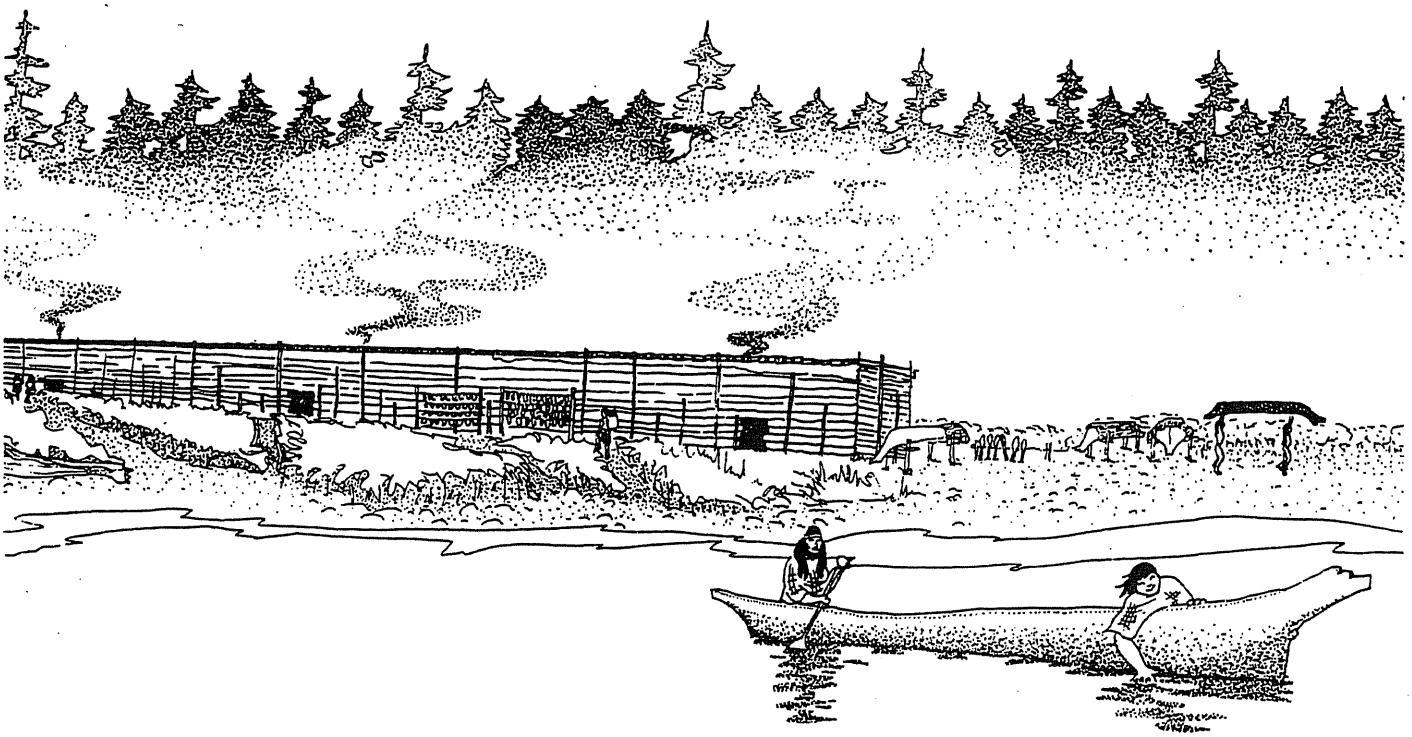
Fish Consumption Survey Of The Suquamish Indian Tribe Of The Port Madison Indian Reservation, Puget Sound Region

August 2000



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25 August 2000

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Dear Roseanne:

It is a pleasure to transmit this copy of the *Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region.*

We are encouraged by the interest that other tribes, agencies and consultants have expressed in the application of the results and are considering putting at least part of the report on our web site. I hope that you'll have suggestions with respect to report dissemination.

We deeply appreciate the time that you devoted to reviewing the draft and working with the data on selected projects. Again, thank you for your comments and enduring interest in tribal concerns.

Sincerely,

Margaret Duncan
Study Manager and
Co-Principal Investigator

Enclosure

Fish Consumption Survey Of The Suquamish Indian Tribe Of The Port Madison Indian Reservation, Puget Sound Region

August 2000

For more information or
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Executive Summary

Purpose

The Suquamish Tribal Council approved a proposed study of seafood consumption habits of Suquamish Tribal members living on and near the Port Madison Indian Reservation in March 1997. The study was funded by the Agency for Toxic Substances and Disease Registry (ATSDR) through a grant to the Washington State Department of Health (DOH), awarded for the purpose of determining seafood consumption rates, patterns, and habits of members of the Suquamish Tribe. A secondary objective included the identification of cultural practices and attributes which affect consumption rates, patterns, and habits of members of the Suquamish Tribe.

Methods

A systematic random sample of adults age 16 or over was selected from a sorted Suquamish Tribal enrollment roster. Consumption data for children under six years of age were gathered through adult respondents who had children under six years of age living in the household at the time of the survey since birth or for at least one year. The survey questionnaire was administered by personal interview by Suquamish Tribal members and was adapted from the questionnaire developed and used by the Columbia River Inter-Tribal Fish Commission (CRITFC) and subsequently adapted for use by the Tulalip Tribes, Squaxin Island Tribe, and the Asian and Pacific Islander consumption survey project teams. Suquamish survey interviewers used seafood models and a display booklet containing seafood illustrations for identification and maps of the Suquamish Tribe's Usual and Accustomed fishing areas (U&A) to assist respondents in providing information on harvest locations, portion sizes, and types of finfish and shellfish typically consumed.

Transcripts of the Suquamish Tribe Oral History Project of 1982 and anthropological and archeological literature were consulted to document cultural practices and attributes. As well, Suquamish Elders were consulted concerning fish and shellfish important to tribal members for subsistence, ceremonial, and commercial purposes.

Results

Interviewers collected data from 92 adults and for 31 children under six years of age. All 92 adult respondents who participated in the survey reported eating seafood. Sixteen distinct types of finfish and shellfish were consumed by at least half of the respondents, including cod, halibut, salmon, smelt, shrimp, manila and littleneck clams, geoduck, Dungeness crab, butter clams, cockles, oysters, horse clams, and scallops. Twenty-three types of finfish and shellfish were consumed by 25% of the respondents. The most frequently consumed finfish was salmon, with over 90% of the respondents reporting consuming at social gatherings, followed by manila and littleneck clams, geoduck, shrimp, and tuna (fresh or canned).

Adult respondents reported a mean consumption rate of all finfish and all shellfish (seafood) as 2.707 grams per kilogram per day (g/kg/day). The mean rate for finfish was 1.026 g/kg/day, and for shellfish, 1.680 g/kg/day. The mean seafood consumption rate for all finfish and shellfish reported for children under six years of age was 1.477 g/kg/day. The children's mean rate for finfish was 0.677 g/kg/day, and for shellfish, 0.801 g/kg/day. The Suquamish Tribe's seafood consumption rates for adults and children under six years of age represent the highest seafood consumption rates reported in studies conducted among the CRITFC, Tulalip Tribes, Squaxin Island Tribe, and the Asian Pacific Island population of King County.

The majority of respondents did not report eating parts of finfish that accumulate lipophilic environmental contaminants. The majority of adults reported eating several types of shellfish, including manila, littleneck and butter clams whole, which can include parts of the shellfish that accumulate contaminants.

A majority of respondents (67%) reported that consumption patterns have changed over time. Of those who indicated that their consumption of finfish and shellfish had changed, almost twice as many respondents reported eating less seafood now than twenty years ago (n = 40). This is in contrast with those who reported that they ate more seafood now than in the past (n = 22). A relatively small number (n = 8) explained that while their overall consumption rates have not changed, they now eat a different mix of species of finfish and/or shellfish. Most explanations for changes in consumption related to changes in family composition which affected harvesting patterns, accessibility/availability of finfish and shellfish, and restricted harvesting opportunities due to "red tides" and increased pollution.

Unlike studies conducted thus far, the Suquamish Tribe's study provides consumption rates by individual type of finfish and shellfish as well as by seafood groups. Complete data are provided for participants, including non-consumers, by age and gender. Consumption rates for adults and children under six years of age by individual type of finfish and shellfish as well as by seafood groups are also provided for consumers only (Appendix C, Tables C-2 and C-7).

Introduction

In March 1997, the Suquamish Tribal Council approved a proposed study of seafood consumption habits of Suquamish tribal members living on and near the Port Madison Indian Reservation in North Kitsap County, Washington. The study was funded by a grant awarded to the Washington State Department of Health (DOH) by the Agency for Toxic Substances and Disease Registry (ATSDR), a federal public health agency located in Atlanta Georgia and part of the Public Health Service within the U.S. Department of Health and Human Services.

Survey Goals and Objectives

The grant was awarded for the purpose of determining seafood consumption rates, patterns, and habits of members of the Suquamish Tribe. Survey objectives included obtaining seafood consumption data and the identification of cultural practices and attributes which affect consumption rates, habits, and patterns of members of the Suquamish Tribe.

Project Organization

In a Memorandum of Agreement between the Suquamish Tribe and DOH in June 1997, the Suquamish Tribe was designated as study manager with overall responsibility for insuring that the study would be conducted and a final report prepared for DOH approval in accordance with terms of the ATSDR grant. Frank Westrum, of DOH, and Margaret Duncan, study manager for the Suquamish Tribe Fisheries Department, subsequently worked together as co-principal investigators in all aspects of the study, including selection of a statistical consultant, survey design and pretest, training and supervision of interviewers, and survey implementation. Denise Laflamme, DOH, assumed responsibilities as co-principal investigator upon Mr. Westrum's transfer and worked with the Suquamish Tribe's study manager and co-principal investigator in the analysis and interpretation of survey results and the development of a draft and final report. Dr. Nayak Polissar, of The Mountain-Whisper-Light Statistical Consulting firm and Dr. Shiquan Liao, StatPro Consultants joined the project team as statistical consultants.

At the outset of the study, the Suquamish Tribe established an advisory committee for the purpose of exploring issues and providing guidance concerning questions which might arise during the survey. The Suquamish Tribe's Project Support Team was composed of two members of the Suquamish Tribal Council, the Director of Human Services, and the Self Governance Director, all of whom are enrolled Suquamish tribal members.

The Fishery Resource

The Suquamish culture finds its fullest expression in the acknowledged relationship of the people with the land, air, water and all forms of life found within the natural system. River systems, lakes and numerous small creeks historically supported abundant coho, chinook, sockeye and chum runs, with other salmonids and marine fish available as well. The same forests which sustained life in the riparian zones also harbored deer, bear, and other wildlife. Vast expanses of intertidal habitat supported shellfish. By virtue of the Treaty of Point Elliott[1], Suquamish rights to fish and interests in their habitat were recognized to include the marine waters of Puget Sound from the northern tip of Vashon Island to the Fraser River in Canada, including Haro and Rosario Straits and streams draining into the western side of central Puget Sound.

Increased levels of development as well as pollutants from residential, industrial, and commercial uses have resulted in degraded habitats and harvesting restrictions. There were eleven Superfund sites within the immediate area of the Port Madison Indian Reservation at the time the fish consumption survey was conducted.

Despite degraded water quality and habitat, tribal members continue to rely on fish and shellfish as a significant part of their diet. All species of seafood are an integral component of the cultural fabric that weaves people, the water, and the land together in an interdependent linkage which has been experienced and passed on for countless generations.

Significance of the Data

Suquamish tribal members engage in subsistence, ceremonial, and commercial harvesting throughout the federally adjudicated "usual and accustomed" fishing grounds and stations (U&A). It is anticipated that reported rates of consumption of salmon, other marine fish, and shellfish through the survey will be utilized in risk assessments to result in cleanup levels which will be protective of human health as well as of benefit to the natural resources upon which Suquamish tribal members continue to depend.

Currently, seafood consumption rates from a survey of the Tulalip Tribes and Squaxin Island Tribe (Toy et al.) are being used to develop risk assessments, cleanup levels, and other regulatory standards for aquatic areas in Washington State, including Puget Sound (Washington State Department of Ecology). These data are valuable for illustrating to environmental and regulatory agencies that differences exist in seafood consumption habits among Puget Sound tribes.

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[1] The treaty between the Duwamish, Suquamish and other tribes was signed in January 1855, and is known as the Treaty of Point Elliott. The Tribes ceded land to the United States and retained certain rights and privileges. Treaties were negotiated and signed by Governor Issac Stevens on behalf of the United States and leaders of Puget Sound and Columbia River Tribes in 1854 and 1855. All of the treaties signed during this period contained articles which specified that the Tribes retained their rights to fish in their "usual and accustomed fishing grounds and stations" and to harvest shellfish in areas not staked or claimed by settlers. These articles are the basis for the references made in U.S. v. Washington and other court cases and documents to Tribal treaty fishing rights in their "U&A", i.e., their "usual and accustomed fishing areas."

Cultural Patterns and Practices Affecting Suquamish Seafood Consumption

The name "Suquamish" comes from the main village site of the Suquamish people. Located along Agate Passage in the central part of what is now known as Puget Sound, *d'suq'wub* means the place of "clear salt water." (*Eyes of Chief Seattle*, 16). The name of the home of the Suquamish people reflects their culture and their marine orientation. From the time that knowledge was first imparted and shared through the present, finfish from the oceans, rivers, estuaries, and streams as well as shellfish from the shore areas have been of critical importance to tribal members for subsistence, ceremonial, and commercial purposes.

Pre-Contact Era

Puget Sound tribes are generally described as exhibiting a strong reliance on salmon as a stable subsistence food base. Estuaries, river banks, beaches, and sandspits provided protected places to trade, fish, gather shellfish, plants, berries and other foods and materials, and enjoy social connections during seasonal migrations. From earliest times, the Suquamish are recognized as people who traveled beyond their winter home areas in the Kitsap Peninsula to Elliott Bay, Mukilteo, and other areas in order to procure sufficient food resources (Larson and Lewarch, Haeberlin).

