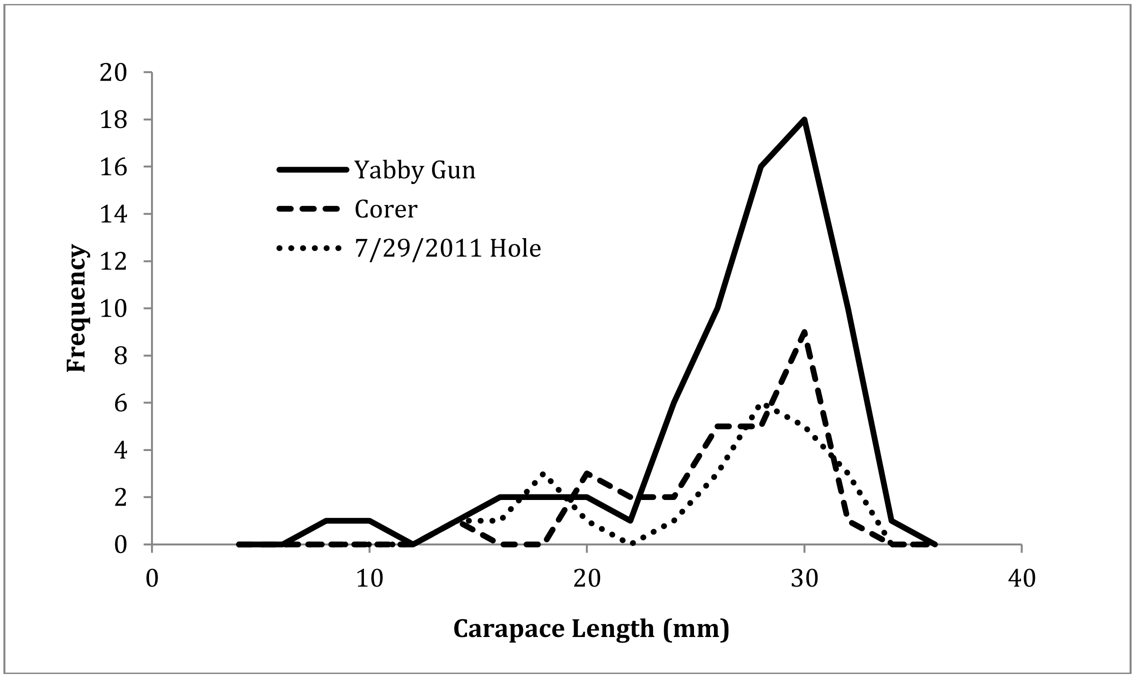


Figure 2: Carapace length frequencies of *Upogebia* from core samples, yabby gun samples, and from a large core on 7/29/2011.

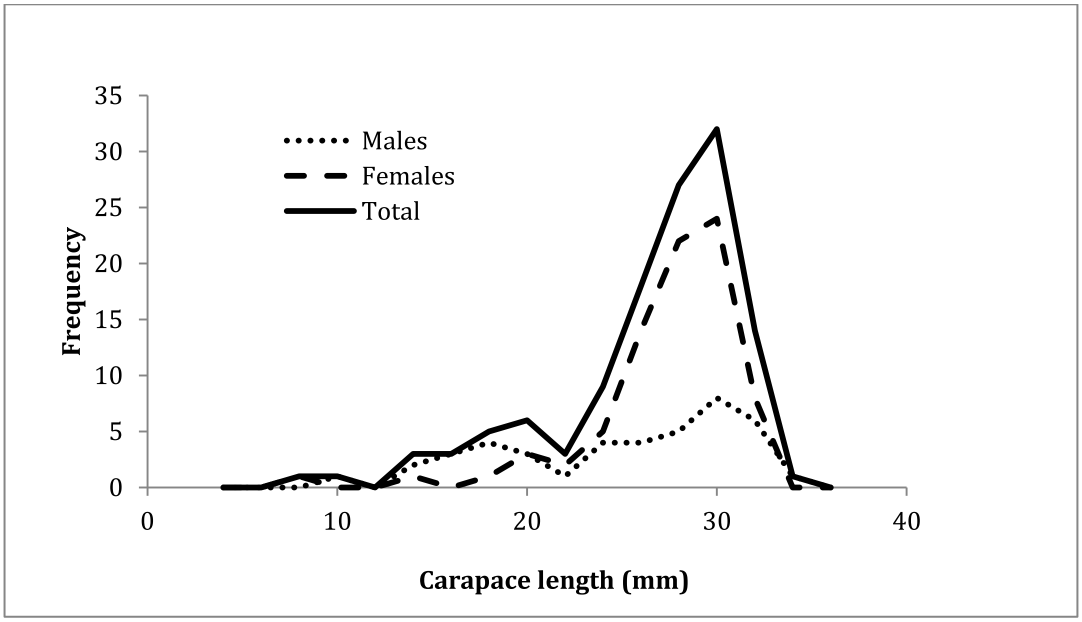


Figure 3: Carapace length frequencies of *Upogebia* males and females by all collection methods.

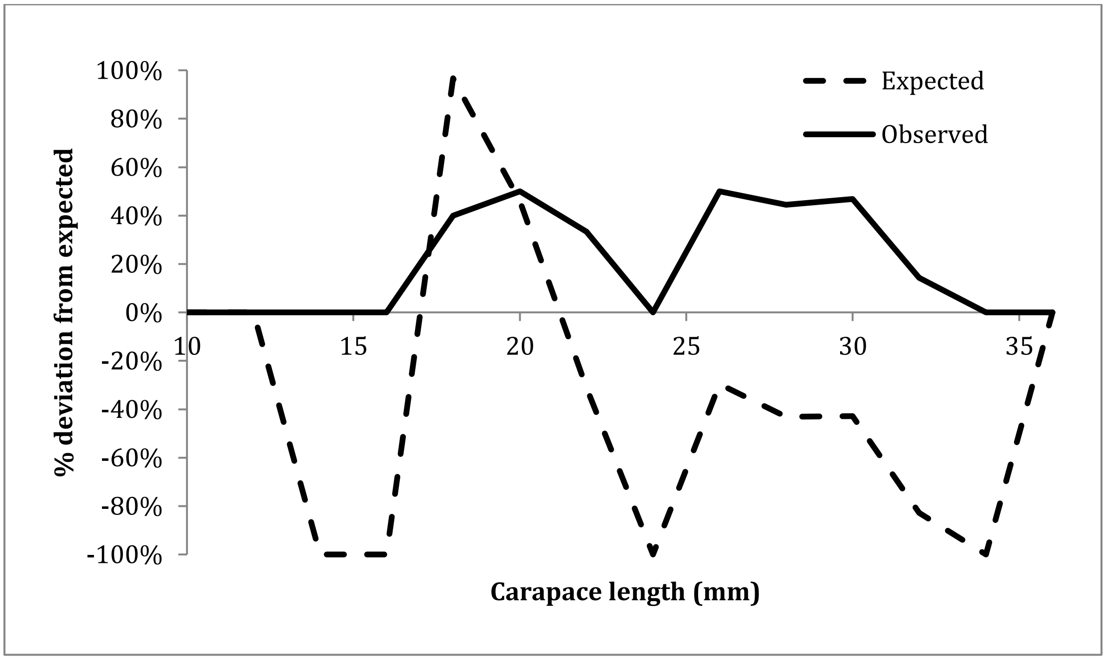


Figure 4: Percent infestation by size class and percent deviation from expected infestation.

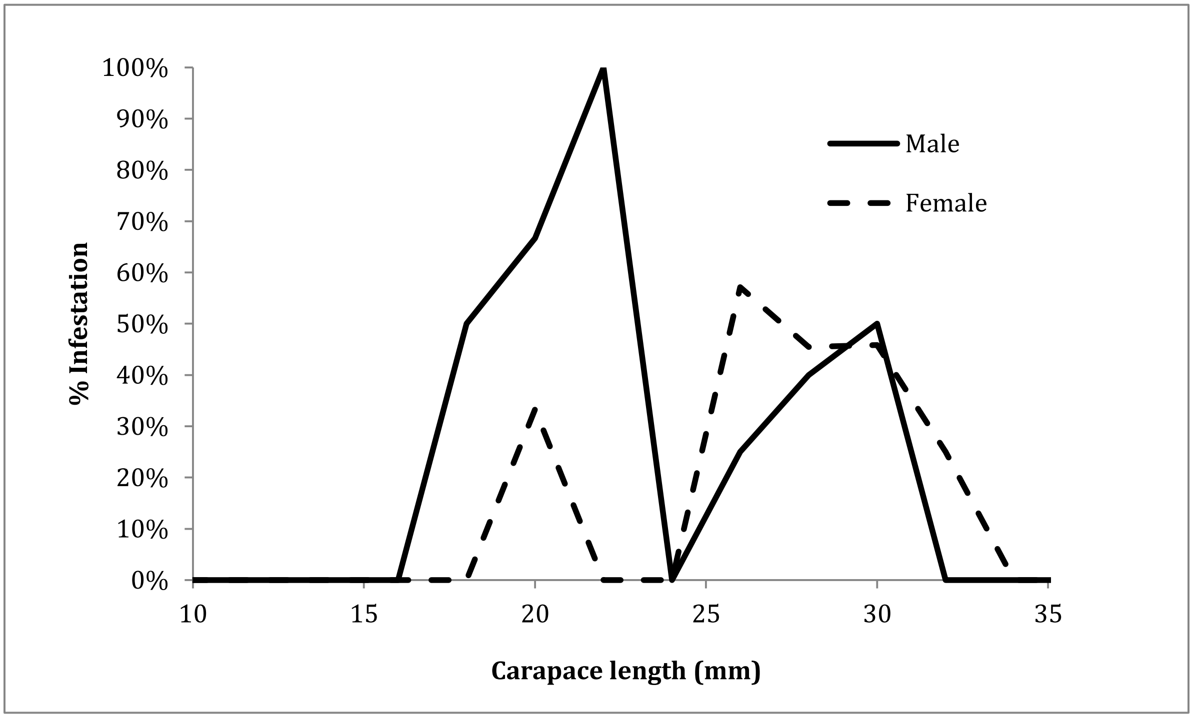


Figure 5: Percent infestation of male and female *Upogebia* by size class

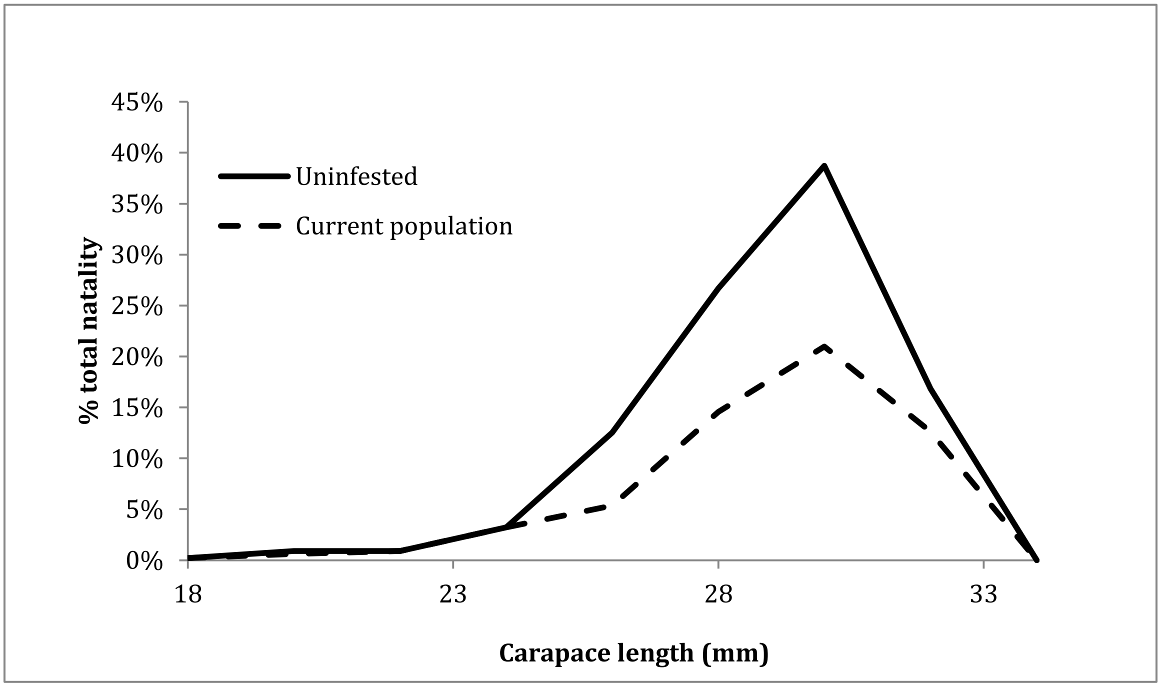


Figure 6: Expected uninfested and infested *Upogebia* natality.

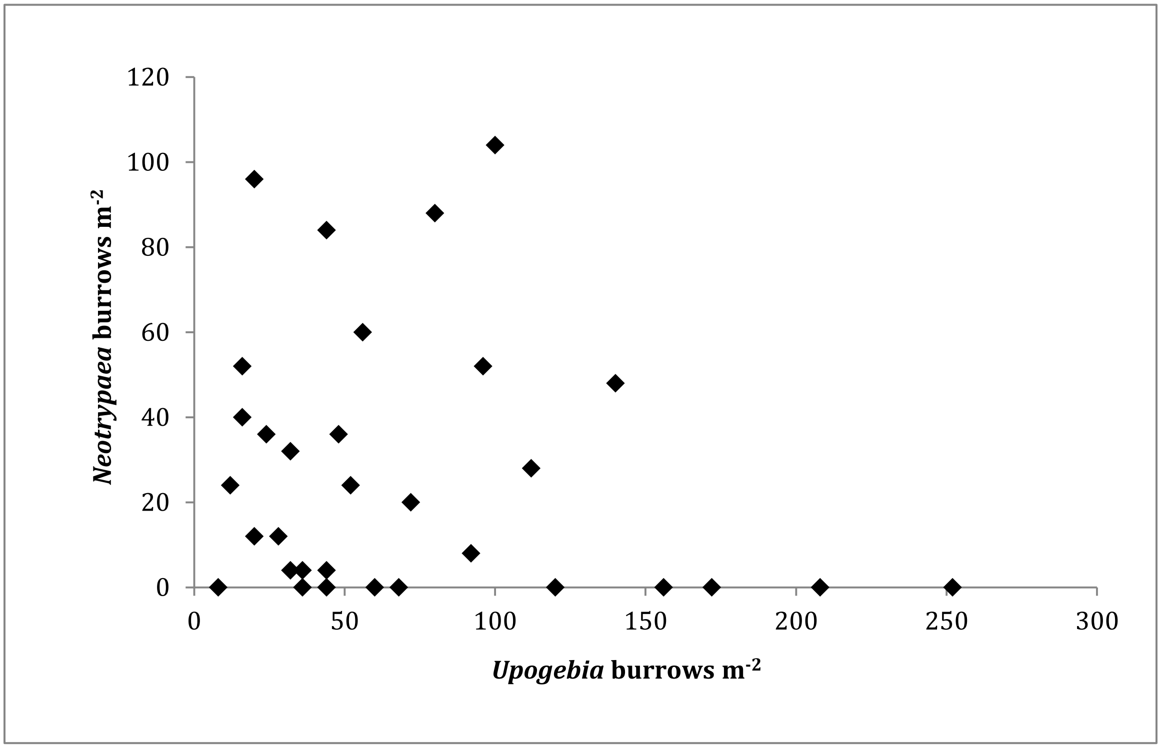


Figure 7: *Upogebia* and *Neotrypaea* burrow densities at 63 sample locations.

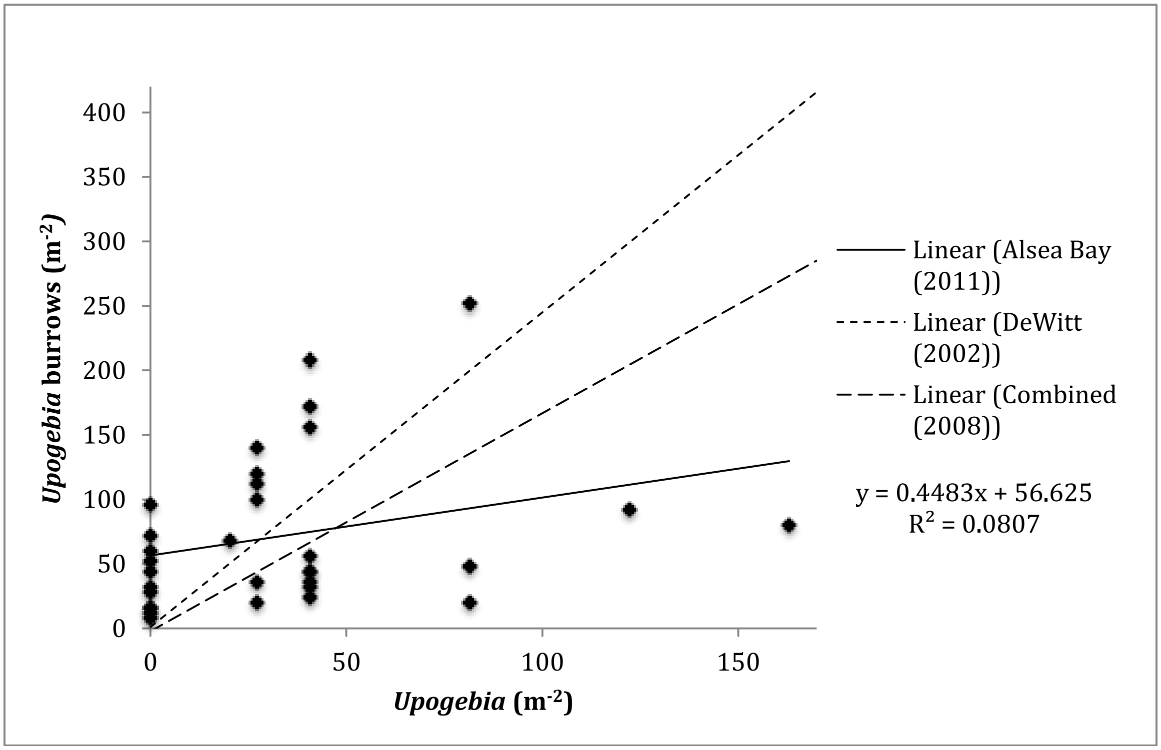


Figure 8: Relationship between the number of *Upogebia* burrows and the number of *Upogebia* shrimp from 90 cores in 2002 (Dewitt 2002), a combination of 60 annual survey cores from 2005-2010, and 42 cores collected by the 2008 Summer Natural Resource Crew (Combined 2008), and Alsea Bay burrow data (Alsea Bay 2011).

m^2

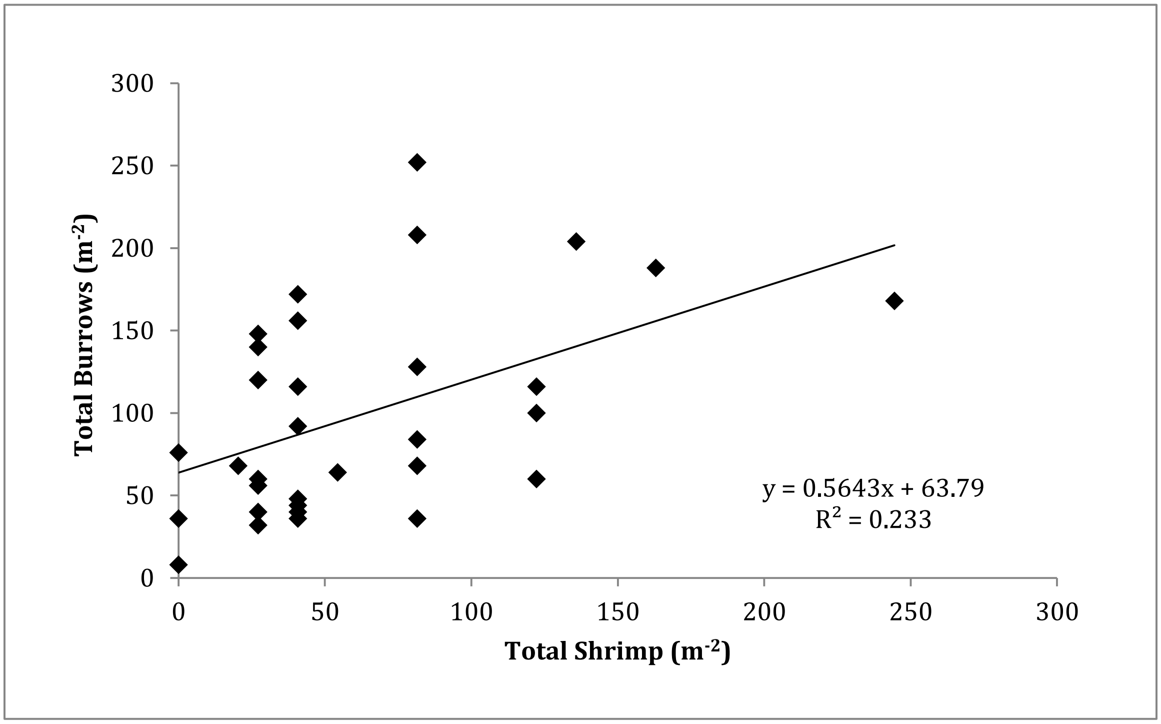


Figure 9: Total *Upogebia* and *Neotrypaea* m^{-2} (from core estimates) in relation to total *Upogebia* and *Neotrypaea* burrows m^{-2}.

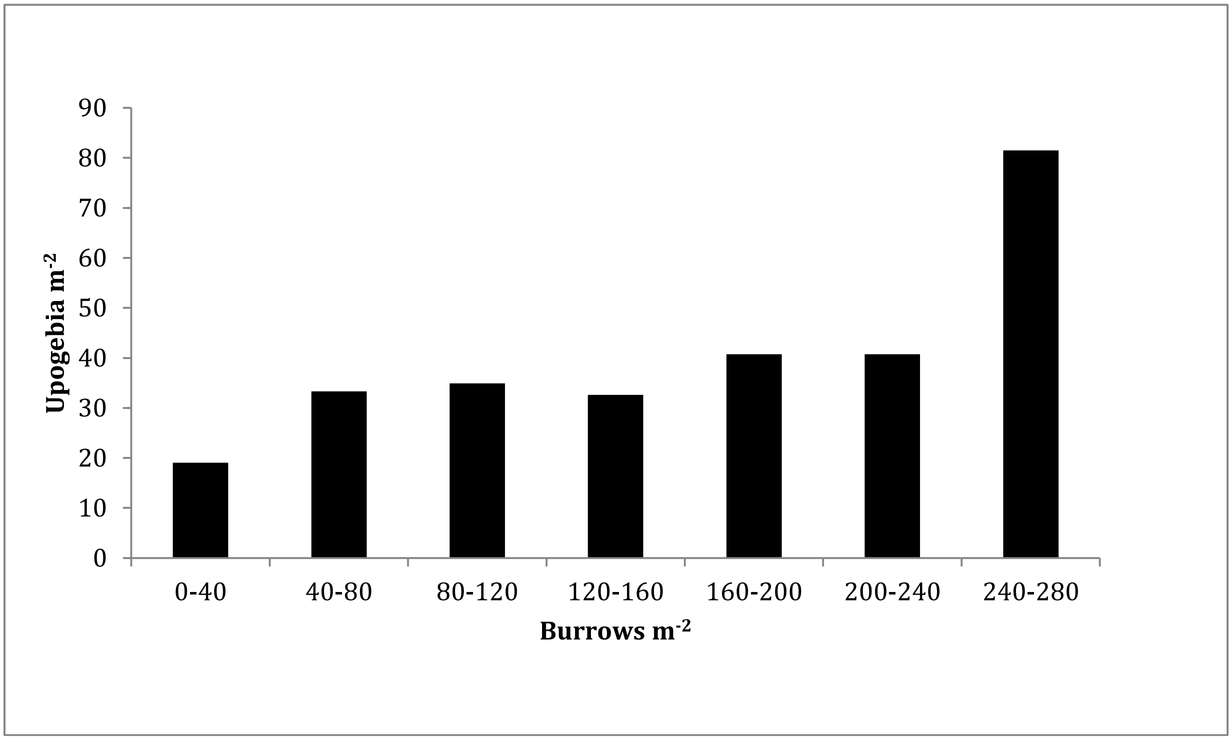


Figure 10: *Upogebia* density, with changes in *Upogebia* burrow density.

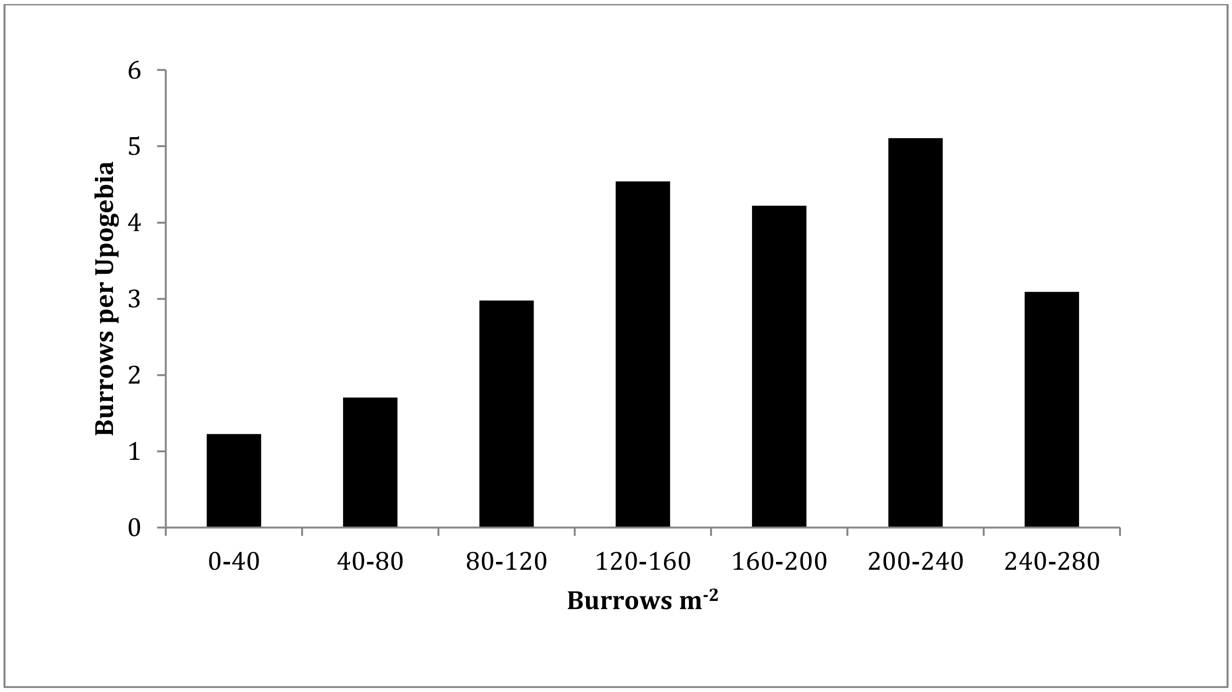


Figure 11: Burrows per *Upogebia*, with changes in *Upogebia* burrow density.

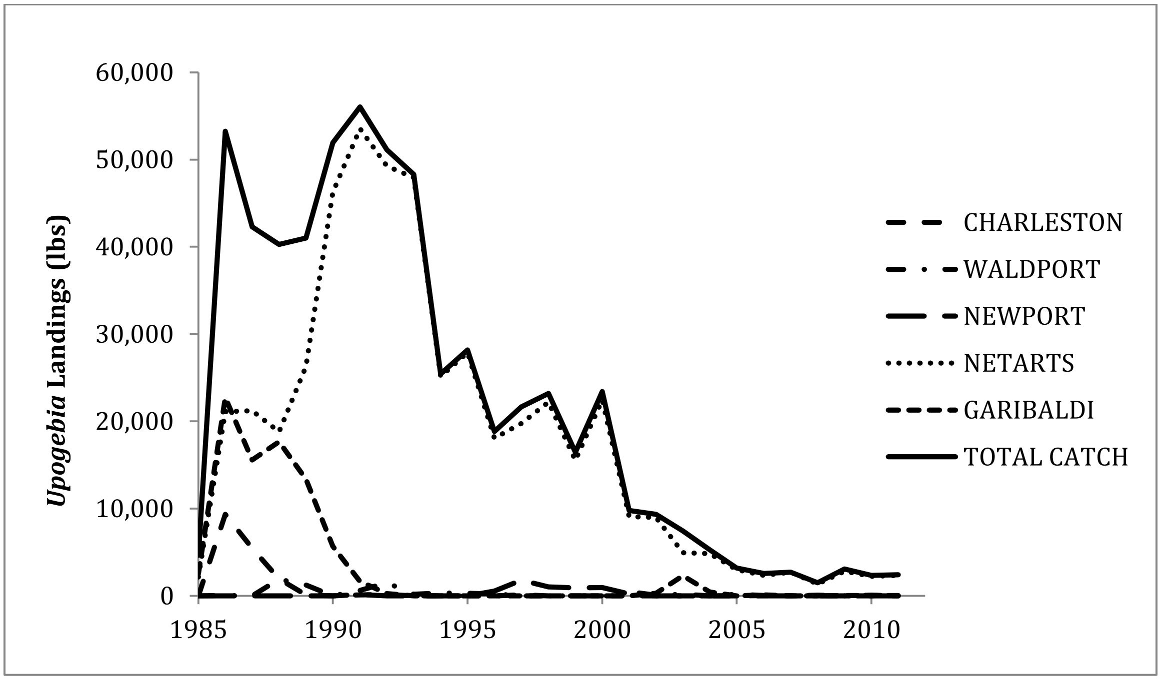


Figure 12: Annual *Upogebia* catch records of major estuaries in Oregon, and total Oregon annual catch.

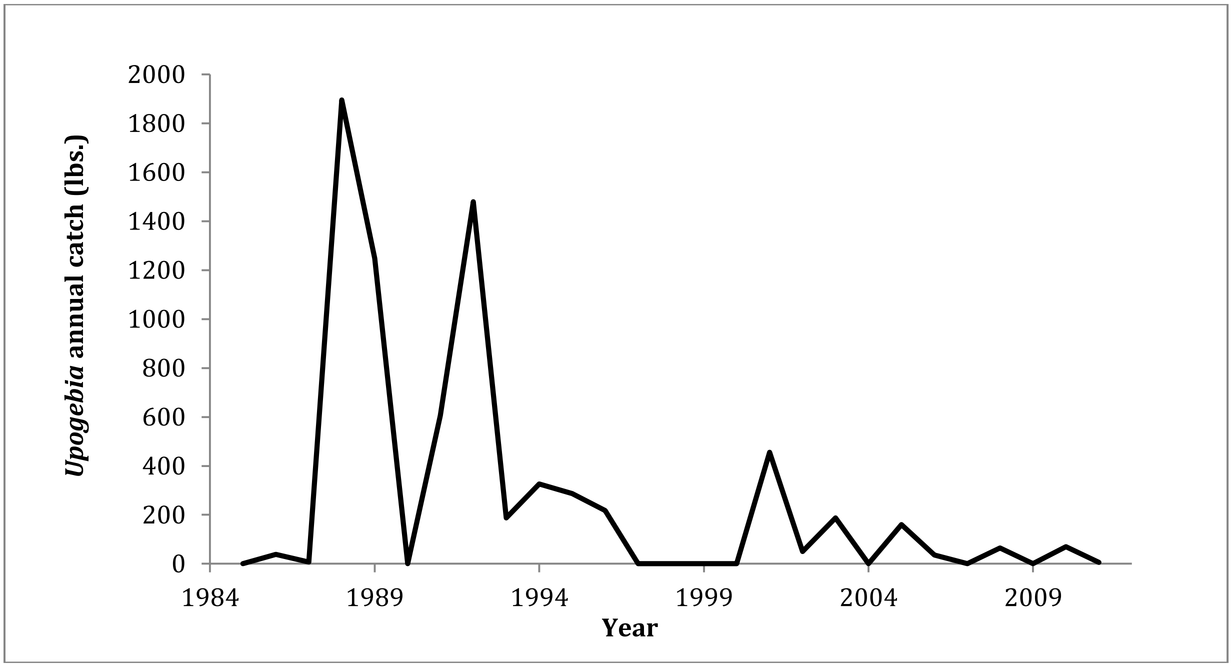


Figure 13: Annual *Upogebia* catch record in Alsea Bay, Oregon.

Chapter 3: Methods-based curriculum

INTRODUCTION

The following middle school curriculum was developed using select methodology from the previously described Alsea Bay *Upogebia* project. The curriculum allows students to pragmatically utilize basic math skills and scientific inquiry to answer a simple biological science question. Students collect, organize, and analyze data to reach a conclusion, and will address issues such as sources of error and confidence intervals.

These curriculum objectives fit well with the Oregon Department of Education's STEM (Science, Technology, Engineering, and Mathematics) Education Initiative. The STEM initiative emphasizes the natural interconnectedness of the four separate STEM disciplines by allowing students to problem solve through discovery, exploration, and application of critical thinking skills as they learn about subject material (ODE, 2011). STEM classrooms are problem-based classrooms, where teachers engage students in instruction centered around important themes or problems, and students work together and access sophisticated technologies to generate creative and innovative solutions based soundly in the fundamentals of each STEM discipline (ODE, 2011). This curriculum serves as an applied math- and science-based problem that students can work through collaboratively, while strengthening learning and innovation skills such as creativity, innovation, critical thinking, problem solving, and communication (ODE, 2011).

Using this curriculum, students will estimate the abundance of earthworms within a nearby schoolyard or small field by calculating the total area, estimating earthworm density within, and multiplying density by total area. A global positioning system (GPS) is used to mark the edges of the courtyard, and the area is calculated by dividing the marked area into multiple, non-overlapping triangles solving using Heron's formula and the Pythagorean theorem. Additionally, students will take “core” samples from within the courtyard to retrieve and count earthworms in order to make an average earthworm density estimate. Students will calculate total abundance by multiplying average density by total area, and report an error range associated with their abundance estimation.

The Oregon common core state standards (OCCSS), defined by the Oregon Department of Education, describes learning objectives for each grade level and subject area. This curriculum was designed for 7^{th} grade math and science, because OCCSS math and science standards align with the goals of this lesson plan.

This curriculum addresses two of the four critical areas for 7^{th} grade mathematics. One critical area encourages students to “solve real-world and mathematical problems involving area, surface area, and volume of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes and right prisms” (DOEa, 2009). This objective is satisfied using this curriculum, because students are asked to calculate the area of an irregular shape by mapping it in GPS, and to making arithmetical calculations with Heron’s formula and the Pythagorean theorem.

Another critical area addresses the concept of drawing inferences about populations based on samples. Students are expected to be able to “compare two data distributions and address questions about differences between populations, and begin informal work with random sampling to generate data sets and learn about the importance of representative samples for drawing inferences” (DOEa, 2009). This curriculum helps students to meet this requirement by collecting data at randomly distributed locations within the school courtyard.

Similarly, the Oregon Department of Education has created Oregon Common

Core State Standards for 7th grade Science. One of the standards addresses scientific inquiry: the investigation of the natural world based on observations and science principles that includes proposing questions or hypotheses, designing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based observations. Using scientific inquiry, students will organize, display, and analyze relevant data, construct an evidence-based explanation on the results of an investigation, and communicate the conclusions including possible sources of error. Students will evaluate the validity of scientific explanations and conclusions based on the amount and quality of the cited evidence (DOEb, 2009). In this curriculum, students collect, organize, and analyze earthworm density data in Microsoft Excel, in order to calculate total earthworm abundance. Additionally, students will calculate the scientific error in their abundance estimation based on mean value and standard deviation calculations from data.

Another standard addresses engineering design: the process of identifying needs, defining problems, identifying constraints, developing solutions, and evaluating proposed solutions. Students must "explain how new scientific knowledge can be used to develop new technologies and how new technologies can be used to generate new scientific knowledge" (DOEb, 2009). As part of the curriculum, students will use a handheld GPS and simple arithmetical approaches to calculate the area of an irregular shape. Students are also asked to propose how these methodologies can be used in other disciplines (i.e. natural resource management, construction engineering, architecture, etc.) to generate new knowledge.

In addition to addressing mathematics and science learning objectives for the 7th grade, this curriculum allows students to gain experience with Microsoft excel, and with a handheld GPS. Microsoft Excel is used to calculate the total courtyard area with Heron's formula and the Pythagorean theorem. The ability to use this program for mathematical calculations is a valuable skill, especially in the sciences.

***To be submitted to the Journal of Marine Education**

OVERVIEW

One of the biggest challenges researchers and natural resource managers often face is estimating populations of a species and calculating changes in distribution. This can be even more challenging when the organism you are trying to quantify is a burrowing species. Utilizing techniques designed by scientists studying burrowing shrimp that live in estuary mudflats, students will act as researchers and attempt to estimate the population of a familiar terrestrial burrowing species, the common earthworm.

ACTIVITY: Use scientific sampling techniques and simple mathematical calculations to conduct a biological survey of earthworms.

FOCUS

Biological population estimation

GRADE LEVEL

7-8 (Math and Science)

TEACHING TIME

4 one-hour class periods

KEY WORDS

Surface area, Heron's formula, Pythagorean theorem, population, sampling, data, Microsoft Excel, scientific error, earthworms.

FOCUS QUESTIONS

- How are biological population estimations conducted in science?
- How can simple mathematical equations be used to solve potentially complex scientific questions?