Archeologists Larsen and Lewarch, while noting cultural similarities in terms of subsistence, linguistic, settlement, and other patterns and practices among tribes prior to the coming of Europeans, also caution that archeological, ethnographic and historic evidence, and inferences from the pre-contact era suggest discernible differences "in types and/or quantities of food resources available and utilized within their resident geographic location" (Larsen and Lewarch, I-9). Seasonal shellfish gathering, for example, is noted as an important part of the Suquamish subsistence strategy which "necessitated special trips to productive beaches to procure shellfish for winter storage and trade" (Larsen and Lewarch, I-12). These patterns persisted through the period which is known as the transition era, in the last half of the nineteenth century, after treaties between Puget Sound tribes and the United States were signed and European settlement occurred in earnest.

The Era of Transition

The time of transition must have been wrenching. The era for Puget Sound tribes is regarded as spanning roughly a half a century, from the mid-1800s through the early 1900s. The increased settlement and harvesting of natural resources on a large scale by Euro-Americans displaced Puget Sound tribes and bands and disrupted their normal ways in every sense. As Castille described it, "The almost total overturning of the way of life of the Salish peoples was accomplished within a period no greater than a single lifetime" (Castille, xiii). Nonetheless, photographs in the Suquamish tribal archives attest to the continuation of vital elements of the Suquamish culture: canoes sailing up Puget Sound or pulled up on the beach at low tide in front of a long house; clams and salmon cooking and drying; a fisher in a dugout canoe, gillnet over the bow with fish; and people digging clams on the beach, with clam baskets in the foreground.

Myron Eells began recording habits and practices of Indians of Puget Sound in 1875, twenty years after treaties were signed between tribes and bands of the Puget Sound area and the United States. Together with his father and brother, Eells observed life among Puget Sound tribes, and served as an active missionary on the Skokomish reservation from 1874 through 1907. He wrote during the time when "[m]uch of Indian life had already undergone accommodation and adjustment to the Anglo-American society that had engulfed it..." (Castille, vii). Eells' notebooks include descriptions of cultural patterns and practices which he observed among the "Sukwamish," identified as "...living on the Duwamish River and its tributaries, and on the islands and peninsulas across the Sound, west of the same region" (Castille, 20). His descriptions of seafood consumption patterns and practices, because they are regarded as factual by Suquamish scholars, are provided below. The observations of Wayne Suttles as recorded in *Northwest Coast (*Smithsonian Institution, Vol. 7) are also noted.

Eells' list of species of finfish eaten by tribal members in the transition era includes the five species of Pacific salmon (which Eells identified as silver, red, dog, black, and hump-backed); trout; flounders (two varieties); codfish (two varieties); herring; smelt; halibut; sturgeon; cuttlefish; dogfish "when food is very scarce;" and twe-kweits (Castille, 53). Skate, too, is noted as part of the subsistence diet. Suttles similarly reports that all five species of salmon and steelhead "were the staple," and that herring, smelt, flounder, lingcod, rockfish, sculpins, and halibut were also harvested (Suttles, 488).

Varieties of shellfish which Eells observed tribal members eating were listed as clams (three varieties), crabs (two varieties), mussels, oysters, and scallops. Sea eggs, porpoise, and hair seal were also part of the diet of tribal members (Castille, 53). Suttles notes that although whales were not hunted in this part of Puget Sound, beached whales, together with their oil, were eaten. In addition to Dungeness and red crabs and sea urchins, Suttles identifies important shellfish species as including "the littleneck clam, butter clam, horse clam, cockle, geoduck, bay mussel, and native oyster" (Suttles, 489). He also notes that twenty species of waterfowl were harvested and consumed.

Fish Parts Consumed

Codfish and salmon eggs were highly prized, according to Eells. He adds that oil of whale, seal, porpoise, and dogfish "was formerly eaten, and still is to some extent" (Eells, 58).

Preparation of Seafood

Eells' notebooks reflect that salmon, smelt, herring, and halibut were eaten both dried and fresh, and that herring and smelt were dried whole. Whereas halibut was dried after being cut into strips, salmon were dried "after being cut open and the head and back bone removed," (Eells, 58). Describing the drying of salmon as "a large business of the summer," Eells notes that the salmon were not generally salted. Suttles writes that butter clams, horse clams, and cockles "were dried for later use or trade" (Suttles, 489).

Ceremonies and Gatherings

Ceremonies and gatherings are documented by Eells and others as important components of traditional life among Puget Sound tribes. Distributions of "food and wealth" accompanied the celebration of a naming, the announcement of a daughter's puberty, and other important events in families' lives. Foods served at potlatches included salmon and clams (Suttles, 497).

Memories of Transition through Contemporary Times

In the Spring of 1982, Suquamish Tribal Elders received a letter from the Suquamish Tribe Oral History Project Team which began: "With all due respect, we come to you to ask to help us to preserve the history of the Suquamish people and their ways. Through the remembrances that you have of your life, you open a window so that we too can see a part of the way of life of the Suquamish."

Thus did the Suquamish Tribe initiate its Oral History Project. Tribal Elders born in the 1920s and earlier were interviewed singly, and their knowledge and experiences concerning various aspects of Suquamish Tribal history and culture were shared and discussed at monthly Elders' luncheons. Information that was imparted by the Elders regarding fish and shellfish gathering and preparation is summarized below (1982 Oral History Project, Tribal Archives).

Tribal Elders participating in the Oral History Project told interviewers that salmon, flounder, rock cod, smelt and herring, and all kinds of clams were important to the Suquamish people. Family members worked together along beaches to gather oysters, cockles, and mussels from the surface. Digging littlenecks; horse clams, both gray and brown necks; and butter clams was also part of traditional life.

Though some tribal members had taken up logging, picking hops, and other activities to earn money, fish and shellfish harvesting, preparation and consumption were critical components of the community and family life. One Elder explained that "quite often, they generally cooked a meal down at Chief Seattle park [the area from Old Man House Park to the foot of the bluff along Angeline Avenue, Suquamish] there during the day when they were all working together and cleaning fish or clams or whatever they were doing...there'd be quite a gathering there pretty regular." Another recalled that during the depression days, "...you didn't have much of anything, but we still never went hungry. We always had something to eat. Like I always said, they couldn't starve me to death anyhow. As long as the tide went in and out, I could live on clams."

Besides eating dried cockles, butter clams, and horse clams during the winter, people recalled how their mothers and grandmothers always had dried clams behind the stove, and how things were done. One Elder recollected how her grandmother made duck soup and remembered the dried clams behind the stove. She then described the family activity:

> "She dried the horse clams and butter clams and cockles. She dried them. We dug them in big bunches in baskets, wire baskets, then we would take them home and she would build a rack. She built a rack herself, her and [two uncles] and they would fix it so the

> clams were on sticks and they all lined up, leaned against this rack she had, and she'd cook them on that side until they got nice and brown, and then we would turn them over and cook them on the other side, and she'd leave them there until they kind of –you know--dry like?...Then they would take them off and put them on cedar bark—make strings out of cedar bark and string them on that."

Elders also spoke of smoking salmon. Explained one: "Well, we'd smoke a heck of a lot, my Dad and me...they'd get hard...just like a stick...An' then when...we wanted to eat some or something, why, ah, we'd put in some boiling water and eat 'em. But they were pretty good, pretty good for winter time." Another Elder recalled: "We filled the smokehouse in them days." The recorded thoughts of yet another elder impart the shiver of change: "We got a little smoker, one of those Little Chief smokers in the... in the house...in the back. But we haven't got a...we haven't got a hold of enough fish to do it."

Transcripts reveal continuing importance of herring and smelt as well as changes in storage methods.

> "We dried the herring...But from...through...June 25 to around the first of January, you were pretty tired of smelt by that time, and there was...there was plenty of it...But in those days you could dry a whole gunny sack full and just hang it in the corner in the smokehouse, and it would be good for halfway through the summer, until the smelt was running again...what they do nowadays, we freeze it."

Altogether, the Oral History Project has made it possible for people to appreciate more than the variety of species gathered and eaten fresh, smoked and dried. The window which the elders opened also provides a glimpse of a traveling people, a waterborne people. Elders recollected fishing from the Fraser River during fishing season to the Hoh and other little rivers, fishing "out of Westport and...ah, and around the Sound..." And shellfish were also dug and gathered seemingly "all around." Included in places traveled to by small boat, canoe, and dugout were the beaches under the Agate Pass Bridge, past Keyport to Marine Drive and Clam Island, and along a beach in old Elwood. "Rocky Point--We picked oysters there and dug clams there...bring them to Chico [Silverdale area] and then ship them to Seattle from there."

The travelings during the early 1930s of one Elder with family and friends imparts a picture which many continue to carry in their hearts and minds:

> "And you could go, ah, well across from NAD [Navy Ammunition Depot, formerly Naval Magazine Puget Sound, now known as the Jackson Park Housing Complex), all of that, along in through there, up in Oyster Bay. Up on Oyster Bay and Marine Drive and, ah, over Tracyton, and that little Clam Island out there off of Silverdale. But that only shows up on a minus tide. But there was, ah, an awful lot of clams on there. And it was good up until the, ah, State let these guys in there with them dredgers go in there and dig clams that way. Them machine operators clam diggers'd tear up the beaches."

One of the Elders, when discussing the cultural impacts and changes that occurred in the post contact era nonetheless affirmed that continued availability of natural resources is possible where the will exists:

> "...We'd like to live like they did years ago, and we're getting too crowded. We don't have the space, we don't have enough fish to [go] around, all that stuff...Anybody that thinks they're going to make it clam digging is better change their route pretty darn quick...I'm afraid we've over dug it now. Once they're over-dug, they never come back unless you get in there and replant... I think, ah, even the Good Book says you got to put in before you take out if you're going to do any good."

Current Management Issues

The affirmation of treaty fishing rights by George Boldt in February 1974 (U.S. v. Washington) signaled a different relationship between Washington treaty tribes and the state government. As a result of assuming responsibilities as co-managers of the aquatic resources, tribal governments work with the Washington State Department of Fish and Wildlife (WDFW) to regulate finfish and shellfish harvest management plans for conservation purposes and human health concerns. Many Suquamish tribal members lament that butters "are always hot" these days, and fishermen tell of catching rockfish in Sinclair Inlet and releasing them back into the water rather than taking them home to their families. Harvesters now call the Suquamish Tribal Fisheries Hotline to verify marine fish openings and subsistence shellfish digs. Commercial shellfish digs must be scheduled 48-hours in advance.

It has been a long time since people have had the opportunity to watch while great numbers of salmon make their way upstream to spawn. When the tides are out, there are fewer cockles. Nonetheless, and despite all the changes, tribal members retain their attachment to a way of life which once revolved around seasons, cycles, ceremonies, and celebrations. Children still teethe on dried clams, salmon is still served at gatherings, and family members continue to share their harvest with one another. The stories that are woven into the statistics presented in this report will not be forgotten.

Methodology

Sample

Sample Selection

Survey respondents were selected using the Suquamish Tribal enrollment database, which provides residence, gender, age, and other attributes for each enrolled member. The database is maintained by the Suquamish Tribe Enrollment Officer.

Eligibility for recruitment into the survey was driven by enrollment in the Suquamish Tribe; residence, being on or near the Port Madison Reservation; and age, being over 16, or under six years old living in the household of an eligible adult.

The sample size was determined in May 1998, using Suquamish Tribal enrollment data provided in March 1998. A total of 425 individuals of all ages were identified as living within reservation boundaries (Suquamish, Indianola, and part of Poulsbo) and in nearby incorporated and unincorporated communities of North and Central Kitsap County, including Hansville, Kingston, Bainbridge Island, Poulsbo, Silverdale, and Bremerton.

Of the 425 individuals living on and near the reservation, 284 eligible adults were selected into the sample, and 42 children under six years of age were identified. At the time the sample size was determined, the total enrollment of the Suquamish Tribe was 831 individuals. Of the total, no current address was available for 107 enrolled adults. Residence was unevenly distributed throughout the United States, including Alaska.

Target Population

Enrolled Suquamish Tribal members of special interest included children under six years of age; women of childbearing years, identified by the Suquamish Tribe as between the ages of 16 and 42; and Tribal Elders (ages 55 and over). Exposure to contaminants through the consumption of seafood by members of these age groups is of particular concern to ATSDR, the funding agency for this study. In addition to residence, gender, and age, other attributes of interest were vessel ownership, registration as a vessel crew member or operator, and holder of a Suquamish Tribe shellfish sticker/ID.

The roster list of the 425 enrolled tribal members was updated on April 7, 1998, and age was computed from the birth date April 3, 1998 (the reference date). Of the 42 children under six years whose names appeared on the enrollment roster list, there were 17 of whom there was no tribally enrolled adult listed as living in the same household. The project team decided to obtain children's consumption data from adults selected into the sample who had children under six years of age living in their households. This decision was made in part due to anticipated difficulty of contacting tribally enrolled children who were not listed as residing in households also occupied by enrolled tribal adult members. The number of children could not be determined in advance of the survey.

Table T-1, below, provides a summary of the 284 eligible adult tribal members from which the respondents were selected.

Table T-1. Characteristics of Eligible Respondents

AGE	MALE				FEMALE				TOTAL Male & Female
	Total Male	Vessel Owner	Vessel Operator	Shellfish License/ID	Total Female	Vessel Owner	Vessel operator	Shellfish License/ID	
16 – 42	103	23	65	48	85	6	61	29	188
43 – 54	29	17	8	15	21	4	14	3	48
55 and over	25	8	16	4	23	3	17	4	48
All ages	155	48	89	67	129	13	92	36	284

Of the 284 eligible adults in the enrollment database of The Suquamish Tribe, the average age was 38 years (standard deviation [SD] = 16). The range of the ages was 16 through 85. Sixty-six percent of the 284 adults were between 16 and 42 years of age; 17% were 43 through 54 years old; and the remaining 17% were Elders (age 55 and over).

Fifty-five percent of the 284 eligible adults were men, and 45% were women. One hundred three (36%) were shellfish license/ID holders, 61 (22%) owned fishing vessels, and 181 (64%) were vessel operators.