MATERIALS

- GPS unit and software
- Microsoft Excel
- Shovel
- Ruler (1 ft.)
- Tarp
- Gloves
- Clipboard with data sheets

BACKGROUND

The blue mud shrimp, *Upogebia pugettensis*, is a burrowing shrimp that is found in estuaries from Morro Bay, California to Prince William Sound, Alaska. These shrimp build permanent y-shaped burrows in intertidal mudflats and assemble together in large "beds" (Stevens, 1929; Thompson, 1972; Griffis & Suchanek, 1991; Chapman et al., 2012). Mud shrimp are suspension feeders, and feed by filtering plant material as they cycle seawater through their burrows. They are important "ecosystem engineers" that turn over sediment as they create their burrows, which greatly impacts Carbon, Nitrogen, and Oxygen cycling within the estuary. Additionally, the mud shrimp is a critical prey species for many marine organisms, including salmon and sturgeon, and provides habitat for a variety of marine life that live in their burrows (Chapman et al., 2012).

In the 1980s, mud shrimp became heavily infested by an invasive isopod parasite, *Orthione griffenis* (Markham, 2004), most likely introduced from Asia in ship ballast water. Infestation by these parasites has led to mud shrimp population declines of an estimated 18% per year (Chapman et al., 2012). These isopods attach to the gill structures of the shrimp, causing blood loss, and effectively castrate the shrimp host without causing mortality (Fig. 1). Mud shrimp with the isopod are unable to reproduce, and entire populations of mud shrimp have collapsed or gone extinct due to this reduced reproductive capacity.

In 2011, a project funded by The Nature Conservancy sought to establish a baseline assessment of the mud shrimp population in Alsea Bay, Oregon by mapping the spatial extent of the shrimp bed on the mudflat surface and estimating shrimp abundance, biomass, infestation rate, and lost reproductive potential due to infestation (Carter, 2011).

This baseline survey was intended to enable scientists to monitor changes in the shrimp population over time, by comparing future survey results.

Figure 1: The mud shrimp, *Upogebia pugettensis*, and its invasive parasitic isopod, *Orthione griffenis*.

The survey of mud shrimp conducted by researchers at Oregon State University involved circumnavigating shrimp beds using a handheld GPS (global positioning system). When used correctly, the GPS accurately marks the edge of an area (in this case the shrimp bed) with coordinate points every several seconds as the GPS user moves (Fig. 2). The area of each shrimp bed was then calculated using two simple arithmetical formulas: Heron's formula, and the Pythagorean theorem. This approach relies on dividing the shrimp bed into multiple, non-overlapping triangles, calculating the area of each triangle, and summing all individual areas to calculate a total area.

After calculating the area of the shrimp bed, multiple sample "cores" were taken in the mudflat. To take a core sample, a cylindrical tube of known diameter is pressed into the mudflat, and all organisms within that cylinder are removed. This allows calculation of shrimp density (# of shrimp per square meter of mudflat). Researchers also determined the average burrow density of these shrimp (Fig. 2), which can be translated to shrimp density using established relationships between the number of burrows per shrimp (Dumbauld et al., 2008). Total shrimp abundance is then calculated by multiplying the average shrimp density (shrimp / m^2) by the total shrimp bed area (m^2).

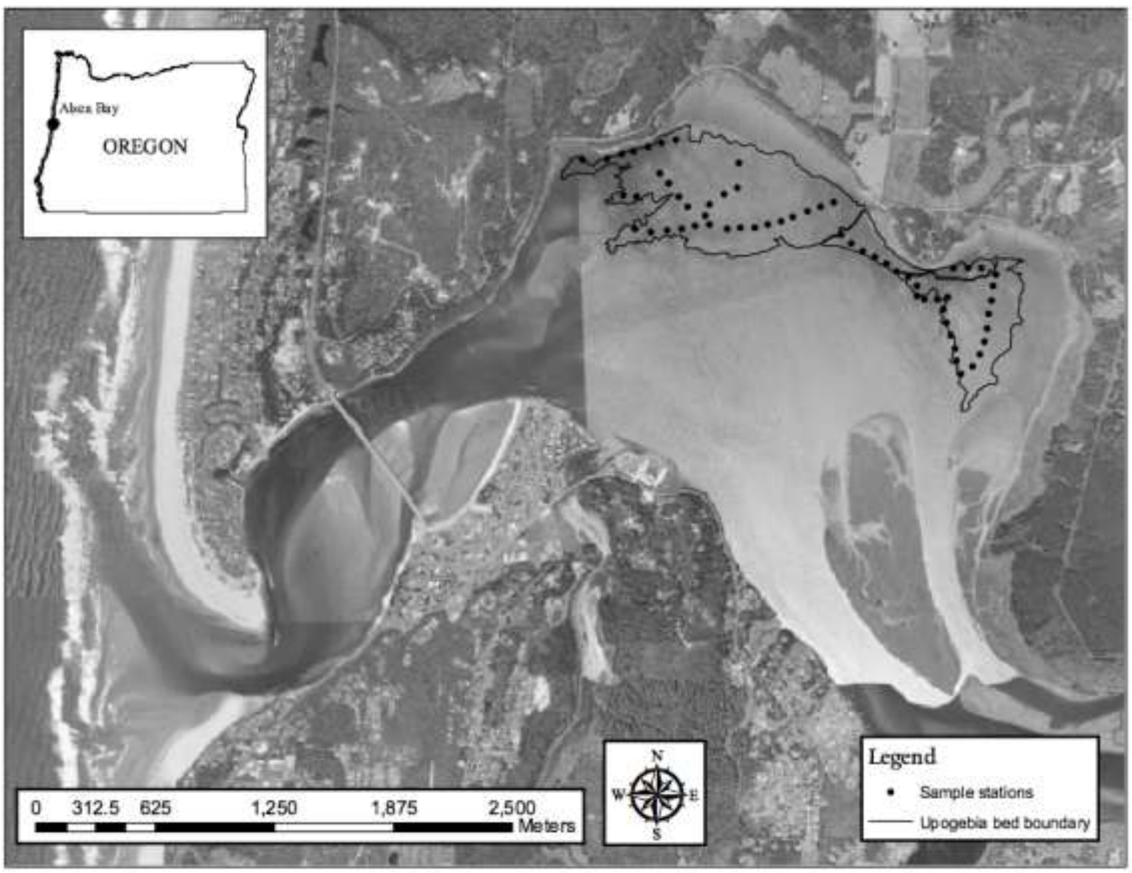


Figure 2: The mud shrimp bed in Alsea Bay, Oregon, and core and burrow density sample locations (n = 63).

The following lesson plan utilizes the same methodology to calculate the abundance of common organisms found in any schoolyard, such as earthworms. Students will calculate the total area of a small schoolyard using a GPS, Heron's formula, and the Pythagorean theorem. They will then collect discrete samples ("cores"), analyze the data using Microsoft Excel, and ultimately calculate a total population of earthworms in the area sampled while addressing the error in their estimate. This methodology demonstrates that simple mathematical approaches can be used to solve potentially complex biological questions.

GOALS

- Apply the Pythagorean theorem and Heron's formula to calculate the area of an irregular shape
- Use basic Microsoft Excel functions
- Use a GPS
- Calculate the density earthworms in a defined area by collecting discrete samples.
- Extrapolate density data to the defined area to estimate a total abundance of earthworms.
- Use basic statistical principles to determine an error range and confidence interval of the estimation.

PREPARATION

- Locate a small courtyard at your school with a significant earthworm population (or other biological organism that can be measured).
- Obtain permission to dig sample "cores", if necessary.

- Become familiar with a handheld GPS unit and download data managing software to a computer.
- Download Microsoft Excel to a class computer.

LEARNING PROCEDURE

Before beginning, assess how familiar the class is with some of the concepts in this curriculum. Specifically, students will need to be comfortable with:

- Area and density
- The Pythagorean theorem
- Calculating a square root
- Calculating a mean value
- A standard bell curve distribution
- Standard deviation

Review of these concepts may be necessary, depending on the comfort level of the class.

PART 1 – SURFACE CALCULATION WITH HERON'S FORMULA AND THE PYTHAGOREAN THEOREM

During the first part of this activity, students will mark the edges of a schoolyard with a handheld GPS, and calculate the area using Heron's formula and the Pythagorean theorem. First, begin by familiarizing yourself with the GPS unit. Refer to the user's manual to find the "track" function on the GPS. When enabled, the track function will record coordinate points every several seconds as the GPS user walks. Verify that that the

GPS unit is in “UTM” (Universal Transverse Mercator) projection. Several projection and coordinate systems exist for mapping the earth, because it is difficult to display a three-dimensional shape (the earth) in two dimensions (a map). Latitude and Longitude is an example of one coordinate system. The UTM coordinate system is in units of meters, rather than degrees, so it can be thought of pragmatically as “meters north/south” and “meters west/east”, instead of “degrees north/south” and “degrees west/east”.

Start by turning on the “track” function on the GPS unit, and then walk around the perimeter of the courtyard while carrying the GPS. Once completed, turn the “track” function off. The GPS will now have list of coordinate points in UTM projection marking the perimeter of the courtyard. Record these coordinate points on a data sheet. Next, average all of the northerly and westerly UTM coordinate points (sum of coordinate values divided by number of coordinate points (n)) to determine a “centroid” coordinate (Equation 1). The centroid coordinate point will mark the exact center of the courtyard.

$$\text{Centroid coordinate} = \frac{\sum \text{northerly coordinates}}{n}, \frac{\sum \text{westerly coordinates}}{n} \qquad (1)$$

To calculate the area of the courtyard, we will use Heron’s formula and the Pythagorean theorem. Heron’s formula computes the area of a triangle from the side lengths (a, b, and c) and semiperimeter (s) (Equation 2):

$$\text{Triangle area} = \sqrt{(s * (s - a) * (s - b) * (s - c))} \qquad (2)$$

$$\text{Where (s) is the semiperimeter} = \frac{(a+b+c)}{2}$$

Here, we will calculate the total area of the courtyard by dividing it into non-overlapping triangles, calculating the area of each triangle using Heron's formula, and summing all triangles together. Each triangle will have the calculated centroid point as one corner, and two adjacent coordinate points marked by the GPS as the other two corners (Fig. 3).

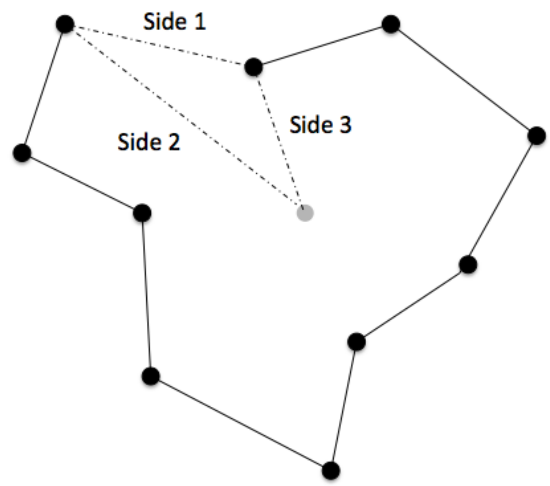


Figure 3: Example of an irregular shape marked by GPS survey. GPS coordinate points (black dots) mark the edge of the sample area, and the centroid (gray dot) marks the central point of this irregular shape. Total area is calculated by dividing this irregular shape into multiple triangles, calculating each triangle area, and summing.

To calculate the area of each triangle, we first need to calculate the 3 side lengths of each triangle. This can be done using the Pythagorean theorem (Equation 3). This equation only applies to right (90^0) triangles, and allows the calculation of one side of the triangle if the other two sides are known. In the Pythagorean theorem, side "c" is the hypotenuse, or the side opposite of the 90^o angle. The hypotenuse is the longest side of a right triangle.

Pythagorean theorem: $a^2 + b^2 = c^2$ for a right (90^o) triangle (3)

Looking more closely at the example triangle from Fig. 3, we see that each side can be calculated using the Pythagorean theorem (Fig. 4). Here, each side of the sub-divided triangle will be the hypotenuse (side c) of the Pythagorean theorem equation. The other two sides (a and b) are the differences in westerly and northerly coordinates between the two endpoints of the triangle side, respectively. Because we have projected all coordinates in UTM projection, the calculated side lengths will be in units of meters.

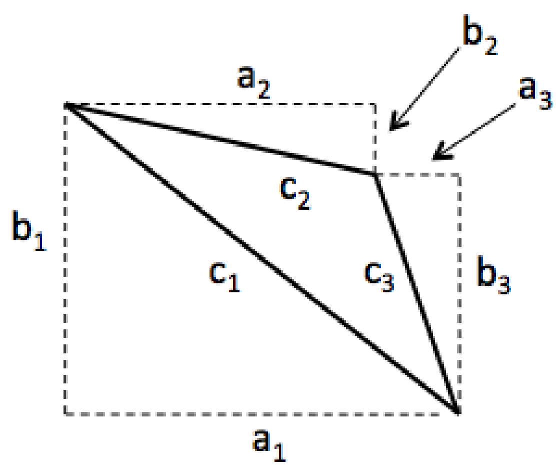


Figure 4: The Pythagorean theorem is used to calculate the side lengths of each triangle included in the total polygon area.

The Pythagorean theorem can now be rearranged to solve for the three sides of the triangle above: c_1, c_2, and c_3 (Equation 4).

$$\text{Side 1}(c_2) = \sqrt{{a_2}^2 + {b_2}^2}$$

$$\text{Side 2 }(c_3) = \sqrt{{a_3}^2 + {b_3}^2}$$

$$\text{Side 3 } (c_1) = \sqrt{a_1{}^2 + b_1{}^2} \qquad (4)$$

Once calculated, enter these three side lengths into Heron's formula (Equation 2) to calculate the total area of the triangle, which will be in units of m^2. The total area of the courtyard is simply the sum of all triangles within.

Calculating each triangle area by hand would be very labor intensive, so refer to the attached Microsoft Excel worksheet to calculate for total area. The Microsoft Excel worksheet requires only the coordinates marked by the GPS in UTM projection to be entered into the "northerly" and "westerly" coordinates column. The students can manually do this, by transcribing from the handwritten data sheet. The workbook will automatically subdivide the total area into multiple triangles, calculate the area of each triangle, and sum them together to produce a total area. The total area is calculated at the top of the workbook.

Each student should calculate the area of one triangle using Heron's formula and the Pythagorean theorem before using the Microsoft Excel workbook, so that they are able to demonstrate their understanding of the concept. Students should be able to use two adjacent coordinate points from the GPS and the centroid point to create a triangle, calculate the three side lengths, and then the total area.

PART 2 – SAMPLING AND DENSITY CALCULATIONS

The next activity involves students collecting samples within the marked courtyard area, in order to determine an average density of earthworms. The average density will then be used to estimate total abundance in the courtyard.

Begin sampling by randomly picking several spots within the surveyed area to serve as sample locations. Students can throw a ball or Frisbee into the sampling area, or generate other possible methods for choosing random sampling sites. Dig a 30x30x30 cm hole, or otherwise collect a standard volume of sample using the shovel and ruler. Place all of the removed soil onto the tarp and sort through it for the worms. Count them and record everything systematically for each sample. The number of worms per sample area will provide an estimate of average density (i.e., worms/m^2 of courtyard). For this activity, we will assume that all earthworms live within the top 30 cm of soil and that all are collected for a given patch of grass to estimate units of earthworms per m^2 (instead of earthworms per m^3) so that the abundance calculation (made later) makes sense. Record the earthworm density for each sample station on a data sheet. Repeat these steps for a minimum of three sample stations; more sample stations will result in a more accurate earthworm density approximation and a smaller error range (calculated later).

PART 3 – ABUNDANCE CALCULATION AND CONFIDENCE INTERVAL

The total abundance of earthworms within the irregular shape can now be calculated using your earthworm density calculations. To do so, first take the average earthworm density across all samples (Equation 5).

$$Average\ density = \frac{Sum\ of\ all\ earthworms\ collected}{Number\ of\ samples * sample\ area\ (m^2)} = \frac{Worms}{m^2} \qquad (5)$$

Multiplying this density estimate by the total area (calculated in part 1) will provide an estimate of total earthworms in the area (Equation 6). You might be surprised at how large the number will be.

$$Total\ earthworm\ abundance = Area\ (m^2) * \frac{Worms}{m^2} \qquad (6)$$

However, it is important to note that this estimation is not the “actual” number of earthworms. In science there is always uncertainty, which can be quantified with “standard error”. For this activity, we will calculate a 95% standard error, which means that if further density samples were to be collected, we would expect 95% of the samples to have a density within this range.

To calculate standard error, we will first need to calculate the standard deviation of the sample earthworm densities. Standard deviation is a representation of how much the data varies around the calculated mean density value, and is dependent on the number of samples (n), the mean density value of the samples ($\bar{x}$), and individual sample density values (x). The closer the sample earthworm density values are to each other (and thus the mean), the smaller the standard deviation is (Equation 7).

$$\text{Standard deviation } \sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}} \qquad (7)$$

Standard deviation can be easily calculated from a set of numbers in Microsoft Excel, rather than calculating by hand with this equation. Enter your average density data into a column in an excel workbook, type the standard deviation command (Equation 8) into an open cell, and highlight all of the density data when prompted to do so (in-between the parentheses) to calculate the standard deviation for your data set.

Standard deviation Microsoft Excel command → =Stdev() (8)

The standard deviation can now be used to calculate the 95% standard error. To explain further, we will examine a standard bell curve (Fig. 5), shown below.

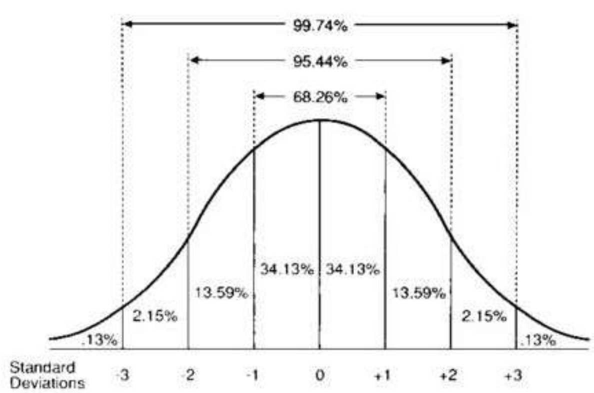


Figure 5: A standard bell curve distribution about a mean value. Standard deviation values are useful to determine standard error ranges in scientific calculations.

Let's think of this bell curve as representing possible earthworm densities. The "0" line through the middle of the curve is the mean earthworm density (calculated by averaging all samples). The y-axis is probability. That is, if one were to dig a hole, count earthworms, and determine a density, the highest probability would be the mean density with decreasing probability further above and below that value.

The standard error calculated from one standard deviation is equal to the standard deviation divided by $\sqrt{n}$, and is equal to a 68.26% probability (34.13% above and below the mean). That is, subsequent density samples have a 68.26% probability of being within this error range. For this activity, we will calculate the 95% error range, which is calculated from 1.96 standard deviations above and below the mean (Equation 9).

$$\text{95\% standard error} = 1.96 * \frac{Standard\ Deviation}{\sqrt{n}} \qquad (9)$$

We will calculate the 95% standard error in Microsoft Excel, using a simple command (Equation 10). The prompt “alpha, standard_dev, sample #” will appear in-between the parentheses of the equation, once entered. Enter in the value 0.05 for “alpha”, the standard deviation calculated with equation 6 for “st_dev”, and the number of sample locations for “sample#”.

95% standard error command “= confidence ()” (10)

The resulting number is an error range above and below the mean density value with 95% confidence. Subtract and add this value to your mean density to calculate the low- and high-end density values, respectively. Multiply these density values by the total courtyard area to estimate the minimum and maximum total abundance. In science, it is important to state the accurateness of estimations, and this is a common way to do so.

FOLLOW UP QUESTIONS

This activity should reveal how relatively simple mathematics can be used to address potentially complex questions. In this case, we only calculated the abundance of earthworms in a courtyard, but other more complex questions could have been answered as well, including: What is the average earthworm length/weight? What is the total biomass of earthworms? We were able to use these same techniques to answer more in-depth questions during our study of a disappearing estuary shrimp (*Upogebia pugettensis*).

Heron's formula and the Pythagorean theorem are simple to use and have broad application. What else could they be used for? Have the students come up with some other ideas (i.e. construction, city planning, manufacturing, engineering, natural resources management, etc.), and state the information needed to answer their question. A follow up assignment could have students produce their own research plan.

FURTHER INFORMATION

More information about research on the mud shrimp, *Upogebia pugettensis*, and the methodology that inspired this lesson plan can be found at the following website:

http://hmsc.oregonstate.edu/marinebioinvasionslab/research

ACKNOWLEDGEMENTS

This lesson plan was created by Cameron S. Carter, a graduate student at Oregon State University in Corvallis, Or, with help from to John W. Chapman (Oregon Department of Fish and Wildlife) and Tracy Crews (Oregon Sea Grant Marine Education Manager). Comments from Robyn Paul helped in the refinement of this lesson plan.

REFERENCES

Carter, C. 2011. Population structure and spatial extent of the mud shrimp *Upogebia pugettensis* in Alsea Bay, Oregon. Report to The Nature Conservancy, 12 pp. + fig.

Chapman, J. W., Dumbauld, B. R., Itani, G., and J. C. Markham. 2012. An introduced Asian parasite threatens northeastern Pacific estuarine ecosystems. Biological Invasions 14 (6): 1221-1236.

Dumbauld B. R., and J. W. Chapman. 2008. Could burrowing shrimp host populations with pelagic larval dispersal be controlled by an invading parasite? In: 37th Annual Benthic Ecology Meeting. Providence, RI April 9-13, 2008.

Griffis, R. B., and T. H. Suchanek. 1991. A model of burrow architecture and trophic modes in thalassinidean shrimp (Decapoda: Thalassinidea). Marine Ecology Progress Series 79: 171-183.

Markham, J. C. 2004. New species and records of Bopyridae (Crustacea: Isopoda) infesting species of the genus *Upogebia* (Crustacea: Decapoda: Upogebiidae): the genera *Orthione* Markham, 1988, and *Gyge* Cornalia & Panceri, 1861. Proc Biol Soc Wash 117: 186-198.

Oregon Department of Education (ODE). 2011. DRAFT for public review – November 2011: The Oregon STEM Education Initiative. Retrieved from: http://www.ode.state.or.us/wma/stem/stem-education-initiative-draft-for-public-review-11-3-11-.pdf

Oregon Department of Education [DOEa]. 2009. Oregon Common Core State Standards for Mathematics. Downloaded from: http://www.ode.state.or.us.

Oregon Department of Education [DOEb]. 2009. Oregon Common Core State Standards for Science. Downloaded from: http://www.ode.state.or.us.

Stevens, B. A. 1929. Ecological observations on Callianassidae of Puget Sound. *Ecology* 10: 399-405.

Thompson, R. K. 1972. Functional morphology of the hind-gut gland of *Upogebia pugettensis* (Crustacea, Thalassinidea) and its role in burrow construction. Ph.D. Dissertation, University of California, Berkeley, California.

Chapter 4: Lessons Learned, and Implications for Marine Resource Management

MARINE RESOURCE MANAGEMENT

I chose the Marine Resource Management (MRM) graduate program at Oregon State University because I perceived the broad application of the degree and the diversity of experiences available to students in the program. The versatility of the program allows students to undertake a variety of projects, dealing with every facet of the marine environment and associated management.

This description has matched my overall experience. Academically, I have had the opportunity to take a wide range of courses within several departments of the university, and have learned an incredible amount on an assortment of subject material. I had the opportunity to serve as a graduate teaching assistant for three out of my six quarters as a graduate student, for both graduate and undergraduate courses. These teaching positions challenged my ability to communicate classroom material in a variety of ways to students and colleagues.

As part of the degree requirements, students must complete a project related to marine resource management in addition to compulsory coursework. My project started with a small grant from The Nature Conservancy, with the somewhat abstract objective of "identifying non-vegetated tidelands that should be candidates for restoration and/or conservation". I was given authority to take my own approach on the stated goals, and after contacting various researchers involved with intertidal habitat, I eventually met Dr. John Chapman and made the decision to study the Alsea Bay *Upogebia pugettensis* population. A project that started with answering the questions "how many shrimp are there, where are they, and what percent are infested?" turned into something much more in depth and comprehensive. In the midst of it, the decision was made to use some of the methodology from the project to develop a middle school class curriculum. This project has structured and restructured itself throughout the year that I have worked on it into an end product that I never would have imagined at the beginning of this journey. I began graduate school unaware that burrowing mud shrimp existed in Oregon, and left as an expert.

My overall experience with this project has been a positive one. I have had the opportunity to develop new skills, strengthen existing ones, and contribute to an ever-increasing body of scientific knowledge. I feel that the research I have completed will contribute to marine resource management in a positive way, and bring awareness to this very important issue.

PROJECT RATIONALE

The MRM program focuses on both ocean science research, as well as communication of science to various stakeholders. This is reaffirmed on the MRM website, which states, "Marine and coastal issues are technically and politically complex, involving many interests, perspectives, and stakeholders. To deal effectively with these issues, marine resource managers need a broad-based background in both physical and social sciences. Graduates from the program bridge the gap between science and policy".

The management of *Upogebia pugettensis* fits this description, because of its inherit complexity, tumultuous political environment, and involvement of multiple perspectives and stakeholders. The management of these shrimp extends far beyond the study of its invasive parasite and continued population declines. This is particularly evident in Willapa Bay, Washington, with regards to the oyster industry and the interactions between this burrowing shrimp and oyster farmers. Oyster farmers are valuable stakeholders within intertidal ecosystems, and capitalize on the natural growth of oysters on the mudflat surface. However, sediment bioturbation by *Upogebia* negatively impacts oyster survival substantially, and oyster growers do not view burrowing shrimp favorably. Management of burrowing shrimp in this area has become an exceptionally contentious issue with regards to the use of the pesticide carbaryl to control burrowing shrimp populations, and is an issue I feel should be discussed in this paper.

CARBARYL

Although a native and endemic species, *U. pugettensis* has historically been seen as a "nuisance pest" by oyster farmers along the Pacific coast, as they indirectly kill oysters through bioturbation and sediment destabilization (Feldman et al., 2000). *Upogebia* and co-occurring shrimp *Neotrypaea californiensis* burrow through the mud, constructing extensive burrow galleries up to 90 cm in depth with multiple openings to the surface (Stevens, 1928; MacGinitie, 1930, 1934; Thompson, 1972; Swinbanks and Luternauer, 1987). During this process sediment compaction is reduced to the point that oysters growing directly on the benthos sink into the unconsolidated mud. Settling larvae and spat (juvenile oysters) are particularly vulnerable to burial or suffocation by suspended sediments (Stevens, 1929; Loosanoff and Tommers, 1948; Washington Department of Fisheries [WDF], 1970; Peterson, 1984; Murphy, 1985; WDF and Washington Department of Ecology [WDOE], 1985, 1992).

Washington State produces approximately 25% of the nation's oysters (Conway, 1991), with Willapa Bay and Grays Harbor accounting for over 60% of the states production (Hoines, 1996). In Willapa Bay, although oyster growers utilize suspended culture techniques, bottom or ground culture is the most extensive method used, accounting for over 95% of production (Dumbauld, 2004). Therefore, the impacts of *Upogebia* and *Neotrypaea* sediment destabilization are significant on the local oyster industry.

To expand tideland suitable for oyster culture, farmers began seeking means to reduce numbers of burrowing shrimp in the early 1960's. Experimental application of a broad range of pesticides tested by Dr. Victor Loosanoff for use on "shrimp-infested" oyster grounds identified carbaryl (1-napthol n-methyl carbamate; sold under the brand name Sevin®) to be an effective, practical, and relatively inexpensive method to control burrowing shrimp (WDF, 1970). Carbaryl is extremely toxic to arthropods (Mount and Oehme, 1981), and death results from muscle and respiratory paralysis (Estes, 1986; Fukuto, 1990). Carbaryl has been widely used for terrestrial insect control due to its very low mammalian toxicity (Mount and Oehme, 1981; Cranmer, 1986) and rapid breakdown in the environment (Carpenter et al., 1961; Karinen et al., 1967; Rajagopal et al., 1984; Larkin and Day, 1985), and has been used to control populations of *Upogebia* and *Neotrypaea* in Washington State since 1964.

Although effective at killing burrowing shrimp, application of carbaryl has been found to kill other intertidal species, including: staghorn sculpin (*Leptocottus armatus),* saddleback gunnels (*Parophrys vetulus* and *Psettichthys melanosticus)*, shiner perch (*Cymatogaster aggregate)*, starry flounder (*Platichthys stellatus)*, bay gobies

(*Lepidogobius Lepidus)*, three-spine sticklebacks (*Gasterosteus aculeatus*), and other crustaceans such as Dungeness crab (*Cancer magister*) (Feldman et al., 2000). The EC_{50} values for carbaryl are generally an order of magnitude higher for fishes than for many invertebrates (particularly crustaceans), but fish are more sensitive to 1-napthol, carbaryl's immediate breakdown product, than invertebrates (Stewart et al., 1967). Furthermore, this pesticide can indirectly affect biota in the area, such as Western gulls (*Larus occidentalis*) and Glaucous-winged gulls (*Larus glaucescens*) that consume contaminated shrimp after treatment (Feldman et al., 2000).

Some environmentalists have sought to ban the use of carbaryl due to short-term and potential long-term impacts to the estuarine ecosystem. Similar concerns in Oregon led to the termination of their carbaryl program in 1984 (Bakalian, 1985; Buchanan et al., 1985). The ecosystem services of *Upogebia* have been juxtaposed with economic gains from use of carbaryl for management in several studies. However, because there are multiple stakeholders impacted by the management of these shrimp, reaching a solution has been difficult. At the writing of this paper, oyster growers in Willapa Bay have agreed to discontinue the use of carbaryl by the end of 2012 due to concern by various stakeholder groups. However, alternative management options are being considered, and the most likely alternative seems to be application of the pesticide imadacloprid, which is the most widely used insecticide in the world (Yamamoto, 1999).

LESSONS LEARNED

I decided to accept the grant for this project from The Nature Conservancy without a full understanding of how the project would shape itself or what the end result would be. The grant had the goal of "identifying non-vegetated tidelands in Alsea Bay that would be good candidates for restoration and/or conservation", and I had a fair amount of freedom to create my own research questions and objectives. Studying the Alsea Bay *Upogebia pugettensis* was an unexpected turn in the direction of the project, and ultimately became a topic that increasingly captured my interest as I became more versed on the subject.

This project required more fieldwork than I had completed previously, which took a tremendous amount of effort and was a truly memorable experience. Through personal observations of *Upogebia* on the mudflat while collecting data, conducting data analysis, and reading previously published literature, I've gained incredible insight regarding the critical role this species of shrimp plays in overall ecosystem function. *Upogebia* and *Neotrypaea* exist in incredible numbers in Alsea Bay, and contain more biomass than any other species in the estuary; around 800+ metric tons, based on my survey. They dominate carbon, nitrogen, and oxygen cycling in intertidal estuaries, provides vast amounts of habitat by creating mostly permanent burrows, and serves as an important prey source for salmon, sturgeon, and shorebirds. Losing *Upogebia* presence due to infestation by *Orthione* will have tremendous impacts on estuary productivity and viability.

However, discussions of estuary conservation rarely include either of these burrowing shrimp, despite their integral roles. Although the objectives of the grant that funded this project were to identify areas within the estuary suitable for conservation, I've discovered that perhaps the focus for conservation should be on "what", rather than "where" within Alsea Bay. Estuary-wide conservation is simply impossible without consideration of the rapid decline in abundance of both *Upogebia* and *Neotrypaea*. Population collapse or extinction of these burrowing shrimp in Alsea Bay, as has been observed in other estuaries, would render the Alsea Bay tidal flats essentially a "biological desert". All the species that co-exist and depend on the ecosystem functions of these shrimp will suffer as a result. My hope with this project is that more light will be cast on this incredibly important and time-sensitive problem, and that there will be serious consideration toward *Neotrypaea* and *Upogebia* with regards to estuary conservation.

I sincerely hope that the class curriculum I have developed will inspire students to become involved in the sciences and time-sensitive conservation issues, like the one discussed in this paper. By submitting this curriculum in a marine education journal, I hope to give teachers the tools and insight they need to relate the discussed concepts, like the Pythagorean theorem and Heron's formula, to real world applications. This curriculum fits well with the objectives of STEM and the Oregon Department of Education's Common Core State Standards, both of which aspire to encourage student involvement in the increasingly important disciplines of science, technology, engineering, and mathematics.

We are unable to quantify *Upogebia* population change in Alsea Bay with one survey; subsequent surveys are required of the entire population. However, we attempted to use anecdotal evidence to describe changes in the density and spatial extent of *Upogebia* in Alsea Bay. We interviewed a local mud shrimp harvester to note his observations over time, and obtained *Upogebia* commercial harvest data from the Oregon Department of Fish and Wildlife.

A small *Upogebia* fishery exists in Oregon, primarily for the use as live bait for recreational fishermen. Shrimp are extracted commercially by pumping large amounts of seawater through a hose and into the mudflat surface, loosening the sediment substantially so that shrimp will come to the surface where they can be collected. Mud shrimp "pumping" is usually done from small handmade floats constructed from polystyrene foam ("Styrofoam®") and plywood with a water pump attached. The pump is powerful enough to push water through two-inch diameter hose that these mud shrimpers carry up to 1500 feet onto the mudflat, and also doubles as a water jet to slowly move the float around the estuary. Extraction of these shrimp requires tremendous effort, and involves wading through partially liquefied mud as the shrimp are pumped.

One commercial fisherman graciously set aside an afternoon to meet with Dr. Chapman and myself to visit the sites he used to harvest mud shrimp in Alsea Bay. During this survey of historical sites, we found that at least in one area of the estuary, populations of this shrimp had diminished from densities that allowed a harvest of up to 1,000 shrimp in a 3-hour tidal cycle to extremely low densities. This fisherman also noted that *Upogebia* populations in surrounding estuaries, such as Coos Bay, had also shown visible declines in the areas where they were once abundant.

We obtained the annual *Upogebia* harvest data from Oregon Department of Fish and Wildlife, and these data corroborate the observations of this fisherman. Total Oregon *Upogebia* catch peaked in 1991 at 56,022 lbs. and has decreased steadily since to 2,396 lbs. in 2011. The story has been the same for harvests in Alsea Bay, which peaked at 1,895 lbs. in 1988 and was reported to be 70 lbs. in 2010 and only 6 lbs. in 2011.

Through my interactions with this commercial fisherman, I’ve learned that some of the best information can’t be found in a book or journal article. Meeting this fisherman and discussing his experiences firsthand added a unique component to this project that wouldn’t have been possible otherwise.

ACKNOWLEDGEMENTS

This project has been an experience that I’ll never forget, and this paper has challenged my writing abilities and organizational skills in an unprecedented way. I sincerely thank Dr. John Chapman for giving me the resources, guidance, and inspiration throughout the development of this project and manuscript. I’ve gained a tremendous amount of respect for the passion he has for his work, and the quality of research that he and his colleagues conduct. I also thank Tracy Crews for her help with developing the class curriculum and Flaxen Conway for her unending encouragement and help with content organization.

I thank my family and friends for their unwavering support throughout my graduate school career, and for the exposure to marine science that my parents encouraged throughout my childhood. I find it incredible that I have learned so much in the short time that I have worked on this project, and look forward to moving on to the next chapter in my life.

REFERENCES

Bakalian, A. B. 1985. The use of Sevin on estuarine oyster beds in Tillamook Bay, Oregon. *Coastal Zone Management Journal* 13: 49-83.

Buchanan, D. V., Bottom, D. L., and D. A. Armstrong. 1985. The controversial use of the insecticide Sevin in Pacific Northwest estuaries: Its effects on Dungeness Crab, Pacific Oyster, and other species. Proceedings of the symposium on Dungeness Crab biology and management. Alaska Sea Grant Report 85-3, University of Alaska, Fairbanks, Alaska.

Carpenter, C. P., C. S. Weil, P. E. Palm, M. W. Woodside, J. H. Nair III, and H. F. Smyth, Jr. 1961. Mammalian toxicity of 1-naphthyl-N-methylcarbamate (Sevin insecticide). Journal of Agricultural and food chemistry 9: 30-39.

Conway, Jr., R. S. 1991. The economic impact of the oyster industry. Report to the Willapa-Grays Harbor Oyster Growers Association, Washington State Department of Community Development, and Pacific County Economic Development Council Port of Peninsula, Washington.

Cranmer, M. F. 1986. Carbaryl: A toxicological review and risk analysis. Neurotoxicology 7: 247-332.

Dumbauld, B. R., Feldman, K., and D. Armstrong. 2004. A comparison of the ecology and effects of two species of thalassinidean shrimps on oyster aquaculture operations in the eastern North Pacific. In *Proceedings of the symposium on "Ecology of large bioturbators in tidal flats and shallow sublittoral sediments-from individual behavior to their role as ecosystem engineers"*, ed. A. Tamaki, 53-61. Nagasaki: Nagasaki University.

Estes, P.S. 1986. Cardiovascular and respiratory responses of the ghost shrimp, *Callianassa californiensis* Dana, to the pesticide carbaryl and its hydrolytic product 1-napthol. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Feldman, K. L., Armstrong, D. A., Dumbauld, D. R., DeWitt, T. H., and D. C. Doty. 2000. Oysters, crabs, and burrowing shrimp: an environmental conflict over aquatic resources and pesticide use in Washington state's (USA) coastal estuaries. *Estuaries* 23: 141-176.

Fukuto, T.R. 1990. Mechanism of action of organophosporus and carbamate insecticides. Environmental Health Perspectives 87: 245-54.