Sample Size and Representation

The desired sample size was specified to provide approximately a +/- 20% precision on estimated means. Precision was defined as the half-width of a 95% confidence interval on the logarithmic scale. The antilogarithm of this half-width should be approximately 20% of the antilog of the mean consumption rate on the log scale. The calculation requires the standard deviation (SD) on the logarithmic scale. In a previous study of fish consumption, a summary standard deviation (SD) of fish consumption—on the logarithmic scale—had been estimated from the 5^{th} to 95^{th} percentiles of four published fish consumption studies (Toy et al.). The 5^{th} to 95^{th} percentiles of the normal distribution span 3.3 SD units, so the SD of lognormally distributed fish consumption rates can be estimated as SD = [(log 95^{th} percentile)-(log 5^{th} percentile)]/3.3. The logarithm to base ten is used throughout this report. The sample size for 20% precision can be calculated as $n = [1.96 \times SD/ \log(1.2)]^2$. The 20% precision criterion appears as the " .2" part of "1.2" in this equation, and the 95% confidence limits used to specify precision are embodied in the multiplier 1.96. The earlier studies considered in Toy et al. had a mean SD = 1.15. The total fish consumption rates for the combined Tulalip and Squaxin Island Tribes had 5^{th} and 95^{th} percentiles (0.047, 2.936 g/kg/day, respectively) implying an SD of 1.26—slightly more variable than the summary SD from earlier studies. The mean SD (implied by percentiles) from all five studies combined was 1.17, yielding a sample size of 158 (rounded down to 150) to achieve a precision of approximately ±20%.

Sampling Procedure

The target sample size was n = 150 adult enrolled tribal members. An initial sample of 160 eligible adults was generated to allow for some attrition. A systematic random sample of adults age 16 or over was selected from a sorted roster of 284 eligible adults. The roster was sorted to ensure proper representation of key groups (e.g. both genders) in the following hierarchical order: households with a child (age birth through 5) present versus those without; gender (male/female); age group (55 and over, 35 to 55, and 16 to less than 35); and, finally, possession of a shellfish license/ID (yes/no). Using a random starting number, the systematic sample was selected across the sorted list of 284 eligible adults.

Sampling of Children

Initially, the project team discussed the possibility that relatively few tribally enrolled children under six years of age might be encountered through contact with adults selected into the sample. To increase the probability of obtaining data on a larger number of children, the scope was widened for inclusion of children. However, difficulty was experienced in reaching children listed in the enrollment database for whom there were no corresponding street addresses for adult tribal members. Accordingly, the project team determined that the best way to obtain consumption data for children was through adults selected into the sample.

Data collection was not limited to tribally enrolled children. Rather, it was broadened to include any children under six years of age who had lived within the household of the adult respondent regularly and for at least one year or since birth. Thus, formally the target population consisted of all children, enrolled or not enrolled, under age six, living in the household of an enrolled adult respondent and who had been living in the household regularly for at least one year or since birth.

Questionnaire, Display Booklet, and Seafood Models

Questionnaire Development

Prior to drafting the survey instrument for the study, the study manager reviewed questionnaires developed by the CRITFC and the combined survey of the Tulalip Tribes and Squaxin Island Tribe (Toy et al.) for seafood consumption surveys of tribal members. Also reviewed was a draft of the survey instrument developed for a study of seafood consumption among Asian and Pacific Islander population of King County, state of Washington (Sechena et al.).

The questionnaire for the Suquamish Tribe survey was designed to be administered by personal interview. Physical models and illustrations of selected finfish and shellfish were shown to respondents to identify types of seafood consumed and to determine portion sizes typically eaten. Maps showing catch management areas within the Suquamish Tribe's U&A were shown to respondents to determine harvest locations of seafood consumed by the respondent.

Early in the process of questionnaire development, ATSDR communicated its desire that the survey instrument elicit information on amounts per meal of each type of seafood consumed,

frequency of seafood meals, and consumption according to seasonality and throughout the year. Also requested were age groupings that would provide insight into consumption habits of populations deemed to be most sensitive to chemical contaminants: children five years of age and younger, women of childbearing years (16 through 42 years) and Elders (55 and over).

Transcripts of The Suquamish Tribe Oral History Project conducted in 1982 were reviewed early on to gain insight on past seafood consumption patterns and practices as reported by Elders (Suquamish Tribe Oral History Project). Tribal harvesters were consulted concerning fish and shellfish important to tribal members for subsistence, ceremonial and commercial purposes. Suquamish Fisheries Department biologists were consulted concerning salmon, marine fish, and shellfish harvest data by reporting area and assisted in developing fish groups used in the questionnaire. As well, the project team met with Suquamish Tribal Elders to introduce the study and to benefit from their discussion and guidance concerning seafood consumption patterns and practices.

The Suquamish Tribe's Director of Human Services provided guidance concerning age groupings, the participation of Elders in questionnaire development, and other aspects of the survey. Epidemiologists with DOH confirmed that asking whether respondents consume fish eggs and other internal organs in separate questions would be appropriate for two principal reasons. First, because of the high lipid content of eggs, eggs may contain elevated concentrations of organic chemicals compared to fillet. As well, literature suggests that anglers are more inclined to report consumption of eggs when eggs are separated from other internal organs (Westrum, 1997, personal communication).

Finfish and Shellfish Groups

Finfish Groups A, B, D, and F

For ease in administering the questionnaire, finfish and shellfish were grouped into categories (Figure 1). At the outset of the Suquamish study, the study manager consulted with Suquamish fisheries biologists to develop fish groupings which reflected similarities in life history as well as practices of Suquamish Tribal members who fish for subsistence, ceremonial, and commercial purposes. Suquamish fishermen and Tribal Elders also provided input.

With the exception of Group A (Pacific salmon), the finfish groups utilized in this study are not considered "pure" in terms of biological behavior and life cycles. Sturgeon, technically anadromous, are placed with finfish in Group C, which are otherwise described as pelagic. Similarly, smelt, which are anadromous, are in a separate group along with herring, which are pelagic. Rockfish, which are pelagic, are placed in a group with bottom, or benthic fish in Group D.

Smelt harvested by Suquamish Tribal members, though biologically anadromous, typically spawn in the nearshore saltwater environment, as do herring. Since incidents of spawning in fresh water systems in the Kitsap County are unknown, it was judged reasonable to include smelt

in a separate Group B along with herring, since both are available to subsistence harvesters when they come to the nearshore environment to spawn.

With the exception of sturgeon, Group C is comprised of finfish which are referred to as pelagic. Sturgeon, although biologically anadromous, are bottom dwellers and are harvested by Suquamish Tribal fishers in pelagic waters incidental to salmon fishing. Fresh water systems are generally not available and hence not utilized by Puget Sound sturgeon for spawning purposes. Hence, it was considered appropriate to include sturgeon with Group C.

Group D is comprised of halibut, sole, flounder, and rockfish. With the exception of rockfish, these fish are identified and used in bottom and benthic assemblages for risk assessment and public health advisory purposes. Rockfish may rightfully be considered an oddity in this assemblage. Yet, East Kitsap species have a high degree of site fidelity. The decision to include rockfish with bottom fish was driven by their propensity for site fidelity, which makes them dependent upon prey resources from the same sediment which comprise the habitat of bottom dwellers. In terms of consumption pathways and risk exposure, it was considered appropriate to include rockfish caught and consumed by Suquamish Tribal members with bottom fish.

Group F is straightforward, representing a mix of finfish reported by respondents. Group F includes canned and fresh tuna, pelagic species (mackerel and shark), and bottom or benthic species (skate and eel). Grunters are also included in this grouping, as are marine mammals (seal and whale [muktuk]). This group was provided to enable interviewers to record consumption of finfish, which are not included in tables on the questionnaire.

Shellfish Groups E and G

Shellfish are identified in two groups. Group E is comprised of shellfish currently consumed most often by Tribal members. Group G lists shellfish currently consumed less frequently.

Display Booklet and Seafood Models

A Display Booklet (Appendix A-3) was developed to assist respondents in providing consumption data and identifying harvest locations of seafood consumed. The first pages provide a listing of finfish and shellfish by groups as they appear on the questionnaire, along with lists and illustrations of additional finfish and shellfish. Colored maps displaying management and catch area boundaries are included as an aid in identifying harvest locations.

Physical models of finfish and shellfish listed in Groups A through E (see Figure 1) were constructed or drawn and displayed to assist respondents in determining typical food portions. Shells of manila and littleneck clams, cockles, horse clams, butter clams, and oysters used as models were harvested by a Suquamish Tribal member from two locations in the reservation area used often by tribal members for subsistence and ceremonial harvests so that size would be generally representative. Groups of shells were placed in bowls or on plates and glued onto a display board. The geoduck which was weighed and then sketched for a drawing on the display board was secured from the Suquamish Fisheries Department during a period when geoducks were being distributed to tribal members. The geoduck shell was placed on top of the drawing

on the display board to provide dimension. Mussels, scallops, and Dungeness crab of a size typically harvested by tribal members were purchased at a local grocery store. Mussel shells were glued together and placed in a bowl. Models were made of the scallops and placed on a small plate. Before being broken apart for weighing purposes, a Dungeness crab was sketched for a drawing on the display board. As with the geoduck shell, interviewers placed the carapace on top of the drawing to provide dimension. Weights noted on display boards were in grams or ounces.

Figure 1. FINFISH AND SHELLFISH GROUPS
(by common name)

Group A – Salmon
King (Tyee, Chinook)
Sockeye (Red)
Coho (Silver)
Chum (Dog)
Pink
Steelhead

Group B -Finfish
Smelt
Herring

Group C - Finfish
Cod (Rock, Tom)
Perch
Pollock
Sturgeon
Sable fish
Spiny dogfish (Shark)
Greenling

Group D - Finfish
Halibut
Sole
Flounder
Rockfish

Group E - Shellfish
Manila, littleneck clams
Horse clams
Butter clams
Geoducks
Cockles
Oysters
Mussels
Moon snails
Shrimp
Dungeness crab
Red rock crab
Scallops
Squid
Sea urchin
Sea cucumber

Group F – Other Finfish
Tuna, canned and fresh
Mackerel
Shark
Skate
Eel
Grunters
Other aquatic resources
Marine mammals (seal, whale [muktuk])

Group G – Other Shellfish
Limpets
Lobster
Bullhead
Manta ray
Razor clams
Chitons
Octopus
Abalone
Crayfish
Barnacles

Raw seafood was weighed and used for modeling salmon, scallops, shrimp, smelt, herring and Dungeness crab. Clams were pried open carefully so that the raw "meat" could be weighed. The shells were then glued shut and were arranged into groupings in bowls or plates. Weights and portion sizes portrayed on the display boards were the same for each set of models used by the interviewers. Respondents were asked to refer to the model for salmon to estimate typical portions of halibut, sole, flounder, rockfish, cod, and other fish. Respondents looked at the

models of fish and the groupings of shellfish in bowls, and expressed typical portion sizes in fractions or multiples of what the model portrayed.

No models were made for squid, sea urchin, sea cucumber, moon snail, red rock crab, selected finfish, aquatic resources (seal and whale [muktuk]), and shellfish included in Group G. It was decided that the seafood models which were provided could serve as surrogates for certain types, and that otherwise, respondents would be generally comfortable with estimating typical portion sizes in ounces or grams independent of models.

Survey Questionnaire

The survey questionnaire of thirty-nine pages (Appendix A-1) is divided into four parts, each of which is discussed below. The four parts of the survey questionnaire are:

1. A 24-hour dietary recall,
2. Identification, portions, frequency of consumption of fish, preparation, harvest location,
3. Shellfish consumption, preparation, harvest location, and
4. Changes in consumption over time, cultural information, physical information, and socio-economic information

Part one is comprised of a 24-hour dietary recall form which elicits information on whether seafood was eaten during the previous day, where it was prepared, and the amount (Appendix A-1, pages 3 and 4). Questions about adult finfish consumption according to season, portions eaten, parts consumed and preparation methods are asked in the first section of Part Two (Tables I through III, questions 1-18). Information is sought by species within four groups (Figure 1). Interviewers showed respondents a display card of fish groups listed in the questionnaire. Illustrations of finfish and shellfish using Mac's Field Guides (Mountaineers) were also shown to respondents to secure information on consumption of finfish and shellfish indicated by Elders and others as consumed less frequently and/or less available (Groups F and G).

Following the identification, portions, and frequency of consumption of salmon, smelt, and herring (Groups A and B), respondents are asked which parts of the fish they typically eat and percentages of the time they eat those parts. Categories of interest are eggs, head, bones, organs and skin, with eggs separated out from other internal organs and skin. This is followed by method of preparation. The two categories are: baked, roasted/barbequed, soup, stew, or poached; and smoked, canned, fried, or raw. Salads and dips are included in the latter category. Respondents are then asked to indicate what percentages of salmon which they consume are obtained from the following sources: grocery stores; fish from Puget Sound caught by the respondent, family members, the Suquamish Tribe, and/or friends; fish from outside Puget Sound caught by the respondent, family members, and/or friends, restaurants, and "other." After identifying sources of salmon consumed, respondents are invited to identify harvest locations, if they know them, referring to U&A maps in the Display Booklet (Appendix A-3). The last part of the finfish section solicits consumption information on cod, perch, pollock, sturgeon, and other fish listed under Group C. Questions concerning fish parts consumed, preparation, and sources follow. In the final section of Part Two, respondents are requested to provide

information on consumption, portion size, preparation, and harvest locations for halibut, sole, flounder, and rockfish (Group D).

Part Three of the questionnaire is devoted to questions concerning shellfish consumption, preparation, and harvest locations (Appendix A, Tables IV and V, questions 19-27). In addition to identifying consumption of shellfish such as manilas and littleneck clams, butter clams, geoducks, cockles and others listed in Group E, respondents are asked to provide typical serving portions and the number of portions per year or number of portions per day, week, or month for the corresponding period within a year. Interviewers ask respondents to refer to seafood models to indicate portion sizes they typically consume. Responses are recorded by the interviewer after the respondent refers to the display models, giving fractions or multiples of the model. For example, the respondent would look at the cockle shell and say that s/he typically eats three as one serving, and the interviewer would record "3" in the appropriate space. Respondents are then asked to provide information on the percentages of time the species are eaten whole or by parts (siphon [neck] and strap only, siphon only, siphon and stomach, and other, as appropriate). Shellfish preparation methods are identified in two categories: baked, steamed, boiled, broiled, roasted or poached; and canned, smoked, dried, fried or raw. Respondents are also asked what they typically do with the nectar resulting from steaming or boiling and of the shellfish, with the options identified as "use it in cooking," "drink it," "throw it out," and "unknown/non-applicable."

After responding to questions on sources of shellfish, respondents are invited to provide harvest location information for shellfish listed in Group E (questions 24 and 25) using display maps corresponding to catch reporting areas for marine fish and shellfish (Appendix A-3). As is true for salmon and other marine fish harvest locations, the interviewer clearly states that the respondent may decline to provide the information.

Finally, adult respondents are asked whether they consume tuna fish, including typical portions and frequency, and to provide the same information concerning other finfish and shellfish not listed in the questionnaire.

After noting the respondent's gender in question 28, women are asked whether they have given birth within the last five years and, if so, to respond to questions concerning breast feeding. If the respondent responds affirmatively to the question asking whether there are children under six years of age living in the household (question 33), the interviewer asks for the first names of all children who are five years and younger who have been living in the household since birth or regularly for at least one year. The respondent is then asked to provide information on up to three children, selected by the interviewer using a random number table if there are more than three children fitting the criteria (questions 34 through 42). General questions include tribal enrollment (Suquamish, other tribe, or not enrolled in any tribe), gender, weight, height, age, number of months each child was breast-fed, and the age at which each child began to eat seafood. After indicating the percentage of time the adult respondent is present during meals with the child(ren) and whether s/he prepares the majority of the child(ren)'s meals, the adult respondent is asked to provide information about finfish and shellfish consumption if s/he is comfortable and confident about doing so. In table form, consumption data is sought for finfish by groups corresponding to those used in the adult's section of the questionnaire, and for

shellfish listed under Group E. Categories concerning portion size, consumption frequency and parts consumed are the same as those used for adult respondents.

The fourth and final part of the questionnaire is devoted to questions concerning changes in consumption over time (questions 43-45), fish and shellfish consumed at gatherings, ceremonies or community events (questions 46-49), and age, weight, height, and household income (questions 50-53).

At the conclusion of the interview, respondents are asked to sign a form verifying that the interview occurred, writing in the date and time, and placing and sealing the form in an envelope to be provided to the study manager along with the completed questionnaire (Appendix A-2).

Data Collection and Processing

Data Collection Procedures

Suquamish Tribal members were recruited to administer the questionnaire through personal interview of respondents in the respondent's home, at the Tribal Center, or a location of the respondent's choice. Interviewers recorded responses to questions and referred respondents to seafood display models and the display booklet containing illustrations of finfish and shellfish and U&A maps showing harvest management areas.

The survey was conducted during the months of July, August, and September 1998. Timing coincided with tribal participation in salmon and other finfish and shellfish fisheries for subsistence, ceremonial, and commercial purposes. There were two community wide cultural celebrations which occurred during the survey period: a celebration at the Suquamish Tribal Center for participants and families involved in Summer 1998 canoe journeys in which Canadian, Coastal and Puget Sound tribal members participate, and the annual Chief Seattle Days celebration in Suquamish.

Following a short article in the Suquamish Newsletter distributed monthly to all enrolled members of the Suquamish Tribe, a letter from the Chairman of the Suquamish Tribal Council was mailed to all individuals included in the sample (Appendix B). The letter invited participants to telephone the study manager to arrange for an interview, and indicated that the approximately one hour interview could be conducted at the Suquamish Tribal Center, the respondent's home or another location of the respondent's choice, during the weekday and on weekends, at hours most convenient for them. The Chairman also indicated that an honorarium of $25.00 would be provided to participants in appreciation for their time.

The study manager and interviewers began to contact participants by telephone and through personal conversations upon meeting them casually in the community one week after the Chairman's letter was mailed. Up to eight attempts were made to confirm and/or reschedule an appointment. A general rule that a participant should not be formally asked to reschedule after three broken appointments was also observed unless the respondent asked for an additional appointment. Project team members were encouraged to exercise their judgement in accordance

with cultural norms. In certain cases, members of the tribal support team were asked to assist in encouraging participation and determining participants' willingness to participate in the survey.

Data Processing

Interviewers provided the study manager with completed survey questionnaires within one week of having completed the interview. The study manager reviewed each completed survey questionnaire and consulted with the interviewer concerning ambiguous or incomplete answers within one week. If necessary, the interviewer contacted the respondents to obtain clarification. All completed survey questionnaires were subjected to a field validation. This editing process was used to check for expected and plausible relationships across data fields.

The study manager provided completed survey questionnaires to statistical consultants for data processing. A double key entry procedure was employed to minimize data entry error. The "double entry" procedure involved 100% re-entry and comparison of all data. Any discovered inconsistencies in data entry were promptly corrected.

Quality Assurance/Quality Control in Survey Implementation

Pretest

A survey pretest was conducted during November and December 1997. Because it was anticipated that many actual survey interviews would occur in people's homes, pretest participants were invited to bring their children to the interview at the Suquamish Tribal Center to simulate home conditions. Toys, crayons, shells, and other items were provided to children accompanying adult participants in the pretest at the Tribal Center.

Project team members identified residence and other characteristics that would span those of survey respondents and recruited enrolled adult members of the Suquamish Tribe to assist with the survey as pretest participants. Ten pretest participants with characteristics noted below were interviewed and were offered the same honorarium which was provided to survey participants.

Residence:
At least one respondent living on the Port Madison Indian Reservation
At least one respondent living off the reservation, within Puget Sound

Gender:
At least two male respondents
At least two female respondents

Children under the age of six living in the household since birth or regularly for one year:
At least one respondent with no children fitting the criteria
At least one respondent with at least one child fitting the criteria

Age:
At least one female between the age of 16 through 42
At least one Elder (55 years of age and older)

Fishing/Shellfish License/ID:
At least one licensed shellfish harvester
At least one fishing vessel licensed operator or owner

Participants were invited to comment and make suggestions about all aspects of the survey. The Display Booklet and seafood models were altered pursuant to pretest participants suggestions. Drawings of a Dungeness crab and a geoduck of the size distributed to tribal members by the Suquamish Tribe were added to the display boards. The respective drawings were covered with the carapace and shell in order to add dimension. Pretest participants found the standard black and white WDFW salmon, marine fish, and shellfish management and catch reporting area maps showing locations within the Suquamish Tribe's U&A difficult to read. Hence, the maps were substituted in the display booklet with colored area maps developed by the Suquamish Tribe GIS specialist (Appendix A-3).

In the pretest instrument, respondents were asked to state their relationship to children under six years of age whom they identified as living within their household since birth or regularly for at least one year. Pretest subjects commented that that information was irrelevant and intrusive. The project team had expressed the same concerns prior to the pretest. The relationship question was eliminated and replaced with two questions which ask the respondent to estimate the percentage of time s/he is present with the children during meals and whether the s/he prepares the majority of the meals eaten by the listed children.

Pretest participants were not comfortable with reporting their weight, and suggested that the question be made optional or eliminated. This suggestion was not adopted, given the goals and objectives of the seafood consumption survey. Participants remarked that estimating percentages for various activities, for example, sources of seafood consumed and preparation methods, required thought, but observed that they could not think of another way to elicit the information. The dietary recall question was altered pursuant to the suggestion that respondents' identification of ounces or grams would be preferable to asking them to estimate snacks or seafood portions according to "small, medium, and large." Three questions concerning consumption at ceremonies, gatherings, and community events were reformatted into tables to assist the interviewer. Other tables in the questionnaire were refined.

One pretest participant suggested that rather than asking a respondent to initial the top sheet of the survey instrument, a form verifying that the interview took place could be signed and sealed in an envelope by the respondent and retained as a separate record. This suggestion was adopted (See Participation Verification Form, Appendix A-2).

Interviewer Training

Four Suquamish Tribal members participated in one day of training in survey techniques, including a supervised practice session with the questionnaire, display booklet, seafood display

models, and interview verification forms. Training was provided by Jude Ballard, of the Fred Hutchinson Cancer Research Center. Co-principal investigators Frank Westrum, DOH, and Margaret Duncan, Suquamish Tribe, also discussed approaches, techniques, and other issues commonly encountered in survey research, including maintaining rapport, avoiding the introduction of bias, and securing accurate and complete information. Tina Jackson, a member of the project team and Suquamish Tribal member, took the lead in the group's discussion about the cultural context within which the survey was being conducted. Special attention was devoted to effective use of the models and display booklet, rescheduling, and how, given multiple contacts, to know whether a respondent who didn't directly say "no" actually did not wish to participate. In questionable cases, interviewers were encouraged to pass a questionnaire on to another interviewer or the study manager, who could then initiate a "fresh" contact. An additional half day of training and orientation focused on respondent notification, securing cooperation, maintaining an interview schedule, project team cooperation and coordination, the cultural context, and related matters. Interviewers once again practiced interviewing one another using the display booklets and seafood models.

Final training occurred with each interviewer conducting a full, unsupervised interview of another tribal member who had not been selected into the sample. The interviews served as the final "dress rehearsal" in which interviewers gained insight and confidence in pacing the interview, using the display booklet and seafood models effectively, and sensing when to repeat questions. The study manager reviewed the completed questionnaires and experiences with each interviewer.

Procedures for Protecting Confidentiality

Information from the tribal enrollment roster was coded by the study manager and provided to the statistical team. Respondents' names were provided neither to the statistical team nor to individuals who coded the completed questionnaires.

Tribal members selected for the study were sent a letter of invitation to participate by the Chairman of the Suquamish Tribal Council (See Appendix B). In addition to introducing the study, the Chairman assured participants of confidentiality. At the beginning of each interview, interviewers emphasized that all of the information which would be provided during the interview would remain confidential and that responses to the questions would be combined with those of other respondents so that answers and information could not be associated with identifiable individual respondents.

At the time interviews were scheduled, post-it notes identifying respondents were affixed to a large envelope containing each questionnaire. Each questionnaire reflected an identification number assigned by the study manager and retained on the master sample list, which was kept in a locked file. Upon completion of the interview, the post-it notes were destroyed. Upon delivery to the study manager, the questionnaire and the verification form were separated and stored separately from the master sample list.

Statistical Methods

Consumption Rates

Respondents were invited to provide consumption information on types of finfish and shellfish by when the fish was "in season" and "during the rest of the year" or "throughout the year." For a specific type of finfish or shellfish, the consumption for a respondent was calculated by multiplying the portion size typically eaten by the respondent by the "frequency" of consumption (number of times consuming the specific type of fish). The consumption was computed for "in season" and "during the rest of the year," separately. Finally, the sum of the consumption for the two time periods yields an annual consumption (in grams) for the specific type of fish. Division of annual consumption by 365 days and the weight of the respondent yielded a weight standardized daily consumption rate in units of grams/kilogram body weight/day (g/kg/day). The individual types of seafood were also aggregated into groups based on similarities in life history as well as tribal member practices. A respondent's consumption rate for a finfish and shellfish group was calculated by adding together the rates for individual types of finfish and shellfish in that group.

Presentation of Results

Survey results are presented in this report in several forms. Consumption rates are reported for adults and children, including non-consumers, as the mean, the standard error (SE) of the mean, the median (50^{th} percentile) and other percentiles as noted. For some rates, a 95% confidence interval is reported for the mean in tables in Appendix C. The confidence interval is calculated as the mean ±1.96*SE. The maximum consumption rate is reported in some tables. Also reported are the percentage of respondents who are consumers of a particular type of finfish or shellfish or one or more types within finfish and shellfish groups, as well as the geometric mean of the consumers' rates. Consumption rates are reported for consumers only as the mean, SE of the mean, median, 75^{th} and 90^{th} percentiles (Appendix C, Tables C-2 and C-7).

A quantity designated as the "multiplicative standard error" (MSE) is also presented. It is defined as the anti-log of the standard error of the log of consumption rates (for consumers only). The MSE can be used to form a confidence interval for the geometric mean of the consumers' consumption rates as follows. For a 95% confidence interval, the MSE can be raised to the power of 1.96 and the resulting value can be used to multiply and divide the geometric mean for the upper and lower confidence limits, respectively. In addition, the MSE can be used in a calculation that indicates the variability of the consumption rates among consumers only. To do this, the MSE is raised to the power $\sqrt{n}$. The result can be referred to as a multiplicative standard deviation (MSD). It would be very common to find members of the sample who differed by one MSD unit (for example, these might three or four-fold differences). As well, it would not be uncommon to find members of the sample who differed by the square of the MSD, multiplicatively. Thus, if the MSD were 3.0, it would be very common to find members who differed in their consumption rates by a factor of three, and it would not be uncommon to have nine-fold differences.

Hypothesis Testing

The statistical significance of differences in consumption rates between groups was based on the Mann-Whitney test for comparison of two groups or the Kruskal-Wallis test for comparison of three or more groups. A nonparametric test has been used because of the skewness of the fish consumption rate distribution. Throughout the report, $p<0.05$ is considered statistically significant.

Distribution of Consumption Rates

In this study, the consumption rate is expressed on a common scale after adjusting for the respondent's weight in units of grams/kilogram body weight/day. Some large fish consumption rates were encountered in the data. Using strictly numerical criteria, some of these rates might be designated as "outliers." The term "outlier" sometimes carries a connotation of error. However, the study staff were familiar with a number of the individuals with large consumption rates and maintained that the reported rates were likely to reflect real consumption. Thus, no adjustment for potential outliers has been carried out. Consumption rates that are more than three standard deviations above the mean for a group of species are listed in the appendix (Appendix C, Table C-5). The large consumption rates of some individuals may be quite influential in the calculation of the mean. Throughout most of this report, the median consumption rate is used for comparing consumption rates between types of finfish and shellfish, groups of finfish and shellfish, and for comparing consumption rates among groups of respondents, such as men and women.

Statistical Dependence among Reported Rates

A fraction of adult respondents (19 out of 92) was drawn from households providing two respondents. This posed the potential for statistical dependence among observations. However, between-household variance in total adult consumption rates of finfish and shellfish was of comparable magnitude to the within-household variance, suggesting that adults within the same households have relatively independent consumption. Thus, standard errors and confidence intervals for adults have not been adjusted for possible statistical dependence.