Hoines, L. 1996. Washington State Fisheries Statistical Report: 1993. Washington State Department of Fish and Wildlife. Olympia, Washington.

Karinen, J. F., J. G. Lamberton, N. E. Stewart, and L. C. Terriere. 1967. Persistence of carbaryl in the marine estuarine environment. Chemical and biological stability in aquarium systems. Journal of Agricultural and Food Chemistry 15: 148-156.

Larkin, M. J. and M. J. Day. 1985. The effect of pH on the selection of carbaryl-degrading bacteria from garden soil. Journal of applied bacteriology 58: 175-185.

Loosanoff, V. L. and F. D. Tommers. 1948. Effect of suspended silt and other substances on rate of feeding of oysters. *Science* 107: 69-70.

MacGinitie, G. E. 1930. The natural history of the mud shrimp *Upogebia pugettensis* (Dana). *Annals and Magazine of Natural Hisory* 6: 37-45.

MacGinitie, G. E. 1934. The natural history of *Callianassa californiensis* (Dana). *American Midland Naturalist* 15: 166-177.

Mount, M. E. and F. W. Oehme. 1981. Carbaryl: A literature review. *Residue Reviews*: 80: 1-64.

Murphy, R. C. 1985. Factors affecting the distribution of the introduced bivalve, *Mercenaria mercenaria* in a California lagoon – The importance of bioturbation. *Journal of Marine Research* 43: 673-692.

Peterson, C. H. 1984. Does a rigorous criterion for environmental identity preclude the xistence of multiple stable points? *American Naturalist* 124: 127-133.

Rajagopal, B. S., B. R. Reddy, G. P. Brahraprabash, V. D. Singh and N. Sethunathan. 1984. Effect and persistence of selected carbamate pesticides in soil. Residue Reviews 93: 1-207.

Stevens, B. A. 1929. Ecological observations on Callianassidae of Puget Sound. *Ecology* 10: 399-405.

Stevens, B. A. 1928. Callianassidae from the West coast of North America. *Publications Puget Sound Biological Station* 6: 315-369.

Stewart, N.E., R.E. Millemann, and W.P. Breese. 1967. Acute toxicity of the insecticide Sevin and its hydrolytic product 1-napthol to some marine organisms. Transactions of the American Fisheries Society 96: 25-30.

Swinbanks, D. D. and J. L. Luternauer. 1987. Burrow distribution of the thalassinidean shrimp on a Fraser Delta tidal flat, British Columbia. *Journal of Palentology* 61: 315-332.

Thompson, R. K. 1972. Functional morphology of the hind-gut gland of *Upogebia pugettensis* (Crustacea, Thalassinidea) and its role in burrow construction. Ph. D. Dissertation, University of California, Berkelely, California.

Washington Department of Fisheries. 1970. Ghost shrimp control experiments with Sevin, 1960-1968. Washington Department of Fisheries Technical Report 1. Olympia, Washington.

Washington Department of Fisheries and Washington Department of Ecology. 1985. Use of the insecticide Sevin to control ghost and mud shrimp in oyster beds of Willapa Bay and Grays Harbor. Final Environmental Impact Statement. Olympia, Washington.

Washington Department of Fisheries and Washington Department of Ecology. 1992. Use of the insecticide carbaryl to control ghost and mud shrimp in oyster beds of Willapa Bay and Grays Harbor. Final Supplemental Environmental Impact Statement. Olympia, Washington.

Yamamoto, Izuru. 1999. Nicotine to Nicotinoids: 1962 to 1997. In Yamamoto, Izuru; Casida, John, Nicotinoid Insecticides and the Nicotinic Acetylcholine Receptor, Tokyo: Springer-Verlag, pp. 3-27.

APPENDIX A – Heron's formula example

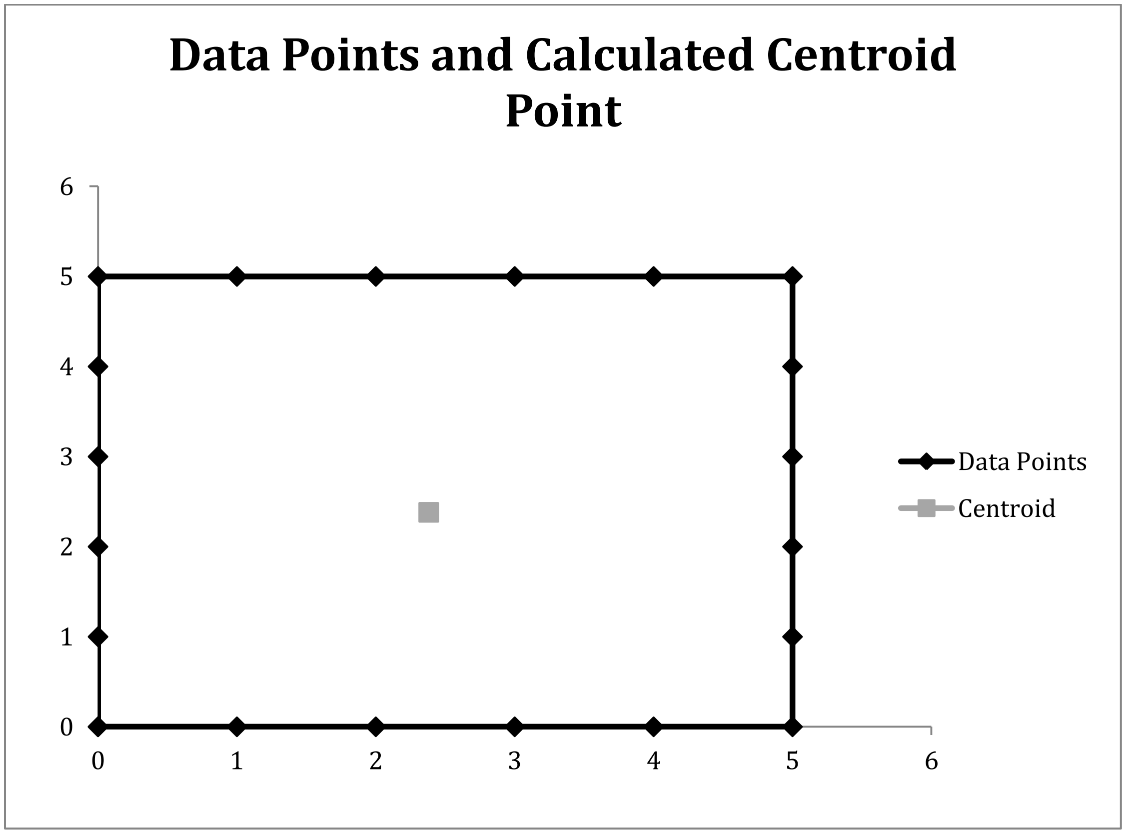
Heron's Formula Triangle Area Calculation

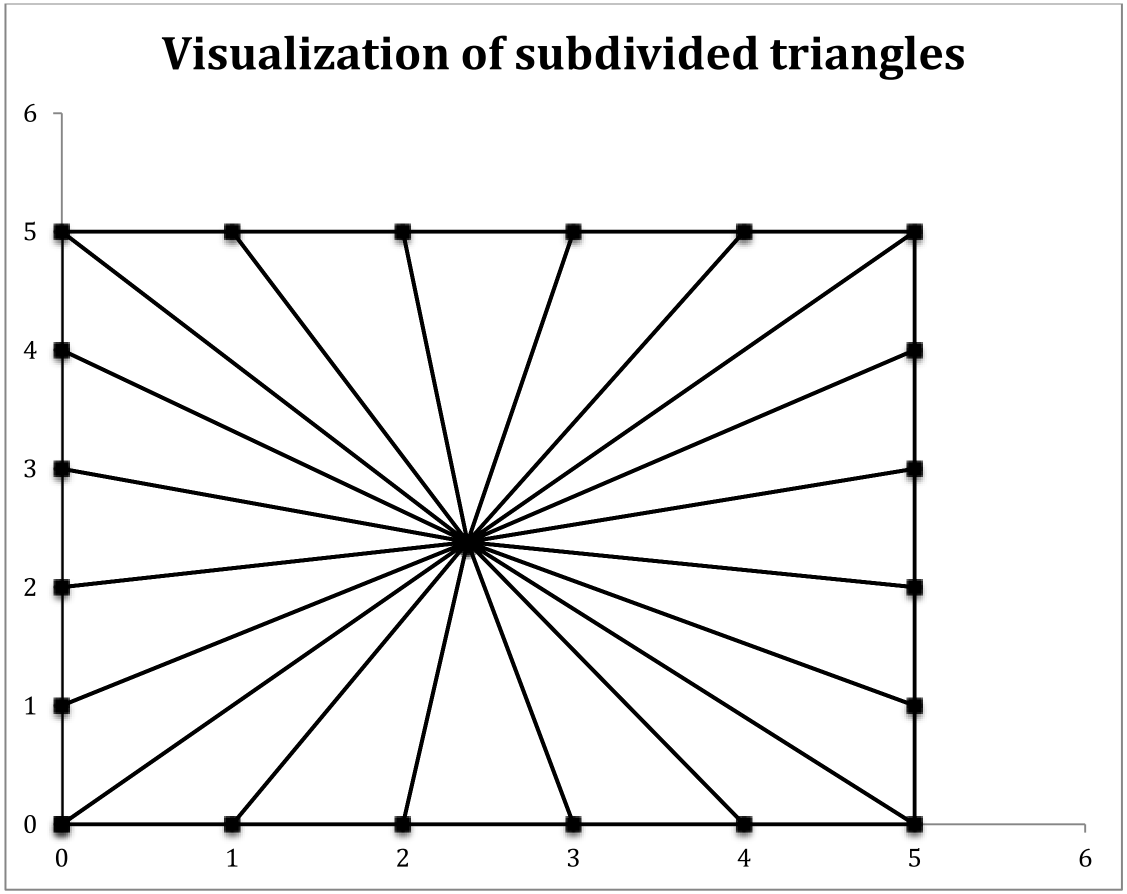
Calculated Area	Estimated Area
25.0	25.0

Centroid Longitude	Centroid Latitude	Av Radius
2.38	2.38	3.40

Longitude (x)	Latitude (y)	Radius/Hypotenuse	Opposite	Semiperimeter (s)	Triangle Area
0	0	3.367175149			
0	1	2.75244686	1	3.559811004	1.19047619
0	2	2.411235981	1	3.081841421	1.19047619
0	3	2.460112639	1	2.93567431	1.19047619
0	4	2.879279325	1	3.169695982	1.19047619
0	5	3.539540178	1	3.709409752	1.19047619
1	5	2.960817439	1	3.750178809	1.30952381
2	5	2.646608235	1	3.303712837	1.30952381
3	5	2.691213553	1	3.168910894	1.30952381
4	5	3.079078697	1	3.385146125	1.30952381
5	5	3.703892663	1	3.89148568	1.30952381
5	4	3.079078697	1	3.89148568	1.30952381
5	3	2.691213553	1	3.385146125	1.30952381
5	2	2.646608235	1	3.168910894	1.30952381
5	1	2.960817439	1	3.303712837	1.30952381
5	0	3.539540178	1	3.750178809	1.30952381
4	0	2.879279325	1	3.709409752	1.19047619
3	0	2.460112639	1	3.169695982	1.19047619
2	0	2.411235981	1	2.93567431	1.19047619

1	0	2.75244686	1	3.081841421	1.19047619
0	0	3.367175149	1	3.559811004	1.19047619




Visualization of subdivided triangles
6
5
4
3
2
1
0
0
1
2
3
4
5
6

APPENDIX B – *Upogebia* bed area calculations

Polygon 1

					Est Area		
					10430.75079		
		Cent Long	Cent Lat	Av Radius			
		4921544.348	582796.1668	60.75867262			
						Heron's Formula for Area	
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	
4921600.168	582746.3774		74.79878277				
4921602.07	582750.3327		73.70607629	4.388743333	76.4468012		157.7374043
4921603.955	582752.9616		73.61839879	3.234936946	75.27970601		119.0738609
4921611.478	582762.1513		75.25624227	11.87637161	80.37550633		436.4038621
4921611.495	582763.4776		74.68131805	1.326363088	75.6319617		44.8026969
4921611.596	582771.4351		71.65173869	7.9581786	77.14561767		268.8162742
4921611.613	582772.7614		71.22077312	1.326363113	72.09943746		44.8027241
4921609.778	582774.1112		69.04793263	2.277500446	71.2731031		23.92932639
4921596.836	582775.6022		56.37329789	13.0276995	69.22446501		93.94397587
4921587.614	582778.3724		46.78221565	9.629724093	56.39261882		22.12822807
4921582.127	582783.748		39.76827672	7.681009066	47.11575072		67.47802116
4921576.675	582791.7762		32.62367901	9.704789225	41.04837248		117.7932966
4921571.256	582802.457		27.63346612	11.9767345	36.11693981		160.741611
4921567.739	582817.093		31.38549016	15.05262016	37.03578822		207.9740635
4921562.387	582833.0788		41.08445444	16.85774019	44.66384239		242.9542928
4921555.117	582843.7831		48.81912548	12.93974859	51.42166426		230.7287303
4921545.996	582854.5111		58.36760003	14.08145354	60.63408953		274.9309462
4921538.794	582870.5206		74.56095769	17.55504214	75.24179993		223.3070807
4921535.159	582875.8728		80.23396504	6.469889518	80.63240612		120.2749685
4921527.821	582881.2721		86.69518461	9.110041155	88.0195954		267.6164001
4921527.821	582881.2721		86.69518461	0	86.69518461		0
4921527.838	582882.5984		87.99432935	1.326380756	88.00794736		11.67815503
4921525.953	582879.9694		85.79776587	3.23496366	88.51352944		103.1663657

4921525.784	582866.7067		72.94171129	13.2638111	86.00164414		129.0593543
4921525.683	582858.749		65.30640299	7.958286487	73.10320039		77.43515486
4921523.747	582852.1412		59.64505527	6.88549921	65.91847873		122.237885
4921523.73	582850.815		58.40815492	1.326381428	59.68979581		14.13364476
4921523.679	582846.8361		54.72260753	3.979144263	58.55495336		42.40088998
4921523.46	582829.5946		39.41720898	17.2429581	55.6913873		183.7364774
4921521.49	582820.3342		33.26432592	9.467474872	41.07450489		129.6308996
4921521.339	582808.3977		26.05787899	11.93743534	35.62982013		138.2522339
4921521.322	582807.0715		25.47755132	1.326381687	26.430906		15.36135104
4921519.335	582796.4848		25.01421147	10.7713731	30.63156795		132.71355
4921519.335	582796.4848		25.01421147	0	25.01421147		0
4921511.492	582762.0958		47.33223824	35.27220032	53.80932502		431.3196194
4921511.492	582762.0958		47.33223824	0	47.33223824		0
4921511.509	582763.4221		46.37474303	1.326383451	47.51668236		21.50068846
4921511.492	582762.0958		47.33223824	1.326383451	47.51668236		21.50068846
4921511.509	582763.4221		46.37474303	1.326383451	47.51668236		21.50068846
4921511.509	582763.4221		46.37474303	0	46.37474303		0
4921509.624	582760.7931		49.5687262	3.234967783	49.58921851		12.30520605
4921503.867	582744.9483		65.28383964	16.85792334	65.85524459		173.2875969
4921499.929	582726.4275		82.68375107	18.93500062	83.45129567		273.9997198
4921492.305	582709.2799		101.2808364	18.7661341	101.3653608		114.9822843
4921488.45	582697.3904		113.4957147	12.49860829	113.6375797		141.9416562
4921480.809	582678.9165		133.359443	19.99175166	133.4234547		138.9447206
4921600.168	582746.3774		74.79878277	137.103623	172.6309244		4854.224193

Polygon 2

					Est Area		
					27374.52882		
		Cent Long	Cent Lat	Av Radius			
		4921605.946	582637.1156	85.70004904			
						Heron's Formula for Area	
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	

4921480.809	582678.9165	131.933772			
4921476.989	582669.6796	133.0051807	9.995882889	137.4674178	657.7918598
4921475.036	582661.7454	133.2063951	8.170870922	137.1912234	543.3740648
4921465.527	582641.9686	140.5024586	21.94407049	147.8264621	1411.586634
4921459.805	582628.7762	146.3785997	14.37993827	150.6304983	940.1123318
4921516.101	582541.8401	130.9563361	103.5717727	190.4533543	6587.198084
4921523.54	582544.3987	124.0452122	7.866509574	131.4340289	239.4241208
4921532.779	582542.9551	119.2458193	9.351678772	126.3213551	487.8142273
4921543.904	582544.1406	111.7747438	11.18748648	121.1040248	480.376514
4921553.261	582551.9808	100.11807	12.20775222	112.050283	191.7858187
4921555.129	582553.2836	98.03135839	2.277516615	100.2134725	45.2014867
4921568.29	582569.0345	77.80108344	20.52553772	98.17898977	151.4463444
4921577.647	582576.8747	66.55658918	12.20773394	78.28270328	170.9151789
4921579.516	582578.1774	64.59315314	2.277513936	66.71362813	37.83486747
4921579.516	582578.1774	64.59315314	0	64.59315314	0
4921579.516	582578.1774	64.59315314	0	64.59315314	0
4921581.367	582578.154	63.8796572	1.851429346	65.16211984	54.86582506
4921590.691	582583.3416	55.89608338	10.66973618	65.22273838	211.116866
4921590.707	582584.6679	54.61667641	1.326366376	55.91956308	9.663863397
4921600.031	582589.8555	47.62882636	10.66973269	56.45761773	204.9779598
4921601.882	582589.832	47.45789988	1.851429451	48.46907785	43.81532148
4921600.014	582588.5292	48.94713108	2.277511409	49.34127118	41.5185105
4921601.899	582591.1582	46.13517382	3.234935867	49.15862038	37.99387209
4921609.321	582592.3906	44.8521983	7.523562772	49.25546744	168.0531564
4921622.381	582600.1837	40.42373041	15.20839422	50.24216146	305.2049153
4921626.101	582601.463	40.95501578	3.933248704	42.65599745	79.19468387
4921646.582	582610.4884	48.58321872	22.38228432	55.96025941	456.0681311
4921654.038	582614.3731	53.19835742	8.407015665	55.0942959	178.1932089
4921661.527	582620.9104	57.89556011	9.941100061	60.5175088	242.3577845
4921680.141	582628.6329	74.67852697	20.15222325	76.36315516	365.4344855
4921696.954	582640.3576	91.066004	20.49751356	93.12102226	506.2676358
4921696.971	582641.6838	91.13967842	1.326345035	91.76601372	60.32202318
4921697.005	582644.3363	91.34464447	2.65269008	92.56850648	120.6440445
4921699.041	582658.9014	95.61050325	14.70680608	100.8309769	655.7882608
4921699.025	582657.5752	95.30060237	1.326344704	96.11872516	61.54980122
4921702.778	582661.5069	99.85637807	5.435441602	100.296211	144.5851437

4921699.126	582665.5326		97.416438	5.43541411	101.3541151		239.4474239
4921699.126	582665.5326		97.416438	0	97.416438		0
4921693.622	582669.5818		93.4943232	6.832469542	98.87161537		266.8467318
4921677.079	582679.0771		82.5870974	19.07486212	97.57814136		684.8087593
4921667.873	582683.1734		77.17676869	10.07607544	84.91997076		338.8355648
4921658.701	582689.9222		74.64309492	11.38746904	81.60366633		420.1899634
4921649.512	582695.3447		72.72276965	10.66966571	79.01776514		385.652334
4921640.356	582703.4198		74.70156067	12.20762053	79.81597543		442.4501519
4921629.367	582712.8447		79.26803037	14.47762261	84.22360683		526.4883348
4921622.063	582720.8963		85.31675125	10.87089669	87.72783915		370.8489581
4921618.411	582724.9221		88.6867821	5.435450872	89.71949211		185.4243795
4921616.559	582724.9456		88.46893525	1.851430001	89.50357368		81.42380353
4921616.543	582723.6193		87.15035296	1.326361852	88.47282503		6.297752621
4921612.857	582724.9926		88.14836147	3.933237707	89.61597607		166.6896927
4921607.455	582736.9995		99.89530569	13.16616298	100.6049151		278.849711
4921605.637	582739.6755		102.5604154	3.23492019	102.8453207		92.79122855
4921600.168	582746.3774		109.4145066	8.650482571	110.3127023		279.4428204
4921480.809	582678.9165		131.933772	137.103623	189.2259509		6715.56418

Polygon 3

			Est Area
			11467.02583
Cent Long	Cent Lat	Av Radius	
4921440.988	582522.9223	59.31287307	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area	
4921450.381	582469.7157		54.02950416				
4921454.134	582473.6476		50.99828861	5.435548661	55.23167071		118.3090338
4921459.722	582476.2299		50.31049553	6.155283426	53.73203378		154.6335554
4921469.079	582484.0703		47.94361744	12.20781596	55.23096447		291.8975038
4921474.7	582489.3051		47.60914625	7.681104198	51.61693395		182.7204041
4921478.504	582497.2159		45.47793543	8.777616125	50.9323489		197.2751872

4921478.504	582497.2159	45.47793543	0	45.47793543	0
4921480.372	582498.5187	46.33155201	2.277524967	47.04350621	48.44916249
4921485.959	582501.1009	49.98579944	6.155279398	51.23631542	119.0253714
4921489.712	582505.0328	51.9045049	5.435533416	53.66291888	129.3595323
4921495.35	582511.5938	55.52988242	8.650604907	58.04249612	210.2697801
4921495.35	582511.5938	55.52988242	0	55.52988242	0
4921500.971	582516.8286	60.29189384	7.681090215	61.75143324	174.1246758
4921500.971	582516.8286	60.29189384	0	60.29189384	0
4921506.643	582526.0421	65.72878271	10.81924312	68.41995984	293.6094998
4921510.429	582532.6265	70.11613948	7.59563627	71.72027923	210.2433277
4921510.463	582535.2791	70.56531483	2.652764911	71.66710961	91.93517376
4921512.348	582537.9082	72.91647264	3.234965048	73.35837626	79.68203108
4921516.101	582541.8401	77.45858609	5.435522338	77.90529054	112.16849
4921459.805	582628.7762	107.5133972	103.5717727	144.271878	3797.50908
4921456.018	582622.1918	100.4008693	7.595683721	107.7549751	138.4706847
4921446.543	582605.0675	82.33276327	19.57094874	101.1522906	341.6090833
4921444.625	582599.7858	76.94944786	5.619351558	82.45078135	64.13204655
4921438.97	582591.8985	69.00570586	9.704966479	77.8300601	202.9836529
4921435.166	582583.9878	61.3422944	8.777662861	69.56283156	139.1599087
4921425.758	582572.1685	51.54733959	15.10635364	63.99799382	321.6518313
4921425.758	582572.1685	51.54733959	0	51.54733959	0
4921425.725	582569.5159	49.02990075	2.652799803	51.61502007	21.02764408
4921423.772	582561.5816	42.31922553	8.170928713	49.7600275	106.0325153
4921416.25	582552.3915	38.47623011	11.8765717	46.33601367	224.5216425
4921414.348	582548.4361	36.88698216	4.388842861	39.87602757	76.94680174
4921412.429	582543.1544	34.99909195	5.619375085	38.7527246	94.82776631
4921406.724	582531.2881	35.27045677	13.16653744	41.71804308	227.1568278
4921399.252	582526.0768	41.85539287	9.110136172	43.1179929	120.5364676
4921393.597	582518.1893	47.62685377	9.705009306	49.59362797	173.5144509
4921389.81	582511.6048	52.41419127	7.595739425	53.81839224	147.0641151
4921387.942	582510.3019	54.52645418	2.277535572	54.60909051	22.76706759
4921384.139	582502.391	60.44313768	8.777716653	61.87365426	185.8193392
4921384.088	582498.4121	61.95422285	3.979224022	63.18829227	112.5811349
4921382.103	582487.8252	68.55150116	10.7715802	70.63865211	276.8616359
4921382.086	582486.4989	69.25421405	1.326408349	69.56606178	38.75497035
4921383.937	582486.4754	67.6992855	1.851428425	69.40246399	34.40573126

4921383.937	582486.4754		67.6992855	0	67.6992855	0
4921383.903	582483.8228		69.19121992	2.652815931	69.77166068	75.05418378
4921383.87	582481.1702		70.75119301	2.652815918	71.29761443	75.05420492
4921387.505	582475.8181		71.2687052	6.46998162	74.24493992	228.7427662
4921389.289	582470.4895		73.63407458	5.619375022	75.2610774	184.5141043
4921450.381	582469.7157		54.02950416	61.09713959	94.38035916	1621.623443

Polygon 4

					Est Area	
					5009.711215	
		Cent Long	Cent Lat	Av Radius		
		4921402.579	582414.6076	43.63976364		

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921389.289	582470.4895		57.44049418			
4921387.287	582458.5762		46.55216486	12.08038915	58.0365241	135.1169577
4921383.382	582442.7075		34.03120354	16.34194388	48.46265614	207.1685106
4921379.462	582425.5124		25.56068592	17.63642304	38.61415625	220.1345626
4921375.541	582408.3174		27.76074792	17.636432	35.47893292	220.13454
4921373.555	582397.7304		33.57458707	10.7715901	36.05346255	136.8843582
4921371.553	582385.8171		42.32673722	12.08041418	43.99086923	155.9904555
4921373.219	582371.2043		52.40097552	14.7074952	54.71760397	250.6844744
4921373.152	582365.8991		56.90766316	5.305638151	57.30713842	76.42372827
4921373.152	582365.8991		56.90766316	0	56.90766316	0
4921374.97	582363.2231		58.33230049	3.234993456	59.23747855	83.64301849
4921374.936	582360.5705		60.69723373	2.652818285	60.84117625	35.75616932
4921402.789	582366.8507		47.75738659	28.55236355	68.50349194	665.7491578
4921408.561	582384.0223		31.16485193	18.1157477	48.51899311	139.6312907
4921408.662	582391.9801		23.43089961	7.958414552	31.27708305	25.34258213
4921418.17	582411.7573		15.84950037	21.94420761	30.6123038	167.7254524
4921421.907	582414.3631		19.32880207	4.555062697	19.86668257	25.63757308
4921427.578	582423.5768		26.55898451	10.81933563	28.3535611	89.73170222

4921427.578	582423.5768		26.55898451	0	26.55898451		0
4921431.365	582430.1614		32.71862525	7.595703589	33.43665667		65.32180064
4921444.525	582445.9128		52.33986824	20.52576252	52.79212801		124.3555481
4921452.031	582453.7768		63.08479955	10.87110011	63.14788395		47.44252682
4921452.149	582463.0608		69.31685123	9.284757594	70.84320418		227.2514292
4921450.381	582469.7157		72.95158629	6.885542783	74.57699015		207.7536089
4921389.289	582470.4895		57.44049418	61.09713959	95.74461003		1701.831768

Polygon 5

			Est Area
			1005.628033
Cent Long	Cent Lat	Av Radius	
4921385.493	582337.7915	22.28052173	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area	
4921374.936	582360.5705		25.10633778				
4921371.183	582356.6384		23.66375636	5.435581865	27.102838		63.49876342
4921371.116	582351.3332		19.7501996	5.305639502	24.35979773		38.59053345
4921374.685	582340.6759		11.1867558	11.23876851	21.08786195		52.44807029
4921381.855	582322.014		16.19146596	19.99193668	23.68507922		90.51216914
4921385.457	582314.0094		23.78205507	8.7776793	24.37560017		42.97582746
4921387.224	582307.3545		30.48611969	6.885602319	30.57688854		21.13726498
4921390.876	582303.3288		34.88055841	5.435546468	35.40111228		52.09715058
4921392.912	582317.8947		21.23496075	14.7074665	35.41149283		74.28565653
4921393.063	582329.8314		10.98492725	11.93764743	22.07876771		45.78180305
4921395.032	582339.0921		9.627073894	9.467636155	15.03981865		42.88766018
4921400.837	582358.9163		26.10956422	20.65683002	28.19673406		90.77435839
4921402.789	582366.8507		33.81719167	8.170949554	34.04885272		40.25622864
4921374.936	582360.5705		25.10633778	28.55236355	43.7379465		350.3825466

Polygon 6

			Est Area
			10994.8209
Cent Long	Cent Lat	Av Radius	
4921398.092	582191.2803	64.28684593	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921387.224	582307.3545		116.5818542			
4921383.421	582299.4435		109.1536302	8.777710948	117.2565977	263.7136735
4921381.486	582292.8354		102.9038352	6.88562378	109.4715446	153.1286834
4921379.584	582288.8799		99.33888193	4.38885792	103.3157875	129.4007325
4921372.095	582282.342		94.69979374	9.941279511	101.9899776	425.9606815
4921360.921	582277.1771		93.59473045	12.31059141	100.3025578	575.9298927
4921359.036	582274.5479		91.97215966	3.235012541	94.40095133	129.8155272
4921353.331	582262.6813		84.27124993	13.16661307	94.70501133	469.2411051
4921353.18	582250.7445		74.51888485	11.93771707	85.36392592	272.5361045
4921353.18	582250.7445		74.51888485	0	74.51888485	0
4921353.029	582238.8078		65.49428248	11.93771678	75.97544205	272.5354532
4921352.845	582224.2184		55.96610651	14.59054234	68.02546567	333.0981803
4921352.627	582206.9764		48.0979384	17.24336766	60.65370629	393.6607907
4921354.361	582197.6689		44.19492189	9.467669605	50.88026495	197.9733834
4921354.194	582184.4058		44.43323696	13.26412454	50.9461417	290.5368395
4921352.158	582169.8398		50.69122718	14.70754479	54.91600446	312.714537
4921348.188	582148.6656		65.62344194	21.54323784	68.92895348	443.7406858
4921346.203	582138.0785		74.31645533	10.77162303	75.35576015	221.8711218
4921344.134	582120.8598		88.71599545	17.34250041	90.18747559	391.6990711
4921344.084	582116.8809		91.93571372	3.979242438	92.3154758	105.58018
4921408.761	582106.7797		85.17153505	65.46170913	121.284479	2678.76532
4921410.646	582109.4089		82.8283019	3.234994195	85.61741557	93.65709673
4921410.663	582110.7352		81.52015595	1.326400547	82.8374292	9.010120541
4921410.663	582110.7352		81.52015595	0	81.52015595	0
4921410.679	582112.0615		80.21260961	1.326400551	81.52958306	9.010131382
4921410.696	582113.3878		78.90569269	1.326400553	80.22235143	9.01014211
4921410.713	582114.7141		77.59943699	1.326400558	78.91576512	9.010152637
4921412.665	582122.6485		70.16184169	8.170930068	77.96610437	124.786526

4921416.384	582123.9281	69.7919246	3.933257724	71.94351201	136.9544619
4921418.269	582126.5574	67.79498254	3.234991848	70.41094949	87.51796622
4921420.153	582129.1866	65.89641231	3.234991251	68.46319305	87.5179862
4921420.153	582129.1866	65.89641231	0	65.89641231	0
4921421.988	582127.837	67.79438383	2.277518598	67.98415737	42.0692769
4921421.988	582127.837	67.79438383	0	67.79438383	0
4921433.196	582135.6546	65.77627539	13.66517245	73.61791584	448.9448411
4921435.215	582148.8941	56.34436237	13.3925593	67.75659853	288.5260713
4921435.248	582151.5467	54.39986034	2.652791506	56.69850711	49.94510892
4921435.248	582151.5467	54.39986034	0	54.39986034	0
4921433.397	582151.5701	53.13514094	1.851427332	54.6932143	36.3450612
4921433.397	582151.5701	53.13514094	0	53.13514094	0
4921433.397	582151.5701	53.13514094	0	53.13514094	0
4921433.414	582152.8964	52.16272589	1.326396135	53.31213148	23.74470652
4921433.414	582152.8964	52.16272589	0	52.16272589	0
4921433.397	582151.5701	53.13514094	1.326396135	53.31213148	23.74470652
4921427.893	582155.619	46.47416106	6.832552908	53.22092745	37.8009882
4921424.308	582164.9498	37.15607864	9.995898822	46.81306926	75.10532038
4921415.236	582179.6558	20.71322112	17.27925564	37.57427769	73.32870273
4921413.468	582186.3107	16.15938581	6.885571518	21.87908922	46.77112902
4921413.451	582184.9844	16.59977346	1.326400373	17.04277982	10.23831945
4921415.303	582184.961	18.33422747	1.851427397	18.39271416	5.648316903
4921415.319	582186.2873	17.93647671	1.326399996	18.79855209	11.4661832
4921413.552	582192.9422	15.54903108	6.885571611	20.1855397	52.91049539
4921411.851	582204.9022	19.36174619	12.08031384	23.49554555	93.86380795
4921410.05	582208.9044	21.29819683	4.388822811	22.52438291	39.80107333
4921408.316	582218.2119	28.80707294	9.467592191	29.78643098	70.93132926
4921408.383	582223.5171	33.83963756	5.305606396	33.97615845	26.21872546
4921404.865	582238.1531	47.35960089	15.05294008	48.12608926	132.0210053
4921403.114	582246.1342	55.08337443	8.170924913	55.30695012	68.05965854
4921403.181	582251.4394	60.37401588	5.30561122	60.38150077	11.48382296
4921399.563	582258.1177	66.85355172	7.5956912	67.4116294	125.8449823
4921397.829	582267.4252	76.1453006	9.467608655	76.23323049	64.79042893
4921392.459	582282.0846	90.97883557	15.61186985	91.36800301	202.4976994
4921390.709	582290.0658	99.06103009	8.170941052	99.10540336	57.00686984
4921390.876	582303.3288	112.2805851	13.26405574	112.3028355	57.2453516

4921387.224	582307.3545		116.5818542	5.435546468	117.1489929	190.0903671

Polygon 7

Cent Long	Cent Lat	Av Radius	Est Area
4921391.427	582057.6964	50.39505903	8876.678618

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921344.084	582116.8809		75.79039156			
4921342.032	582100.9886		65.68180105	16.02429614	78.74824437	436.9221966
4921343.682	582085.0495		55.02496427	16.02427707	68.3655212	357.9284161
4921350.903	582070.3668		42.45815238	16.36237895	56.9227478	251.7505097
4921352.721	582067.6908		39.97523299	3.234997702	42.83419154	42.70305279
4921352.721	582067.6908		39.97523299	0	39.97523299	0
4921352.704	582066.3645		39.68074758	1.326412122	40.49119635	25.75137272
4921352.704	582066.3645		39.68074758	0	39.68074758	0
4921354.539	582065.0149		37.60683667	2.277526061	39.78255515	18.17952321
4921361.81	582054.3111		29.80934728	12.93998195	40.17808295	170.8117564
4921361.81	582054.3111		29.80934728	0	29.80934728	0
4921363.544	582045.0037		30.635361	9.467651172	34.95617973	140.7626396
4921363.544	582045.0037		30.635361	0	30.635361	0
4921363.561	582046.33		30.09457755	1.326409801	31.02817418	18.38407967
4921363.528	582043.6774		31.22316128	2.652819599	31.98527922	36.7681609
4921361.526	582031.7639		39.57958612	12.08041554	41.44158147	152.1549141
4921365.028	582015.8016		49.51828715	16.34193295	52.71990311	284.0495283
4921370.482	582007.7739		54.13830004	9.704975384	56.68078128	220.1993601
4921374.151	582005.0746		55.38508778	4.555047066	57.03921744	119.8542405
4921388.978	582006.2144		51.5401816	14.87069295	60.89798116	380.2645217
4921394.465	582000.8393		56.93820358	7.681099118	58.07974215	147.8227711
4921452.155	582023.9897		69.45562131	62.16216272	94.27799381	1675.221854
4921452.239	582030.6211		66.56703202	6.631958262	71.3273058	202.7667409

4921454.123	582033.2503		67.29402566	3.234978923	68.5480183	105.4594804
4921456.108	582043.8373		66.14983253	10.77144545	72.10765182	356.1467412
4921454.341	582050.4921		63.32519102	6.885527907	68.18027573	202.9713948
4921454.391	582054.4709		63.04677258	3.979174028	65.17556882	125.3437214
4921454.424	582057.1235		63.00025915	2.652782703	64.34990722	83.56248312
4921447.136	582066.5008		56.40103738	11.87646023	65.63887838	293.287515
4921441.633	582070.5497		51.82511546	6.832546585	57.52934971	137.0087685
4921437.964	582073.2489		49.06686583	4.555032164	52.72350672	91.33926396
4921428.841	582083.9759		45.72133009	14.08156266	54.43487929	320.5402649
4921419.718	582094.703		46.58225787	14.08157424	53.1925811	320.5405975
4921406.927	582108.1293		52.7610996	18.54435982	58.94385864	426.6146721
4921408.761	582106.7797		52.05438418	2.27752001	53.5465019	56.72056193
4921344.084	582116.8809		75.79039156	65.46170913	96.65324243	1674.847515

Polygon 8

Cent Long	Cent Lat	Av Radius	Est Area
4921413.725	581992.1274	28.92684041	1962.125156

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921394.465	582000.8393		21.13919325			
4921390.645	581991.6018		23.08608118	9.995971809	27.11062312	105.5969013
4921385.024	581986.3665		29.27322993	7.681139606	30.02022536	58.93795696
4921386.859	581985.0169		27.79121714	2.277521824	29.67098445	24.6518235
4921388.677	581982.341		26.89224289	3.234984845	28.95922243	42.40872348
4921401.502	581971.5675		23.91890457	16.74986357	33.78050551	197.6865591
4921412.593	581970.1014		22.05516804	11.18746103	28.58076682	122.9753046
4921431.189	581976.4997		23.43558459	19.66627968	32.57851616	201.1805952
4921444.332	581990.9258		30.63060283	19.51515135	36.79066939	228.665377
4921448.235	582006.7946		37.49761703	16.34177026	42.23499506	245.1938175
4921448.285	582010.7734		39.2693564	3.97917707	40.37307525	68.28777521