Among children there is more clustering of respondents within households than among adults. Among the 31 children included in the survey, 13 were drawn from households which provided only one child each and 18 children were drawn from eight households which provided responses for two or more children. Two households provided three children each and six households provided two children each. There was greater dependence of consumption rates among children in the same household than was found among the adults in the same household. The children's between-household variances were considerably larger than within-household variances. For total seafood consumption, the within-household variance was 0.73 versus 6.5 between households. (The units are the square of g/kg/day.) The corresponding figures for finfish consumption were 0.08 (within) and 1.53 (between), and for shellfish consumption, 0.52 and 4.24. These variances show that children in the same household had relatively similar consumption rates compared to the differences observed between households. However, standard errors in the tables have not been adjusted. Thus, the true standard error would be

somewhat larger than those presented, and the confidence intervals would be somewhat wider. If the standard error were calculated based on 21 households rather than 31 children, it would be larger by a factor of about $\sqrt{(31/21)} = 1.2$, or 20% larger. Similarly, confidence intervals would be about 20% wider. The actual adjustment for a type of finfish or shellfish or a finfish or shellfish group would depend on the observed rates across and within households.

Adjustment of Reported Values

Several of the questions answered by respondents require them to estimate the percentage of time that various activities were carried out (for example, eating fillet only, versus eating fillet plus skin) along with the requirement that the reported percentages add to 100%. There was a very small incidence of responses where percentages did not add to 100, and the reported percentages were simply increased or decreased by a common multiplier specific to the question and the respondent so that they would add to a total of 100%.

Results

Descriptive Characteristics

A total of 92 enrolled tribal adults responded to the survey out of 142 considered eligible in an initial sample of 160 adults. The participation rate was 64.8%. All respondents consumed at least one type of finfish or shellfish. Thus, no respondents were excluded due to non-consumption.

Table T-2 provides a demographic profile of the respondents included in the survey. Adult respondents were split equally between men and women. Respondents were relatively young, with 63% in the age 16 through 42 age-group. The women respondents were somewhat younger than men, with 72% in the 16 through 42 age-group, compared to 54% of men. Men had a greater mean weight than the women (87 vs. 71 kilograms [kg]) and a somewhat wider range, 45 to 120 kg for men and 45 to 114 kg for women. The mean weight gap narrows with age, with a 22 kg gap (mens' minus womens' mean weight) at ages 16 through 42, down to 4 kg at ages 43 through 54, and 6 kg among Elders (age 55 and over).

Table T-2. Demographic and Descriptive Statistics

Adult respondents (n=92)

		Body weight (kg)		
	n	Mean (± SE)	Median	Range
All male	46	87.1 (± 2.5)	85.1	45.4 - 120.3
All female	46	70.9 (± 2.1)	70.4	45.4 – 113.5
All respondents	92	79.0 (± 1.8)	79.5	45.4 – 120.3
Male, 16-42 years old	25	90.2 (± 3.7)	90.8	61.3 – 120.3
Male, 43-54 years old	10	87.9 (± 2.7)	86.3	77.2 – 104.4
Male, 55 years old and over	11	79.2 (± 5.1)	79.5	45.4 – 102.2
Female, 16-42 years old	33	68.3 (± 2.2)	63.6	48.6 – 95.3
Female, 43-54 years old	5	83.5 (± 8.1)	77.2	68.1 – 113.5
Female, 55 years old and over	8	73.6 (± 5.1)	75.8	45.4 – 90.8

	Age group (yrs)			
	16-42	43-54	55 and over	Total
Male	25 (54%)	10 (22%)	11 (24%)	46 (100%)
Female	33 (72%)	5 (11%)	8 (17%)	46 (100%)
All respondents	58 (63%)	15 (16%)	19 (21%)	92 (100%)

Children less than six years old (n=31)

	n	Mean (± SE)	Median	Range
Girls	13 (42%)			
Boys	18 (58%)			
Age (months)	31	41 (± 3.4)	48	9 - 72
Breastfeed duration (mo.)	18	5.3 (± 1.2)	2.5	1 – 18
Age start eating seafood (mo.)	26	12.2 (± 1.1)	11.0	2 - 24
Children body weight (kg)	31	16.8 (± 0.8)	17.3	8.2 – 29.5
% of time eat with respondent	20	70% (± 6%)	73%	25% - 100%

A total of 20 adult respondents provided data for 31 children under six years of age in 21 households. One of the adults, a non-tribal mother of the child whose tribal father was selected into the sample but never interviewed, provided consumption data for the child. The 31 children had a mean age of about 3 1/2 years (41 months). Sixty percent (18/31) had been or were being breast-fed at the time of the survey. Among those children who were eating seafood, the average age when they began consumption was approximately one year (12 months). There was a slightly larger percentage (58%) of boys than girls (42%). The mean children's body weight is 16.8 kg. Of the 20 respondents providing data for children under six, 65% (13/20) reported preparing the majority of meals for the child. Respondents reported that they were present for a mean of 70% of the children's meals.

Adult Consumption Patterns

Seafood consumption by the Suquamish Tribe is diverse, including over 50 distinct types of finfish and shellfish (Table T-3). Consumption rates include seafood consumed at ceremonies, social gatherings, and community events. Table T-4 presents aggregated finfish and shellfish groups to which consumption rates refer in the report.

Seventeen distinct types of finfish and shellfish were consumed by at least half of the respondents, and 26 were consumed by at least a quarter (25% or more) of the respondents. The most frequently consumed finfish (with over 90% of respondents consuming) were salmon (at social gatherings), followed by manila and littleneck clams, geoduck, shrimp, and tuna (fresh or canned). A number of finfish and shellfish listed in the table were consumed by fewer than half of the respondents. For all of these the median consumption rate is zero.

Fifty percent or more of the respondents consumed cod (n = 78) followed by halibut (n = 74), king salmon (n = 63), sockeye salmon (n = 59), coho salmon (n = 50) and smelt (n = 49). Fewer than 50% of the respondents reported that they consumed chum (n = 42), pollock (n = 40), other salmon unidentified (n = 32), steelhead (n = 26), sole/flounder (n = 20), herring (n = 14), pink salmon (n = 17) and rockfish (n = 12). Fewer than ten respondents consumed sturgeon, sable, perch, greenling, and dogfish. Eighty-three respondents reported consuming fresh or canned tuna.

Fifty percent or more of the respondents consumed ten types of shellfish: shrimp (n = 86), manila and littleneck clams (n = 84), geoduck (n = 83), Dungeness crab (n = 81), butter clams (n = 72), cockles (n = 61), oysters (n = 60), horse clams (n = 52), and scallops (n = 54). Fewer than 50% of the respondents reported consuming mussels (n = 25), squid (n = 23), red rock crab (n = 19), sea urchin (n = 6) and sea cucumber (n = 5).

Mean consumption rates of over 0.1 g/kg/day were reported for 13 finfish and shellfish. The mean consumption rate was highest for manila and littleneck clams (0.439 g/kg/day), which is more than twice the consumption rate of butter clams (0.206 g/kg/day), the second most frequently consumed type of shellfish.

Table T-3. Adult Consumption Rate (g/kg/day): Individual Finfish and Shellfish and Fish Groups

		All Adult Respondents (including non-consumers)					Consumers Only	
Group	**Species**	**n**	**Mean**	**SE**	**Median**	**90%tile**	**n**	**%**
Group A	King Salmon	92	0.137	0.023	0.041	0.445	63	68%
	Sockeye	92	0.108	0.019	0.027	0.428	59	64%
	Coho	92	0.104	0.021	0.010	0.470	50	54%
	Chum	92	0.111	0.024	0.000	0.348	42	46%
	Pink	92	0.007	0.002	0.000	0.032	17	18%
	Other Salmon, unidentified	92	0.055	0.025	0.000	0.167	32	35%
	Steelhead	92	0.029	0.011	0.000	0.062	26	28%
	Salmon (gatherings)	92	0.068	0.011	0.029	0.205	85	92%
Group B	Smelt	92	0.042	0.013	0.003	0.117	49	53%
	Herring	92	0.009	0.004	0.000	0.019	14	15%
Group C	Cod	92	0.107	0.021	0.046	0.275	78	85%
	Perch	92	0.0003	0.0002	0.000	0.000	2	2%
	Pollock	92	0.024	0.009	0.000	0.063	40	43%
	Sturgeon	92	0.004	0.002	0.000	0.000	8	9%
	Sable fish	92	0.001	0.001	0.000	0.000	5	5%
	Spiny dogfish	92	0.000	-	0.000	0.000	1	1%
	Greenling	92	0.0003	0.0002	0.000	0.000	2	2%
	Bull Cod	92	0.0002	0.0002	0.000	0.000	1	1%
Group D	Halibut	92	0.064	0.015	0.026	0.144	74	80%
	Sole/Flounder	92	0.011	0.004	0.000	0.028	20	22%
	Rockfish	92	0.022	0.011	0.000	0.045	12	13%
Group E	Manila/littleneck clams	92	0.439	0.141	0.077	1.080	84	91%
	Horse clams	92	0.041	0.010	0.005	0.112	52	57%
	Butter clams	92	0.206	0.050	0.049	0.486	72	78%
	Geoduck	92	0.166	0.035	0.041	0.392	83	90%
	Cockles	92	0.155	0.038	0.027	0.299	61	66%
	Oysters	92	0.107	0.023	0.021	0.348	60	65%
	Mussels	92	0.016	0.006	0.000	0.048	25	27%
	Moon snails	92	0.000	-	0.000	0.000	0	0%
	Shrimp	92	0.163	0.026	0.075	0.476	86	93%
	Dungeness crab	92	0.144	0.026	0.060	0.408	81	88%
	Red rock crab	92	0.008	0.003	0.000	0.016	19	21%
	Scallops	92	0.022	0.005	0.003	0.059	54	59%
	Squid	92	0.010	0.005	0.000	0.011	23	25%
	Sea urchin	92	0.002	0.001	0.000	0.000	6	7%
	Sea cucumber	92	0.003	0.002	0.000	0.000	5	5%
	Oyster (gatherings)	92	0.027	0.007	0.000	0.089	40	43%
	Clams (gatherings)	92	0.047	0.011	0.010	0.105	61	66%
	Crab (gatherings)	92	0.026	0.009	0.000	0.058	43	47%
	Clams (razor, unspecified)	92	0.047	0.015	0.000	0.137	35	38%
	Crab (king/snow)	92	0.0002	0.0002	0.000	0.000	1	1%

Table T-3 continued next page.

Table T-3 cont. Adult Consumption Rate (g/kg/day): Individual Finfish and Shellfish and Fish Groups

		All Adult Respondents (including non-consumers)					Consumers Only	
Group	Species	n	Mean	SE	Median	90%tile	n	%
Group F	Cabezon	92	0.001	0.001	0.000	0.000	1	1%
	Blue Back (sockeye)	92	0.0001	0.0001	0.000	0.000	2	2%
	Trout/Cutthroat	92	0.004	0.002	0.000	0.000	3	3%
	Tuna (fresh/canned)	92	0.116	0.016	0.060	0.313	83	90%
	Groupers	92	0.0003	0.0003	0.000	0.000	1	1%
	Sardine	92	0.001	0.001	0.000	0.000	1	1%
	Grunter	92	0.002	0.002	0.000	0.000	4	4%
	Mackerel	92	0.0001	0.0001	0.000	0.000	1	1%
	Shark	92	0.000		0.000	0.000	1	1%
Group G	Abalone	92	0.001	0.001	0.000	0.000	3	3%
	Lobster	92	0.022	0.007	0.000	0.085	22	24%
	Octopus	92	0.019	0.006	0.000	0.069	25	27%
	Limpets	92	0.010	0.009	0.000	0.000	2	2%
	Miscellaneous	92	0.0003	0.0003	0.000	0.000	1	1%
	Group A	92	0.618	0.074	0.350	1.680	92	100%
	Group B	92	0.051	0.016	0.003	0.128	49	53%
	Group C	92	0.136	0.025	0.055	0.369	87	95%
	Group D	92	0.097	0.021	0.029	0.206	76	83%
	Group E	92	1.629	0.262	0.740	4.555	91	99%
	Group F	92	0.124	0.016	0.068	0.352	85	92%
	Group G	92	0.052	0.017	0.000	0.128	42	46%
	All Finfish*	92	1.026	0.113	0.639	2.526	92	100%
	All Shellfish*	92	1.680	0.269	0.796	4.590	91	99%
	All Seafood*	92	2.707	0.336	1.672	6.190	92	100%

*Note: Three summary fish categories are created in this study: 1) "All Finfish" includes Group A, B, C, D, and F; 2) "All Shellfish" includes Group E and G; 3) "All Seafood" includes "All Finfish" and "All Shellfish." The following finfish and shellfish were not listed in the questionnaire, but were encountered in the survey and therefore allocated into appropriate groups for analysis: bull cod (Group C), snappers (Group D), razor or unspecified clams (Group E) and king or snow crabs (Group E). Finfish not listed in Group F but reported by the respondents include cabezon, blueback (sockeye), trout/cutthroat, groupers, and sardines.

Ceremonies, social gatherings, and community events were frequently cited as occasions at which respondents consumed seafood. Consumption of salmon, oysters, clams, and crabs on these occasions totaled a mean of 0.168 g/kg/day, which was 6% of the mean total seafood consumption rate (2.707 g/kg/day). Ninety-two percent of the respondents reported consumption of salmon at these occasions. Sixty-six percent of the respondents reported consuming clams. Forty-seven percent of the respondents reported consuming crabs, and 43% reported consuming oysters.

Adult Consumption by Finfish and Shellfish Groups

Table T-4 presents aggregated finfish and shellfish groups to which consumption rates refer in this section. Table T-5 displays adult consumption rates of fish groups by gender and for all finfish, all shellfish, and all seafood (all finfish plus all shellfish).

Table T-4. Grouping of Finfish and Shellfish for Analysis

Group/Fish Category	Common Name	Group/Fish Category	Species
Group A/Finfish	King Salmon	Group F/Other Finfish	Cabezon
	Sockeye		Blue Back
	Coho		Trout/cutthroat
	Chum		Tuna (fresh/canned)
	Pink		Groupers
	Other Salmon, unidentified		Sardines
	Steelhead		Grunters
			Mackerel
Group B/Finfish	Smelt		Shark
	Herring		
Group C/Finfish	Cod	Group G/Other Shellfish	Abalone
	Perch		Lobster
	Pollock		Octopus
	Sturgeon		Limpets
	Sable fish		
	Spiny dogfish		
	Greenling		
	Bull cod		
Group D/Finfish	Halibut		
	Sole/flounder		
	Rockfish		
Group E/Shellfish	Manila/Littleneck clams		
	Horse clams		
	Butter clams		
	Geoducks		
	Cockles		
	Oysters		
	Mussels		
	Moon snails*		
	Shrimp		
	Dungeness crab		
	Red rock crab		
	Scallops		
	Squid		
	Sea urchin		
	Sea cucumber		
	Clams (razor, unspecified)		
	Crab (king/snow)		

Note: Three summary fish categories are created in this study: 1) "All Finfish" includes Group A, B, C, D, and F; 2) "All Shellfish" includes Group E and G; 3) "All Seafood" includes "All Finfish" and "All Shellfish." The following finfish and shellfish were not listed in the questionnaire, but were encountered in the survey and therefore allocated into appropriate groups for analysis: bull cod (Group C), snappers (Group D), razor or unspecified clams (Group E) and king or snow crabs (Group E). Finfish not listed in Group F but reported by the respondents include cabezon, blueback (sockeye), trout/cutthroat, groupers, and sardines.
*Moon snails were included in the questionnaire, but no consumption was reported by the respondents.

The median consumption rate for all seafood, 1.67 g/kg/day, indicates consumption of approximately a third of a pound of seafood per respondent per day for a 79.0 kilogram respondent, the mean weight of adult respondents.

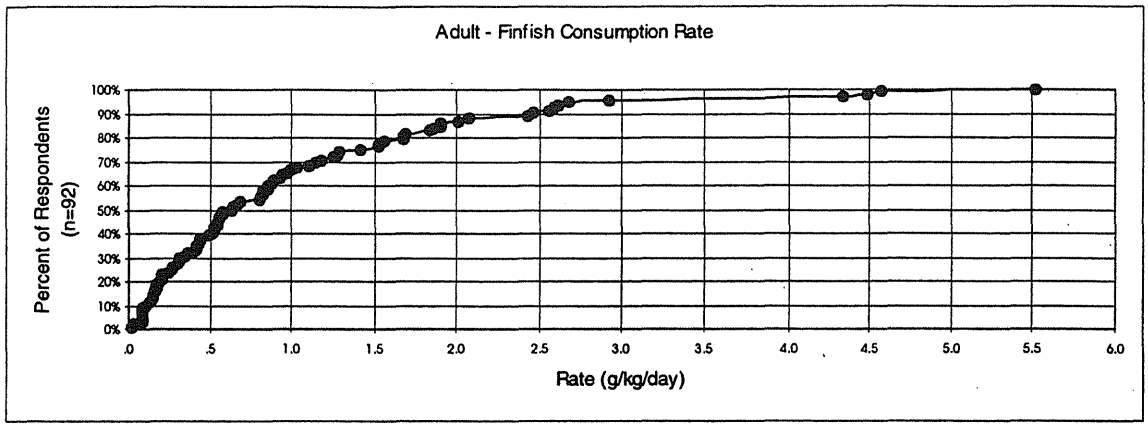
Consumption rates across individual types of finfish and shellfish and across groups were quite varied (Table T-3). Median consumption rates were higher for shellfish than for finfish (0.796 g/kg/day vs. 0.639 g/kg/day).

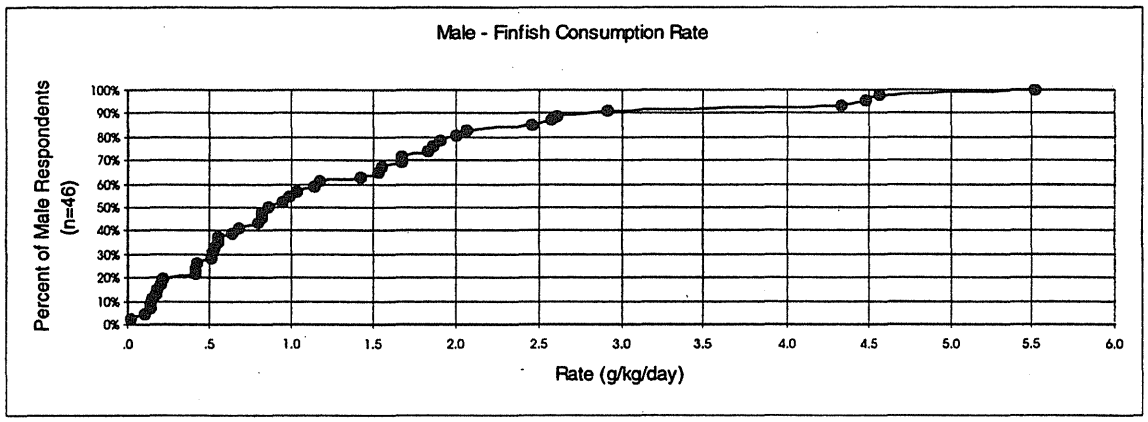
Respondents reported a median consumption rate of the 18 shellfish comprising Group E as 0.74 g/kg/day, the largest rate reported for any seafood group. A median consumption rate of less than 0.001 g/kg/day was reported for selected shellfish listed on the display card under Group G.

Table T-3 shows that reported fish consumption rates are quite skewed. Across all groups, the 90th percentile is usually several fold beyond the median consumption rate. For example, the 90^{th} percentile for "all seafood" consumption, 6.19 g/kg/day is almost four times as large as the median, 1.67 g/kg/day. This is also shown in Figures 2, 3, and 4. In the upper part of each of these plots, the very slow convergence of the plot line toward 100% is due to a few individuals with very high consumption rates. The consumption rate is also quite varied among respondents, as indicated by the multiplicative standard error (MSE). For example, the MSE for total seafood consumption is 1.123 for n = 92 respondents, yielding a multiplicative SD of $3.04 = \text{antilog}\,[(\log(1.123)) * \sqrt{92}\,]$. It would be common to find individuals whose total seafood consumption rates differed by one multiplicative SD unit, a factor of three, and, based on two standard deviations, ninefold differences would not be uncommon. The variability of finfish consumption rates would be very similar, starting from an MSE of 1.123. (See statistical methods, Appendix C (Table C-1), and Appendix D for further discussion.)

It appears that dividing the daily consumption rate (g/day) by body weight (kg) controls for the obvious tendency for consumption to depend on the weight of the individual. Scatterplots of consumption rate (g/kg/day) vs. body weight (kg), with each respondent contributing one point to the plot, show no trend between consumption rate (g/kg/day) and weight (kg) for each finfish and shellfish group (A – G) and for all finfish, all shellfish, and all seafood. Male and female respondent values were plotted separately for this analysis. Also, Spearman correlation coefficients between the paired weight-normalized consumption rates (g/kg/day) and weights are all less than a weak ± 0.3 and not statistically significant (i.e., p: > 0.05), with one exception. For smelt and herring (Group B), the correlation between the consumption rates of females and weight is 0.37, still somewhat weak, with p = 0.01. This significant correlation is only one exception out of 20 correlations calculated for the two genders and the seven finfish and shellfish groups (A - G) and the three summary categories (all finfish, all shellfish, and all seafood).

Figure 2. Adult Consumption Rate: All Finfish by Gender





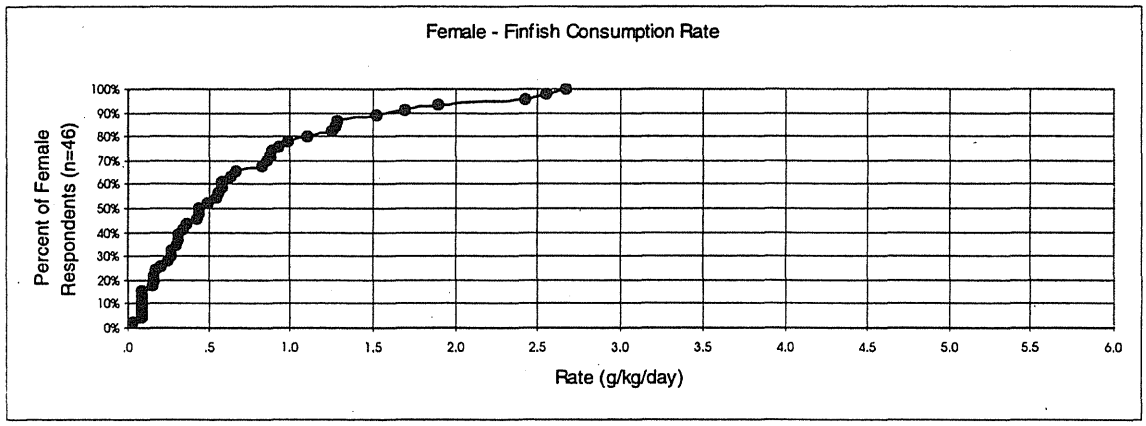
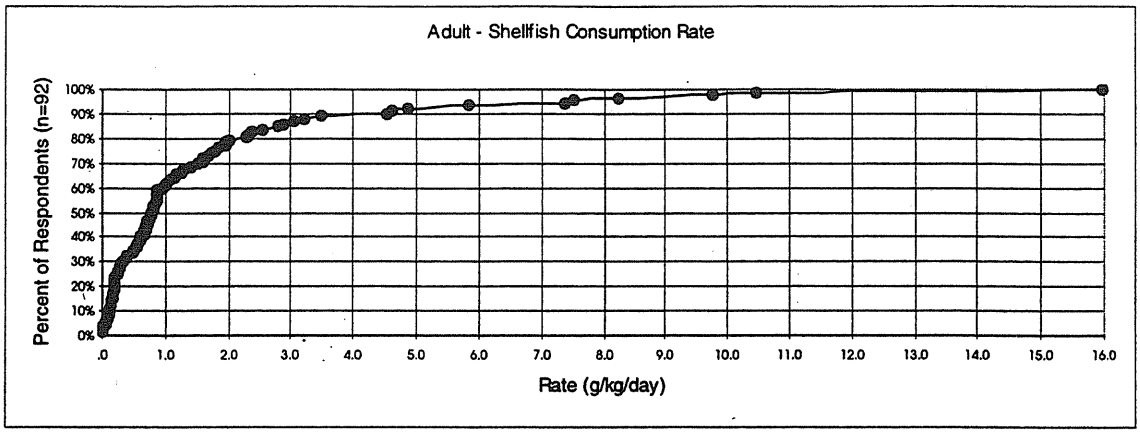
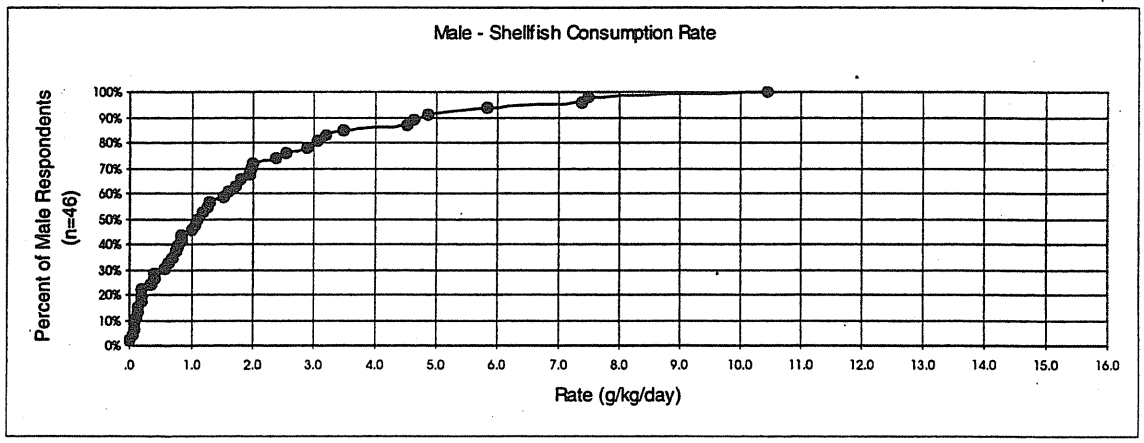