4921452.155	582023.9897		49.92053418	13.77110001	51.48049529		192.3008105
4921394.465	582000.8393		21.13919325	62.16216272	66.61094507		474.2395114

Polygon 9

				Est Area
				90611.89358
		Cent Long	Cent Lat	Av Radius
		4921742.276	583043.3004	200.0974799

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area	
4921535.294	582886.483		259.6792048				
4921533.442	582886.5065		261.1430438	1.851430362	261.3368395		147.5955462
4921533.459	582887.8328		260.3353437	1.326379639	261.4023836		137.1607372
4921526.24	582902.5161		257.8598043	16.36206271	267.2786054		2094.239389
4921524.524	582913.1498		253.6829774	10.77135092	261.1570663		1269.438085
4921520.973	582925.1335		250.8748004	12.49852599	258.5281519		1535.777022
4921519.274	582937.0935		247.0012066	12.08015404	254.9780805		1423.78782
4921515.707	582947.7509		245.892611	11.23857151	252.0661945		1377.743357
4921517.693	582958.3375		240.1165171	10.77138536	248.3902567		1104.394126
4921515.893	582962.3399		240.42429	4.38877624	242.4647917		525.9265309
4921515.927	582964.9925		239.5121363	2.652767235	241.2945968		298.8774986
4921517.829	582968.9477		236.4420424	4.388793414	240.1714861		373.1613328
4921516.062	582975.6027		236.126447	6.885491757	239.7269906		812.5254202
4921514.211	582975.6263		237.8938902	1.851430638	237.9358839		65.33221902
4921510.643	582986.2837		238.5466274	11.23858092	243.8395493		1335.997284
4921512.613	582995.544		234.575494	9.467496212	241.2948088		1016.34577
4921512.664	582999.5228		233.7480716	3.97915339	236.1513595		455.6829827
4921510.88	583004.8516		234.5682517	5.619291415	236.9678074		650.8090185
4921510.88	583004.8516		234.5682517	0	234.5682517		0
4921507.262	583011.5301		237.1513468	7.595615725	239.6576071		842.2520883
4921507.262	583011.5301		237.1513468	0	237.1513468		0
4921509.164	583015.4854		234.7652011	4.388798953	238.1526734		434.5524411

4921512.934	583020.7433	230.4480282	6.469940844	235.8415851	560.4040847
4921512.934	583020.7433	230.4480282	0	230.4480282	0
4921516.654	583022.0223	226.6230336	3.933259355	230.5021606	104.7208811
4921518.573	583027.3038	224.2741607	5.619305237	228.2582498	575.394778
4921520.475	583031.259	222.1275246	4.388792955	225.3952391	427.183911
4921520.576	583039.2167	221.7369907	7.958298343	225.9114068	881.895828
4921524.38	583047.1271	217.9288873	8.777583093	224.2217305	869.1007417
4921524.38	583047.1271	217.9288873	0	217.9288873	0
4921522.478	583043.1719	219.7973738	4.388791053	221.0575261	434.5502496
4921533.772	583057.6192	208.9945797	18.33783504	223.5648943	1587.01631
4921535.657	583060.2482	207.3122585	3.234963003	209.7709006	287.5667946
4921539.445	583066.8323	204.1916517	7.595624958	209.5497676	712.2925912
4921541.381	583073.44	203.1435341	6.885489553	207.1103377	692.9053413
4921545.1	583074.7191	199.6632398	3.933258029	203.370016	184.5274284
4921550.671	583075.9745	194.370943	5.710475225	199.872329	211.280866
4921550.705	583078.627	194.8010878	2.652754276	195.9123925	254.6729237
4921558.144	583081.185	187.9890735	7.866514753	195.328338	376.4208768
4921561.88	583083.7903	184.8838827	4.555038437	188.7139973	310.6351184
4921563.765	583086.4192	183.6443854	3.234953949	185.881611	275.286634
4921565.684	583091.7007	183.1042572	5.619270425	186.1839565	512.7691436
4921567.519	583090.3508	180.9801784	2.277507497	183.1809715	74.79826485
4921558.33	583095.774	191.2839986	10.66971209	191.4669445	257.7062606
4921558.448	583105.0579	193.9238995	9.284629844	197.246264	856.9752656
4921556.665	583110.3866	197.3624961	5.61925848	198.4528271	434.7071805
4921556.733	583115.6916	199.1651268	5.305504414	200.9165637	494.612008
4921551.263	583122.3939	206.7401114	8.650530731	207.2778845	423.8183806
4921549.497	583129.0489	210.9893192	6.885463054	212.3074469	565.7290722
4921553.25	583132.9804	209.2203093	5.435515856	212.8225722	539.8816498
4921560.655	583132.8858	202.5129882	7.405725399	209.5695114	323.1093973
4921579.151	583131.3232	185.358081	18.56175727	203.2164132	686.5764118
4921593.945	583129.8078	171.7139576	14.87071451	185.9713765	527.4778841
4921603.184	583128.3634	163.040565	9.351688978	172.0531058	292.5130934
4921605.035	583128.3398	161.4516545	1.851431472	163.1718255	77.09390378
4921616.143	583128.1979	152.0429862	11.10858893	162.3016148	462.5634167
4921629.085	583126.7062	140.6011337	13.02770885	152.8359144	455.2962255
4921642.027	583125.2145	129.4593798	13.0277088	141.5441111	455.2965266

4921656.82	583123.6992	117.3311298	14.87071465	130.8306121	529.9350882
4921669.762	583122.2075	107.1658604	13.02770871	118.7623494	456.5248739
4921673.465	583122.1602	104.6604137	3.70286329	107.7645687	144.3652972
4921679.019	583122.0893	101.0402891	5.554294975	105.6274989	216.5479456
4921693.812	583120.574	91.21368575	14.87071475	103.5623448	534.8469112
4921708.605	583119.0587	82.90361892	14.87071478	94.49400972	534.8470697
4921723.399	583117.5433	76.60522642	14.87071481	87.18978008	534.8471867
4921734.506	583117.4015	74.50734265	11.10859077	81.11057992	410.9952772
4921738.192	583116.028	72.84221664	3.933233459	75.64139637	131.2188642
4921749.317	583117.2125	74.24667543	11.18749826	79.13819516	406.9523423
4921762.259	583115.7208	75.12677013	13.02770851	81.20057703	483.5374357
4921775.201	583114.2291	78.1980657	13.02770846	83.17627215	483.5374053
4921788.109	583110.085	80.99913591	13.55706645	86.37713403	526.0017334
4921804.736	583107.2199	89.37028578	16.87269833	93.62106001	620.8949613
4921817.695	583107.0545	98.75583944	12.96002398	100.5430746	419.331763
4921830.654	583106.889	108.8774913	12.96002424	110.2966775	419.3317843
4921851.002	583105.3029	125.1623605	20.40888862	127.2243702	717.015771
4921863.944	583103.8112	135.8846379	13.02770816	137.0373533	482.3085154
4921876.869	583100.9934	146.4368568	13.22869285	147.7750938	562.4739693
4921891.645	583098.152	159.1222758	15.04710127	160.303117	617.4665796
4921902.736	583096.684	169.1072256	11.18748334	169.7084924	413.8083003
4921915.678	583095.1924	181.0002241	13.02770791	181.5675788	465.1178209
4921928.603	583092.3746	192.6813908	13.22868943	193.4551522	579.6603167
4921945.248	583090.8357	208.4638535	16.71558467	208.9304145	551.7751186
4921952.636	583089.415	215.3552996	7.523548913	215.671351	319.7814486
4921956.321	583088.0416	218.6717222	3.933219437	218.9801206	229.4395561
4921961.858	583086.6445	223.8196196	5.710446261	224.100894	273.3823895
4921967.412	583086.5736	229.2574594	5.554297112	229.3156881	128.1456448
4921976.652	583085.1293	238.0792319	9.351682772	238.344187	362.4957013
4921991.428	583082.2879	252.1842401	15.04709591	252.6552839	642.0155073
4921996.965	583080.8909	257.4483124	5.710444834	257.6714987	281.9754744
4921998.816	583080.8672	259.2764702	1.851432446	259.2881075	37.80398111
4922000.668	583080.8436	261.1049561	1.85143245	261.1164294	37.80398208
4922006.204	583079.4466	266.3923667	5.710444457	266.6038836	284.4306361
4922008.056	583079.4229	268.2234619	1.851432469	268.2336305	36.57617345
4922011.758	583079.3757	271.8864787	3.702864951	271.9064028	73.15234995

4922011.707	583075.3972	271.3368016	3.978849713	273.601065	535.1553565
4922011.707	583075.3972	271.3368016	0	271.3368016	0
4922013.593	583078.0259	273.5300823	3.234804358	274.0508441	323.8774021
4922009.856	583075.4208	269.5014215	4.554933364	273.7932186	288.5291417
4922007.971	583072.7921	267.3270546	3.234805571	270.0316408	321.4222011
4922006.035	583066.1848	264.7502698	6.885032255	269.4811784	849.2117405
4922000.397	583059.6248	258.6365801	8.650224495	266.0185372	800.6167256
4922000.346	583055.6463	258.36525	3.978856339	260.4903432	513.0566658
4921994.707	583049.0862	252.4979343	8.650228608	259.7567064	811.6685846
4921994.623	583042.4553	252.3484287	6.63143273	255.7388979	836.6787516
4921988.95	583033.2429	246.8796562	10.81866785	255.0233764	1164.759008
4921983.312	583026.6828	241.6084021	8.650236819	248.5691476	837.4554596
4921975.839	583021.4726	234.5812001	9.109880368	242.6497413	690.0237524
4921966.566	583020.2644	225.4699869	9.351694932	234.701441	242.2967059
4921961.012	583020.3352	219.9385301	5.554296358	225.4814067	56.02622697
4921957.309	583020.3825	216.2515428	3.702864212	219.9464686	37.35082154
4921947.968	583013.8696	207.7875497	11.3873659	217.7132292	807.2842344
4921944.131	583003.3073	205.7785612	11.23795153	212.4020312	1142.7699
4921942.229	582999.3523	204.7255515	4.388558337	207.4463355	437.1982097
4921940.327	582995.3973	203.761642	4.388559325	206.4378764	437.1983829
4921932.888	582992.8394	197.178033	7.866464942	204.40307	431.4787585
4921927.317	582991.584	192.132189	5.710459395	197.5103407	260.1990986
4921925.381	582984.9766	192.169663	6.885109134	195.5934806	661.3740806
4921923.513	582983.674	190.793498	2.277476253	192.6203186	173.7359394
4921919.759	582979.7426	188.5207088	5.435349193	192.374778	468.1539197
4921917.824	582973.1353	189.0507988	6.885116225	192.2283119	647.8691408
4921917.824	582973.1353	189.0507988	0	189.0507988	0
4921914.037	582966.5515	188.1280404	7.595287081	192.3870631	710.7460564
4921910.249	582959.9677	187.508653	7.59529026	191.6159919	710.7464461
4921908.314	582953.3603	188.8327088	6.885125017	191.6132434	635.5918659
4921904.56	582949.4289	187.4783864	5.435355417	190.8732253	495.166622
4921902.658	582945.4739	187.8632491	4.388579342	189.8651074	410.1895158
4921900.79	582944.1713	186.9582791	2.277478648	188.5495034	195.8370082
4921895.219	582942.9158	182.9448575	5.710460043	187.8067984	375.6141462
4921889.598	582937.6818	181.2708425	7.680880656	185.9482904	682.4101997
4921882.075	582928.4927	180.8991279	11.87607046	187.0230204	1074.184196

4921880.156	582923.2115		182.8447526	5.61902388	184.6814522		479.3053993
4921878.169	582912.6255		188.5283964	10.77080226	191.0719756		849.0769344
4921535.294	582886.483		259.6792048	343.8706887	396.0391449		24178.9117

Polygon 10

			Est Area
			51033.58242
Cent Long	Cent Lat	Av Radius	
4921710.794	582778.0233	132.2059744	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Area	Formula for Area
4921878.169	582912.6255		214.7840427				
4921881.737	582901.9687		211.1488006	11.23801313	218.5854282		1131.928233
4921883.486	582893.9879		208.0155736	8.170376293	213.6673753		790.5743494
4921883.402	582887.3569		204.3217063	6.631541877	209.4844109		567.6647283
4921885.169	582880.7024		202.3599843	6.885129416	206.78341		670.9028472
4921885.118	582876.7237		200.3264472	3.978923899	203.3326777		344.2824795
4921881.331	582870.1399		193.825638	7.595313464	200.8736994		386.9739759
4921877.595	582867.5346		189.3007631	4.55496153	193.8406813		50.05838863
4921873.875	582866.2555		185.4196639	3.933235183	189.3268311		59.79131438
4921870.105	582860.9978		179.6241755	6.469697551	185.7567685		262.3923817
4921866.301	582853.0877		172.6766014	8.77719491	180.5389859		472.2712015
4921860.646	582845.2012		164.22105	9.704554344	173.3011029		400.9577859
4921858.761	582842.5723		161.4337597	3.234852644	164.4448311		133.6528954
4921854.94	582833.336		154.3945815	9.995389336	162.9118653		560.0241907
4921849.336	582829.4281		147.771163	6.832451128	154.4990978		126.659295
4921845.549	582822.8441		142.0134116	7.595343901	148.6899592		358.7415025
4921839.843	582810.9789		133.190746	13.16583273	144.1849951		671.5811598
4921834.154	582800.4399		125.3805635	11.97640631	135.2738579		586.2876642
4921832.185	582791.1799		122.1018762	9.467039575	128.4747396		549.0807592
4921826.564	582785.9457		116.0404123	7.680912235	122.9116003		280.7145895
4921822.844	582784.6666		112.246982	3.933237681	116.110316		59.30874301

4921817.172	582775.4537	106.4093148	10.81886747	114.7375822	497.3121409
4921809.666	582767.5906	99.42084409	10.87078723	108.3504731	427.8776923
4921802.143	582758.4012	93.43244903	11.87615238	102.3647227	493.52935
4921792.768	582749.2353	86.88229234	13.11081777	96.71277957	510.6184377
4921789.032	582746.6299	84.30141282	4.554980622	87.86934289	160.567073
4921783.394	582740.0694	81.92212132	8.650383803	87.43695897	345.1410358
4921777.756	582733.5089	80.40771061	8.650387991	85.49010996	345.1413195
4921775.786	582724.2489	84.35460852	9.467115908	87.11471752	353.8647335
4921766.48	582720.3878	80.14183263	10.07609108	87.28626611	375.7082637
4921757.139	582713.8743	79.13865193	11.38746751	85.33397603	450.531522
4921753.386	582709.9426	80.30576332	5.435418388	82.43991682	211.4851285
4921751.383	582698.0301	89.7013958	12.07974123	91.04345018	321.8685529
4921747.646	582695.4247	90.44678205	4.554989611	92.35158373	202.3132034
4921745.812	582696.7744	88.47388036	2.277484167	90.59907329	50.88994209
4921738.39	582695.5423	86.97500274	7.523561086	91.4862221	323.0874106
4921732.718	582686.3292	94.27868126	10.81896704	96.03632552	361.0298347
4921732.6	582677.0456	103.305384	9.284365855	103.4342155	107.1753569
4921726.929	582667.8325	111.3657326	10.8189734	112.745045	386.8128488
4921726.777	582655.8964	123.1682626	11.93705152	123.2355234	104.6441396
4921719.304	582650.6855	127.6218475	9.109990454	129.9500503	497.9390523
4921715.602	582650.7325	127.381538	3.702860032	129.3531228	235.5379813
4921710.065	582652.1292	125.8961458	5.710450552	129.4940672	349.0468399
4921706.396	582654.8287	123.2730385	4.554976768	126.8620805	231.9289286
4921700.943	582662.8566	115.5871562	9.704661179	124.2824279	353.5297762
4921695.457	582668.2321	110.8572543	7.68094342	117.0626769	342.4049019
4921689.987	582674.9338	105.1682453	8.650411013	112.3379553	351.6503329
4921684.467	582677.6568	103.7619126	6.155223482	107.5426907	312.8630492
4921667.957	582689.8046	98.0690255	20.4974306	111.1641844	988.4264847
4921664.288	582692.5041	97.34635041	4.554987012	99.98518146	219.6503725
4921658.785	582696.5534	96.65548471	6.832482178	100.4171587	329.4756009
4921653.299	582701.9289	95.37337602	7.680967632	99.85491418	363.2776108
4921644.11	582707.3515	97.166452	10.66966815	101.6047481	505.5017986
4921633.12	582716.7764	98.91644224	14.47761939	105.2802568	702.5766885
4921622.147	582727.5275	102.0201674	15.3619679	108.1492888	753.5690802
4921614.843	582735.5791	104.9194721	10.87090358	108.9052716	541.2857632
4921611.208	582740.9312	106.2695288	6.469836071	108.8294185	333.9130818

4921609.508	582752.8911		104.3571098	12.07998187	111.3533102		627.0359113
4921615.13	582758.1255		97.71174716	7.681032234	104.8749446		194.448449
4921617.099	582767.3857		94.29691383	9.467341695	100.7380013		423.3451229
4921617.2	582775.3433		93.63214649	7.958171876	97.9436161		372.2519811
4921613.565	582780.6954		97.2655813	6.469835359	98.68378158		255.3324214
4921604.343	582783.4656		106.5905609	9.629722558	106.7429324		122.3500126
4921591.367	582782.3041		119.5040643	13.02771314	119.5611692		97.13034359
4921585.863	582786.3535		125.2080144	6.832509236	125.772294		230.025338
4921576.742	582797.0813		135.3999788	14.08141357	137.3447034		632.1235934
4921571.323	582807.762		142.6061709	11.97673463	144.9914421		664.2511883
4921571.323	582807.762		142.6061709	0	142.6061709		0
4921573.208	582810.391		141.3419132	3.234947792	143.5915159		211.3624564
4921573.276	582815.6961		142.5851844	5.30548457	144.6162911		366.042725
4921573.343	582821.0011		144.0132922	5.305484627	145.9519806		366.0428067
4921571.526	582823.6772		146.560424	3.234932429	146.9043243		144.8578948
4921571.543	582825.0034		146.9629691	1.326371549	147.4248823		92.73859644
4921569.725	582827.6795		149.5533689	3.234933069	149.8756355		143.6302212
4921567.924	582831.6819		152.6138399	4.388745405	153.2779771		237.5968791
4921566.141	582837.0105		156.2181241	5.619245414	157.2256047		332.7915301
4921562.539	582845.0152		162.6879521	8.777496128	163.8417862		472.7393306
4921553.384	582853.0906		174.3930702	12.20769401	174.6443581		291.9479706
4921549.732	582857.1165		179.4341378	5.435483505	179.6313458		179.7903345
4921549.732	582857.1165		179.4341378	0	179.4341378		0
4921549.766	582859.769		180.5889375	2.652752334	181.3379138		214.9465741
4921546.148	582866.4475		186.8881225	7.595577401	187.5363187		389.8264024
4921542.513	582871.7997		192.6461517	6.469884541	193.0020794		279.8980941
4921535.294	582886.483		206.3101969	16.36204374	207.6591962		896.9538129
4921878.169	582912.6255		214.7840427	343.8706887	382.4824641		20888.09862

Polygon 11

			Est Area
			1361.669252
Cent Long	Cent Lat	Av Radius	
4921656.303	583787.2707	26.1888589	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921624.271	583762.1483		40.70839373			
4921626.242	583771.4082		33.98946797	9.467366476	42.08261409	123.551657
4921626.362	583780.692		30.65575185	9.284558266	36.96488904	138.5924411
4921628.315	583788.6257		28.02061313	8.170726802	33.42354589	112.3473573
4921630.201	583791.2544		26.40464842	3.234939623	28.83010058	38.06303641
4921652.484	583796.2735		9.779261116	22.84192176	29.51291565	109.8915413
4921658.055	583797.5283		10.4061947	5.710479939	12.94796788	27.47287781
4921665.478	583798.7592		14.70225827	7.523580457	16.31601671	36.98862176
4921676.619	583801.2687		24.67175616	11.42095873	25.39748658	52.49013765
4921682.173	583801.1973		29.38044976	5.554302673	29.80325429	39.59772489
4921683.973	583797.1947		29.39595689	4.388697746	31.5825522	64.30754947
4921683.922	583793.216		28.25154988	3.979061487	30.81328413	54.79180501
4921683.905	583791.8897		27.98564313	1.326353822	28.78177342	18.26393661
4921678.249	583784.0037		22.18736458	9.704767136	29.93888743	95.7705078
4921676.329	583778.7226		21.77403916	5.619198841	24.79030129	61.0844674
4921624.271	583762.1483		40.70839373	54.63259911	58.557516	388.4555908

Polygon 12

			Est Area
			17874.7052
Cent Long	Cent Lat	Av Radius	
4921693.72	583701.9326	77.54300384	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921607.892	583640.323		105.651337			
4921607.977	583646.9543		101.85506	6.631842493	107.0691197	281.9502147
4921606.262	583657.5881		98.05758798	10.77125142	105.3419497	503.0299348
4921608.216	583665.5219		92.93386681	8.17074674	99.58110076	303.6195208

4921606.518	583677.482	90.56499831	12.08003148	97.7894483	542.2296805
4921604.735	583682.8109	91.01638798	5.619233732	93.60031001	254.1409384
4921606.637	583686.7658	88.39351634	4.388755946	91.89933013	157.7781963
4921610.391	583690.697	84.08295411	5.435500012	88.95598523	142.7029457
4921612.276	583693.3257	81.89702351	3.234944499	84.60746106	98.93239708
4921614.281	583705.2383	79.50745996	12.08004093	86.7422622	476.4712994
4921616.201	583710.5195	77.99333509	5.619244918	81.56001998	212.9396219
4921618.086	583713.1482	76.46084445	3.234942786	78.84456116	109.9826483
4921620.125	583727.7132	77.97974722	14.70704413	84.5738179	562.2379278
4921620.176	583731.692	79.33656131	3.979099414	80.64770397	147.0683263
4921620.227	583735.6708	80.86658798	3.979099446	82.09112437	147.0683626
4921622.113	583738.2995	80.31262812	3.234941726	82.20707891	128.40004
4921622.164	583742.2782	82.14627296	3.979098368	83.21899973	143.3848735
4921622.215	583746.257	84.12828411	3.979098402	85.12682774	143.3849227
4921624.271	583762.1483	91.91859202	16.023721	96.03529857	613.7171468
4921676.329	583778.7226	78.73458768	54.63259911	112.6428894	2142.877465
4921681.815	583773.3461	72.39905319	7.680979174	79.40731002	163.8673686
4921689.169	583769.2721	67.49312259	8.406994095	74.14958494	238.3331786
4921689.1	583763.9671	62.20628925	5.305410478	67.50241116	14.37135889
4921690.9	583759.9646	58.10042898	4.388693321	62.34770578	46.58821728
4921692.717	583757.2883	55.36474855	3.234902861	58.3500402	48.95324183
4921700.003	583747.9094	46.40407934	11.87625255	56.82254022	196.9503469
4921700.003	583747.9094	46.40407934	0	46.40407934	0
4921701.82	583745.2331	44.05160522	3.234899706	46.84529213	50.18118209
4921712.911	583743.7639	46.02341221	11.18749948	50.63125845	246.0645223
4921714.694	583738.4352	42.09925177	5.619151931	46.87090796	88.42523824
4921714.66	583735.7827	39.8033657	2.652694518	42.277656	27.19366676
4921720.145	583730.4063	38.84660879	7.680956869	43.16546568	149.1342289
4921723.763	583723.7275	37.11583264	7.595446282	41.77894386	139.7435142
4921731.1	583718.3274	40.81696399	9.109970584	43.52138361	161.0711963
4921729.265	583719.6774	39.72849963	2.277492313	41.41147796	40.26778151
4921742.088	583708.9009	48.86727776	16.74959837	52.67268788	305.2936177
4921745.722	583703.5484	52.02732496	6.469769956	53.68218634	142.1078421
4921753.059	583698.1483	59.45967681	9.109959882	60.29848083	146.3365559
4921756.693	583692.7957	63.63284978	6.469762431	64.78114451	151.9299438
4921762.179	583687.4194	69.98056146	7.680932507	70.64717187	144.2215528

4921767.682	583683.3694		76.25573696	6.832464207	76.53438131	98.70133465
4921773.15	583676.6668		83.35189781	8.650378384	84.12900658	197.1075887
4921780.453	583668.6143		92.91259078	10.87079453	93.56764156	227.5515497
4921789.607	583660.538		104.4407926	12.20754394	104.7804637	197.7415105
4921795.042	583651.1831		113.3208405	10.81888553	114.2902593	336.0290301
4921791.288	583647.252		111.8458529	5.435417486	115.3010554	294.4018291
4921787.568	583645.9734		109.2655937	3.933247606	112.5223471	164.072948
4921787.551	583644.6472		109.9361561	1.326331924	110.2640409	62.70890552
4921785.683	583643.3447		109.0401367	2.277496379	110.6268946	114.6187766
4921780.078	583639.4374		106.5991326	6.832490389	111.2358798	343.8564913
4921776.358	583638.1587		104.3850041	3.933248247	107.4586925	171.4400597
4921772.639	583636.8801		102.2742598	3.933248469	105.2962562	171.4401138
4921766.983	583628.9941		103.3802109	9.704673534	107.6795721	495.1496033
4921607.892	583640.323		105.651337	159.493707	184.2626274	5386.934446

Polygon 13

Cent Long	Cent Lat	Av Radius	Est Area
4921671.751	583361.6726	232.4222124	176122.4614

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921766.983	583628.9941		283.7778604			
4921768.8	583626.3178		281.8787326	3.234876156	284.4457346	370.3191656
4921768.8	583626.3178		281.8787326	0	281.8787326	0
4921770.532	583617.0105		273.7793398	9.467140541	282.5626065	680.8173617
4921770.515	583615.6843		272.5366916	1.326335239	273.8211833	63.32753827
4921768.578	583609.0769		265.6773551	6.885279523	272.5496631	80.34070113
4921766.727	583609.1007		265.0304483	1.851433758	266.2796186	230.1584505
4921766.71	583607.7745		263.7865992	1.326335971	265.0716918	60.87215573
4921766.693	583606.4482		262.5435577	1.326335968	263.8282465	60.87218896
4921764.757	583599.8409		255.6837507	6.885283019	262.5562957	76.65874058

4921766.523	583593.186	250.1602059	6.885264605	256.3646106	519.7868307
4921766.403	583583.9024	241.547467	9.28435142	250.4960122	426.1084579
4921770.021	583577.2237	236.8950525	7.595401353	243.0189604	718.0232893
4921773.638	583570.5451	232.3978007	7.595397967	238.4441256	718.02365
4921773.553	583563.9139	226.4183009	6.631671751	232.7238867	328.9213628
4921777.136	583554.5828	219.8192005	9.99548889	228.1164952	837.3152982
4921782.571	583545.228	214.4148108	10.81889675	222.526454	1017.133338
4921789.874	583537.1756	211.5523919	10.87078178	218.4189922	1116.432462
4921793.543	583534.4757	211.40988	4.554968086	213.75862	481.3812006
4921795.309	583527.8208	207.0550511	6.885234653	212.6750829	557.852973
4921795.275	583525.1684	204.9122287	2.652659428	207.3099696	161.0369477
4921793.355	583519.8873	199.5483281	5.619103359	205.0398301	169.2690322
4921791.47	583517.2586	196.315249	3.234882407	199.5492297	10.68778391
4921793.219	583509.2775	191.1590073	8.170503265	197.8223798	613.816846
4921793.219	583509.2775	191.1590073	0	191.1590073	0
4921793.168	583505.2988	188.0708796	3.978990116	191.6044385	237.8729863
4921796.837	583502.5989	188.4321831	4.55496693	190.5290148	427.3575741
4921804.157	583495.8728	188.5232567	9.940979395	193.4482096	936.4614388
4921809.642	583490.4967	188.7055059	7.680901627	192.4548321	724.0101884
4921813.243	583482.4919	186.057364	8.777243552	191.7700567	783.8108335
4921818.695	583474.4634	185.2411646	9.704575682	190.5015521	897.3253339
4921822.346	583470.4373	185.7653212	5.435374541	188.2209302	501.7363299
4921829.683	583465.0375	188.7511447	9.109918557	191.8131922	805.600312
4921831.518	583463.6876	189.5586711	2.277479085	190.2936474	201.399966
4921837.003	583458.3115	191.435399	7.680885675	194.3374779	709.2744089
4921836.935	583453.0067	188.7534492	5.305283389	192.7470658	435.0328339
4921840.57	583447.6544	189.4538604	6.469701368	192.3385055	608.0377643
4921838.668	583443.6995	185.9828955	4.388622763	189.9126893	252.0504059
4921836.782	583441.0708	183.1378743	3.234866508	186.1778182	142.0645553
4921836.748	583438.4183	181.9727934	2.652641608	183.8816546	217.5166952
4921838.532	583433.0898	181.428362	5.619050284	184.5101029	508.029768
4921844	583426.3875	184.0053354	8.650316594	187.042007	754.1856654
4921847.635	583421.0353	185.6318344	6.469696096	188.053433	578.5696737
4921845.75	583418.4066	183.0146629	3.23486328	185.9406803	175.2155918
4921845.716	583415.7541	182.1774058	2.652637713	183.9223532	229.7946451
4921853.036	583409.0282	187.3681554	9.940944124	189.7432527	782.9792911

4921862.241	583404.931	195.3404941	10.07605014	196.3923498	589.3455627
4921864.075	583403.5811	196.8378314	2.277474936	197.2279002	168.2478664
4921865.91	583402.2312	198.3500165	2.277474713	198.7326613	168.2478002
4921867.676	583395.5764	198.8371391	6.885160208	202.0361579	681.8586126
4921869.51	583394.2265	200.4211224	2.277474247	200.7678679	163.3363722
4921871.311	583390.2242	201.5920527	4.388587674	203.2008813	425.0528019
4921873.043	583380.917	202.2100876	9.466988468	206.6345643	953.3967121
4921876.627	583371.5862	205.1155881	9.995350531	208.6605131	973.5958236
4921878.444	583368.9101	206.8198523	3.234836929	207.5851387	283.1435815
4921878.308	583358.3004	206.584794	10.61049538	212.0075708	1095.976732
4921878.257	583354.3218	206.6370951	3.978935708	208.6004124	410.9912667
4921876.389	583353.0193	204.8209132	2.277484025	206.8677461	141.3539024
4921868.916	583347.8093	197.6517546	9.10993819	205.791303	565.4163765
4921868.848	583342.5045	198.0269062	5.305255032	200.4919579	523.433272
4921868.763	583335.8735	198.6941549	6.631568709	201.6763149	654.2915314
4921866.895	583334.571	197.016801	2.277485013	198.9942205	152.4047014
4921864.958	583327.9636	196.1262162	6.885177522	200.0140974	670.9270358
4921864.941	583326.6374	196.3417938	1.326314464	196.8971622	128.4027629
4921861.171	583321.38	193.6582103	6.469713577	198.2348589	573.8936226
4921861.12	583317.4014	194.4753316	3.978945589	196.0562438	377.8416632
4921859.235	583314.7727	193.2611178	3.234857658	195.4856535	290.6304408
4921859.201	583312.1202	193.8890391	2.652631115	194.901394	249.4388739
4921859.099	583304.163	195.9762712	7.957893257	198.9116018	748.3164606
4921860.848	583296.1821	200.1172617	8.170416012	202.1319745	697.3017362
4921860.746	583288.2248	202.7658179	7.957890734	205.4204852	755.6823994
4921864.313	583277.5678	210.1284205	11.23805583	212.0661471	876.0790866
4921864.194	583268.2844	213.9064361	9.28420021	216.6595284	898.8169558
4921864.144	583264.3058	215.6277211	3.978942893	216.75655	385.2070772
4921864.127	583262.9796	216.2147103	1.326314289	216.5843729	128.4023326
4921864.093	583260.3271	217.4082098	2.65262857	218.1377744	256.8046253
4921865.876	583254.9986	221.503931	5.619025492	222.2655832	422.076411
4921865.876	583254.9986	221.503931	0	221.503931	0
4921865.876	583254.9986	221.503931	0	221.503931	0
4921862.123	583251.0674	220.1703406	5.435379342	223.5548255	581.7778227
4921862.123	583251.0674	220.1703406	0	220.1703406	0
4921860.22	583247.1124	220.5558249	4.388607668	222.5573866	481.6506919

4921860.187	583244.46	221.9162924	2.652629992	222.5623736	251.8932539
4921858.301	583241.8313	221.72746	3.234857167	223.4393048	358.1597172
4921860.102	583237.829	225.4181311	4.388591435	225.7670913	265.43418
4921859.983	583228.5455	230.5519326	9.284204732	232.6271342	881.6252963
4921858.115	583227.243	229.7887297	2.277485366	231.3090738	246.946813
4921852.459	583219.3568	230.020276	9.704574794	234.7567902	1114.996725
4921854.31	583219.3331	231.4920624	1.851432542	231.6818855	129.5951672
4921854.26	583215.3545	233.9197757	3.97894815	234.6953931	366.7889336
4921852.391	583214.0519	233.2871191	2.277485949	234.7421904	255.5416202
4921852.323	583208.7471	236.6278211	5.305265644	237.6101029	484.1405203
4921848.519	583200.8372	238.9876981	8.777225787	242.1963725	1005.046131
4921848.383	583190.2275	246.1555877	10.61053698	247.8769114	948.6348465
4921848.35	583187.5751	247.9861286	2.652634208	248.3971753	237.1584797
4921846.346	583175.6628	255.1138206	12.07959213	257.5897707	1226.275301
4921844.342	583163.7506	262.6039724	12.07959518	264.8986941	1226.273855
4921844.206	583153.1409	270.6037849	10.6105422	271.9091497	928.985082
4921844.122	583146.5099	275.6931818	6.631588761	276.4642777	580.61476
4921844.105	583145.1837	276.7189005	1.326317741	276.8692	116.1228647
4921842.084	583131.9452	285.9861771	13.39178748	288.0484325	1359.580813
4921841.965	583122.6618	293.4266981	9.284226476	294.3485508	804.2627463
4921841.813	583110.7259	303.1425953	11.93686235	304.2530779	1034.049776
4921839.894	583105.4447	306.4716992	5.619058707	307.6166766	689.8538522
4921821.398	583107.0072	295.3790792	18.56176012	310.2062692	2238.215616
4921806.588	583107.1963	287.9917678	14.81145604	299.0911515	1871.683237
4921793.663	583110.0141	279.6328539	13.22869735	290.4266595	1454.58927
4921780.721	583111.5058	272.8697546	13.02770835	282.7651584	1537.560882
4921765.944	583114.3473	264.6549654	15.0471071	276.2859135	1693.459485
4921753.019	583117.1652	257.6595725	13.22870005	267.771619	1465.637532
4921741.911	583117.307	254.238275	11.10859109	261.5032193	1352.193685
4921736.358	583117.3779	252.6934381	5.554295473	256.2430043	676.0968372
4921732.621	583114.7727	254.2927306	4.554998298	255.7705835	540.5528998
4921730.77	583114.7963	253.8329636	1.851431793	254.988563	227.8212622
4921727.101	583117.4961	250.3714729	4.554977564	254.3797071	373.1876654
4921714.176	583120.314	245.0590024	13.22870253	254.3295889	1500.015382
4921697.515	583120.5267	242.5183257	16.66288565	252.1201069	2006.189575
4921686.424	583121.9948	240.1266039	11.18748526	246.9162074	1318.332718

4921673.482	583123.4865	238.1924729	13.0277087	245.6733927	1540.014746
4921662.374	583123.6283	238.2289651	11.10858984	243.7650139	1322.725737
4921653.118	583123.7465	238.6546814	9.257158051	243.0704023	1102.27143
4921645.73	583125.1672	237.9325539	7.523556744	242.055396	892.1579203
4921634.639	583126.6353	237.9492271	11.18748572	243.5346334	1330.610831
4921621.697	583128.127	238.849212	13.02770884	244.913074	1548.609484
4921608.755	583129.6187	240.4526928	13.02770889	246.1648068	1548.609547
4921597.681	583132.4131	240.92793	11.42092117	246.400772	1372.875546
4921586.556	583131.2286	245.6878285	11.18749963	248.901629	1231.347831
4921575.466	583132.6967	248.3964197	11.18748625	252.6358672	1340.433891
4921566.226	583134.1412	250.8106641	9.351689458	254.2793866	1127.346735
4921555.118	583134.283	255.5564815	11.10858819	258.7378669	1271.156778
4921551.382	583131.6778	259.58864	4.555040638	259.8500811	272.8854043
4921551.382	583131.6778	259.58864	0	259.58864	0
4921547.578	583123.7674	268.3613199	8.777555973	268.3637579	38.60552322
4921545.625	583115.8334	276.3053212	8.170801461	276.4187213	260.2891651
4921545.574	583111.8546	279.8742157	3.979135105	280.079336	244.6696082
4921538.05	583102.6652	291.4800038	11.87645812	291.6153388	360.0323388
4921528.743	583098.8046	299.2503304	10.0761542	300.4032442	947.2307742
4921528.743	583098.8046	299.2503304	0	299.2503304	0
4921528.743	583098.8046	299.2503304	0	299.2503304	0
4921526.892	583098.8282	300.118743	1.851431135	300.6102523	245.0107289
4921526.926	583101.4807	297.7819164	2.652764204	300.2767118	187.6713241
4921517.89	583118.8405	287.4729615	19.5707348	302.4128064	2432.637331
4921517.89	583118.8405	287.4729615	0	287.4729615	0
4921510.671	583133.5241	279.2821327	16.36210724	291.5586007	2006.093184
4921507.053	583140.2027	275.996872	7.595619339	281.437312	950.603349
4921501.567	583145.5788	275.0619901	7.681062042	279.3699621	1050.210137
4921499.766	583149.5812	273.0592455	4.388788137	276.2550119	535.1116466
4921492.531	583162.9386	267.6097837	15.19126225	277.9301457	1915.940802
4921494.484	583170.8727	260.4384982	8.170866126	268.109574	516.908502
4921494.636	583182.8092	251.717408	11.93750188	262.046704	1043.422912
4921491.086	583194.793	245.94397	12.49859111	255.0799846	1378.736957
4921481.966	583205.5216	245.7673124	14.08154695	252.8964147	1730.167739
4921474.628	583210.9213	248.1596771	9.110073891	251.5185317	1085.261619
4921472.93	583222.8816	242.4722786	12.0802516	251.3561037	1306.852332