Figure 3. Adult Consumption Rate: All Shellfish by Gender





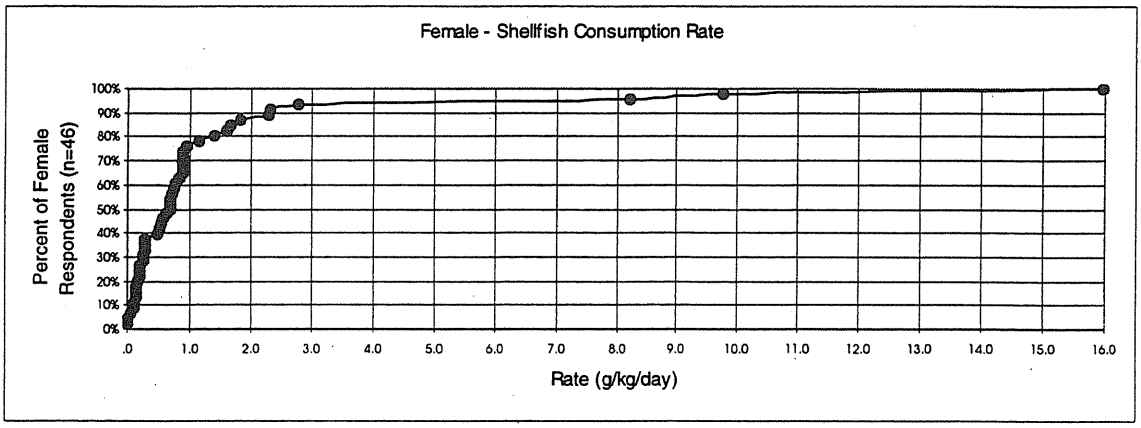
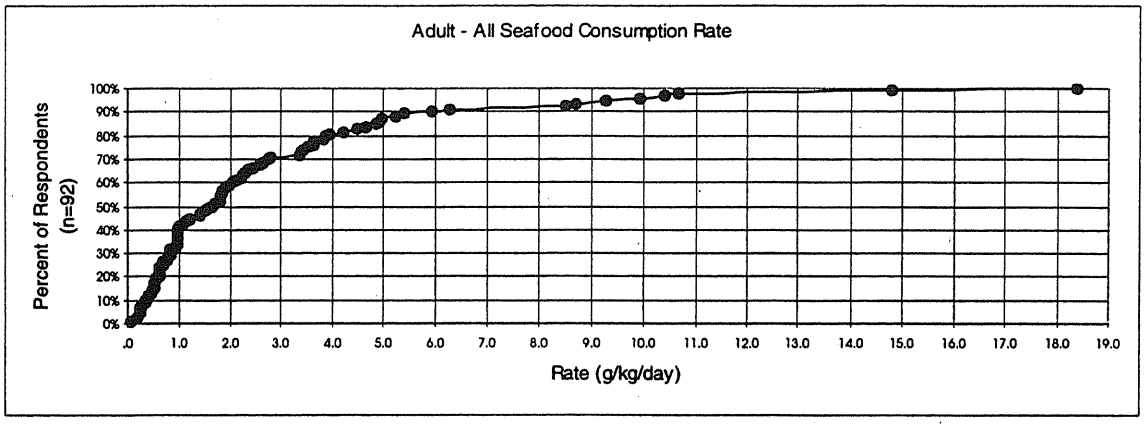
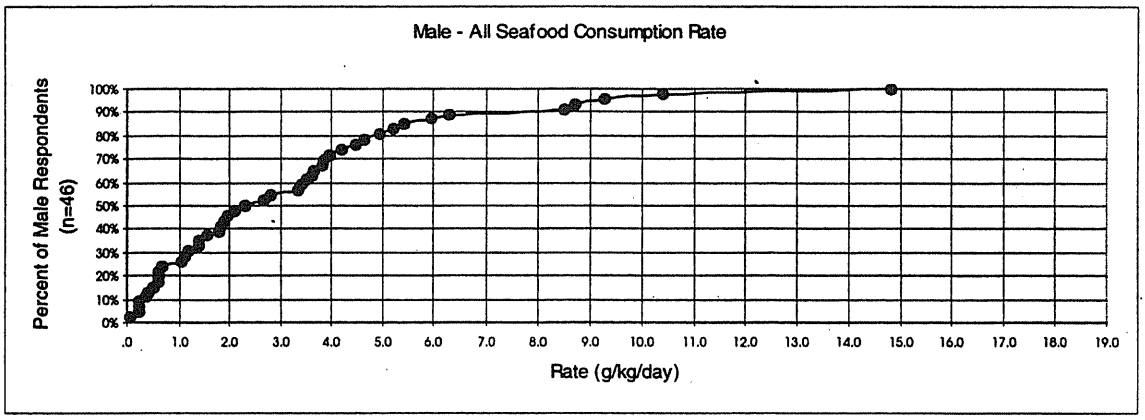
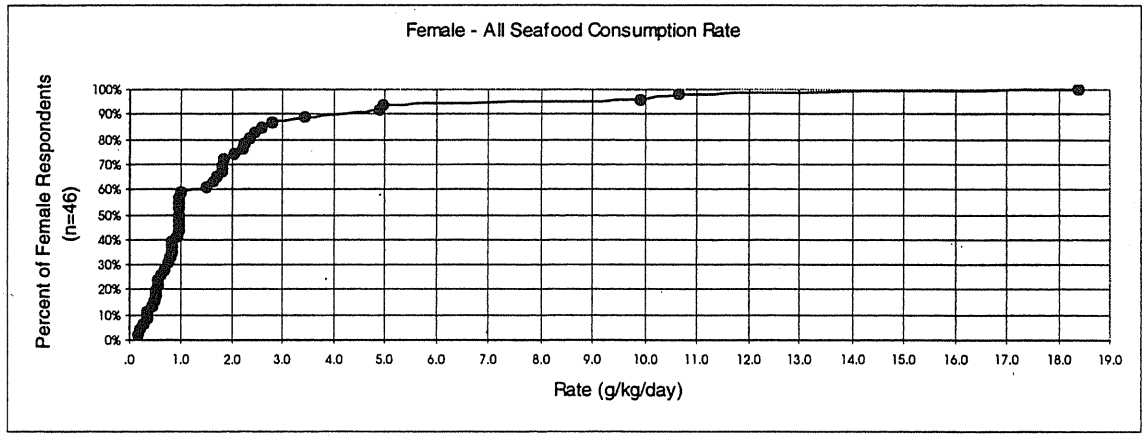


Figure 4. Adult Consumption Rate: All Seafood by Gender







Adult Consumption Rates by Gender

Adult men consumed more seafood per kilogram (kg) body weight than adult women overall and in each of the fish groups (Table T-5). The median male consumption rate was somewhat under double the female median consumption rate for most fish groups and more than double for some. For example, for all seafood, the male median rate of 2.473 g/kg/day was more than double the female rate of 0.965 g/kg/day. Among seafood groups with more than 0.02 g/kg/day median consumption rates, males and females had the most similar consumption rates (smallest ratio of medians) for finfish Group F. Of this seafood group, males consumed 0.072 g/kg/day and females consumed 0.052 g/kg/day. The difference between male and female consumption rates is highly significant for the all seafood consumption rate ($p = 0.008$) and also significant for all of the seafood groups in Table T-5 except for Groups D (bottom fish and rockfish), F (selected pelagic, bottom, and other aquatic resources), and selected shellfish listed in Group G.

Table T-5. Adult Consumption Rate (g/kg/day) of Fish Groups by Gender

	All Adult Respondents (including non-consumers)					Consumers Only	
	n	Mean	SE	Median	90%tile	n	%
Group A (p=0.02)							
Male	46	0.817	0.120	0.459	2.033	46	100%
Female	46	0.419	0.077	0.294	1.028	46	100%
Group B (p=0.04)							
Male	46	0.089	0.031	0.008	0.269	27	59%
Female	46	0.013	0.004	0.000	0.044	22	48%
Group C (p=0.03)							
Male	46	0.170	0.043	0.078	0.432	46	100%
Female	46	0.102	0.025	0.047	0.277	41	89%
Group D (p=0.08)							
Male	46	0.135	0.037	0.045	0.546	39	85%
Female	46	0.060	0.018	0.026	0.105	37	80%
Group E (p=0.03)							
Male	46	1.865	0.316	1.101	4.980	46	100%
Female	46	1.392	0.419	0.644	2.462	45	98%
Group F (p=0.6)							
Male	46	0.141	0.026	0.072	0.413	40	87%
Female	46	0.107	0.020	0.052	0.322	45	98%
Group G (p=0.2)							
Male	46	0.081	0.032	0.001	0.261	23	50%
Female	46	0.023	0.007	0.000	0.093	19	41%
All Finfish (p=0.007)							
Male	46	1.351	0.193	0.905	3.341	46	100%
Female	46	0.701	0.100	0.465	1.751	46	100%
All Shellfish (p=0.03)							
Male	46	1.946	0.335	1.121	5.146	46	100%
Female	46	1.415	0.421	0.678	2.462	45	98%
All Seafood (p=0.008)							
Male	46	3.297	0.458	2.473	8.563	46	100%
Female	46	2.116	0.480	0.965	4.898	46	100%

P-value for gender differences is two-sided and based upon the Mann-Whitney test.

Adult Consumption Rates by Age

Table T-6 presents adult consumption rates (g/kg/day) for finfish and shellfish groups by age. Median consumption rates were highest among respondents of the 43 through 54 age-group. Depending on the seafood group, median consumption rates were often two or more times larger than those for the 16 through 42 age-group and for Elders (55 years and over). The age differences in consumption rates were statistically significant for salmon (Group A) and smelt and herring (Group B), and for all finfish consumption.

Table T-6. Adult Consumption Rate (g/kg/day) of Fish Groups by Age

	All Adult Respondents (including non-consumers)					Consumers Only	
	n	Mean	SE	Median	90%tile	n	%
Group A (p=0.04)							
16-42 Years	58	0.512	0.083	0.294	1.544	58	100%
43-54 Years	15	1.021	0.233	1.020	2.468	15	100%
55 Years and Over	19	0.623	0.159	0.394	2.170	19	100%
Group B (p=0.001)							
16-42 Years	58	0.042	0.022	0.000	0.098	22	38%
43-54 Years	15	0.097	0.047	0.019	0.421	12	80%
55 Years and Over	19	0.041	0.017	0.010	0.182	15	79%
Group C (p=0.6)							
16-42 Years	58	0.122	0.026	0.055	0.301	54	93%
43-54 Years	15	0.117	0.029	0.078	0.339	15	100%
55 Years and Over	19	0.193	0.091	0.050	0.503	18	95%
Group D (p=0.2)							
16-42 Years	58	0.079	0.023	0.026	0.164	44	76%
43-54 Years	15	0.164	0.079	0.049	0.862	15	100%
55 Years and Over	19	0.102	0.038	0.033	0.513	17	89%
Group E (p=0.1)							
16-42 Years	58	1.537	0.289	0.740	3.513	57	98%
43-54 Years	15	2.241	0.571	1.679	6.115	15	100%
55 Years and Over	19	1.425	0.811	0.678	1.662	19	100%
Group F (p=0.5)							
16-42 Years	58	0.119	0.021	0.044	0.387	53	91%
43-54 Years	15	0.154	0.050	0.109	0.472	14	93%
55 Years and Over	19	0.115	0.029	0.072	0.302	18	95%
Group G (p=0.6)							
16-42 Years	58	0.052	0.024	0.006	0.126	30	52%
43-54 Years	15	0.088	0.043	0.000	0.420	5	33%
55 Years and Over	19	0.023	0.011	0.000	0.091	7	37%
All Finfish (p=0.03)							
16-42 Years	58	0.874	0.136	0.536	2.471	58	100%
43-54 Years	15	1.554	0.304	1.422	3.578	15	100%
55 Years and Over	19	1.074	0.247	0.861	2.424	19	100%
All Shellfish (p=0.1)							
16-42 Years	58	1.589	0.301	0.799	3.626	57	98%
43-54 Years	15	2.330	0.586	1.724	6.447	15	100%
55 Years and Over	19	1.447	0.815	0.688	1.837	19	100%
All Seafood (p=0.09)							
16-42 Years	58	2.463	0.387	1.270	6.206	58	100%
43-54 Years	15	3.884	0.781	3.869	9.725	15	100%
55 Years and Over	19	2.522	0.927	1.393	5.220	19	100%

P-value for age differences is two-sided and based upon the Kruskal-Wallis test.

For all finfish, the median consumption rate of 1.422 g/kg/day for respondents of the 43 through 54 age group was more than twice the rate for respondents in the 16 through 42 age group (0.536), and over 60% larger than the median rate for Elders (0.861). Among seafood groups showing consumption rates of at least 0.02 g/kg/day, the most similar consumption rates reported across age groups occurred for finfish Group C, which includes cod and pollock and where the consumption rates of respondents in the 43 through 54 age group were still about 50% larger than that for the other age groups.

Adult Consumption Rates by Combination of Gender and Age

As reflected in Table T-7, men ages 43 through 54 years had the highest consumption rate for all seafood combined, with a median consumption rate of 4.56 g/kg/day, followed by men ages 16 through 42 years (2.29 g/kg/day), women of age 55 and over (2.07 g/kg/day), and men of age 55 and over (median rate of 1.38 g/kg/day), women ages 16 through 42 years (median rate of 0.97 g/kg/day), and women ages 43 through 54 years (median rate of 0.77 g/kg/day). A similar ordering of age and gender groups by consumption rate was observed for all finfish and all shellfish.

Table T-7. Consumption Rate (g/kg/day) by Combination of Gender and Age

Fish Group	Gender and Age	n	Mean	SE	Median	90%tile	95%tile
Group A	Male, 16-42	25	0.720	0.145	0.445	2.043	2.163
	Female, 16-42	33	0.354	0.087	0.226	0.941	1.579
	Male, 43-54	10	1.323	0.300	1.292	3.302	
	Female, 43-54	5	0.418	0.168	0.335		
	Male, 55 and over	11	0.578	0.227	0.217	2.132	
	Female, 55 and over	8	0.686	0.230	0.449		
Group B	Male, 16-42	25	0.085	0.049	0.000	0.351	0.938
	Female, 16-42	33	0.009	0.004	0.000	0.003	0.098
	Male, 43-54	10	0.126	0.069	0.047	0.149	
	Female, 43-54	5	0.040	0.027	0.019		
	Male, 55 and over	11	0.062	0.027	0.014	0.245	
	Female, 55 and over	8	0.012	0.006	0.006		
Group C	Male, 16-42	25	0.168	0.044	0.101	0.528	0.869
	Female, 16-42	33	0.087	0.029	0.040	0.201	0.564
	Male, 43-54	10	0.131	0.040	0.101	0.389	
	Female, 43-54	5	0.091	0.039	0.050		
	Male, 55 and over	11	0.211	0.152	0.046	1.422	
	Female, 55 and over	8	0.169	0.072	0.078		
Group D	Male, 16-42	25	0.120	0.047	0.044	0.374	0.934
	Female, 16-42	33	0.048	0.018	0.026	0.095	0.261
	Male, 43-54	10	0.227	0.115	0.060	1.033	
	Female, 43-54	5	0.038	0.015	0.024		
	Male, 55 and over	11	0.085	0.046	0.024	0.447	
	Female, 55 and over	8	0.125	0.068	0.033		
Group E	Male, 16-42	25	1.922	0.459	1.038	5.910	8.633
	Female, 16-42	33	1.246	0.368	0.634	2.600	8.662
	Male, 43-54	10	3.088	0.716	2.354	7.159	
	Female, 43-54	5	0.548	0.185	0.500		
	Male, 55 and over	11	0.625	0.143	0.664	1.286	
	Female, 55 and over	8	2.525	1.917	0.683		
Group F	Male, 16-42	25	0.156	0.037	0.079	0.534	0.600
	Female, 16-42	33	0.092	0.023	0.033	0.326	0.495
	Male, 43-54	10	0.184	0.072	0.116	0.727	
	Female, 43-54	5	0.093	0.038	0.057		
	Male, 55 and over	11	0.068	0.026	0.032	0.271	
	Female, 55 and over	8	0.180	0.051	0.129		
Group G	Male, 16-42	25	0.090	0.054	0.013	0.188	1.024
	Female, 16-42	33	0.023	0.009	0.000	0.085	0.169
	Male, 43-54	10	0.132	0.060	0.035	0.532	
	Female, 43-54	5	0.000		0.000		
	Male, 55 and over	11	0.013	0.008	0.000	0.069	
	Female, 55 and over	8	0.036	0.023	0.004		

Table T-7 continued next page.