4921478.653	583236.0734	230.3516481	14.37994549	243.6019361	914.2280852
4921476.887	583242.7285	228.2974945	6.885537228	232.7673399	753.4746741
4921476.92	583245.3811	226.8976552	2.652786103	228.9239679	256.4276218
4921471.587	583262.6938	223.2985565	18.11558187	234.1558968	1996.629048
4921471.791	583278.6092	216.5259551	15.91673106	227.8706214	1582.766741
4921471.876	583285.2407	213.9903704	6.63197143	218.5741485	659.4856654
4921470.058	583287.9169	214.7550262	3.234971147	215.9901838	336.909345
4921470.279	583305.1586	209.2478991	17.24313114	220.6230282	1730.624019
4921470.364	583311.7901	207.4727112	6.631973677	211.676292	665.6242798
4921470.466	583319.7478	205.6047878	7.958368531	210.5179338	798.7489138
4921468.631	583321.0978	207.1322166	2.277520173	207.5072623	174.3164197
4921465.082	583333.0817	208.6372812	12.4986432	214.1340705	1289.102272
4921463.383	583345.042	209.0300575	12.08027473	214.8738067	1260.189699
4921457.846	583346.4394	214.4460231	5.710468711	214.5932746	191.6250657
4921459.766	583351.7208	212.2185381	5.619357366	216.1419593	550.2450261
4921461.702	583358.3286	210.0754765	6.88557526	214.5897949	690.7367854
4921467.307	583362.2363	204.444834	6.832596141	210.6764533	401.0385493
4921471.026	583363.5152	200.7329657	3.93326529	204.5555324	131.7782012
4921472.894	583364.8178	198.8811113	2.277531204	200.9458041	132.4513806
4921476.665	583370.0755	195.26661	6.469972612	200.308847	528.69601
4921482.27	583373.9833	189.8804078	6.83259114	195.9898045	404.7202222
4921486.04	583379.241	186.5395329	6.469966584	191.4449537	521.3276295
4921487.96	583384.5224	185.2060961	5.619336413	188.6824827	507.2666198
4921486.21	583392.5038	188.0846294	8.170862399	190.7307939	713.4701854
4921484.427	583397.8327	190.7819267	5.619320077	192.2429381	466.8675203
4921486.312	583400.4615	189.451882	3.234983135	191.7343959	280.3091027
4921486.329	583401.7878	189.7112588	1.326391971	190.2447664	123.3015925
4921484.512	583404.4641	192.066328	3.234967603	192.5062772	211.6695803
4921479.077	583413.8192	199.6056207	10.81925477	201.2456017	759.5393718
4921479.145	583419.1244	200.9916444	5.305574084	202.9514196	512.8530423
4921473.761	583432.4584	210.2628383	14.37990229	212.8171925	1129.447888
4921473.795	583435.1109	211.1387267	2.652789399	212.0271772	263.7941523
4921471.995	583439.1135	214.2415845	4.38880811	214.8845597	330.0620323
4921473.965	583448.3738	215.9541109	9.467567153	219.8316313	1001.187994
4921474.033	583453.6789	218.0764626	5.305578986	219.6680763	527.5888718
4921474.05	583455.0052	218.6239495	1.326394756	219.0134034	131.8972491

4921475.868	583452.3289	215.8443308	3.234971626	218.8516259	179.7476132
4921475.953	583458.9604	218.6362418	6.63197191	220.5562722	653.3467959
4921475.97	583460.2866	219.214434	1.326394393	219.5885351	130.6693987
4921476.021	583464.2655	220.9877029	3.9791832	222.0906601	392.0082761
4921476.072	583468.2444	222.8179266	3.979183233	223.8924064	392.008401
4921476.259	583482.8335	229.9935994	14.5903388	233.7009324	1437.365247
4921481.881	583488.0674	228.0927013	7.681123197	232.8837119	852.1718694
4921483.8	583493.3488	229.486581	5.619341948	231.5993122	622.6865799
4921485.719	583498.6302	231.0087724	5.619340589	233.057347	622.6865814
4921487.656	583505.2379	233.4565444	6.885553764	235.6754353	747.2170126
4921491.375	583506.5167	231.3333064	3.933265288	234.3615581	384.7110223
4921496.963	583509.098	228.6589956	6.155292526	233.0737972	637.489674
4921498.9	583515.7057	231.524757	6.885543027	233.5346478	720.2035482
4921499.036	583526.3159	238.6166281	10.61112028	240.3762527	927.4834859
4921504.624	583528.8972	236.4223995	6.155291539	240.5971595	682.919428
4921506.526	583532.8523	237.9111622	4.38880878	239.3611852	489.5608506
4921510.382	583544.7413	244.0371074	12.49861689	247.2234432	1312.194309
4921510.484	583552.699	249.9961534	7.95832709	250.9957939	651.4114783
4921505.1	583566.0331	263.6959505	14.37985065	264.0359773	560.9705384
4921505.254	583577.9696	272.957278	11.93750139	274.2953649	1010.274482
4921510.927	583587.1822	276.9818985	10.81927819	280.3792273	1380.474493
4921514.68	583591.1135	278.0544016	5.43554074	280.2359204	739.3673751
4921520.319	583597.6736	280.4067391	8.650615794	283.5558782	1162.107802
4921527.724	583597.5785	276.396763	7.405731999	282.104617	866.6090294
4921533.227	583593.5284	270.0849444	6.832544311	276.6571258	357.4011757
4921538.73	583589.4783	263.7990779	6.832542317	270.3582823	357.4019285
4921542.398	583586.7782	259.6238493	4.555027106	263.9889771	238.2683578
4921549.718	583580.0518	250.1626531	9.941152442	259.8638274	388.8425326
4921551.536	583577.3755	246.9400752	3.234947831	250.1688381	35.12316033
4921555.272	583579.9805	247.4380079	4.555046153	249.4665646	559.5811804
4921557.158	583582.6093	248.886705	3.234961595	249.7798373	358.8906835
4921559.026	583583.9118	249.1929541	2.277522561	250.1785908	281.0184144
4921566.38	583579.8379	242.2789684	8.407024421	249.9394734	587.5629612
4921568.197	583577.1616	239.0791693	3.234942291	242.29654	57.22484663
4921571.814	583570.4827	231.492786	7.595576835	239.0837661	43.94550699
4921575.5	583569.109	228.6788616	3.93324772	232.0524477	316.1423544

4921579.322	583578.3453		235.5634518	9.995786433	237.1190499		840.8892693
4921579.441	583587.6291		244.0848562	9.284617925	244.4664629		441.9651472
4921581.36	583592.9104		248.2766902	5.619269147	248.9904078		460.609575
4921586.982	583598.1442		251.2059875	7.681067278	253.5818725		886.5473572
4921596.239	583598.0253		248.1222165	9.257165998	254.292685		1089.400471
4921598.175	583604.6329		253.856275	6.885448124	254.4319698		478.3178696
4921603.814	583611.1928		258.603328	8.650551458	260.5550772		926.3568977
4921603.9	583617.8241		264.9856083	6.631845866	265.1103911		235.8823863
4921602.202	583629.7842		276.9854038	12.08003701	277.0255245		188.2930577
4921605.938	583632.3892		278.6014023	4.555035029	280.0709206		591.5054926
4921605.955	583633.7155		279.8862949	1.326368847	279.907033		45.94911949
4921607.892	583640.323		285.8740552	6.88543956	286.3228948		480.777574
4921766.983	583628.9941		283.7778604	159.493707	364.5728113		21803.6343

Polygon 14

Cent Long	Cent Lat	Av Radius	Est Area
4921939.128	583355.6662	166.2977899	107111.6728

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area	
4922064.306	583568.1402		246.6066248				
4921770.021	583577.2237		278.7203003	294.4257889	409.876357		31832.55415
4921773.638	583570.5451		271.2191435	7.595397967	278.7674209		163.9731097
4921773.553	583563.9139		266.0492601	6.631671751	271.9500377		557.8405717
4921777.136	583554.5828		256.5329016	9.99548889	266.2888253		399.3844688
4921782.571	583545.228		245.8531537	10.81889675	256.602476		217.1811774
4921789.874	583537.1756		234.9945631	10.87078178	245.8592493		61.856163
4921793.543	583534.4757		230.5818251	4.554968086	235.0656781		131.4457762
4921795.309	583527.8208		224.3239286	6.885234653	230.8954942		326.5216238
4921795.275	583525.1684		222.316877	2.652659428	224.6467325		193.6665651
4921793.355	583519.8873		219.5865559	5.619103359	223.7612681		542.522738

4921791.47	583517.2586	218.8949602	3.234882407	220.8581993	346.4006761
4921793.219	583509.2775	211.8627914	8.170503265	219.4641274	447.9090887
4921793.219	583509.2775	211.8627914	0	211.8627914	0
4921793.168	583505.2988	209.0316678	3.978990116	212.4367246	294.182398
4921796.837	583502.5989	204.5386855	4.55496693	209.0626601	77.42480817
4921804.157	583495.8728	194.6154623	9.940979395	204.5475636	59.24563013
4921809.642	583490.4967	186.9379509	7.680901627	194.6171574	21.76182678
4921813.243	583482.4919	178.6948194	8.777243552	187.2050069	275.5248194
4921818.695	583474.4634	169.1655393	9.704575682	178.7824672	159.6226255
4921822.346	583470.4373	163.7388393	5.435374541	169.1698766	25.54365785
4921829.683	583465.0375	154.7263399	9.109918557	163.7875489	105.7436816
4921831.518	583463.6876	152.4750251	2.277479085	154.739422	26.4360602
4921837.003	583458.3115	144.7947228	7.680885675	152.4753168	7.032741623
4921836.935	583453.0067	141.1329775	5.305283389	145.6164918	274.369376
4921840.57	583447.6544	134.8166757	6.469701368	141.2096773	96.58952275
4921838.668	583443.6995	133.5745525	4.388622763	136.3899255	282.3885358
4921836.782	583441.0708	133.2988917	3.234866508	135.0541553	215.0241395
4921836.748	583438.4183	131.6416883	2.652641608	133.7966108	137.1843898
4921838.532	583433.0898	126.9411879	5.619050284	132.1009632	198.9843819
4921844	583426.3875	118.5359928	8.650316594	127.0637487	125.4019831
4921847.635	583421.0353	112.4459997	6.469696096	118.7258443	126.0547302
4921845.75	583418.4066	112.4983408	3.23486328	114.0896019	181.8734231
4921845.716	583415.7541	111.0695062	2.652637713	113.1102424	124.9059073
4921853.036	583409.0282	101.2886066	9.940944124	111.1495284	94.21642906
4921862.241	583404.931	91.31597856	10.07605014	101.3403176	69.24065132
4921864.075	583403.5811	89.04337561	2.277474936	91.31841455	6.712841753
4921865.91	583402.2312	86.7710283	2.277474713	89.04593931	6.712807165
4921867.676	583395.5764	81.84259242	6.885160208	87.74939046	202.5005315
4921869.51	583394.2265	79.58340851	2.277474247	81.85173759	11.62382864
4921871.311	583390.2242	76.11472639	4.388587674	80.04336129	104.606407
4921873.043	583380.917	70.74489029	9.466988468	78.16330258	285.6601836
4921876.627	583371.5862	64.49709667	9.995350531	72.61866875	263.0700162
4921878.444	583368.9101	62.11251413	3.234836929	64.92222387	69.16478812
4921878.308	583358.3004	60.87706696	10.61049538	66.80003824	322.81795
4921878.257	583354.3218	60.88585201	3.978935708	62.87092734	121.0567253
4921876.389	583353.0193	62.79508513	2.277484025	62.97921058	38.38644176

4921868.916	583347.8093	70.65057736	9.10993819	71.27780034	153.5460095
4921868.848	583342.5045	71.50209018	5.305255032	73.72896129	185.9650309
4921868.763	583335.8735	73.09592284	6.631568709	75.61479087	232.4563285
4921866.895	583334.571	75.2507995	2.277485013	75.31210368	27.33659389
4921864.958	583327.9636	79.17430516	6.885177522	80.65514109	218.21303
4921864.941	583326.6374	79.66383936	1.326314464	80.08222949	48.94690245
4921861.171	583321.38	85.1637104	6.469713577	85.64863167	140.2894954
4921861.12	583317.4014	86.88760114	3.978945589	88.01512857	154.2076204
4921859.235	583314.7727	89.75089093	3.234857658	89.93667487	66.46156341
4921859.201	583312.1202	91.01987667	2.652631115	91.71169936	105.2607419
4921859.099	583304.163	95.16953771	7.957893257	97.07365382	315.7823669
4921860.848	583296.1821	98.31618915	8.170416012	100.8280714	364.4038692
4921860.746	583288.2248	103.4021504	7.957890734	104.8381151	308.4160656
4921864.313	583277.5678	108.1508466	11.23805583	111.3955264	537.9310271
4921864.194	583268.2844	115.1113375	9.28420021	116.2731921	342.6304629
4921864.144	583264.3058	118.1922116	3.978942893	118.641246	146.8418041
4921864.127	583262.9796	119.2309867	1.326314289	119.3747563	48.94729266
4921864.093	583260.3271	121.3253533	2.65262857	121.6044843	97.89462303
4921865.876	583254.9986	124.4982112	5.619025492	125.721295	284.9273234
4921865.876	583254.9986	124.4982112	0	124.4982112	0
4921865.876	583254.9986	124.4982112	0	124.4982112	0
4921862.123	583251.0674	129.8874403	5.435379342	129.9105154	44.93930932
4921862.123	583251.0674	129.8874403	0	129.8874403	0
4921860.22	583247.1124	134.2025646	4.388607668	134.2393063	52.79336507
4921860.187	583244.46	136.3766043	2.652629992	136.6158995	102.8061762
4921858.301	583241.8313	139.6114247	3.234857167	139.6114431	1.065030912
4921860.102	583237.829	141.8829484	4.388591435	142.9414822	264.2196944
4921859.983	583228.5455	149.745132	9.284204732	150.4561426	359.8226536
4921858.115	583227.243	151.840954	2.277485366	151.9317857	67.20129495
4921852.459	583219.3568	161.5294618	9.704574794	161.5374953	43.70986081
4921854.31	583219.3331	160.5638474	1.851432542	161.9723709	127.1990476
4921854.26	583215.3545	163.9818517	3.97894815	164.2623236	165.2606117
4921852.391	583214.0519	166.0658565	2.277485949	166.1625971	75.79545207
4921852.323	583208.7471	170.6465976	5.305265644	171.0088599	225.2590603
4921848.519	583200.8372	179.3934284	8.777225787	179.4086259	63.84686844
4921848.383	583190.2275	188.6916407	10.61053698	189.347803	470.1650415

4921848.35	583187.5751	191.0375628	2.652634208	191.1909188	117.541484
4921846.346	583175.6628	202.5086619	12.07959213	202.8129084	372.2722815
4921844.342	583163.7506	214.0467179	12.07959518	214.3174875	372.274568
4921844.206	583153.1409	223.6662843	10.6105422	224.1617722	489.8154266
4921844.122	583146.5099	229.7228299	6.631588761	230.0103515	306.1355309
4921844.105	583145.1837	230.93793	1.326317741	230.9935388	61.22719098
4921842.084	583131.9452	243.8618945	13.39178748	244.095806	416.3191508
4921841.965	583122.6618	252.4512818	9.284226476	252.7987014	437.1879148
4921841.813	583110.7259	263.5640201	11.93686235	263.9760821	562.1010146
4921839.894	583105.4447	269.1806618	5.619058707	269.1818703	21.94693946
4922015.495	583081.9808	284.1400478	177.1614892	365.2410994	23133.75872
4922015.495	583081.9808	284.1400478	0	284.1400478	0
4922017.465	583091.2404	275.7854469	9.466794215	284.6961445	623.1163851
4922010.178	583100.6181	264.7595178	11.87587593	276.2104203	596.0706413
4922010.347	583113.8799	252.0571413	13.26283696	265.039748	492.7219051
4922001.26	583127.2598	236.7063159	16.17395802	252.4687076	622.1022926
4922001.464	583143.174	221.4467629	15.91542789	237.0342534	517.6092364
4922003.45	583153.7597	211.9046682	10.77061425	222.0610227	541.029584
4922003.552	583161.7168	204.3693474	7.957712048	212.1158638	266.1740016
4922007.441	583176.2574	191.9744244	15.0517316	205.6977517	845.5192342
4922014.982	583186.7722	185.1458281	12.93922394	195.0297382	1035.586511
4922016.918	583193.3794	179.9673787	6.885026709	185.9991167	414.0850433
4922013.266	583197.4053	174.7655214	5.435283667	180.0840919	139.7262194
4922020.824	583209.2462	167.6694284	14.04730881	178.2411293	1036.979539
4922030.182	583217.0849	165.8180204	12.20740106	172.8474249	1005.306482
4922037.689	583224.9473	163.7122478	10.87060693	170.2004376	878.1071499
4922041.459	583230.2046	161.9021869	6.469594125	166.0420144	505.5163935
4922050.784	583235.3909	164.1131256	10.66957329	168.3424429	850.2800658
4922052.72	583241.9981	160.6969744	6.884992921	165.8475465	485.2962332
4922052.839	583251.2813	154.3576649	9.283930445	162.1692849	533.9953718
4922052.974	583261.8906	147.4951728	10.61020644	156.231522	610.2812718
4922051.225	583269.8713	141.1610836	8.170186369	148.4132214	372.2569485
4922042.07	583277.9467	128.9860939	12.20732484	141.1772512	59.90610694
4922044.074	583289.8586	123.8723437	12.07924259	132.4688401	690.9919767
4922047.947	583303.0729	120.8616422	13.77000019	129.2519931	820.8103121
4922055.505	583314.9136	123.3055593	14.04726019	129.1072309	842.9946417

4922063.046	583325.4282	127.5534279	12.93916613	131.8990767	765.4802367
4922066.833	583332.0116	129.8772207	7.595164731	132.5129067	465.1639002
4922063.249	583341.3422	124.9450569	9.995097583	132.4086876	553.3937568
4922057.831	583352.0226	118.7592175	11.97605748	127.840166	624.0310416
4922056.133	583363.9818	117.3000483	12.07920222	124.069234	706.704545
4922063.674	583374.4963	125.9613934	12.93916745	128.1003045	583.7695785
4922074.901	583383.6372	138.623875	14.47733155	139.5312999	463.5305362
4922084.225	583388.8233	148.8372614	10.66956434	149.0653504	221.6577152
4922086.093	583390.1257	150.9511527	2.277460091	151.0329371	63.51724777
4922091.698	583394.033	157.320224	6.832379021	157.5518778	190.551379
4922095.503	583401.9426	163.0783058	8.776963204	164.5877465	530.3941518
4922099.256	583405.8736	167.8148586	5.435278447	168.1642214	220.5068643
4922101.176	583411.1545	171.2843859	5.618865903	172.3590552	374.6305385
4922101.227	583415.133	172.6621492	3.978800409	173.9626677	320.9358991
4922092.055	583421.8824	166.6471605	11.38723942	175.3482746	819.7315402
4922088.387	583424.5822	164.400473	4.554897319	167.8012654	327.8929525
4922088.421	583427.2345	165.5604932	2.652538955	166.3067526	196.7690277
4922090.374	583435.1677	170.8677596	8.170165762	172.2992092	522.2891257
4922090.493	583444.4508	175.4822879	9.283883969	177.8169657	697.28489
4922092.446	583452.3841	181.2755125	8.170163851	182.4639821	513.6934469
4922092.446	583452.3841	181.2755125	0	181.2755125	0
4922098.034	583454.9652	187.3804155	6.155190971	187.4055595	72.35678711
4922103.656	583460.1986	194.9268188	7.68077663	194.9940055	136.6882589
4922109.312	583468.0843	203.9617056	9.704332274	204.2964283	353.0988757
4922113.117	583475.9938	211.54366	8.776946133	212.1411559	459.1760601
4922113.185	583481.2984	214.6604979	5.305058875	215.7546084	457.3772839
4922113.253	583486.603	217.8619458	5.305058933	218.9137513	457.3770125
4922118.926	583495.8149	227.9666911	10.81853359	228.3235852	430.6055808
4922117.142	583501.1433	229.8970977	5.61883621	231.7413125	603.9709484
4922106.069	583503.9381	223.2794895	11.42089077	232.298739	1054.238274
4922100.532	583505.3355	220.1183468	5.710445731	224.554141	527.1193769
4922100.549	583506.6616	221.0346343	1.326267433	221.2396243	105.7499329
4922093.195	583510.7351	218.5930822	8.406873945	224.0172952	883.9871647
4922085.807	583512.1562	214.484895	7.523552079	220.3007646	682.3095441
4922078.385	583510.9251	208.5610288	7.523565662	215.2847447	490.4533626
4922067.26	583509.7414	200.3919541	11.18750515	210.070244	781.1882721

4922061.791	583516.4435		202.2265254	8.650145839	205.6343126	850.6737884
4922061.825	583519.0958		204.3619939	2.65255077	204.620535	159.9350411
4922065.664	583529.6576		215.1379705	11.23779283	215.3688786	334.2703598
4922067.6	583536.2647		221.6324559	6.884986225	221.8277063	249.5569781
4922064	583544.2692		226.1947814	8.776964082	228.3021007	839.2930084
4922065.919	583549.5501		231.6613802	5.618895966	231.7375288	148.7167387
4922064.068	583549.5739		230.6733267	1.851434402	232.0930706	180.9731958
4922064.306	583568.1402		246.6066248	18.56785168	247.9239016	1136.722891

Polygon 15

			Est Area
			95336.87702
Cent Long	Cent Lat	Av Radius	
4921891.985	583722.613	166.4287848	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921948.154	583894.6016		180.9281544			
4921940.629	583885.4137		169.9125889	11.87604288	181.3583931	389.0531601
4921931.27	583877.5758		159.8648454	12.20749517	170.9924647	571.1908292
4921927.516	583873.6449		155.1550612	5.435360961	160.2276338	213.64078
4921897.827	583868.7217		146.2254651	30.09430202	165.7374141	2154.520347
4921873.675	583862.4007		140.9817705	24.96556638	156.086401	1745.952831
4921851.391	583857.3821		140.7499187	22.84189074	152.28679	1603.442047
4921823.554	583852.4349		146.7533588	28.27375365	157.8885156	1976.233714
4921795.733	583848.8139		158.7168756	28.05514022	166.7626873	1929.74835
4921771.598	583843.8189		170.8327553	24.64645741	177.0980441	1763.315254
4921764.091	583835.9569		170.8912023	10.87086393	176.2974108	928.2252028
4921758.452	583829.3973		170.9798376	8.650433547	175.2607367	739.0576614
4921758.4	583825.4186		168.5642366	3.979016499	171.7615454	268.3804243
4921762	583817.4136		160.8825253	8.777310946	169.1120365	349.6222131
4921773.108	583817.2706		151.9599111	11.10860726	161.9755219	517.2134445
4921782.313	583813.1727		142.2286632	10.07607792	152.1323261	192.0995632

4921785.862	583801.1891	132.0465833	12.49811141	143.386679	496.4446728
4921785.811	583797.2104	129.7603564	3.978999297	132.8929695	213.1270897
4921791.262	583789.1816	120.733085	9.704613268	130.0990273	222.8973573
4921794.828	583778.5242	112.0960591	11.23818394	122.033664	418.0325336
4921796.645	583775.8479	109.195376	3.234868523	112.2631518	79.20977564
4921789.121	583766.6596	111.898143	11.87620599	116.4848625	638.290112
4921789.121	583766.6596	111.898143	0	111.898143	0
4921787.269	583766.6834	113.6115422	1.851434413	113.6805598	39.54624233
4921770.557	583762.9191	127.9431606	17.13142425	129.3430635	565.3597019
4921757.581	583761.7596	139.9893731	13.02773931	140.4801365	331.9051123
4921751.993	583759.1786	144.6891012	6.155252629	145.4168635	282.8247352
4921750.022	583749.9188	144.565438	9.467190272	149.3608647	684.1817804
4921746.268	583745.9878	147.5798779	5.435439126	148.7903775	330.2830784
4921751.702	583736.6327	140.9814214	10.81894158	149.6901205	618.0810908
4921751.668	583733.9803	140.7764173	2.652679424	142.2052591	186.2862232
4921760.856	583728.5563	131.263198	10.66965324	141.3546343	328.3142868
4921762.657	583724.5538	129.3430477	4.38865309	132.4974494	257.0712718
4921768.091	583715.1988	124.1157166	10.8189208	132.1388426	599.660945
4921769.908	583712.5225	122.4932208	3.234876723	124.9219071	172.5225963
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921769.908	583712.5225	122.4932208	0	122.4932208	0
4921771.708	583708.5201	121.0996326	4.388647828	123.9907506	253.387216
4921775.343	583703.1676	118.2522423	6.46975026	122.9108126	347.5003559
4921775.326	583701.8413	118.494343	1.32633472	119.03646	77.18123954
4921777.126	583697.8389	117.500833	4.388644661	120.1919104	252.1590828
4921777.126	583697.8389	117.500833	0	117.500833	0
4921777.109	583696.5126	117.8042245	1.326334328	118.3156959	75.95341949
4921778.943	583695.1626	116.3274512	2.277486613	118.2045812	101.4799699
4921778.943	583695.1626	116.3274512	0	116.3274512	0
4921778.943	583695.1626	116.3274512	0	116.3274512	0

4921778.943	583695.1626	116.3274512	0	116.3274512	0
4921778.943	583695.1626	116.3274512	0	116.3274512	0
4921780.743	583691.1601	115.6031878	4.388642556	118.1596408	250.93109
4921786.194	583683.1314	112.917904	9.704614867	119.1128533	532.2995172
4921786.126	583677.8265	114.9431304	5.305329589	116.583182	279.2573001
4921786.075	583673.8478	116.5974596	3.978997153	117.7597936	209.4430385
4921789.726	583669.8216	115.0814993	5.435392331	118.5571756	302.2409315
4921789.726	583669.8216	115.0814993	0	115.0814993	0
4921789.607	583660.538	119.7269523	9.284321208	122.0463864	471.5112225
4921795.042	583651.1831	120.4170097	10.81888553	125.4814238	647.5418152
4921791.288	583647.252	125.774355	5.435417486	125.8133911	56.48347214
4921787.568	583645.9734	129.5240805	3.933247606	129.6158416	75.77840575
4921787.551	583644.6472	130.3268534	1.326331924	130.5886329	68.58671101
4921785.683	583643.3447	132.6031672	2.277496379	132.6037585	4.823579729
4921780.078	583639.4374	139.4323417	6.832490389	139.4339996	14.47043063
4921776.358	583638.1587	143.1853883	3.933248247	143.2754891	83.14481856
4921772.639	583636.8801	146.9478616	3.933248469	147.0332492	83.14471738
4921766.983	583628.9941	156.1733219	9.704673534	156.4129285	228.1260367
4921768.8	583626.3178	156.3565	3.234876156	157.882349	252.3297542
4921768.8	583626.3178	156.3565	0	156.3565	0
4921770.532	583617.0105	160.943398	9.467140541	163.3835192	656.6558517
4921770.515	583615.6843	161.8294819	1.326335239	162.0496076	79.63746061
4921768.578	583609.0769	167.6892045	6.885279523	168.201983	297.7659804
4921766.727	583609.1007	169.0402901	1.851433758	169.2904642	106.5605935
4921766.71	583607.7745	169.9462661	1.326335971	170.1564461	82.09321907
4921766.693	583606.4482	170.8577341	1.326335968	171.0651681	82.09323458
4921764.757	583599.8409	176.8052766	6.885283019	177.2741469	301.450358
4921766.523	583593.186	180.2558998	6.885264605	181.9732205	531.7609888
4921766.403	583583.9024	187.113343	9.28435142	188.3267971	574.6542866
4921770.021	583577.2237	189.7718062	7.595401353	192.2402753	670.2447994
4922064.306	583568.1402	231.4227285	294.4257889	357.8101618	21946.92061
4922073.631	583573.326	235.1208477	10.66957352	238.6065748	1167.007995
4922088.458	583574.4621	246.0698993	14.8707441	248.0307455	1209.937549
4922103.286	583575.5981	257.4126219	14.8707442	259.1766327	1209.936956
4922114.393	583575.4555	266.6846642	11.10860778	267.602947	801.4317961
4922132.855	583571.2393	284.4859709	18.93702826	285.0538317	889.5395573

4922147.631	583568.3969	298.5590406	15.04710352	299.0460575	776.0351799
4922151.385	583572.3278	299.7896588	5.435258174	301.8919788	791.8984194
4922151.436	583576.3063	297.8596605	3.978772311	300.8140458	519.8432433
4922147.836	583584.3107	290.838398	8.776872684	298.7374656	774.9992733
4922142.503	583601.622	278.2051996	18.11391629	293.5787569	1845.807117
4922139.022	583618.9095	267.9210921	17.6345026	281.8803972	1954.829137
4922137.409	583637.4994	259.7642035	18.65971403	273.1725048	2212.576295
4922126.387	583644.2728	247.1465636	12.93733776	259.9240524	362.1075883
4922120.952	583653.6273	239.1340346	10.81848137	248.5495398	883.479368
4922117.301	583657.6533	234.4931523	5.435245227	239.5312161	334.968779
4922113.735	583668.3102	228.3019283	11.2376833	237.0163819	1084.748699
4922111.935	583672.3124	225.6280245	4.388458128	229.1592055	394.8745709
4922101.015	583687.0429	212.03441	18.33675772	227.9995961	1345.342566
4922099.266	583695.0237	209.1086521	8.170142801	214.6566025	803.0017236
4922101.322	583710.9138	209.6632765	16.02255973	217.3972441	1675.216772
4922099.573	583718.8946	207.6210002	8.1701432	212.7272099	825.1022201
4922092.321	583730.9252	200.508509	14.04714728	211.0883282	1235.228207
4922086.836	583736.3013	195.3307663	7.680749818	201.7600125	561.3105274
4922081.333	583740.3512	190.1769559	6.832353893	196.170038	432.226402
4922073.996	583745.7512	183.4758699	9.109808293	191.381317	576.3028259
4922070.311	583747.125	180.0023255	3.933217796	183.7057066	167.6609171
4922053.717	583752.644	164.4967815	17.48702447	180.9930657	695.4578849
4922050.1	583759.3225	162.320543	7.595154622	167.2062396	594.3773172
4922052.105	583771.2342	167.3392613	12.07925125	170.8695278	904.9097723
4922050.322	583776.5627	167.2757348	5.618893423	170.1169448	469.9451878
4922050.493	583789.8243	172.1687328	13.26279127	176.3536294	1045.302335
4922048.744	583797.8052	173.8597966	8.170206197	177.0993678	691.2832121
4922037.756	583807.2314	168.550866	14.47729933	178.443981	1151.930618
4922032.287	583813.9337	167.4043844	8.650176895	172.3027136	719.8698971
4922032.39	583821.8908	171.9581282	7.957697962	173.6601053	553.5157352
4922034.429	583836.4548	182.3465745	14.7061299	184.5054163	921.2082822
4922030.846	583845.7857	185.6176923	9.995159263	188.979713	868.5105486
4922029.097	583853.7666	189.7394761	8.170231364	191.7636999	661.8165463
4922025.463	583859.119	190.9196341	6.469584859	193.5643475	605.2589636
4922021.812	583863.1452	191.3225571	5.435290998	193.8387411	517.9179001
4922018.229	583872.4762	195.9502471	9.995176945	198.6339906	857.4604148

4922020.251	583885.7141		207.494981	13.39147188	208.41835	684.0739361
4922018.468	583891.0426		210.6337019	5.618920343	211.8738016	487.1330871
4922012.914	583891.1142		207.4043852	5.554306647	211.7961968	472.2423312
4922012.966	583895.0927		210.6788798	3.978862044	211.0310635	236.2393689
4921948.154	583894.6016		180.9281544	64.81381943	228.2104268	5559.664057

Polygon 16

Cent Long	Cent Lat	Av Radius	Est Area
4921965.561	583940.8364	42.23285807	5831.161942

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4922012.966	583895.0927		65.87666019			
4922013	583897.7451		64.08865512	2.652574714	66.30894501	63.64976849
4922011.285	583908.3784		56.07396135	10.77061224	65.46661436	215.2782019
4922009.537	583916.3593		50.32927131	8.170256643	57.28674465	154.0841986
4922007.703	583917.7093		48.07090157	2.277461165	50.33881702	7.23714327
4922002.269	583927.0642		39.2064275	10.81863636	49.04798272	134.2784113
4922000.434	583928.4142		37.02008757	2.277462074	39.25198857	12.14832999
4921996.903	583941.7238		31.3547711	13.77009053	41.0724746	210.1420676
4921995.12	583947.0524		30.20585824	5.61893948	33.58978441	84.29598651
4921991.452	583949.7525		27.38322012	4.55492628	31.07200232	51.30787341
4921989.703	583957.7334		29.46802416	8.170281566	32.51076292	111.1130689
4921988.023	583971.0191		37.62377507	13.39151882	40.24165902	174.5691668
4921986.326	583982.9787		46.98034979	12.07935839	48.34174163	159.9326332
4921982.76	583993.6359		55.5301973	11.23789846	56.87422278	185.7804379
4921979.211	584005.6193		66.20552545	12.4977763	67.11674952	196.7328703
4921977.394	584008.2956		68.4892616	3.234810344	68.9647987	77.1232051
4921953.157	583995.3443		55.90139151	27.4810936	75.93587336	740.9010687
4921949.386	583990.0873		51.83898174	6.46966969	57.10502147	135.3794127
4921941.878	583982.2257		47.68594482	10.87071131	55.19781894	248.4644639

4921947.26	583968.8921		33.49655043	14.37905386	47.78077456	46.49557415
4921950.826	583958.2348		22.79936365	11.23795195	33.76693302	47.49644826
4921948.906	583952.9539		20.59607656	5.618993207	24.50721671	55.60572299
4921946.97	583946.3469		19.39053785	6.885113773	23.43586409	66.75272953
4921939.53	583943.79		26.19744035	7.866481154	26.72722968	44.26476632
4921933.993	583945.1878		31.86564478	5.710457545	31.88677134	10.01623514
4921932.057	583938.5807		33.57981817	6.885128179	36.16529556	108.497505
4921930.171	583935.9522		35.72492029	3.23484093	36.26978969	41.90630701
4921930.103	583930.6474		36.8927882	5.305217714	38.9614631	93.69949757
4921931.92	583927.9711		36.01693661	3.234825217	38.07227502	56.70427551
4921937.422	583923.9209		32.83132052	6.832409444	37.84033329	103.5214793
4921939.239	583921.2447		32.81220793	3.234822712	34.43917558	53.0208726
4921935.468	583915.9877		39.02562903	6.469677301	39.15375713	32.24591686
4921933.617	583916.0115		40.4556517	1.851435406	40.66635807	23.36007667
4921931.68	583909.4044		46.21516502	6.885127761	46.77797224	81.48661642
4921933.515	583908.0544		45.84335488	2.277469951	47.16799492	51.69608797
4921939	583902.678		46.4922612	7.680839032	50.00822755	176.0575639
4921948.154	583894.6016		49.40301389	12.20742757	54.05135133	281.9051856
4922012.966	583895.0927		65.87666019	64.81381943	90.04674676	1494.010773

Polygon 17

Cent Long	Cent Lat	Av Radius	Est Area
4921941.478	584045.2584	34.11788055	3424.372271

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921898.903	584095.5259		65.87500659			
4921891.309	584081.0333		61.61826632	16.36147336	71.92737314	499.3722515
4921900.428	584070.3042		48.08737337	14.08108703	61.89336336	106.0152848
4921907.748	584063.5776		38.3841363	9.940926293	48.20621798	46.40294775
4921916.902	584055.5009		26.62579897	12.20745775	38.60869651	52.37234793

4921916.833	584050.1961		25.13519678	5.305231094	28.53311342		65.5385608
4921920.467	584044.8435		21.01547706	6.469661225	26.31016753		56.98650183
4921924.05	584035.5123		19.96861257	9.995312663	25.48970115		98.77358464
4921929.467	584024.8311		23.69725049	11.97627938	27.82107122		119.4766153
4921933.169	584024.7833		22.09692208	3.702871615	24.7485221		38.10371185
4921940.472	584016.7305		28.5455901	10.87066433	30.75658826		108.2148176
4921947.808	584011.3302		34.51355253	9.109877021	36.08450982		107.3680153
4921953.157	583995.3443		51.26203971	16.85692716	51.3162597		40.13749503
4921977.394	584008.2956		51.53838862	27.4810936	65.14076097		680.5291142
4921977.463	584013.6003		47.92821812	5.305180853	52.3858938		96.52817776
4921973.863	584021.6052		40.10282716	8.77707907	48.40406218		87.0442503
4921973.863	584021.6052		40.10282716	0	40.10282716		0
4921973.949	584028.2362		36.66161888	6.631480031	41.69796304		108.3827251
4921972.2	584036.2172		32.02450358	8.17030491	38.42821369		114.6908731
4921970.366	584037.5672		29.89391275	2.277466241	32.09794128		12.44698085
4921964.881	584042.9437		23.51644221	7.680824661	30.54558981		56.56205487
4921959.395	584048.3201		18.17664533	7.680827834	24.68695769		56.56216512
4921955.727	584051.0203		15.36955184	4.554935828	19.0505665		29.80522523
4921955.83	584058.9775		19.85386627	7.95779916	21.59060864		56.39296216
4921952.179	584063.0038		20.72188564	5.435325223	23.00553857		53.9374359
4921941.122	584067.1258		21.87037837	11.79968563	27.19597483		120.1527766
4921937.488	584072.4784		27.51095795	6.469647981	27.92549215		38.7806032
4921937.54	584076.457		31.4462827	3.978911054	31.46807585		8.637048744
4921898.903	584095.5259		65.87500659	43.08643772	70.2038635		565.157744

Polygon 18

					Est Area		
					10690.5082		
		Cent Long	Cent Lat	Av Radius			
		4921927.263	584172.3571	60.06789008			
						Heron's Formula for Area	
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	

4921937.54	584076.457	96.44922082			
4921943.196	584084.3424	89.44534584	9.70451832	97.79954249	311.7561769
4921947.019	584093.5779	81.21863783	9.995319831	90.32965175	241.796706
4921950.807	584100.1611	75.93821035	7.595288502	82.37606834	214.2464744
4921954.613	584108.0704	69.86272443	8.777141935	77.28903835	230.4775489
4921967.657	584114.5339	70.5354077	14.55818009	77.4781561	507.6879895
4921969.526	584115.8362	70.57461383	2.277478182	71.69374985	80.3213796
4921978.885	584123.6737	70.95724879	12.20747364	76.86966813	430.1154843
4921986.376	584130.2089	72.60045601	9.940926435	76.74931562	351.0216534
4921986.513	584140.8184	67.12139834	10.61035238	75.16610337	316.4696238
4921988.519	584152.7301	64.32338746	12.07938489	71.76208535	384.5132922
4921984.902	584159.4088	59.07549746	7.595223186	65.49705406	169.063385
4921979.485	584170.0901	52.27157292	11.97620538	61.66163788	272.7610884
4921977.754	584179.3974	50.97965062	9.466869231	56.35904638	241.0606028
4921974.12	584184.75	48.46838297	6.469626078	52.95882983	147.9219371
4921970.486	584190.1026	46.72425741	6.469628611	50.83113449	147.9220511
4921966.784	584190.1505	43.34158255	3.70287309	46.88435652	33.8866743
4921959.396	584191.5724	37.43986238	7.523565865	44.1525054	93.82668953
4921959.396	584191.5724	37.43986238	0	37.43986238	0
4921953.91	584196.949	36.26091111	7.680834284	40.69080389	139.0823058
4921953.927	584198.2752	37.18540389	1.326301006	37.386308	17.45888347
4921944.791	584207.6783	39.43131718	13.11065635	44.86368871	243.7625214
4921931.918	584214.4769	42.37621147	14.55813276	48.18283071	286.9317517
4921924.667	584226.5084	54.21344709	14.04743152	55.31854504	180.7029113
4921917.365	584234.5614	62.98676721	10.8706854	64.03544984	187.259666
4921913.663	584234.6093	63.7204558	3.702873113	65.20504806	114.9205532
4921908.109	584234.6812	65.20091415	5.554309635	67.23783979	172.3808292
4921908.109	584234.6812	65.20091415	0	65.20091415	0
4921897.035	584237.4773	71.79362528	11.42092488	74.20773216	318.2897986
4921889.665	584240.2255	77.58694069	7.86646691	78.62351644	198.4579511
4921876.74	584243.0456	86.88731717	13.22872381	88.85149083	385.5720194
4921873.02	584241.7673	88.09095585	3.933247582	89.4557603	163.762543
4921867.363	584233.882	85.86749228	9.704593529	91.83152083	410.1825062
4921865.444	584228.6011	83.57629066	5.619063299	87.53142312	217.222529
4921874.58	584219.1979	70.49502772	13.11073647	83.59102743	33.71972952
4921881.916	584213.7973	61.42953219	9.109912635	70.51723627	29.56275524

4921887.419	584209.7468		54.64011065	6.832432153	61.45103749		22.17230425
4921889.098	584196.4608		45.13881614	13.39173453	56.58533065		233.2827393
4921889.081	584195.1346		44.45951802	1.3263142	45.46232418		25.51369666
4921896.246	584176.472		31.28843361	19.99071453	47.86933308		274.6842566
4921898.063	584173.7957		29.23511018	3.234839147	31.87919147		37.76724514
4921901.628	584163.1382		27.2416736	11.23803633	33.85741005		153.0330773
4921903.36	584153.8309		30.2420557	9.466975014	33.47535215		127.2737806
4921901.388	584144.5714		37.96754354	9.466993608	38.83829642		92.404567
4921899.468	584139.2905		43.19635621	5.619035224	43.39146749		41.64737403
4921895.68	584132.7074		50.69088441	7.595335074	50.74128785		28.85416521
4921897.343	584118.0952		61.96415126	14.70643267	63.68073417		263.7075792
4921902.725	584104.7615		71.91149158	14.37914467	74.12739376		345.5030864
4921898.903	584095.5259		81.89829419	9.995378816	81.9025823		15.88452301
4921937.54	584076.457		96.44922082	43.08643772	110.7169764		1754.661795

Polygon 19

				Est Area
				1360.464967
Cent Long	Cent Lat	Av Radius		
4921544.851	583985.8218	18.86357453		

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921550.881	583958.0867		28.38310969			
4921550.984	583966.0443		20.70655276	7.958290887	28.52397667	25.41634321
4921552.869	583968.673		18.93082122	3.234967285	21.43617063	26.70579662
4921556.623	583972.604		17.70011704	5.435528665	21.03323346	47.94767464
4921556.743	583981.8879		12.5257489	9.284665073	19.75526551	55.43747731
4921554.977	583988.5432		10.48554722	6.885480582	14.94838835	36.09883099
4921556.863	583991.1718		13.14933296	3.234966206	13.43492319	10.74369103
4921556.914	583995.1506		15.24943624	3.979142306	16.18895575	23.7589192
4921556.914	583995.1506		15.24943624	0	15.24943624	0
4921547.692	583997.9226		12.42977699	9.629753449	18.65448334	59.73511644

4921545.858	583999.2727		13.48854093	2.277515347	14.09791663		13.015245
4921544.006	583999.2966		13.50123645	1.851434578	14.42060598		12.46273165
4921544.006	583999.2966		13.50123645	0	13.50123645		0
4921540.321	584000.6707		15.52444586	3.933253517	16.47946791		24.2501187
4921529.282	584006.1191		25.58078897	12.31053688	26.70788585		69.61925184
4921527.345	583999.5116		22.2231886	6.885526456	27.34475201		71.09312558
4921527.276	583994.2065		19.47215862	5.305547249	23.50044724		46.90429505
4921521.671	583990.2993		23.60815789	6.832587082	24.9564518		57.83216394
4921524.912	583954.4421		37.17874782	36.00336565	48.39513568		408.3248645
4921550.881	583958.0867		28.38310969	26.2237555	45.8928065		371.1193211

Polygon 20

					Est Area		
					1398.536728		
		Cent Long	Cent Lat	Av Radius			
		4921506.455	583982.9787	21.61005503			
						Heron's Formula for Area	
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	
4921521.671	583990.2993		16.88519168				
4921519.82	583990.3232		15.24958725	1.851434475	16.99310671		6.957891672
4921518.003	583992.9996		15.28924449	3.234962856	16.8868973		24.5571914
4921516.22	583998.3286		18.19247911	5.619308477	19.55051604		39.70076623
4921516.254	584000.9812		20.49646229	2.652778165	20.67085978		12.68783941
4921512.586	584003.6815		21.59137761	4.555038259	23.32143908		46.24942905
4921512.603	584005.0078		22.87076908	1.326389849	22.89426827		3.888190429
4921510.718	584002.3791		19.86302825	3.234981069	22.9843892		12.68799907
4921503.261	583998.4958		15.84244577	8.407084807	22.05627941		64.05361364
4921503.261	583998.4958		15.84244577	0	15.84244577		0
4921497.69	583997.2412		16.74059714	5.710488421	19.14676566		45.22632016
4921490.234	583993.3578		19.25804229	8.407088333	22.20286388		70.19295157
4921486.48	583989.4267		20.99059856	5.43555845	22.84209965		51.36575951
4921484.509	583980.1666		22.12620032	9.467570011	26.29218444		98.84338306

4921484.474	583977.5141		22.65009751	2.652790872	23.71454435		29.05955311
4921486.223	583969.5325		24.2930308	8.170883199	27.55700576		92.4993898
4921486.172	583965.5536		26.74067615	3.979185083	27.50644602		39.90575061
4921495.325	583957.4766		27.82511825	12.20778547	33.38678994		161.6689671
4921508.319	583959.962		23.09200274	13.22876619	32.07294359		151.8456119
4921513.855	583958.5641		25.51141223	5.710474224	27.1569446		62.41640492
4921517.575	583959.8427		25.6695062	3.933267708	27.55709307		50.13767902
4921523.095	583957.1185		30.75087348	6.155270202	31.28782494		48.70535434
4921524.912	583954.4421		33.98494198	3.234960774	33.98538812		1.228031251
4921521.671	583990.2993		16.88519168	36.00336565	43.43674966		284.6586512

Polygon 21

Cent Long	Cent Lat	Av Radius	Est Area
4921586.386	583880.2403	65.82967697	14331.56587

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Area	Formula for Area
4921628.589	583809.8458		82.07562006				
4921628.606	583811.1721		80.9498996	1.326365184	82.17594242		28.58662675
4921626.891	583821.806		71.09992228	10.77122534	81.41052361		165.2641843
4921628.776	583824.4346		70.07990276	3.234940462	72.20738275		108.3241932
4921638.016	583822.9892		77.09270739	9.351701893	78.26215602		227.1671313
4921639.867	583822.9654		78.36200439	1.851434187	78.65307298		52.37860749
4921641.718	583822.9415		79.65411194	1.851434194	79.93377526		52.37860748
4921643.587	583824.2439		80.04668317	2.277514234	80.98915467		89.56010866
4921649.175	583826.8249		82.43529964	6.155271775	84.31862729		230.270914
4921651.043	583828.1274		83.04366932	2.277513392	83.87824117		90.78788711
4921652.946	583832.0823		82.15431106	4.388732714	84.79335655		177.4291919
4921654.814	583833.3847		82.93243533	2.277512989	83.68212969		88.33217056
4921654.865	583837.3634		80.79469672	3.979079918	83.85310598		137.3290181
4921658.653	583843.947		80.86844295	7.595540423	84.62934005		306.6262627

4921656.836	583846.6233	78.05940099	3.234915123	81.08137953	63.7310152
4921649.482	583850.6975	69.66974334	8.407004716	78.06807452	19.9033555
4921645.814	583853.3977	65.20857708	4.555005442	69.71666293	30.99827791
4921647.682	583854.7001	66.40399619	2.277513949	66.94504361	63.77540485
4921645.831	583854.7239	64.68963347	1.85143433	66.47253199	22.91027747
4921642.214	583861.4029	58.91994039	7.595518872	65.60254637	152.3660655
4921640.414	583865.4055	56.02716031	4.38872186	59.66791128	94.77397274
4921636.694	583864.1269	52.82537792	3.9332591	56.39289867	62.12885747
4921633.009	583865.5008	48.89679835	3.933246465	52.82771137	4.867504596
4921623.855	583873.5776	38.05629186	12.2076741	49.58038216	120.8179406
4921623.889	583876.2301	37.71650273	2.652732983	39.21276379	49.80675376
4921624.009	583885.5139	37.99018486	9.284565555	42.49562657	174.3236553
4921625.928	583890.7951	40.92647924	5.619241339	42.26795272	94.28326489
4921629.682	583894.7262	45.65494875	5.435494947	46.00846147	57.91036851
4921631.585	583898.6811	48.81560468	4.388745606	49.42964952	71.83541777
4921627.968	583905.3601	48.57998801	7.595532681	52.49556268	184.2908614
4921626.185	583910.6889	50.1103003	5.619222126	52.15475522	133.1839693
4921626.202	583912.0152	50.94043604	1.326366213	51.18855128	26.13116182
4921624.368	583913.3653	50.39699176	2.277505693	51.80746675	56.01832326
4921620.699	583916.0655	49.60682108	4.555012051	52.27941245	112.0366754
4921618.848	583916.0894	48.36246444	1.851434483	49.91036	33.57070032
4921616.997	583916.1133	47.15797764	1.85143448	48.68593828	33.57070014
4921613.38	583922.7923	50.3916686	7.595546078	52.57259616	167.1012691
4921609.711	583925.4925	50.90998942	4.55501472	52.92833637	114.4924328
4921606.043	583928.1928	51.8249981	4.555015607	53.64500156	114.4924428
4921602.426	583934.8718	56.9374862	7.595556112	58.17902021	152.3670839
4921600.66	583941.527	62.92699726	6.885434553	63.37495901	101.6063786
4921596.975	583942.901	63.54904592	3.933249426	65.20464631	122.7409059
4921589.57	583942.9965	62.83687737	7.405738032	66.89583066	232.5106043
4921580.313	583943.1158	63.16814445	9.257172419	67.63109712	290.6382514
4921578.462	583943.1397	63.39660552	1.851434468	64.20809221	58.12764984
4921569.257	583947.2378	69.15264172	10.07612742	71.31268733	273.2595767
4921563.771	583952.6145	75.82518892	7.681045759	76.3294382	137.7048313
4921554.515	583952.7338	79.19024404	9.257172222	82.13630259	333.6129139
4921552.664	583952.7577	79.97492545	1.851434429	80.50830196	66.72258256
4921550.881	583958.0867	85.56105325	5.619280989	85.57762984	25.20917004

4921524.912	583954.4421	96.35887849	26.2237555	104.0718436	1075.508296
4921524.912	583954.4421	96.35887849	0	96.35887849	0
4921524.826	583947.8107	91.40794172	6.631935319	97.19937776	207.0044102
4921524.706	583938.5267	84.86295726	9.284709293	92.77780413	289.8057904
4921520.918	583931.9431	83.42203988	7.595661719	87.94032943	313.4365323
4921519.033	583929.3144	83.33521724	3.234977496	84.99611731	134.7900422
4921520.816	583923.9854	78.82347786	5.619304838	83.88899997	135.7160282
4921524.45	583918.6326	72.87038052	6.469921708	79.08189005	96.00584993
4921524.416	583915.98	71.53803779	2.652773942	73.53059613	82.80139268
4921524.399	583914.6538	70.89970349	1.326386966	71.88206412	41.40068908
4921526.113	583904.0197	64.79448709	10.77139376	73.23279217	300.0902485
4921527.947	583902.6695	62.59550791	2.277517055	64.83375603	18.88054783
4921531.616	583899.9693	58.21566987	4.555033447	62.68310561	37.76102087
4921538.952	583894.5688	49.55085625	9.110064237	58.43829518	75.52176355
4921540.735	583889.2398	46.52969172	5.619288793	50.84991838	113.6134307
4921540.684	583885.261	45.97730914	3.979150485	48.24307567	91.04946155
4921536.862	583876.0248	49.70365289	9.995849123	52.83840558	220.6535629
4921538.679	583873.3484	48.20270544	3.234955315	50.57065682	70.10365005
4921536.725	583865.4146	51.82706914	8.170836164	54.10030537	182.5179199
4921534.84	583862.7859	54.42171929	3.234971508	54.74187997	51.29579651
4921534.788	583858.8071	55.87251844	3.979153661	57.1366957	102.1003009
4921534.72	583853.502	58.17517737	5.305538164	59.67661699	136.1337751
4921532.869	583853.5258	59.81473044	1.851433994	59.9206709	25.36596829
4921536.52	583849.4993	58.58037769	5.435507587	61.91530786	156.515846
4921542.023	583845.449	56.37889432	6.83254587	60.89590894	185.5652534
4921543.823	583841.4463	57.59031844	4.388775922	59.17899434	120.0990943
4921540.069	583837.5152	63.01390257	5.435532095	63.01987655	10.84939013
4921536.349	583836.2366	66.63369162	3.933265186	66.79042969	49.85033222
4921536.212	583825.6264	74.16263164	10.61107276	75.70369801	262.4453663
4921537.978	583818.9712	78.08481045	6.885494612	79.56646835	215.1792992
4921537.944	583816.3186	80.20361894	2.652767363	80.47059837	63.15576479
4921541.595	583812.2921	81.38284891	5.435504712	83.51098628	214.225018
4921543.344	583804.3107	87.28069836	8.170809946	88.41717861	238.1624707
4921545.11	583797.6555	92.32532938	6.885487054	93.2457574	210.2683104
4921628.589	583809.8458	82.07562006	84.36378793	129.3823687	3195.437722

Polygon 22

					Est Area	
					5687.893599	
		Cent Long	Cent Lat	Av Radius		
		4921585.785	583765.168	42.54155955		
						Heron's Formula for Area
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area
4921545.11	583797.6555		52.05672379			
4921537.62	583791.1194		54.71200721	9.941212538	58.35497177	254.6013404
4921541.1	583773.8302		45.51686152	17.63607066	58.93246969	371.2091027
4921544.735	583768.4775		41.18392634	6.469904961	46.58534641	103.8528985
4921548.386	583764.451		37.40625725	5.4355009	42.01284225	76.60231251
4921548.369	583763.1248		37.47220151	1.326381271	38.10242001	24.79474954
4921550.203	583761.7747		35.74367973	2.277513605	37.74669742	27.13160046
4921550.203	583761.7747		35.74367973	0	35.74367973	0
4921555.757	583761.7032		30.22762826	5.554301113	35.76280455	10.69411321
4921559.442	583760.3293		26.78360627	3.933250426	30.47224248	27.01271172
4921561.277	583758.9792		25.2779919	2.2775123	27.16955524	22.2201465
4921564.928	583754.9528		23.22452648	5.435493409	26.96900589	60.64000551
4921566.745	583752.2765		22.99392612	3.234944675	24.72669864	37.19200809
4921562.906	583741.7139		32.76513721	11.23856898	33.49881616	75.81035043
4921561.038	583740.4115		35.00471366	2.277523097	35.02368698	7.010479352
4921557.216	583731.1752		44.40420025	9.995816731	44.70236532	66.97807101
4921620.125	583727.7132		50.81416108	63.00460209	79.11148171	1118.686565
4921620.176	583731.692		47.99354178	3.979099414	51.39340114	69.27365915
4921620.227	583735.6708		45.34697091	3.979099446	48.65980607	69.27369987
4921622.113	583738.2995		45.18416624	3.234941726	46.88303944	73.07626097
4921622.164	583742.2782		42.98086144	3.979098368	46.07206303	72.95725617
4921622.215	583746.257		41.04590901	3.979098402	44.00293443	72.95728404
4921624.271	583762.1483		38.60433514	16.023721	47.83698257	308.9003001
4921626.242	583771.4082		40.93525723	9.467366476	44.50347942	181.1654581

4921626.362	583780.692		43.44461276	9.284558266	46.83221413	187.423432
4921628.315	583788.6257		48.5702749	8.170726802	50.09280723	145.7955329
4921630.201	583791.2544		51.50958627	3.234939623	51.6574004	33.78506929
4921639.594	583801.7453		65.06347658	14.08146437	65.32726361	110.4639609
4921628.589	583809.8458		61.87269409	13.66502409	70.30059738	419.2086406
4921628.606	583811.1721		62.84870758	1.326365184	63.02388343	28.00250731
4921545.11	583797.6555		52.05672379	84.58247147	99.74395142	1631.174083

Polygon 23

Cent Long	Cent Lat	Av Radius	Est Area
4921590.297	583703.9254	26.04879649	2101.388746

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921604.735	583682.8109		25.57903972			
4921606.637	583686.7658		23.69534173	4.388755946	26.8315687	48.63616343
4921610.391	583690.697		24.0577718	5.435500012	26.59430677	64.32530283
4921612.276	583693.3257		24.40216675	3.234944499	25.84744152	38.88165111
4921614.281	583705.2383		24.02053654	12.08004093	30.25137211	141.5427048
4921616.201	583710.5195		26.73026461	5.619244918	28.18502304	62.07411311
4921618.086	583713.1482		29.28001442	3.234942786	29.62261091	27.83099755
4921620.125	583727.7132		38.15233527	14.70704413	41.06969691	192.9751968
4921557.216	583731.1752		42.85907828	63.00460209	72.00800782	799.8726308
4921562.616	583719.1674		31.59961768	13.16629389	43.81249492	125.0367499
4921564.467	583719.1436		29.97913854	1.851433573	31.71509489	13.77913913
4921569.936	583712.4408		22.06978365	8.650536871	30.34972953	44.9531757
4921568.067	583711.1384		23.37011257	2.277522094	23.85870915	21.21448428
4921571.651	583701.8069		18.76595804	9.995766054	26.06591833	90.7927266
4921571.633	583700.4806		18.97830128	1.326376198	19.53531776	12.34671247
4921575.302	583697.7805		16.20487161	4.555020813	19.86909685	31.51480092
4921576.983	583684.494		23.55496456	13.39233654	26.57608635	104.7765079

4921604.735	583682.8109		25.57903972	27.80315185	38.46857806		280.8356891

Polygon 24

			Est Area
			1959.54215
Cent Long	Cent Lat	Av Radius	
4921585.969	583651.8532	23.25106224	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Area	Formula for Area
4921576.983	583684.494		33.85530865				
4921569.509	583679.2842		31.99035534	9.110085659	37.47787483		145.3772418
4921563.751	583663.4403		25.05817497	16.85784442	36.95318737		209.3731084
4921565.585	583662.0903		22.8102129	2.277511208	25.07294954		4.371204393
4921567.419	583660.7402		20.56875325	2.277510986	22.82823857		4.371195369
4921576.625	583656.6425		10.50035258	10.07612111	20.57261347		2.897585128
4921580.259	583651.2898		5.737877082	6.469878807	11.35405423		16.30589233
4921580.225	583648.6373		6.583180564	2.652748345	7.486902995		7.563573403
4921580.191	583645.9848		8.235741273	2.65274833	8.735835084		7.563575143
4921576.454	583643.3798		12.74100077	4.555041186	12.76589162		3.437919967
4921572.717	583640.7748		17.27239432	4.55504202	17.28421856		3.437900791
4921574.466	583632.7935		22.261696	8.170767431	23.85242887		62.57128257
4921576.267	583628.7909		25.02013655	4.388754575	25.83529356		40.17526633
4921578.05	583623.4621		29.47494692	5.619254448	30.05716896		46.41280324
4921578.05	583623.4621		29.47494692	0	29.47494692		0
4921602.202	583629.7842		27.3958391	24.96562239	40.91820421		317.8153969
4921605.938	583632.3892		27.88571644	4.555035029	29.91829528		62.37441382
4921605.955	583633.7155		26.98934132	1.326368847	28.1007133		13.40799625
4921607.892	583640.323		24.76993908	6.88543956	29.32235998		83.5913607
4921607.977	583646.9543		22.54656601	6.631842493	26.97417379		73.17924538
4921606.262	583657.5881		21.08781501	10.77125142	27.20281622		112.8139548
4921608.216	583665.5219		26.1102348	8.17074674	27.68439827		74.89817867
4921606.518	583677.482		32.84949198	12.08003148	35.51987913		144.6394797

4921604.735	583682.8109		36.2012254	5.619233732	37.33497556		77.59945794
4921576.983	583684.494		33.85530865	27.80315185	48.92984295		445.3641171

Polygon 25

					Est Area		
					1008.061074		
		Cent Long	Cent Lat	Av Radius			
		4921581.237	583607.3559	17.37375013			
						Heron's Formula for Area	
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	
4921579.441	583587.6291		19.8084147				
4921581.36	583592.9104		14.44602512	5.619269147	19.93685449		14.18835256
4921586.982	583598.1442		10.85640831	7.681067278	16.49175035		40.92813519
4921596.239	583598.0253		17.66642832	9.257165998	18.89000131		42.29245695
4921598.175	583604.6329		17.15537457	6.885448124	20.85362551		58.5953713
4921603.814	583611.1928		22.90062828	8.650551458	24.35327715		63.23383713
4921603.9	583617.8241		24.96306241	6.631845866	27.24776828		74.693673
4921602.202	583629.7842		30.70060789	12.08003701	33.87185365		144.4077633
4921578.05	583623.4621		16.41854545	24.96562239	36.04238787		204.572984
4921576.13	583618.1808		11.96911875	5.61927235	17.00346828		23.87486391
4921574.262	583616.8783		11.80388926	2.277520786	13.0252644		13.43811543
4921572.394	583615.5758		12.07385539	2.277520994	13.07763282		13.43811677
4921570.508	583612.947		12.09851672	3.234956896	13.70366451		19.3727278
4921568.64	583611.6445		13.30741255	2.277521408	13.84172534		12.21027516
4921563.035	583607.7371		18.20636636	6.832565474	19.1731722		36.6308507
4921562.933	583599.7794		19.81063568	7.958264638	22.98763334		72.4431698
4921564.767	583598.4294		18.73379788	2.277510915	20.41097224		19.3045065
4921579.441	583587.6291		19.8084147	18.22007933	28.38114596		154.4358746

Polygon 26

Est Area

					345.025401	
		Cent Long	Cent Lat	Av Radius		
		4921566.867	583584.5254	11.08680773		

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921564.767	583598.4294		14.06178327			
4921562.831	583591.8218		8.338702241	6.885480698	14.64298311	20.40122555
4921562.831	583591.8218		8.338702241	0	8.338702241	0
4921555.374	583587.9381		11.98896899	8.407061594	14.36736641	35.04092629
4921559.026	583583.9118		7.86548905	5.435493164	12.6449756	16.90658032
4921559.026	583583.9118		7.86548905	0	7.86548905	0
4921566.38	583579.8379		4.712747227	8.407024421	10.49263035	18.22886199
4921568.197	583577.1616		7.482859784	3.234942291	7.715274651	4.911410741
4921571.814	583570.4827		14.88856485	7.595576835	14.98350074	8.878349557
4921575.5	583569.109		17.66886042	3.93324772	18.2453365	22.47910378
4921579.322	583578.3453		13.90346976	9.995786433	20.78405831	69.3260939
4921579.441	583587.6291		12.95108038	9.284617925	18.06958403	58.18100521
4921564.767	583598.4294		14.06178327	18.22007933	22.61647149	90.67184363

Polygon 27

					Est Area	
					1090.711152	
		Cent Long	Cent Lat	Av Radius		
		4921748.172	583984.7245	20.59374257		

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921747.065	583951.5775		33.16548584			
4921745.231	583952.9276		31.93261785	2.277491888	33.68779779	31.14570719
4921739.712	583955.6517		30.27884319	6.155232905	34.18334697	91.75902049
4921736.095	583962.3306		25.44311374	7.595438387	31.65869766	80.83163384

4921734.243	583962.3544	26.35200198	1.851434996	26.82327536	20.87289099
4921736.112	583963.6568	24.27547699	2.277504354	26.45249166	11.82790526
4921738.014	583967.6116	19.90047891	4.388687903	24.2823219	3.806400014
4921738.014	583967.6116	19.90047891	0	19.90047891	0
4921741.802	583974.195	12.3061348	7.595470292	19.901042	1.023384644
4921741.871	583979.5	8.185346487	5.305372053	12.89842667	16.5347233
4921741.922	583983.4787	6.372752213	3.979029079	9.268563889	12.40103507
4921743.859	583990.0859	6.880890157	6.885315733	10.06947905	19.44057534
4921743.876	583991.4122	7.948539059	1.326342675	8.077885945	2.905859997
4921740.242	583996.7649	14.41715993	6.46977744	14.41773822	0.654744582
4921740.242	583996.7649	14.41715993	0	14.41715993	0
4921742.179	584003.3722	19.58703844	6.885317738	20.44475805	37.85791445
4921745.967	584009.9555	25.32721115	7.595467579	26.25485858	55.04742221
4921747.836	584011.2579	26.53553127	2.27750329	27.07012286	25.00662454
4921749.687	584011.234	26.55275306	1.851435222	27.46985978	24.55636992
4921753.424	584013.8387	29.58404204	4.555005522	30.34590031	47.55762555
4921757.126	584013.7909	30.41436309	3.702870503	31.85063782	54.0240128
4921760.76	584008.4382	26.84780131	6.469766588	31.86596549	76.77930437
4921762.526	584001.7832	22.29426466	6.885279441	28.0136727	62.82306567
4921762.475	583997.8045	19.38169832	3.979016785	22.82748988	28.11687241
4921762.457	583996.4783	18.49934078	1.326338921	19.60368901	9.372294342
4921758.669	583989.8949	11.70156536	7.595452595	18.89817937	24.76077813
4921760.418	583981.9136	12.56435811	8.170557432	16.21824045	46.41132883
4921762.235	583979.2373	15.09556471	3.234882171	15.4474025	13.83334737
4921764.035	583975.2347	18.48477899	4.388656357	18.98450003	23.20562994
4921747.065	583951.5775	33.16548584	29.11409611	40.38218047	268.1546809

Polygon 28

			Est Area
			8159.093409
Cent Long	Cent Lat	Av Radius	
4921768.938	583921.9605	46.97451356	

						Heron's Formula for Area
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area
4921764.035	583975.2347		53.49941238			
4921765.869	583973.8846		52.01476073	2.277489839	53.89583147	45.54696648
4921771.44	583975.1392		53.23754328	5.710477739	55.48139087	146.5588021
4921775.211	583980.3964		58.77158855	6.469787639	59.23945973	93.69272369
4921777.097	583983.0249		61.60701897	3.234892923	61.80675022	46.84641659
4921784.467	583980.2769		60.34872132	7.866476567	64.91110843	236.2592755
4921788.067	583972.2718		53.82524974	8.777287112	61.47562909	167.1227749
4921789.884	583969.5955		52.03691283	3.234872875	54.54851773	71.30716813
4921791.719	583968.2454		51.58721553	2.277486801	52.95080758	57.82508746
4921793.553	583966.8953		51.23490302	2.27748658	52.54980256	57.82508534
4921800.855	583958.8425		48.77475864	10.87078617	55.44022391	263.1757511
4921800.804	583954.8638		45.80448463	3.978992674	49.27911797	62.54688524
4921800.787	583953.5376		44.84914015	1.326330884	45.98997783	20.84897063
4921800.735	583949.559		42.10390716	3.97899263	45.46601997	62.54693752
4921802.57	583948.2089		42.66202304	2.277485415	43.52170781	46.77477699
4921806.135	583937.5514		40.3323703	11.23817337	47.11628336	226.0102964
4921804.284	583937.5752		38.64126768	1.85143511	40.41253655	14.87547299
4921807.867	583928.244		39.43249926	9.995462243	44.03461459	192.8831967
4921809.65	583922.9152		40.72271255	5.619082932	42.88714737	109.3216464
4921809.581	583917.6103		40.87525024	5.305315621	43.4516392	107.9520946
4921813.198	583910.9315		45.61359648	7.595372051	47.04210938	127.8565662
4921823.554	583852.4349		88.41201529	59.40619103	96.7159014	1237.430503
4921795.733	583848.8139		77.89999411	28.05514022	97.18357481	1065.999604
4921771.598	583843.8189		78.18681367	24.64645741	90.3666326	949.6170519
4921762.376	583846.5906		75.65500015	9.629729206	81.73577151	356.6331175
4921762.376	583846.5906		75.65500015	0	75.65500015	0
4921756.857	583849.3146		73.64369151	6.155228466	77.72696006	216.9458017
4921749.52	583854.7149		69.99319469	9.109961819	76.37342401	299.1155073
4921745.851	583857.415		68.55010725	4.554982239	71.54914209	149.5577417
4921745.903	583861.3937		64.79945475	3.979024681	68.66429334	44.27315297
4921745.988	583868.0249		58.61532721	6.631707874	65.02324492	73.78842462
4921746.056	583873.3298		53.74492265	5.305366365	58.83280812	59.03060846
4921742.456	583881.3349		48.49454472	8.77733037	55.50839887	179.1205337
4921738.839	583888.0138		45.36870424	7.595433951	50.72934146	161.9072277

4921740.742	583891.9686		41.16481248	4.388685162	45.46110094	27.22513504
4921740.862	583901.2522		34.88733453	9.284399555	42.66827328	129.0871321
4921742.764	583905.2071		31.07660579	4.38868426	35.17631229	35.81969318
4921744.684	583910.4881		26.8307131	5.619150536	31.76323471	53.0328081
4921744.684	583910.4881		26.8307131	0	26.8307131	0
4921746.604	583915.7692		23.17689481	5.619149176	27.81337854	53.03274661
4921746.621	583917.0954		22.84166441	1.326341717	23.67245047	14.75752005
4921746.655	583919.7479		22.39292413	2.652683444	23.94363599	29.51503814
4921748.609	583927.6814		21.11908718	8.170588202	25.84129976	86.23116349
4921748.626	583929.0077		21.50009811	1.326341372	21.97276333	13.52969907
4921744.957	583931.7079		25.88600753	4.554983357	25.9705445	14.4978645
4921746.826	583933.0102		24.71945202	2.277502917	26.44148123	24.72174475
4921745.077	583940.9915		30.52088783	8.170572029	31.70545594	78.58098393
4921746.963	583943.6201		30.85545864	3.234902501	32.30562448	49.30181267
4921747.031	583948.925		34.74196042	5.305367192	35.45139312	59.03019326
4921747.065	583951.5775		36.8182859	2.652683619	37.10646497	29.51511852
4921747.065	583951.5775		36.8182859	0	36.8182859	0
4921764.035	583975.2347		53.49941238	29.11409611	59.7158972	510.0185858

Polygon 29

Cent Long	Cent Lat	Av Radius	Est Area
4921839.49	583912.6652	29.69513797	3695.677217

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921813.198	583910.9315		26.3489313			
4921820.655	583914.8147		18.95766189	8.406996522	26.85679486	44.58472983
4921824.409	583918.7457		16.26113632	5.435409037	20.32710362	41.05476129
4921826.397	583929.3315		21.19442088	10.7709316	24.1132444	85.86979696
4921826.551	583941.2675		31.392963	11.93692997	32.26215693	79.4240704
4921841.344	583939.7503		27.14842151	14.87074043	36.70606247	201.7427933

4921843.161	583937.074		24.68324098	3.234854816	27.53325865	27.08818765
4921848.612	583929.0451		18.74862697	9.704560649	26.5682143	81.26462587
4921850.446	583927.695		18.5992527	2.277479725	19.8126797	21.17948385
4921855.949	583923.6448		19.7848145	6.832437848	22.60825253	63.53843942
4921855.949	583923.6448		19.7848145	0	19.7848145	0
4921863.354	583923.5494		26.22869541	7.40574086	26.70962539	41.4382242
4921873.675	583862.4007		60.7876238	62.0135794	74.51494931	785.7877079
4921851.391	583857.3821		56.5497055	22.84189074	70.08961002	645.8220863
4921823.554	583852.4349		62.30296691	28.27375365	73.56321303	798.9135435
4921813.198	583910.9315		26.3489313	59.40619103	74.02904462	777.9687668

Polygon 30

Cent Long	Cent Lat	Av Radius	Est Area
4921903.451	583921.9473	32.51794702	4272.896152

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
4921863.354	583923.5494		40.12916008			
4921870.845	583930.0849		33.60665175	9.940998003	41.83840491	137.0293371
4921874.633	583936.6682		32.36060955	7.595351542	36.78130642	122.7422676
4921878.472	583947.2301		35.54116916	11.23809847	39.56993859	180.44868
4921880.426	583955.1635		40.41623285	8.170432286	42.06391715	123.7842159
4921882.363	583961.7706		45.06234518	6.885179228	46.18187863	108.2321663
4921884.266	583965.7254		47.79760331	4.388607033	48.62427776	79.58349282
4921887.968	583965.6776		46.39039681	3.702870905	48.94543551	80.58749387
4921889.785	583963.0013		43.26888394	3.234839601	46.44706018	19.01177108
4921891.517	583953.694		33.9159278	9.466984053	43.3258979	28.05401409
4921893.214	583941.7343		22.27844179	12.07952867	34.13694913	44.42442552
4921896.865	583937.708		17.0814458	5.435349324	22.39761846	15.51450986
4921904.202	583932.3077		10.3876348	9.109895355	18.28948798	40.03298779
4921907.853	583928.2814		7.713555361	5.435344296	11.76826723	20.42572104

4921911.556	583928.2337		10.25684551	3.702870758	10.83663582	11.8313336
4921917.161	583932.1407		17.08396475	6.83244997	17.08663012	1.78591519
4921920.829	583929.4405		18.92476332	4.554943332	20.2818357	37.2054927
4921922.663	583928.0905		20.17051649	2.277471334	20.68637557	18.60273816
4921922.663	583928.0905		20.17051649	0	20.17051649	0
4921926.315	583924.0641		22.96129781	5.435336042	24.28357517	49.89251989
4921920.675	583917.5048		17.78783614	8.650310292	24.69972212	69.01631549
4921918.704	583908.2452		20.5037543	9.466960487	23.87927546	84.12165804
4921918.687	583906.9191		21.40057195	1.32630662	21.61531644	10.23149528
4921922.356	583904.2189		25.91660677	4.554942668	25.93606069	6.994922096
4921924.19	583902.8689		28.1793208	2.277471002	28.18669929	3.497475307
4921929.641	583894.8401		37.69223574	9.704478742	37.78801764	31.25193776
4921927.704	583888.233		41.53145921	6.885131087	43.05441302	112.7697789
4921931.338	583882.8805		47.99904861	6.469650472	48.00007915	3.645369417
4921931.27	583877.5758		52.37098934	5.305215624	52.83762679	75.3035151
4921927.516	583873.6449		53.9652292	5.435360961	55.88578975	137.9581823
4921897.827	583868.7217		53.52183473	30.09430202	68.79068297	776.2598471
4921873.675	583862.4007		66.57624213	24.96556638	72.53182162	624.9808276
4921863.354	583923.5494		40.12916008	62.0135794	84.35949081	1217.675745

Polygon 31

			Est Area
			121.5
Cent Long	Cent Lat	Av Radius	
418167.2857	4921441.714	7.420626113	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
418161	4921445		7.092680907			
418170	4921444		3.548497814	9.055385138	9.848281929	11.64285714
418174	4921444		7.092680907	4	7.32058936	4.571428571
418178	4921441		10.73806884	5	11.41537487	14.64285714
418169	4921436		5.965889434	10.29563014	13.49979421	30

418158	4921437		10.41388398	11.04536102	13.71256722	30.57142857
418161	4921445		7.092680907	8.544003745	13.02528432	30.07142857

Polygon 32

Cent Long	Cent Lat	Av Radius	Est Area
418081	4921431.582	51.97272852	6978.890909

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
418158	4921437		77.1903925			
418148	4921431		67.00252616	11.66190379	77.92741123	203.9090909
418134	4921419		54.47294878	18.43908891	69.95728193	406.0727273
418120	4921407		46.10060504	18.43908891	59.50632137	406.0727273
418103	4921404		35.28110959	17.2626765	49.32219557	267.4454545
418088	4921392		40.19602382	19.20937271	47.34325306	338.8636364
418083	4921389		42.62876071	5.830951895	44.32786821	109.4545455
418065	4921385		49.25307894	18.43908891	55.16046428	387.2363636
418049	4921382		59.01149629	16.2788206	62.27169791	348.6545455
418033	4921380		70.46051353	16.1245155	72.79826266	364.6545455
418021	4921373		83.85600409	13.89244399	84.1044808	141.4909091
418017	4921372		87.44136926	4.123105626	87.71023949	87.16363636
418013	4921385		82.42490998	13.60147051	91.73387487	535.1636364
418015	4921387		79.64633395	2.828427125	82.44983553	21.41818182
418018	4921388		76.60531885	3.16227766	79.70696523	33.87272727
418029	4921401		60.32617677	17.02938637	76.98044099	169.8
418032	4921406		55.2759389	5.830951895	60.71653378	84.12727273
418032	4921406		55.2759389	0	55.2759389	0
418037	4921413		47.76278852	8.602325267	55.82052634	107.5454545
418038	4921425		43.50080839	12.04159458	51.65259574	254.7090909
418040	4921428		41.15615897	3.605551275	44.13125932	57.91818182
418041	4921434		40.07302838	6.08276253	43.65597494	121.2090909

418035	4921443	47.39593734	10.81665383	49.14280977	172.7454545
418032	4921448	51.67742925	5.830951895	52.45215924	97.87272727
418029	4921454	56.62662692	6.708203932	57.50613005	122.3727273
418030	4921456	56.54420928	2.236067977	57.70345209	63.20909091
418031	4921460	57.51167758	4.123105626	59.08949624	114.2090909
418035	4921464	56.27555875	5.656854249	59.72204529	156.8363636
418042	4921462	49.45973903	7.280109889	56.50770383	67.46363636
418048	4921456	41.05176736	8.485281374	49.49839388	25.74545455
418055	4921457	36.36047259	7.071067812	42.24165388	101.9636364
418062	4921455	30.15644607	7.280109889	36.89851428	62.96363636
418067	4921453	25.58785869	5.385164807	30.56473478	39.54545454
418071	4921450	20.95780097	5	25.77282983	21.83636364
418076	4921449	18.12161852	5.099019514	22.0892195	41.04545454
418083	4921451	19.52090636	7.280109889	22.46131739	65.96363636
418087	4921455	24.17459906	5.656854249	24.67617983	34.83636364
418094	4921451	23.36805052	8.062257748	27.80245366	93.96363636
418098	4921450	25.06450521	4.123105626	26.27783068	45.33636364
418107	4921452	33.0590706	9.219544457	33.67156013	65.88181818
418113	4921455	39.65364094	6.708203932	39.71045773	22.25454545
418117	4921456	43.49997245	4.123105626	43.63835951	30.83636364
418121	4921455	46.35095727	4.123105626	46.98701767	66.83636364
418125	4921452	48.50672272	5	49.92883999	106.8363636
418128	4921450	50.47999031	3.605551275	51.29613215	74.62727273
418128	4921448	49.78510514	2	51.13254773	47
418129	4921445	49.84022074	3.16227766	51.39380177	78.70909091
418136	4921445	56.61313985	7	56.72668029	46.96363636
418142	4921446	62.6808102	6.08276253	62.68835629	12.75454545
418144	4921447	64.85923474	2.236067977	64.88805646	16.08181818
418147	4921447	67.77698968	3	67.81811221	23.12727273
418153	4921450	74.31843258	6.708203932	74.4018131	52.74545455
418157	4921449	77.97046273	4.123105626	78.20600047	72.83636364
418161	4921445	81.11749259	5.656854249	82.37240478	186.8363636
418158	4921437	77.1903925	8.544003745	83.42594441	299.8727273

Polygon 33

					Est Area
					434.5
		Cent Long	Cent Lat	Av Radius	
		418003.9	4921378.2	13.3057503	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
418017	4921372		14.49310181			
418009	4921371		8.823264702	8.062257748	15.68931213	31.35
417994	4921366		15.71146079	15.8113883	20.17305689	66.75
417992	4921370		14.45164351	4.472135955	17.31762012	32
417995	4921373		10.30776406	4.242640687	14.50102413	5.55
417994	4921389		14.65093854	16.03121954	20.49496107	73.8
418000	4921394		16.27421273	7.810249676	19.36770047	57.15
418008	4921390		12.49199744	8.94427191	18.85524104	55.4
418013	4921385		11.36001761	7.071067812	15.46154143	39.75
418017	4921372		14.49310181	13.60147051	19.72729496	72.75

Polygon 34

					Est Area
					14726.46667
		Cent Long	Cent Lat	Av Radius	
		417611.5167	4921333.767	75.43730469	

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
417708	4921300		102.2214331			
417699	4921296		95.28722224	9.848857802	103.6787566	344.9166667
417690	4921289		90.35312975	11.40175425	98.52105312	476.1416667
417689	4921289		89.48587257	1	90.41950116	22.38333333
417683	4921278		90.6630468	12.52996409	96.33944173	560.4583333

417680	4921269	94.25862324	9.486832981	97.20425151	405.325
417671	4921266	90.16977351	9.486832981	96.95761487	394.175
417667	4921266	87.58265461	4	90.87621406	135.5333333
417655	4921266	80.51783274	12	90.05024368	406.6
417647	4921264	78.27167254	8.246211251	83.51785826	314.55
417638	4921257	81.20645329	11.40175425	85.43994004	438.1416667
417618	4921262	72.05892072	20.61552813	86.94045107	701.4583333
417618	4921264	70.06726332	2	72.06309202	6.483333333
417617	4921270	64.00198999	6.08276253	70.07600792	15.43333333
417613	4921277	56.78604338	8.062257748	64.42514555	108.3416667
417608	4921275	58.87179338	5.385164807	60.52150078	143.4
417601	4921279	55.76726688	8.062257748	61.350659	212.7166667
417596	4921288	48.32550799	10.29563014	57.19420251	184.2416667
417589	4921290	49.21911609	7.280109889	52.41236698	175.7
417588	4921297	43.64425952	7.071067812	49.96722171	100.6916667
417582	4921309	38.53078495	13.41640786	47.79572617	251.4
417571	4921317	43.84884706	13.60147051	47.99055126	254.2833333
417568	4921323	44.82880089	6.708203932	47.69292594	146.7
417566	4921334	45.51726473	11.18033989	50.76320275	250.1083333
417555	4921336	56.56077606	11.18033989	56.62919034	44.23333333
417544	4921341	67.90302931	12.08304597	68.27342567	129.0083333
417534	4921353	79.86710663	15.62049935	81.69531765	368.9333333
417526	4921364	90.70366433	13.60147051	92.08612073	349.4083333
417524	4921370	94.72075479	6.32455532	95.87448722	226.3166667
417520	4921373	99.57185708	5	99.64630594	58.80833333
417520	4921374	99.97010248	1	100.2709798	45.75833333
417519	4921375	101.2892955	1.414213562	101.3368058	25.64166667
417519	4921375	101.2892955	0	101.2892955	0
417519	4921377	102.1198057	2	102.7045506	92.51666667
417519	4921378	102.5471667	1	102.8334862	46.25833333
417519	4921381	103.8764718	3	104.7118192	138.775
417525	4921381	98.57038799	6	104.2234299	141.7
417528	4921382	96.44422251	3.16227766	99.08844408	114.1083333
417539	4921379	85.46766283	11.40175425	96.65681979	140.0083333
417549	4921374	74.34416401	11.18033989	85.49608336	44.875
417562	4921370	61.3575971	13.60147051	74.65161581	136.4833333

417567	4921369		56.7725408	5.099019514	61.61457871	65.825
417578	4921367		47.19980285	11.18033989	57.57634177	149.2666667
417591	4921366		38.20891766	13.03840481	49.22356266	199.2583333
417601	4921364		32.0102284	10.19803903	40.20859254	140.65
417611	4921363		29.23789873	10.04987562	35.64900138	145.9083333
417626	4921364		33.52344536	15.03329638	38.89732024	219.5083333
417641	4921364		42.22939011	15	45.37641773	226.75
417654	4921366		53.32749187	13.15294644	54.35491421	167.0333333
417656	4921368		56.13099015	2.828427125	56.14345457	10.25
417658	4921368		57.72886097	2	57.92992556	34.23333333
417669	4921373		69.59589108	12.08304597	69.70389901	72.075
417680	4921378		81.52640506	12.08304597	81.60267106	72.075
417692	4921381		93.31963739	12.36931688	93.60767966	162.675
417703	4921378		101.6158849	11.40175425	103.1686382	380.5083333
417714	4921371		109.0374006	13.03840481	111.8458451	563.475
417715	4921370		109.6433068	1.414213562	110.0474605	69.85833333
417719	4921358		110.1813114	12.64911064	116.2368644	693.3666667
417725	4921350		114.6385104	10	117.4099109	502.6333333
417708	4921300		102.2214331	52.81098371	134.8354636	2699.1

Polygon 35

					Est Area	
					12757.70732	
		Cent Long	Cent Lat	Av Radius		
		417760.2927	4921294.805	65.51722264		
						Heron's Formula for Area
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area
417725	4921350		65.51392948			
417740	4921348		56.93429529	15.13274595	68.79048536	378.6707317
417742	4921348		56.25249548	2	57.59339538	53.19512195
417744	4921349		56.59118978	2.236067977	57.53987662	62.34146341
417748	4921349		55.57176708	4	58.08147843	108.3902439

417752	4921349	54.82590477	4	57.19883593	108.3902439
417760	4921348	53.19592713	8.062257748	58.04204482	212.6341463
417772	4921348	54.46817669	12	59.83205191	319.1707317
417781	4921349	58.0164134	9.055385138	60.76998762	233.5243902
417790	4921349	61.80320324	9	64.40980832	243.8780488
417802	4921350	69.18093512	12.04159458	71.51286647	310.3170732
417811	4921350	74.95154096	9	76.56623804	248.3780488
417823	4921349	82.8813541	12.04159458	84.93724482	356.5243902
417833	4921348	90.08926104	10.04987562	91.51024538	302.3292683
417845	4921345	98.46258088	12.36931688	100.4605794	428.2317073
417854	4921343	105.3747173	9.219544457	106.5284213	310.5853659
417864	4921340	113.1273913	10.44030651	114.4712076	381.5365854
417867	4921339	115.4974472	3.16227766	115.8935581	119.6463415
417777	4921223	73.72296084	146.8196172	168.0200127	4200.243902
417768	4921227	68.24151393	9.848857802	75.90666629	289.7073171
417766	4921227	68.04465413	2	69.14308403	67.80487805
417766	4921232	63.06366763	5	68.05416088	14.26829268
417767	4921241	54.22133348	9.055385138	63.17019312	57.08536585
417758	4921243	51.85558586	9.219544457	57.6482319	235.4146341
417750	4921241	54.78050952	8.246211251	57.44115332	204.9268293
417741	4921237	60.93940877	9.848857802	62.78438805	221.5365854
417736	4921235	64.55042899	5.385164807	65.43750128	125.2195122
417733	4921233	67.56281146	3.605551275	67.85939586	65.41463415
417724	4921231	73.40450461	9.219544457	75.09343026	250.8292683
417716	4921232	76.85242005	8.062257748	79.1595912	273.3658537
417715	4921233	76.62421339	1.414213562	77.4454235	53.54878049
417715	4921246	66.58335564	13	78.10378451	294.402439
417716	4921248	64.44019219	2.236067977	66.6298079	20.8902439
417723	4921258	52.39602321	12.20655562	64.52138551	57.64634146
417729	4921267	41.86099913	10.81665383	52.53683808	57.40243902
417727	4921275	38.73804243	8.246211251	44.4226264	152.9756098
417725	4921277	39.52957311	2.828427125	40.54802133	53.09756098
417719	4921284	42.68291289	9.219544457	45.71601523	176.9390244
417715	4921296	45.30844781	12.64911064	50.32023567	269.3658537
417708	4921300	52.55010923	8.062257748	52.96040739	86.40243902
417725	4921350	65.51392948	52.81098371	85.4375112	1351.47561

Polygon 36

Est Area
187348.8984

Cent Long	Cent Lat	Av Radius
417985.1673	4921059.733	240.8862059

LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Heron's Formula for Area Area
417883	4920749		327.0981547			
417882	4920753		323.6180974	4.123105626	327.4196789	359.7011952
417880	4920758		319.5356187	5.385164807	324.2694404	564.6513944
417879	4920759		318.9230003	1.414213562	319.9364163	203.4501992
417877	4920761		317.7131051	2.828427125	319.7322663	406.9003984
417869	4920772		310.2985127	13.60147051	320.8065442	1789.85259
417864	4920780		304.8476853	9.433981132	312.2900895	1184.001992
417861	4920782		304.2255461	3.605551275	306.3393913	540.7669323
417854	4920784		305.3417647	7.280109889	308.4237104	1096.233068
417847	4920792		301.2826029	10.63014581	308.6272567	1489.73506
417844	4920797		298.2564	5.830951895	302.6849774	747.0179283
417844	4920801		294.7388939	4	298.4976469	282.3346614
417839	4920805		293.690014	6.403124237	297.4160161	929.1673307
417841	4920813		285.7646338	8.246211251	293.8504296	329.936255
417843	4920818		280.4397011	5.385164807	285.7947499	113.685259
417843	4920827		272.7200593	9	281.0798802	639.752988
417844	4920832		267.9376147	5.099019514	272.8783468	239.0517928
417844	4920833		267.0881863	1	268.0129005	70.58366534
417839	4920843		261.415591	11.18033989	269.8420586	1272.669323
417834	4920851		257.7228267	9.433981132	264.2861994	1126.501992
417834	4920852		256.9135833	1	257.818205	75.58366534
417828	4920857		256.5195248	7.810249676	260.6216789	1001.11753
417827	4920864		251.6512235	7.071067812	257.620908	651.4521912
417830	4920865		248.9937111	3.16227766	251.9036061	214.5159363

417830	4920865	248.9937111	0	248.9937111	0
417832	4920876	239.202992	11.18033989	249.6885215	658.687251
417833	4920877	237.7945974	1.414213562	239.2059015	15.28286853
417835	4920878	235.7480331	2.236067977	237.8893493	106.6494024
417836	4920886	228.9848715	8.062257748	236.3975812	509.8027888
417830	4920898	224.1305104	13.41640786	233.2658949	1416.203187
417830	4920901	221.9754205	3	224.5529655	232.750996
417820	4920902	228.3855682	10.04987562	230.2054322	871.249004
417810	4920904	234.385115	10.19803903	236.4843611	953.8326693
417808	4920908	233.2620563	4.472135955	236.0596536	506.0677291
417805	4920909	234.9057785	3.16227766	235.6650562	316.1832669
417799	4920913	237.0419123	7.211102551	239.5793966	812.5338645
417792	4920914	241.9746777	7.071067812	243.0438289	606.6494024
417791	4920919	239.8056477	5.099019514	243.4396725	555.7848606
417795	4920926	232.4825737	8.062257748	240.1752395	398.1195219
417803	4920933	221.9148639	10.63014581	232.5137917	130.6533865
417806	4920937	217.1735212	5	222.0441925	174.2350598
417807	4920943	213.0028329	6.08276253	218.1295583	476.1354582
417806	4920949	210.6246535	6.08276253	214.8551245	592.8685259
417803	4920954	210.6286257	5.830951895	213.5421156	614.0179283
417818	4920971	189.2576914	22.6715681	211.2789426	755.4243028
417817	4920972	189.6769419	1.414213562	190.1744234	127.9501992
417815	4920979	188.3474148	7.280109889	192.6522333	676.3187251
417817	4920990	182.0520581	11.18033989	190.7899064	855.187251
417818	4921003	176.5320294	13.03840481	185.8112462	1058.221116
417818	4921004	176.2131984	1	176.8726139	83.58366534
417820	4921006	173.6879089	2.828427125	176.3647672	111.4342629
417818	4921022	171.3729875	16.1245155	180.5927059	1375.071713
417818	4921037	168.7059833	15	177.5394854	1253.75498
417813	4921043	172.9785689	7.810249676	174.747401	558.3346614
417809	4921051	176.3836582	8.94427191	179.1532495	722.1354582
417801	4921062	184.1812821	13.60147051	187.0832054	1003.85259
417796	4921069	189.394179	8.602325267	191.0888932	638.9183267
417794	4921070	191.4428328	2.236067977	191.5365399	85.31673307
417785	4921075	200.7486974	10.29563014	201.2435801	431.7171315
417780	4921085	206.7173226	11.18033989	209.3231799	962.6693227

417780	4921096	208.3480836	11	213.0327031	1128.420319
417765	4921109	225.6122428	19.84943324	226.9048799	1061.585657
417759	4921116	233.0614278	9.219544457	233.9466075	622.7848606
417755	4921118	237.4279586	4.472135955	237.4807612	113.6334661
417749	4921126	245.2882272	10	246.3580929	745.8685259
417748	4921128	246.796914	2.236067977	247.1606046	203.0338645
417750	4921138	247.8495231	10.19803903	252.4222381	1254.103586
417749	4921137	248.4857881	1.414213562	248.8747624	156.7171315
417749	4921137	248.4857881	0	248.4857881	0
417749	4921138	248.7985546	1	249.1421714	118.0836653
417757	4921147	244.2864062	12.04159458	252.5632777	1375.820717
417744	4921161	261.56581	19.10497317	262.4785947	1029.936255
417738	4921167	269.4399453	8.485281374	269.7455183	419.7011952
417738	4921169	270.2423946	2	270.8411699	247.1673307
417741	4921179	271.7393724	10.44030651	276.2110367	1399.737052
417746	4921187	270.9204387	9.433981132	276.0468961	1274.836653
417750	4921193	270.3030682	7.211102551	274.2173047	972.0358566
417752	4921195	269.5628815	2.828427125	271.3471884	368.4342629
417756	4921201	269.2099768	7.211102551	272.9919804	970.0358566
417764	4921205	264.6081438	8.94427191	271.3811963	1023.40239
417768	4921212	265.2298403	8.062257748	268.9501209	1064.619522
417776	4921216	261.0944778	8.94427191	267.634295	1043.40239
417777	4921223	264.5557195	7.071067812	266.3606326	810.2191235
417867	4921339	303.2384169	146.8196172	357.3068768	19420.71713
417870	4921339	302.081998	3	304.1602075	418.9003984
417873	4921339	300.9510418	3	303.0165199	418.9003984
417882	4921338	296.7759824	9.055385138	303.3912046	1200.61753
417892	4921338	293.4495478	10	300.1127651	1391.334661
417901	4921337	289.7604032	9.055385138	296.1326681	1205.61753
417911	4921337	287.0152342	10	293.3878187	1386.334661
417920	4921340	287.7435218	9.486832981	292.1227945	1358.952191
417931	4921346	291.3466256	12.52996409	295.8100557	1736.97012
417932	4921347	292.1456066	1.414213562	292.4532228	170.2171315
417939	4921352	295.890828	8.602325267	298.3193799	1138.35259
417951	4921357	299.2240557	13	304.0574419	1869.01992
417957	4921359	300.5895794	6.32455532	303.0690952	925.9681275

417971	4921357	297.6043385	14.14213562	306.1680268	2066.701195
417973	4921357	297.5158365	2	298.5600875	297.2669323
417986	4921363	303.2680754	14.31782106	307.5508665	1968.737052
417991	4921365	305.322649	5.385164807	306.9879446	757.3346614
417994	4921366	306.3942719	3.16227766	307.4395993	454.9840637
418009	4921371	312.1779929	15.8113883	317.1918265	2274.920319
418017	4921372	313.885259	8.062257748	317.0627548	1233.151394
418021	4921373	315.3096114	4.123105626	316.658988	608.6175299
418033	4921380	323.8191967	13.89244399	326.5106261	1754.187251
418049	4921382	328.5279064	16.1245155	334.2358093	2514.302789
418065	4921385	334.9206359	16.2788206	339.8636814	2482.386454
418083	4921389	343.4937319	18.43908891	348.4267283	2767.737052
418088	4921392	347.8158596	5.830951895	348.5702717	676.4183267
418101	4921390	349.9906482	13.15294644	355.4797271	2262.567729
418101	4921390	349.9906482	0	349.9906482	0
418110	4921393	355.8792541	9.486832981	357.6783676	1312.452191
418116	4921393	358.0279815	6	359.9536178	999.8007968
418118	4921390	355.9786013	3.605551275	358.806067	529.5159363
418133	4921377	350.0182916	19.84943324	362.9231631	3340.414343
418142	4921372	349.4382966	10.29563014	354.8761092	1797.282869
418149	4921374	354.4077429	7.280109889	355.5630747	936.1015936
418151	4921377	357.9927102	3.605551275	358.0030022	68.51792829
418163	4921374	361.0930116	12.36931688	365.7275193	2152.350598
418161	4921366	353.1523204	8.246211251	361.2457716	397.063745
418163	4921360	348.9766309	6.32455532	354.2267533	833.7649402
418161	4921357	345.3762537	3.605551275	348.9792179	33.51792829
418160	4921353	341.4263549	4.123105626	345.4628571	203.0318725
418159	4921350	338.3381281	3.16227766	341.4633803	115.6155378
418162	4921344	334.7797511	6.708203932	339.9130415	956.8984064
418163	4921342	333.6151665	2.236067977	335.3154928	318.9661355
418166	4921335	329.3513903	7.615773106	335.291165	1045.814741
418171	4921330	327.9908469	7.071067812	332.2066525	1140.249004
418173	4921326	325.8514859	4.472135955	329.1572344	641.9322709
418176	4921324	325.9664387	3.605551275	327.711738	587.2330677
418177	4921321	324.1298859	3.16227766	326.6293011	418.3824701
418179	4921313	318.928272	8.246211251	325.6521846	1028.59761

418178	4921307	313.568771	6.08276253	319.2899028	454.8645418
418172	4921295	300.4279876	13.41640786	313.7065832	415.1952191
418172	4921290	296.5287615	5	300.9783746	467.0816733
418172	4921283	291.1263804	7	297.327571	653.9143426
418170	4921280	287.5424092	3.605551275	291.1371705	56.98207171
418169	4921273	281.5621329	7.071067812	288.087805	536.7808765
418168	4921272	280.151808	1.414213562	281.5640772	14.71713147
418164	4921269	275.2703627	5	280.2110853	150.2848606
418160	4921255	262.0985256	14.56021978	275.964554	833.2948207
418160	4921246	255.463955	9	263.2812403	786.747012
418161	4921243	253.9761722	3.16227766	256.3012025	355.3824701
418165	4921232	249.029486	11.70469991	257.3551791	1333.613546
418162	4921229	244.7878414	4.242640687	249.0299841	11.34860558
418160	4921220	237.1749393	9.219544457	245.5911626	626.4800797
418157	4921210	228.2687389	10.44030651	237.9419924	633.7629482
418159	4921200	223.3665356	10.19803903	230.9166568	1009.430279
418155	4921196	217.742537	5.656854249	223.3829634	67.1314741
418151	4921186	208.4317932	10.77032961	218.4723299	576.6294821
418151	4921186	208.4317932	0	208.4317932	0
418150	4921182	205.2291685	4.123105626	208.8920336	268.5318725
418149	4921179	202.6468472	3.16227766	205.5191467	186.1155378
418150	4921177	202.2902427	2.236067977	203.5865789	223.4661355
418153	4921165	198.113432	12.36931688	206.3864958	1164.896414
418156	4921156	196.0895794	9.486832981	201.8449222	913.1474104
418161	4921150	197.6493022	7.810249676	200.7745657	753.1653386
418161	4921146	195.8548218	4	198.752062	351.6653386
418164	4921142	196.8475851	5	198.8512034	481.0657371
418166	4921142	198.6663093	2	198.7569472	82.26693227
418169	4921133	197.8951583	9.486832981	203.0241503	937.1474104
418170	4921130	197.7386088	3.16227766	199.3980224	312.3824701
418171	4921124	196.6316851	6.08276253	200.2265282	589.6314741
418168	4921119	192.1987363	5.830951895	197.3306866	368.1812749
418165	4921112	187.2741871	7.615773106	193.5443483	551.0139442
418159	4921112	181.5203271	6	187.3972571	156.8007968
418151	4921110	173.2836943	8.246211251	181.5251163	35.23505976
418145	4921109	167.2534388	6.08276253	173.3099478	67.88446215

418137	4921109	159.6257814	8	167.4396101	197.0677291
418129	4921108	151.7153042	8.062257748	159.7016717	121.1513944
418126	4921106	148.2378824	3.605551275	151.7793689	71.43227092
418121	4921102	142.2568368	6.403124237	148.4489217	165.998008
418117	4921093	135.9652216	9.848857802	144.0354581	526.7131474
418115	4921089	133.0904781	4.472135955	136.7639178	230.3984064
418113	4921086	130.5034217	3.605551275	133.5997255	165.4820717
418112	4921085	129.3249546	1.414213562	130.6212949	50.78286853
418112	4921079	128.2877262	6	131.8063404	380.498008
418112	4921071	127.3321239	8	131.809925	507.3306773
418111	4921064	125.9049935	7.071067812	130.1540926	438.2808765
418112	4921061	126.8389969	3.16227766	127.953134	190.8824701
418119	4921051	134.1172988	12.20655562	136.5814257	638.5976096
418118	4921050	133.1887782	1.414213562	134.3601453	71.28286853
418114	4921042	130.0473697	8.94427191	136.0902099	550.7968127
418113	4921031	131.0220612	11.04536102	136.057396	717.4462151
418113	4921025	132.4672689	6	134.7446651	383.498008
418111	4921020	131.9567253	5.385164807	134.9045795	354.314741
418111	4921014	133.8856757	6	135.9212005	377.498008
418112	4921008	136.9775029	6.08276253	138.4729706	354.6314741
418112	4921006	137.7453033	2	138.3614031	126.8326693
418112	4921002	139.3543437	4	140.5498235	253.6653386
418111	4921000	139.2907034	2.236067977	140.4405575	155.6992032
418112	4920995	142.3969665	5.099019514	143.3933447	284.7151394
418110	4920989	143.4794836	6.32455532	146.1005027	445.2310757
418108	4920982	145.3626309	7.280109889	148.0611122	507.6474104
418106	4920981	144.2200746	2.236067977	145.9093868	139.1494024
418096	4920974	140.1215169	12.20655562	148.2740736	816.5796813
418093	4920972	139.0143005	3.605551275	141.3706843	239.4322709
418088	4920968	137.8024441	6.403124237	141.6099344	434.998008
418085	4920963	139.0102451	5.830951895	141.3218206	394.6812749
418075	4920954	138.7421713	13.45362405	145.6030202	932.9123506
418073	4920954	137.4556634	2	139.0989174	105.7330677
418065	4920946	138.9549056	11.3137085	143.8621388	774.2629482
418059	4920945	136.4365783	6.08276253	140.7371232	381.1155378
418052	4920940	137.122621	8.602325267	141.0807623	586.1474104

418045	4920933	140.1471326	9.899494937	143.5846243	652.9800797
418038	4920925	144.7214237	10.63014581	147.7493511	682.8964143
418035	4920921	147.4115294	5	148.5664766	307.7649402
418028	4920915	150.9380617	9.219544457	153.7845678	635.063745
418027	4920915	150.6573368	1	151.2976992	72.36653386
418019	4920901	162.2986023	16.1245155	164.5402273	871.7609562
418019	4920899	164.2551934	2	164.2768979	33.83266932
418014	4920890	172.164564	10.29563014	173.3576938	554.0796813
418012	4920888	173.8166813	2.828427125	174.4048362	198.5657371
418010	4920880	181.4404506	8.246211251	181.7516716	279.063745
418011	4920874	187.5209302	6.08276253	187.5220716	15.3685259
418009	4920867	194.201008	7.280109889	194.5010241	276.1474104
418009	4920857	204.1291084	10	204.1650582	119.1633466
418009	4920856	205.1223026	1	205.1257055	11.91633466
418016	4920845	216.9353449	13.03840481	217.5480262	581.9860558
418025	4920844	219.3795753	9.055385138	222.6851527	950.8824701
418027	4920844	219.7515159	2	220.5655456	215.7330677
418034	4920840	225.0938707	8.062257748	226.4538222	671.4003984
418034	4920839	226.070159	1	226.0820149	24.41633466
418036	4920836	229.4350581	3.605551275	229.5553842	147.4840637
418036	4920831	234.3134152	5	234.3742366	127.0816733
418041	4920823	243.2279431	9.433981132	243.4876697	368.501992
418044	4920818	248.7893869	5.830951895	248.9241409	215.5179283
418042	4920814	252.2195331	4.472135955	252.740528	359.3984064
418039	4920804	261.3376326	10.44030651	261.9987361	652.7629482
418037	4920797	267.7971069	7.280109889	268.2074247	444.1474104
418028	4920795	268.1757534	9.219544457	272.5962024	1234.131474
418020	4920794	268.0063024	8.062257748	272.1221568	1080.348606
418013	4920796	265.1976404	7.280109889	270.2420264	895.2330677
418012	4920796	265.0945551	1	265.6460978	131.8665339
418009	4920797	263.8117909	3.16227766	266.0343118	382.1832669
418002	4920796	264.2696914	7.071067812	267.576275	931.4820717
417996	4920793	266.9529474	6.708203932	268.9654214	816.4482072
417985	4920785	274.7331187	13.60147051	277.6437683	1510.36255
417977	4920788	271.8557805	8.544003745	277.5664515	1099.183267
417975	4920789	270.9239166	2.236067977	272.5078825	275.8167331

417965	4920781		279.4617045	12.80624847	281.5959348		1312.996016
417964	4920775		285.5187835	6.08276253	285.5316253		78.86454183
417962	4920773		287.667477	2.828427125	288.0073438		263.5657371
417957	4920773		288.1132601	5	290.3903686		716.8326693
417954	4920772		289.4161723	3.16227766	290.345855		416.0159363
417950	4920766		295.8307899	7.211102551	296.2290323		481.9641434
417948	4920766		296.0752025	2	296.9529962		293.7330677
417945	4920763		299.439356	4.242640687	299.8785996		384.8486056
417940	4920761		302.1283395	5.385164807	303.4764302		701.6653386
417938	4920756		307.3736058	5.385164807	307.443555		185.814741
417883	4920749		327.0981547	55.4436651	344.9577128		8187.573705

Polygon 37

			Est Area
			187348.8984
Cent Long	Cent Lat	Av Radius	
417985.1673	4921059.733	240.8862059	

						Heron's	Formula for Area
LONG	LAT	Cent XY	Radius/Hypot	Opposite	p	Area	
417883	4920749		327.0981547				
417882	4920753		323.6180974	4.123105626	327.4196789		359.7011952
417880	4920758		319.5356187	5.385164807	324.2694404		564.6513944
417879	4920759		318.9230003	1.414213562	319.9364163		203.4501992
417877	4920761		317.7131051	2.828427125	319.7322663		406.9003984
417869	4920772		310.2985127	13.60147051	320.8065442		1789.85259
417864	4920780		304.8476853	9.433981132	312.2900895		1184.001992
417861	4920782		304.2255461	3.605551275	306.3393913		540.7669323
417854	4920784		305.3417647	7.280109889	308.4237104		1096.233068
417847	4920792		301.2826029	10.63014581	308.6272567		1489.73506
417844	4920797		298.2564	5.830951895	302.6849774		747.0179283
417844	4920801		294.7388939	4	298.4976469		282.3346614
417839	4920805		293.690014	6.403124237	297.4160161		929.1673307

417841	4920813	285.7646338	8.246211251	293.8504296	329.936255
417843	4920818	280.4397011	5.385164807	285.7947499	113.685259
417843	4920827	272.7200593	9	281.0798802	639.752988
417844	4920832	267.9376147	5.099019514	272.8783468	239.0517928
417844	4920833	267.0881863	1	268.0129005	70.58366534
417839	4920843	261.415591	11.18033989	269.8420586	1272.669323
417834	4920851	257.7228267	9.433981132	264.2861994	1126.501992
417834	4920852	256.9135833	1	257.818205	75.58366534
417828	4920857	256.5195248	7.810249676	260.6216789	1001.11753
417827	4920864	251.6512235	7.071067812	257.620908	651.4521912
417830	4920865	248.9937111	3.16227766	251.9036061	214.5159363
417830	4920865	248.9937111	0	248.9937111	0
417832	4920876	239.202992	11.18033989	249.6885215	658.687251
417833	4920877	237.7945974	1.414213562	239.2059015	15.28286853
417835	4920878	235.7480331	2.236067977	237.8893493	106.6494024
417836	4920886	228.9848715	8.062257748	236.3975812	509.8027888
417830	4920898	224.1305104	13.41640786	233.2658949	1416.203187
417830	4920901	221.9754205	3	224.5529655	232.750996
417820	4920902	228.3855682	10.04987562	230.2054322	871.249004
417810	4920904	234.385115	10.19803903	236.4843611	953.8326693
417808	4920908	233.2620563	4.472135955	236.0596536	506.0677291
417805	4920909	234.9057785	3.16227766	235.6650562	316.1832669
417799	4920913	237.0419123	7.211102551	239.5793966	812.5338645
417792	4920914	241.9746777	7.071067812	243.0438289	606.6494024
417791	4920919	239.8056477	5.099019514	243.4396725	555.7848606
417795	4920926	232.4825737	8.062257748	240.1752395	398.1195219
417803	4920933	221.9148639	10.63014581	232.5137917	130.6533865
417806	4920937	217.1735212	5	222.0441925	174.2350598
417807	4920943	213.0028329	6.08276253	218.1295583	476.1354582
417806	4920949	210.6246535	6.08276253	214.8551245	592.8685259
417803	4920954	210.6286257	5.830951895	213.5421156	614.0179283
417818	4920971	189.2576914	22.6715681	211.2789426	755.4243028
417817	4920972	189.6769419	1.414213562	190.1744234	127.9501992
417815	4920979	188.3474148	7.280109889	192.6522333	676.3187251
417817	4920990	182.0520581	11.18033989	190.7899064	855.187251
417818	4921003	176.5320294	13.03840481	185.8112462	1058.221116

417818	4921004	176.2131984	1	176.8726139	83.58366534
417820	4921006	173.6879089	2.828427125	176.3647672	111.4342629
417818	4921022	171.3729875	16.1245155	180.5927059	1375.071713
417818	4921037	168.7059833	15	177.5394854	1253.75498
417813	4921043	172.9785689	7.810249676	174.747401	558.3346614
417809	4921051	176.3836582	8.94427191	179.1532495	722.1354582
417801	4921062	184.1812821	13.60147051	187.0832054	1003.85259
417796	4921069	189.394179	8.602325267	191.0888932	638.9183267
417794	4921070	191.4428328	2.236067977	191.5365399	85.31673307
417785	4921075	200.7486974	10.29563014	201.2435801	431.7171315
417780	4921085	206.7173226	11.18033989	209.3231799	962.6693227
417780	4921096	208.3480836	11	213.0327031	1128.420319
417765	4921109	225.6122428	19.84943324	226.9048799	1061.585657
417759	4921116	233.0614278	9.219544457	233.9466075	622.7848606
417755	4921118	237.4279586	4.472135955	237.4807612	113.6334661
417749	4921126	245.2882272	10	246.3580929	745.8685259
417748	4921128	246.796914	2.236067977	247.1606046	203.0338645
417750	4921138	247.8495231	10.19803903	252.4222381	1254.103586
417749	4921137	248.4857881	1.414213562	248.8747624	156.7171315
417749	4921137	248.4857881	0	248.4857881	0
417749	4921138	248.7985546	1	249.1421714	118.0836653
417757	4921147	244.2864062	12.04159458	252.5632777	1375.820717
417744	4921161	261.56581	19.10497317	262.4785947	1029.936255
417738	4921167	269.4399453	8.485281374	269.7455183	419.7011952
417738	4921169	270.2423946	2	270.8411699	247.1673307
417741	4921179	271.7393724	10.44030651	276.2110367	1399.737052
417746	4921187	270.9204387	9.433981132	276.0468961	1274.836653
417750	4921193	270.3030682	7.211102551	274.2173047	972.0358566
417752	4921195	269.5628815	2.828427125	271.3471884	368.4342629
417756	4921201	269.2099768	7.211102551	272.9919804	970.0358566
417764	4921205	264.6081438	8.94427191	271.3811963	1023.40239
417768	4921212	265.2298403	8.062257748	268.9501209	1064.619522
417776	4921216	261.0944778	8.94427191	267.634295	1043.40239
417777	4921223	264.5557195	7.071067812	266.3606326	810.2191235
417867	4921339	303.2384169	146.8196172	357.3068768	19420.71713
417870	4921339	302.081998	3	304.1602075	418.9003984

417873	4921339	300.9510418	3	303.0165199	418.9003984
417882	4921338	296.7759824	9.055385138	303.3912046	1200.61753
417892	4921338	293.4495478	10	300.1127651	1391.334661
417901	4921337	289.7604032	9.055385138	296.1326681	1205.61753
417911	4921337	287.0152342	10	293.3878187	1386.334661
417920	4921340	287.7435218	9.486832981	292.1227945	1358.952191
417931	4921346	291.3466256	12.52996409	295.8100557	1736.97012
417932	4921347	292.1456066	1.414213562	292.4532228	170.2171315
417939	4921352	295.890828	8.602325267	298.3193799	1138.35259
417951	4921357	299.2240557	13	304.0574419	1869.01992
417957	4921359	300.5895794	6.32455532	303.0690952	925.9681275
417971	4921357	297.6043385	14.14213562	306.1680268	2066.701195
417973	4921357	297.5158365	2	298.5600875	297.2669323
417986	4921363	303.2680754	14.31782106	307.5508665	1968.737052
417991	4921365	305.322649	5.385164807	306.9879446	757.3346614
417994	4921366	306.3942719	3.16227766	307.4395993	454.9840637
418009	4921371	312.1779929	15.8113883	317.1918265	2274.920319
418017	4921372	313.885259	8.062257748	317.0627548	1233.151394
418021	4921373	315.3096114	4.123105626	316.658988	608.6175299
418033	4921380	323.8191967	13.89244399	326.5106261	1754.187251
418049	4921382	328.5279064	16.1245155	334.2358093	2514.302789
418065	4921385	334.9206359	16.2788206	339.8636814	2482.386454
418083	4921389	343.4937319	18.43908891	348.4267283	2767.737052
418088	4921392	347.8158596	5.830951895	348.5702717	676.4183267
418101	4921390	349.9906482	13.15294644	355.4797271	2262.567729
418101	4921390	349.9906482	0	349.9906482	0
418110	4921393	355.8792541	9.486832981	357.6783676	1312.452191
418116	4921393	358.0279815	6	359.9536178	999.8007968
418118	4921390	355.9786013	3.605551275	358.806067	529.5159363
418133	4921377	350.0182916	19.84943324	362.9231631	3340.414343
418142	4921372	349.4382966	10.29563014	354.8761092	1797.282869
418149	4921374	354.4077429	7.280109889	355.5630747	936.1015936
418151	4921377	357.9927102	3.605551275	358.0030022	68.51792829
418163	4921374	361.0930116	12.36931688	365.7275193	2152.350598
418161	4921366	353.1523204	8.246211251	361.2457716	397.063745
418163	4921360	348.9766309	6.32455532	354.2267533	833.7649402

418161	4921357	345.3762537	3.605551275	348.9792179	33.51792829
418160	4921353	341.4263549	4.123105626	345.4628571	203.0318725
418159	4921350	338.3381281	3.16227766	341.4633803	115.6155378
418162	4921344	334.7797511	6.708203932	339.9130415	956.8984064
418163	4921342	333.6151665	2.236067977	335.3154928	318.9661355
418166	4921335	329.3513903	7.615773106	335.291165	1045.814741
418171	4921330	327.9908469	7.071067812	332.2066525	1140.249004
418173	4921326	325.8514859	4.472135955	329.1572344	641.9322709
418176	4921324	325.9664387	3.605551275	327.711738	587.2330677
418177	4921321	324.1298859	3.16227766	326.6293011	418.3824701
418179	4921313	318.928272	8.246211251	325.6521846	1028.59761
418178	4921307	313.568771	6.08276253	319.2899028	454.8645418
418172	4921295	300.4279876	13.41640786	313.7065832	415.1952191
418172	4921290	296.5287615	5	300.9783746	467.0816733
418172	4921283	291.1263804	7	297.327571	653.9143426
418170	4921280	287.5424092	3.605551275	291.1371705	56.98207171
418169	4921273	281.5621329	7.071067812	288.087805	536.7808765
418168	4921272	280.151808	1.414213562	281.5640772	14.71713147
418164	4921269	275.2703627	5	280.2110853	150.2848606
418160	4921255	262.0985256	14.56021978	275.964554	833.2948207
418160	4921246	255.463955	9	263.2812403	786.747012
418161	4921243	253.9761722	3.16227766	256.3012025	355.3824701
418165	4921232	249.029486	11.70469991	257.3551791	1333.613546
418162	4921229	244.7878414	4.242640687	249.0299841	11.34860558
418160	4921220	237.1749393	9.219544457	245.5911626	626.4800797
418157	4921210	228.2687389	10.44030651	237.9419924	633.7629482
418159	4921200	223.3665356	10.19803903	230.9166568	1009.430279
418155	4921196	217.742537	5.656854249	223.3829634	67.1314741
418151	4921186	208.4317932	10.77032961	218.4723299	576.6294821
418151	4921186	208.4317932	0	208.4317932	0
418150	4921182	205.2291685	4.123105626	208.8920336	268.5318725
418149	4921179	202.6468472	3.16227766	205.5191467	186.1155378
418150	4921177	202.2902427	2.236067977	203.5865789	223.4661355
418153	4921165	198.113432	12.36931688	206.3864958	1164.896414
418156	4921156	196.0895794	9.486832981	201.8449222	913.1474104
418161	4921150	197.6493022	7.810249676	200.7745657	753.1653386

418161	4921146	195.8548218	4	198.752062	351.6653386
418164	4921142	196.8475851	5	198.8512034	481.0657371
418166	4921142	198.6663093	2	198.7569472	82.26693227
418169	4921133	197.8951583	9.486832981	203.0241503	937.1474104
418170	4921130	197.7386088	3.16227766	199.3980224	312.3824701
418171	4921124	196.6316851	6.08276253	200.2265282	589.6314741
418168	4921119	192.1987363	5.830951895	197.3306866	368.1812749
418165	4921112	187.2741871	7.615773106	193.5443483	551.0139442
418159	4921112	181.5203271	6	187.3972571	156.8007968
418151	4921110	173.2836943	8.246211251	181.5251163	35.23505976
418145	4921109	167.2534388	6.08276253	173.3099478	67.88446215
418137	4921109	159.6257814	8	167.4396101	197.0677291
418129	4921108	151.7153042	8.062257748	159.7016717	121.1513944
418126	4921106	148.2378824	3.605551275	151.7793689	71.43227092
418121	4921102	142.2568368	6.403124237	148.4489217	165.998008
418117	4921093	135.9652216	9.848857802	144.0354581	526.7131474
418115	4921089	133.0904781	4.472135955	136.7639178	230.3984064
418113	4921086	130.5034217	3.605551275	133.5997255	165.4820717
418112	4921085	129.3249546	1.414213562	130.6212949	50.78286853
418112	4921079	128.2877262	6	131.8063404	380.498008
418112	4921071	127.3321239	8	131.809925	507.3306773
418111	4921064	125.9049935	7.071067812	130.1540926	438.2808765
418112	4921061	126.8389969	3.16227766	127.953134	190.8824701
418119	4921051	134.1172988	12.20655562	136.5814257	638.5976096
418118	4921050	133.1887782	1.414213562	134.3601453	71.28286853
418114	4921042	130.0473697	8.94427191	136.0902099	550.7968127
418113	4921031	131.0220612	11.04536102	136.057396	717.4462151
418113	4921025	132.4672689	6	134.7446651	383.498008
418111	4921020	131.9567253	5.385164807	134.9045795	354.314741
418111	4921014	133.8856757	6	135.9212005	377.498008
418112	4921008	136.9775029	6.08276253	138.4729706	354.6314741
418112	4921006	137.7453033	2	138.3614031	126.8326693
418112	4921002	139.3543437	4	140.5498235	253.6653386
418111	4921000	139.2907034	2.236067977	140.4405575	155.6992032
418112	4920995	142.3969665	5.099019514	143.3933447	284.7151394
418110	4920989	143.4794836	6.32455532	146.1005027	445.2310757

418108	4920982		145.3626309	7.280109889	148.0611122	507.6474104
418106	4920981		144.2200746	2.236067977	145.9093868	139.1494024
418096	4920974		140.1215169	12.20655562	148.2740736	816.5796813
418093	4920972		139.0143005	3.605551275	141.3706843	239.4322709
418088	4920968		137.8024441	6.403124237	141.6099344	434.998008
418085	4920963		139.0102451	5.830951895	141.3218206	394.6812749
418075	4920954		138.7421713	13.45362405	145.6030202	932.9123506
418073	4920954		137.4556634	2	139.0989174	105.7330677
418065	4920946		138.9549056	11.3137085	143.8621388	774.2629482
418059	4920945		136.4365783	6.08276253	140.7371232	381.1155378
418052	4920940		137.122621	8.602325267	141.0807623	586.1474104
418045	4920933		140.1471326	9.899494937	143.5846243	652.9800797
418038	4920925		144.7214237	10.63014581	147.7493511	682.8964143
418035	4920921		147.4115294	5	148.5664766	307.7649402
418028	4920915		150.9380617	9.219544457	153.7845678	635.063745
418027	4920915		150.6573368	1	151.2976992	72.36653386
418019	4920901		162.2986023	16.1245155	164.5402273	871.7609562
418019	4920899		164.2551934	2	164.2768979	33.83266932
418014	4920890		172.164564	10.29563014	173.3576938	554.0796813
418012	4920888		173.8166813	2.828427125	174.4048362	198.5657371
418010	4920880		181.4404506	8.246211251	181.7516716	279.063745
418011	4920874		187.5209302	6.08276253	187.5220716	15.3685259
418009	4920867		194.201008	7.280109889	194.5010241	276.1474104
418009	4920857		204.1291084	10	204.1650582	119.1633466
418009	4920856		205.1223026	1	205.1257055	11.91633466
418016	4920845		216.9353449	13.03840481	217.5480262	581.9860558
418025	4920844		219.3795753	9.055385138	222.6851527	950.8824701
418027	4920844		219.7515159	2	220.5655456	215.7330677
418034	4920840		225.0938707	8.062257748	226.4538222	671.4003984
418034	4920839		226.070159	1	226.0820149	24.41633466
418036	4920836		229.4350581	3.605551275	229.5553842	147.4840637
418036	4920831		234.3134152	5	234.3742366	127.0816733
418041	4920823		243.2279431	9.433981132	243.4876697	368.501992
418044	4920818		248.7893869	5.830951895	248.9241409	215.5179283
418042	4920814		252.2195331	4.472135955	252.740528	359.3984064
418039	4920804		261.3376326	10.44030651	261.9987361	652.7629482

418037	4920797	267.7971069	7.280109889	268.2074247	444.1474104
418028	4920795	268.1757534	9.219544457	272.5962024	1234.131474
418020	4920794	268.0063024	8.062257748	272.1221568	1080.348606
418013	4920796	265.1976404	7.280109889	270.2420264	895.2330677
418012	4920796	265.0945551	1	265.6460978	131.8665339
418009	4920797	263.8117909	3.16227766	266.0343118	382.1832669
418002	4920796	264.2696914	7.071067812	267.576275	931.4820717
417996	4920793	266.9529474	6.708203932	268.9654214	816.4482072
417985	4920785	274.7331187	13.60147051	277.6437683	1510.36255
417977	4920788	271.8557805	8.544003745	277.5664515	1099.183267
417975	4920789	270.9239166	2.236067977	272.5078825	275.8167331
417965	4920781	279.4617045	12.80624847	281.5959348	1312.996016
417964	4920775	285.5187835	6.08276253	285.5316253	78.86454183
417962	4920773	287.667477	2.828427125	288.0073438	263.5657371
417957	4920773	288.1132601	5	290.3903686	716.8326693
417954	4920772	289.4161723	3.16227766	290.345855	416.0159363
417950	4920766	295.8307899	7.211102551	296.2290323	481.9641434
417948	4920766	296.0752025	2	296.9529962	293.7330677
417945	4920763	299.439356	4.242640687	299.8785996	384.8486056
417940	4920761	302.1283395	5.385164807	303.4764302	701.6653386
417938	4920756	307.3736058	5.385164807	307.443555	185.814741
417883	4920749	327.0981547	55.4436651	344.9577128	8187.573705

Total Area Calculations

Polygon	Area (m^2)
1	10430.75079
2	27374.52882
3	11467.02583
4	5009.711215
5	1005.628033
6	10994.8209
7	8876.678618
8	1962.125156

9	90611.89358
10	51033.58242
11	1361.669252
12	17874.7052
13	176122.4614
14	107111.6728
15	95336.87702
16	5831.161942
17	3424.372271
18	10690.5082
19	1360.464967
20	1398.536728
21	14331.56587
22	5687.893599
23	2101.388746
24	1959.54215
25	1008.061074
26	345.025401
27	1090.711152
28	8159.093409
29	3695.677217
30	4272.896152
31	121.5
32	6978.890909
33	434.5
34	14726.46667
35	12757.70732
36	187348.8984
37	4435.112245
Total area (m^2)	908734.1055

APPENDIX C – *Upogebia* data

Collection		Sample				Sample	C=small core B=Big core S=slurp gun / Holes: Hole count area - m^2; Hole count area Bucket bottom = B .25 m2 quadrat = Q			Shrimp data			Isopods count (0, 1, 2 or . .)
Date	Location	Name/#	Northing (UTM)	Easting (UTM)	# of Cores	Type	(B or Q)	Upo	Neo	Species	Sex	CL (mm)	Isopod
28-Jun	Alsea Bay	ALS001	416432	4922076	2	C	Q	7	3	NEO	M	23	0
						S	Q			NEO	M	24	0
						S	Q			NEO	M	23	0
						S	Q			UPO	M	24	0
						S	Q			UPO	M	11	0
28-Jun	Alsea Bay	ALS002	416356	4922072	0	N/A	Q	32	0				
28-Jun	Alsea Bay	ALS003	416284	4922055	2	C	Q	43	0	UPO	F	28.2	1
						S	Q			UPO	F	28.5	0
						S	Q			UPO	F	30	2
						S	Q			UPO	F	24	0
28-Jun	Alsea Bay	ALS004	416212	4922033	0	N/A	Q	34	0				
28-Jun	Alsea Bay	ALS005	416140	4922010	2	C	Q	52	0	UPO	F	27	0
						C	Q			NEO	F	19	0
						S	Q			UPO	F	24.6	0
						S	Q			UPO	F	27.5	0
						S	Q			UPO	F	26.4	1
						S	Q			UPO	F	30.8	2
						S	Q			UPO	F	7.3	0
28-Jun	Alsea Bay	ALS006	416072	4921995	0	N/A	Q	46	0				
28-Jun	Alsea Bay	ALS007	415998	4921976	2	C	Q	11	1	UPO	F	27.7	2
						S	Q			UPO	M	20.2	2
28-Jun	Alsea Bay	ALS008	415869	4921966	0	N/A	Q	53	0				
28-Jun	Alsea Bay	ALS009	416080	4921782	3	C	Q	25	26	UPO	F	28.4	1
						C	Q			NEO	?	17.6	0
						C	Q			NEO	F	22.1	0

						C	Q			NEO	M	25.5	0
						C	Q			NEO	J	6.8	0
						S	Q			UPO	F	29.1	0
						S	Q			NEO	M	23.5	0
						S	Q			UPO	M	27	0
						S	Q			NEO	F	19.5	0
						S	Q			UPO	M	15.5	0
						S	Q			UPO	F	26	2
						S	Q			UPO	M	15.1	0
28-Jun	Alsea Bay	ALS010	416148	4921777	0	N/A	Q	56	56				
28-Jun	Alsea Bay	ALS011	416143	4921605	2	C	Q	14	15	UPO	F	26.7	0
						S	Q			UPO	M	31.3	0
						S	Q			UPO	F	25.6	0
						S	Q			UPO	F	27.5	2
						S	Q			NEO	M	24.4	0
28-Jun	Alsea Bay	ALS012	416229	4921591	0	N/A	Q	6	34				
28-Jun	Alsea Bay	ALS013	416311	4921598	2	C	Q	5	24	UPO	F	26.8	2
						C	Q			UPO	F	29.3	1
						C	Q			NEO	M	26.1	0
						S	Q			UPO	M	23.2	0
						S	Q			UPO	M	30.5	2
28-Jun	Alsea Bay	ALS014	416391	4921609	0	N/A	Q	7	20				
28-Jun	Alsea Bay	ALS015	416461	4921619	2	C	Q	11	21	UPO	F	30.8	0
						C	Q			NEO	M	24.1	0
						S	Q			NEO	M	25.4	0
						S	Q			NEO	F	19.8	0
						S	Q			NEO	F	20.2	0
						S	Q			NEO	F	20.7	0
						S	Q			UPO	F	30.5	2
28-Jun	Alsea Bay	ALS016	416534	4921630	0	N/A	Q	3	23				
28-Jun	Alsea Bay	ALS017	416513	4921672	2	C	Q	20	22	NEO	F	20.4	0
						C	Q			NEO	F	19.1	0
						C	Q			UPO	F	20.6	1
						C	Q			UPO	F	19.5	0
						C	Q			UPO	M	21	0
						C	Q			UPO	M	24.3	0

						S	Q			UPO	F	27.6	1
28-Jun	Alsea Bay	ALS018	416535	4921740	0	N/A	Q	6	9				
28-Jun	Alsea Bay	ALS019	416608	4921793	2	C	Q	4	13	NEO	F	18.9	0
						C	Q			NEO	M	20.9	0
						S	Q			NEO	F	19.3	0
						S	Q			NEO	F	19.6	0
						S	Q			NEO	M	21.8	0
						S	Q			UPO	F	30.9	0
28-Jun	Alsea Bay	ALS020	416684	4921818	0	N/A	Q	5	4				
28-Jun	Alsea Bay	ALS021	416691	4921951	2	C	Q	6	9	UPO	F	28.3	0
						C	Q			NEO	F	19.5	0
						C	Q			NEO	F	18.4	0
						S	Q			UPO	F	27.3	0
						S	Q			UPO	M	32.5	0
						S	Q			UPO	M	26.5	0
30-Jun	Alsea Bay	ALS022	417225	4921574	0	N/A	Q	27	0				
30-Jun	Alsea Bay	ALS023	417274	4921528	2	C	Q	39	0	UPO	F	30.2	2
						S	Q			UPO	F	31.3	0
						S	Q			UPO	F	31.7	0
						S	Q			UPO	F	31.2	0
30-Jun	Alsea Bay	ALS024	417335	4921491	0	N/A	Q	52	0				
30-Jun	Alsea Bay	ALS025	417399	4921459	2	C	Q	63	0	UPO	F	32	2
						C	Q			UPO	M	13.3	0
						S	Q			UPO	M	31	0
						S	Q			UPO	M	31.9	0
30-Jun	Alsea Bay	ALS026	417459	4921423	0	N/A	Q	43	0				
30-Jun	Alsea Bay	ALS027	417513	4921382	3	C	Q	30	0	UPO	F	29.3	0
						S	Q			UPO	F	30.6	1
						S	Q			UPO	M	19	1
						S	Q			UPO	F	32.1	0
30-Jun	Alsea Bay	ALS028	417574	4921351	0	N/A	Q	31	0				
30-Jun	Alsea Bay	ALS029	417622	4921306	3	C	Q	15	0	NEO	J	5.1	0
						S	Q			UPO	M	25.3	0
30-Jun	Alsea Bay	ALS030	417622	4921257	0	N/A	Q	8	0				
30-Jun	Alsea Bay	ALS031	417663	4921237	3	C	Q	5	3	UPO	F	26.9	2
						S	Q			UPO	F	28.6	1

30-Jun	Alsea Bay	ALS032	417732	4921242	0	N/A	Q	4	9					
30-Jun	Alsea Bay	ALS033	417786	4921244	4	C	Q	17	0	UPO	M	30.4		0
						S	Q			UPO	F	30		1
						S	Q			UPO	F	27.7		1
						S	Q			NEO	M	24.8		0
						S	Q			UPO	F	24.1	1 (H)	
						S	Q			UPO	F	22.9		0
30-Jun	Alsea Bay	ALS034	417761	4921182	0	N/A	Q	8	2					
30-Jun	Alsea Bay	ALS035	417775	4921115	4	C	Q	12	9	UPO	M	22.1		1
						S	Q			UPO	M	27.4		0
30-Jun	Alsea Bay	ALS036	417799	4921044	0	N/A	Q	6	10					
30-Jun	Alsea Bay	ALS037	417820	4920977	2	C	Q	9	0	UPO	F	30		2
						C	Q			NEO	J	8.1		0
						S	Q			UPO	M	25.3		1
						S	Q			UPO	F	28.2		0
30-Jun	Alsea Bay	ALS038	417831	4920915	0	N/A	Q	9	2					
30-Jun	Alsea Bay	ALS039	417851	4920848	2	S	Q	13	6	UPO	F	28.8		0
						S	Q			UPO	M	31.7		0
						S	Q			UPO	F	26.8		2
30-Jun	Alsea Bay	ALS040	417915	4920887	0	N/A	Q	10	1					
30-Jun	Alsea Bay	ALS041	417954	4920949	3	C	Q	9	1	UPO	F	30.2		0
						S	Q			UPO	F	28.2		0
						S	Q			UPO	F	29.6		0
30-Jun	Alsea Bay	ALS042	417974	4921020	0	N/A	Q	11	2					
30-Jun	Alsea Bay	ALS043	417989	4921089	2	C	Q	11	0	NEO	M	21.3		0
						S	Q			UPO	F	31.3		0
						S	Q			UPO	M	34.1		0
						S	Q			UPO	F	31.9		0
30-Jun	Alsea Bay	ALS044	417998	4921161	0	N/A	Q	5	2					
30-Jun	Alsea Bay	ALS045	418010	4921235	3	S	Q	2	0	UPO	M	30.4		2
						S	Q			UPO	F	30.2		0
30-Jun	Alsea Bay	ALS046	418023	4921310	0	N/A	Q	6	1					
30-Jun	Alsea Bay	ALS047	418035	4921372	3	N/A	Q	3	6					
30-Jun	Alsea Bay	ALS048	417962	4921398	0	N/A	Q	4	0					
30-Jun	Alsea Bay	ALS049	417891	4921398	2	C	Q	8	1	UPO	F	23.5		0
						S	Q			UPO	F	28.4		0

						S	Q			UPO	F	26.8	0
30-Jun	Alsea Bay	ALS050	417814	4921397	0	N/A	Q	20	0				
1-Jul	Alsea Bay	ALS051	417189	4921747	2	C	Q	23	2	UPO	M	28.2	1
						C	Q			UPO	F	29.8	2
						C	Q			UPO	F	22.1	0
1-Jul	Alsea Bay	ALS052	417120	4921720	0		Q	18	2				
1-Jul	Alsea Bay	ALS053	417049	4921699	2	C	Q	18	5	NEO	F	18	0
						S	Q			NEO	M	19.3	0
						S	Q			UPO	F	28.3	0
						S	Q			UPO	M	30.6	0
1-Jul	Alsea Bay	ALS054	416974	4921669	0		Q	16	14				
1-Jul	Alsea Bay	ALS055	416910	4921646	3	C	Q	8	8	NEO	M	22.7	0
						C	Q			NEO	F	19.7	0
						S	Q			UPO	M	30	0
						S	Q			NEO	M	21.7	0
						S	Q			UPO	M	31	1
						S	Q			NEO	F	18.5	0
						S	Q			UPO	M	18	0
1-Jul	Alsea Bay	ALS056	416838	4921632	0		Q	17	3				
1-Jul	Alsea Bay	ALS057	416770	4921616	3	C	Q	28	7	UPO	F	30.3	0
						S	Q			UPO	F	14.1	0
						S	Q			NEO	M	19.6	0
						S	Q			NEO	F	19	0
1-Jul	Alsea Bay	ALS058	416699	4921611	0		Q	31	11				
1-Jul	Alsea Bay	ALS059	416627	4921603	3	C	Q	24	13	NEO	F	21	0
						S	Q			UPO	M	28.1	2
						S	Q			UPO	F	31	0
						S	Q			UPO	F	30.7	0
						S	Q			NEO	M	10.6	0
						S	Q			NEO	M	15.3	0
1-Jul	Alsea Bay	ALS060	416421	4921722	0		Q	23	11				
1-Jul	Alsea Bay	ALS061	416373	4921774	3	C	Q	4	10	NEO	M	19.2	0
						S	Q			NEO	F	20.5	0
						S	Q			NEO	M	23.8	0
1-Jul	Alsea Bay	ALS062	416322	4921842	0		Q	20	12				
1-Jul	Alsea Bay	ALS063	416275	4921895	3	C	Q	35	12	NEO	F	17.3	0

C	Q	NEO	M	20.2	0
C	Q	UPO	F	25.5	2
C	Q	NEO	F	18.5	0
C	Q	NEO	M	21.7	0
C	Q	NEO	M	17.4	0
S	Q	UPO	M	20.6	2
S	Q	UPO	F	27.3	1
S	Q	UPO	F	29.2	0
S	Q	UPO	F	27.2	2
S	Q	UPO	F	26.1	0
S	Q	UPO	F	24.3	0

APPENDIX D – *Upogebia* size frequency distribution

CL	Frequency	Infested	% Infested	ExpInfest	p infest	Detection	% deviation from expected	Wet Weight (g.)	Dry Weight (g.)
4	0	0	0.00	0.00	0.00	0.00	#DIV/0!	0.00	0.00
6	0	0	0.00	0.00	0.00	0.00	#DIV/0!	0.00	0.00
8	1	0	0.00	0.00	0.00	0.00	#DIV/0!	0.27	0.09
10	1	0	0.00	0.00	0.00	0.00	#DIV/0!	0.55	0.16
12	0	0	0.00	0.00	0.03	0.00	#DIV/0!	0.00	0.00
14	3	0	0.00	0.06	0.02	0.00	-1.00	4.78	1.17
16	3	0	0.00	0.26	0.09	0.49	-1.00	7.27	1.69
18	5	2	0.40	1.02	0.20	0.76	0.97	17.55	3.88
20	6	3	0.50	2.06	0.34	0.94	0.46	29.33	6.20
22	3	1	0.33	1.45	0.48	0.58	-0.31	19.78	4.01
24	9	0	0.00	5.49	0.61	0.99	-1.00	78.00	15.26
26	18	9	0.50	12.79	0.71	0.99	-0.30	200.60	37.93
28	27	12	0.44	21.07	0.78	1.00	-0.43	379.77	69.60
30	32	15	0.47	26.21	0.82	1.00	-0.43	559.03	99.50
32	14	2	0.14	11.64	0.83	0.98	-0.83	299.55	51.88
34	1	0	0.00	0.83	0.83	0.07	-1.00	25.88	4.37
36	0	0	0.00	0.00	0.82	0.00	#DIV/0!	0.00	0.00
	123	44		82.86					
		1						1622.39	295.73
							Average shrimp wt. (g.)	13.19	2.40

APPENDIX E – Male and Female *Upogebia* size-frequency distribution

FEMALE			
Carapace length	Frequency	Infested	% infestation
4	0	0	#DIV/0!
6	0	0	#DIV/0!
8	1	0	0.00%
10	0	0	#DIV/0!
12	0	0	#DIV/0!
14	1	0	0.00%
16	0	0	#DIV/0!
18	1	0	0.00%
20	3	1	33.33%
22	2	0	0.00%
24	5	0	0.00%
26	14	8	57.14%
28	22	10	45.45%
30	24	11	45.83%
32	8	2	25.00%
34	0	0	#DIV/0!
36	0	0	#DIV/0!
	81	32	39.51%

MALE			
Carapace length	Frequency	Infested	% infestation
4	0	0	#DIV/0!
6	0	0	#DIV/0!
8	0	0	#DIV/0!
10	1	0	0.00%
12	0	0	#DIV/0!
14	2	0	0.00%
16	3	0	0.00%
18	4	2	50.00%
20	3	2	66.67%
22	1	1	100.00%
24	4	0	0.00%
26	4	1	25.00%
28	5	2	40.00%
30	8	4	50.00%
32	6	0	0.00%
34	1	0	0.00%
36	0	0	#DIV/0!
	42	12	28.57%

Total infestations	44	
Female	32	72.73%
Male	12	27.27%

APPENDIX F – Collection methods size-frequency distributions for *Upogebia*

Size Distribution (Slurp)		Size Distribution (Corer)		Size Distribution (7/29/2011 hole)	
Size Class	Frequency	Size Class	Frequency	Size Class	Frequency
4	0	4	0	4	0
6	0	6	0	6	0
8	1	8	0	8	0
10	1	10	0	10	0
12	0	12	0	12	0
14	1	14	1	14	1
16	2	16	0	16	1
18	2	18	0	18	3
20	2	20	3	20	1
22	1	22	2	22	0
24	6	24	2	24	1
26	10	26	5	26	3
28	16	28	5	28	6
30	18	30	9	30	5
32	10	32	1	32	3
34	1	34	0	34	0
36	0	36	0	36	0
	71		28		24

APPENDIX G – Lost natality

CL	*Frequency*	*Infested*	Uninfested Fecundity	Infested Fecundity	Lost fecundity	% natality uninfested	% natality infested
18	1	0	1,188	1,188	0	0.0020	0.0020
20	3	1	5,501	3,667	1,834	0.0091	0.0061
22	2	0	5,431	5,431	0	0.0090	0.0090
24	5	0	19,433	19,433	0	0.0322	0.0322
26	14	8	75,667	32,429	43,238	0.1252	0.0537
28	22	10	161,363	88,016	73,347	0.2671	0.1457
30	24	11	233,906	126,699	107,207	0.3871	0.2097
32	8	2	101,718	76,289	25,430	0.1683	0.1263
34	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0
	79	32					
		Total	604,207	353,152	251,055		
		Average	7,459				
		Lost Fecundity	41.55%				

Appendix H – *Neotrypaea* size abundance calculations from cores

Station	Cores # of cores	Neo collected	Neo/m^2
ALS001	2	1	40.74
ALS003	2	0	0.00
ALS005	2	1	40.74
ALS007	2	0	0.00
ALS009	3	4	108.65
ALS011	2	0	0.00
ALS013	2	1	40.74
ALS015	2	1	40.74
ALS017	2	2	81.49
ALS019	2	2	81.49
ALS021	2	2	81.49
ALS023	2	0	0.00
ALS025	2	0	0.00
ALS027	3	0	0.00
ALS029	3	1	27.16
ALS031	3	0	0.00
ALS033	4	0	0.00
ALS035	1	0	0.00
ALS037	2	1	40.74
ALS039	2	0	0.00
ALS041	3	0	0.00
ALS043	2	1	40.74
ALS045	3	0	0.00
ALS047	3	0	0.00
ALS049	2	0	0.00
ALS051	2	0	0.00
ALS053	2	1	40.74
ALS055	3	2	54.32
ALS057	3	0	0.00
ALS059	3	1	27.16
ALS061	3	1	27.16

ALS063	3	5	135.81
		avg.	28.44
		st dev	36.40
		95% error	12.61

bulk density

# of cores	77.00
total core area	0.94
neo collected	27.00
neo/ m^2	28.57

	neo/ m^2	plus/minus	bed area	total neo	95% standard error
average density	28.43568317	12.61274128	908734	25,840,472	
low	15.82294188		908734	14,378,845	11,461,627
high	41.04842445		908734	37,302,099	
average bulk density	28.57347965	12.61274128	908734	25,965,692	
low	15.96073837		908734	14,504,066	11,461,627
high	41.18622094		908734	37,427,319	

Appendix I – *Neotrypaea* biomass calculations and size frequency distribution

Method of collection	species	M/F	CL
C	NEO	M	23
S	NEO	M	24
S	NEO	M	23
C	NEO	F	19
C	NEO	?	17.6
C	NEO	F	22.1
C	NEO	M	25.5
C	NEO	J	6.8
S	NEO	M	23.5
S	NEO	F	19.5
S	NEO	M	24.4
C	NEO	M	26.1
C	NEO	M	24.1
S	NEO	M	25.4
S	NEO	F	19.8
S	NEO	F	20.2
S	NEO	F	20.7
C	NEO	F	20.4
C	NEO	F	19.1
C	NEO	F	18.9
C	NEO	M	20.9
S	NEO	F	19.3
S	NEO	F	19.6
S	NEO	M	21.8
C	NEO	F	19.5
C	NEO	F	18.4
C	NEO	J	5.1
S	NEO	M	24.8
C	NEO	J	8.1
C	NEO	M	21.3

C	NEO	F	18
S	NEO	M	19.3
C	NEO	M	22.7
C	NEO	F	19.7
S	NEO	M	21.7
S	NEO	F	18.5
S	NEO	M	19.6
S	NEO	F	19
C	NEO	F	21
S	NEO	M	10.6
S	NEO	M	15.3
C	NEO	M	19.2
S	NEO	F	20.5
S	NEO	M	23.8
C	NEO	F	17.3
C	NEO	M	20.2
C	NEO	F	18.5
C	NEO	M	21.7
C	NEO	M	17.4

CL	Frequency	Wt. Weight
4	0	0
6	2	0.37665582
8	1	0.539263038
10	1	1.219520044
12	0	0
14	0	0
16	1	6.801915384
18	10	104.6381039
20	17	261.498038
22	8	174.3723349
24	6	179.7740816
26	3	120.4530869
28	0	0

30	0	0
32	0	0
34	0	0
36	0	0
	49	849.6729995
	average g./Neo	**17.3402653**

	abundance	**biomass (g)**	**biomass (mt)**	**Error**
Avg. density				
mean	25,840,472	448,080,640	448.0806398	
low	14,378,845	249,332,987	249.3329869	198.7476529
high	37,302,099	646,828,293	646.8282927	
Avg. bulk density				
mean	25,965,692	450,251,988	450.2519879	
low	14,504,065	251,504,335	251.504335	198.7476529
high	37,427,319	648,999,641	648.9996408	
Dumbauld 2008				
mean	25,110,592	435,424,327	435.424327	
low	18,586,963	322,302,869	322.3028695	113.1214575
high	31,634,221	548,545,785	548.5457846	
DeWitt 2002				
mean	15,202,217	263,610,476	263.6104759	
low	8,876,274	153,916,946	153.916946	109.6935299
high	21,528,160	373,304,006	373.3040057	

APPENDIX J – Oregon *Upogebia* catch records

UPOGEBIA CATCH (lbs.)

Year	34-CHARLESTON	30-FLORENCE	26-WALDPORT	24-NEWPORT	20-SILETZ BAY	16-PACIFIC CITY	12-NETARTS	10-GARIBALDI	08-NEHALEM BAY	Total
1985	0	0	0	0	0	0	2144	2519	0	**4663**
1986	9347	0	38	0	0	0	21123	22724	0	**53232**
1987	5471	0	7	12	0	0	21213	15570	0	**42273**
1988	1931	0	1895	0	0	0	18779	17672	0	**40277**
1989	100	0	1248	0	0	0	26271	13376	0	**40995**
1990	0	0	0	0	0	0	46240	5671	0	**51911**
1991	95	0	606	156	0	0	53535	1630	0	**56022**
1992	135	0	1480	0	0	0	49254	250	22	**51119**
1993	0	170	187	0	0	0	47929	0	14	**48286**
1994	0	0	326	0	0	0	25121	0	0	**25447**
1995	0	0	287	0	0	0	27901	0	0	**28188**
1996	0	0	218	552	0	0	18067	0	0	**18837**
1997	109	0	0	1793	0	0	19767	0	0	**21669**
1998	0	0	0	1016	0	0	22189	0	0	**23205**
1999	0	0	0	905	0	0	15531	0	0	**16436**
2000	0	0	0	941	0	0	22469	0	0	**23410**
2001	0	0	455	225	0	0	9099	0	0	**9779**
2002	0	0	50	0	0	0	8988	295	0	**9333**
2003	0	0	188	0	0	0	4929	2308	0	**7425**
2004	0	0	0	0	0	0	4824	437	0	**5261**
2005	0	0	160	0	0	0	3009	0	0	**3169**
2006	20	0	36	0	0	80	2339	100	0	**2575**
2007	0	0	0	0	0	0	2695	0	0	**2695**

2008	0	0	65	0	86	0	1350	0	0	**1501**
2009	0	0	0	0	209	0	2830	17	0	**3056**
2010	0	15	70	0	0	0	2235	30	0	**2350**
2011	8	0	6	0	22	0	2345	15	0	**2396**
Sum	**17216**	**185**	**7322**	**5600**	**317**	**80**	**482176**	**82614**	**36**	**595510**
% of Total Catch	2.9%	0.0%	1.2%	0.9%	0.1%	0.0%	81.0%	13.9%	0.0%	