Table T-7 cont. Consumption Rate (g/kg/day) by Combination of Gender and Age

Fish Group	Gender and Age	n	Mean	SE	Median	90%tile	95%tile
All Finfish	Male, 16-42	25	1.249	0.263	0.823	3.282	5.160
	Female, 16-42	33	0.590	0.113	0.368	1.529	2.588
	Male, 43-54	10	1.991	0.379	1.882	4.404	
	Female, 43-54	5	0.680	0.196	0.560		
	Male, 55 and over	11	1.003	0.390	0.560	4.002	
	Female, 55 and over	8	1.172	0.268	1.018		
All Shellfish	Male, 16-42	25	2.012	0.495	1.081	5.910	9.575
	Female, 16-42	33	1.269	0.369	0.677	2.600	8.691
	Male, 43-54	10	3.221	0.727	2.532	7.215	
	Female, 43-54	5	0.548	0.185	0.500		
	Male, 55 and over	11	0.637	0.144	0.697	1.286	
	Female, 55 and over	8	2.561	1.926	0.683		
All Seafood	Male, 16-42	25	3.260	0.675	2.286	8.584	12.971
	Female, 16-42	33	1.858	0.429	0.965	4.919	10.140
	Male, 43-54	10	5.212	0.898	4.559	10.290	
	Female, 43-54	5	1.228	0.368	0.766		
	Male, 55 and over	11	1.640	0.447	1.381	4.848	
	Female, 55 and over	8	3.733	2.120	2.069		

The gender difference in consumption (males usually greater than females) is reversed for most categories among the Elders (age 55 and over). For groups A, C, D, E, and F, female Elders consumed more than male Elders, while males consume more than females in all other age groups for all seafood groups. For example, for Group A, the female Elder's median consumption rate, 0.449 g/kg/day was more than twice the male rate, 0.217 g/kg/day. In other seafood groups and for the other two age groups (16 through 42 and 55+), the male median rate is usually two or more times as large as the female rate.

Comparison with Dietary Recall

The total seafood consumption rate reported for the day preceding the interview was compared with the rate reported for year-round consumption. Twenty-seven types of finfish or shellfish or seafood groups were listed in the dietary recall question, and respondents were provided with an opportunity to identify other fish or shellfish not listed. Fifty-five percent of the respondents reported no seafood consumption the day before the interview. Mean consumption was 1.5 g/kg/day, including respondents with zero consumption the day before, compared with 2.7 g/kg/day from the full survey. The preceding day rates and annual rates were positively correlated (Spearman's rho = 0.41, $p < 0.001$). The positive and significant correlation indicates some consistency between the dietary recall and the body of the survey results presented in this report.

Portion Size per Serving

In reporting on typical portion sizes per serving consumed, respondents were given the choice to report the typical portion size of species consumed by "in season" and "rest of the year" or "throughout the year." In cases where respondents reported different consumption rates for the periods considered "in season" and the "rest of the year" the larger value of the two was utilized in reporting typical portion sizes.

Table T-8 displays adult portion sizes per serving. Typical portion sizes reported by the respondents varied substantially both across the type of seafood and across the survey respondents for the same type of seafood. The median reported portion size ranged from 72 grams per serving (scallops) to 448 grams (for cockles). The median portion size for most finfish/shellfish ranged between 150 grams to 300 grams per serving.

Table T-8. Portion Size (grams) per Serving of Finfish and Shellfish (consumers only)

	n	Mean	Median	90%tile	Minimum	Maximum
King Salmon	63	263	227	454	113	907
Sockeye Salmon	59	276	227	454	85	907
Coho Salmon	50	290	255	454	85	510
Chum Salmon	42	307	284	454	14	567
Pink Salmon	17	212	227	318	113	454
Other Salmon, unidentified	28	191	170	289	57	454
Steelhead	26	261	227	454	113	907
Smelt	49	216	180	360	36	907
Herrings	14	157	108	378	36	397
Cod	78	237	227	454	57	907
Perch	2	227	227	-	113	340
Pollock	37	152	113	454	28	680
Sturgeon	8	333	227	-	57	907
Sable fish	5	244	170	-	28	454
Dogfish	1	113	-	-	113	113
Greenling	2	312	312	-	170	454
Halibut	73	234	227	454	57	907
Sole/flounder	20	186	170	278	113	454
Rockfish	10	266	227	454	113	454
Manila/Littleneck clams	84	326	196	800	15	2268
Horse clams	51	216	138	441	57	1588
Butter clams	71	428	375	750	33	2268
Geoducks	82	376	272	900	45	2720
Cockles	60	564	448	1120	56	2240
Oysters	60	271	180	477	30	1361
Mussels	25	256	128	806	32	1134
Shrimps	86	300	189	650	13	2268
Dungeness crabs	81	327	261	522	57	1565
Red rock crabs	15	311	261	721	57	782
Scallops	51	137	72	432	24	720
Squid	23	194	108	590	18	907
Sea urchin	6	239	170	-	43	454
Sea cucumber	5	357	227	-	78	907
Tuna (fresh/canned)	83	159	170	215	43	1021

Among finfish groups, reported median portion sizes were largest for greenling (312 grams), followed by chum (284 grams), coho (255 grams), sockeye, king, pink, steelhead, cod, perch, halibut, rockfish and sturgeon (227 grams), smelt (180 grams), and sole/flounder, unidentified salmon species, tuna, and sable fish (170 grams). Reported portion sizes were smallest for pollock (113 grams) and herring (108 grams). Only one respondent reported eating dogfish.

Among shellfish, reported median portion sizes were largest for cockles (448 grams) and butter clams (375 grams). These portion sizes are followed by geoducks (272 grams), Dungeness and

Table T-7 cont. Consumption Rate (g/kg/day) by Combination of Gender and Age

Fish Group	Gender and Age	n	Mean	SE	Median	90%tile	95%tile
All Finfish	Male, 16-42	25	1.249	0.263	0.823	3.282	5.160
	Female, 16-42	33	0.590	0.113	0.368	1.529	2.588
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	Male, 55 and over	11	0.637	0.144	0.697	1.286	
	Female, 55 and over	8	2.561	1.926	0.683		
All Seafood	Male, 16-42	25	3.260	0.675	2.286	8.584	12.971
	Female, 16-42	33	1.858	0.429	0.965	4.919	10.140
	Male, 43-54	10	5.212	0.898	4.559	10.290	
	Female, 43-54	5	1.228	0.368	0.766		
	Male, 55 and over	11	1.640	0.447	1.381	4.848	
	Female, 55 and over	8	3.733	2.120	2.069		

The gender difference in consumption (males usually greater than females) is reversed for most categories among the Elders (age 55 and over). For groups A, C, D, E, and F, female Elders consumed more than male Elders, while males consume more than females in all other age groups for all seafood groups. For example, for Group A, the female Elder's median consumption rate, 0.449 g/kg/day was more than twice the male rate, 0.217 g/kg/day. In other seafood groups and for the other two age groups (16 through 42 and 55+), the male median rate is usually two or more times as large as the female rate.

Comparison with Dietary Recall

The total seafood consumption rate reported for the day preceding the interview was compared with the rate reported for year-round consumption. Twenty-seven types of finfish or shellfish or seafood groups were listed in the dietary recall question, and respondents were provided with an opportunity to identify other fish or shellfish not listed. Fifty-five percent of the respondents reported no seafood consumption the day before the interview. Mean consumption was 1.5 g/kg/day, including respondents with zero consumption the day before, compared with 2.7 g/kg/day from the full survey. The preceding day rates and annual rates were positively correlated (Spearman's rho = 0.41, $p < 0.001$). The positive and significant correlation indicates some consistency between the dietary recall and the body of the survey results presented in this report.

Portion Size per Serving

In reporting on typical portion sizes per serving consumed, respondents were given the choice to report the typical portion size of species consumed by "in season" and "rest of the year" or "throughout the year." In cases where respondents reported different consumption rates for the periods considered "in season" and the "rest of the year" the larger value of the two was utilized in reporting typical portion sizes.

Table T-8 displays adult portion sizes per serving. Typical portion sizes reported by the respondents varied substantially both across the type of seafood and across the survey respondents for the same type of seafood. The median reported portion size ranged from 72 grams per serving (scallops) to 448 grams (for cockles). The median portion size for most finfish/shellfish ranged between 150 grams to 300 grams per serving.

Table T-8. Portion Size (grams) per Serving of Finfish and Shellfish (consumers only)

	n	Mean	Median	90%tile	Minimum	Maximum
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Coho Salmon	50	290	255	454	85	510
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Pink Salmon	17	212	227	318	113	454
Other Salmon, unidentified	28	191	170	289	57	454
Steelhead	26	261	227	454	113	907
Smelt	49	216	180	360	36	907
Herrings	14	157	108	378	36	397
Cod	78	237	227	454	57	907
Perch	2	227	227	-	113	340
Pollock	37	152	113	454	28	680
Sturgeon	8	333	227	-	57	907
Sable fish	5	244	170	-	28	454
Dogfish	1	113	-	-	113	113
Greenling	2	312	312	-	170	454
Halibut	73	234	227	454	57	907
Sole/flounder	20	186	170	278	113	454
Rockfish	10	266	227	454	113	454
Manila/Littleneck clams	84	326	196	800	15	2268
Horse clams	51	216	138	441	57	1588
Butter clams	71	428	375	750	33	2268
Geoducks	82	376	272	900	45	2720
Cockles	60	564	448	1120	56	2240
Oysters	60	271	180	477	30	1361
Mussels	25	256	128	806	32	1134
Shrimps	86	300	189	650	13	2268
Dungeness crabs	81	327	261	522	57	1565
Red rock crabs	15	311	261	721	57	782
Scallops	51	137	72	432	24	720
Squid	23	194	108	590	18	907
Sea urchin	6	239	170	-	43	454
Sea cucumber	5	357	227	-	78	907
Tuna (fresh/canned)	83	159	170	215	43	1021

Among finfish groups, reported median portion sizes were largest for greenling (312 grams), followed by chum (284 grams), coho (255 grams), sockeye, king, pink, steelhead, cod, perch, halibut, rockfish and sturgeon (227 grams), smelt (180 grams), and sole/flounder, unidentified salmon species, tuna, and sable fish (170 grams). Reported portion sizes were smallest for pollock (113 grams) and herring (108 grams). Only one respondent reported eating dogfish.

Among shellfish, reported median portion sizes were largest for cockles (448 grams) and butter clams (375 grams). These portion sizes are followed by geoducks (272 grams), Dungeness and

Among women of childbearing age, 16 through 42, the frequency of parts consumed was very similar to that of the whole group, differing by four percentage points or less, except for salmon (Group A) (Table T-11). Women in the 16 through 42 age group consumed fillet with skin; eggs; and head, bones, organs or skin of salmon substantially less frequently than other adult respondents. Adult females consumed salmon fillet with skin and salmon eggs 10% of the time. The head, bones, organs, or skin were consumed 6% of the time by adult females.

Table T-11. Finfish Parts Consumed by Female Respondents Ages 16 through 42 (consumers only): Percent of Time Eaten in Specified Form

	Mean %	SE
Group A (n=31)		
Fillet with skin	10%	5%
Fillet without skin	90%	5%
Total	**100%**	
Eggs	10%	4%
Head, bones, organs, or skin	6%	3%
Group B & C (n=29)		
Fillet with skin	3%	3%
Fillet without skin	97%	3%
Total	**100%**	
Eggs	2%	2%
Head, bones, organs, or skin	2%	2%
Group D (n=24)		
Fillet with skin	8%	6%
Fillet without skin	92%	6%
Total	**100%**	
Eggs	4%	4%
Head, bones, organs, or skin	7%	4%

Shellfish Parts Consumed by Adults

Table T-12, below, displays the mean percent of shellfish parts consumed by respondents. Manila and littleneck clams (94%), oysters (97%) and mussels (100%) were most commonly eaten whole. In contrast, the most common form of consumption for geoducks was of the siphon and strap (55%), and for horse clams, the most common part consumed was the siphon only (42%). Butter clams and cockles were most commonly eaten whole. Of other shellfish listed in the table, the most common part consumed was the body (shrimp = 90%) or meat only (Dungeness and red rock crab, 74% and 79%, respectively).

Table T-12. Shellfish Parts Consumed (mean %) by Adult Respondents (consumers only): Percent of Time Eaten in Specified Form

	n	Whole	Siphon /Strap	Siphon Only	Siphon /Stomach	Other	Total
Manila/Littleneck clams	84	94%	5%	1%	0%	0%	**100%**
Horse clams	51	20%	36%	42%	2%	0%	**100%**
Butter clams	71	59%	40%	1%	0%	0%	**100%**
Geoducks	82	12%	55%	32%	0%	1%	**100%**
Cockles	60	43%	31%	24%	1%	2%	**100%**
Oysters	60	97%	3%	0%	0%	0%	**100%**
Mussels	25	100%	0%	0%	0%	0%	**100%**
		Body /Head	**Body Only**	**Head Only**			
Shrimp	86	10%	90%	0%		0%	**100%**
		Whole	**Crab Meat Only**	**Crab Butter Only**			
Dungeness crabs	80	24%	74%	0%		0%	**100%**
Red rock crabs	19	11%	79%	0%		10%	**100%**
		Whole	**Abductor Muscle Only**	**Gonads Only**			
Scallops	53	10%	89%	0%		0%	**100%**
		Whole	**Meat Only**				
Squid	22	23%	77%			0%	**100%**
Sea cucumber	4	25%	75%			0%	**100%**
		Egg	**Egg and Meat**				
Sea urchin	6	100%	0%			0%	**100%**

Note: Whole does not include shell.

Women of childbearing age consumed whole shellfish somewhat less frequently than did other adults (Table T-13) and ate the siphon and strap (together) of clams, geoducks, cockles, oysters, and mussels somewhat more often. Rates of consumption of other specified parts for other shellfish were similar between women age 16 through 42 and other adults.

Table T-13. Shellfish Parts Consumed (mean %) by Female Respondents Ages 16 through 42 (consumers only): Percent of Time Eaten in Specified Form

	n	Whole	Siphon /Strap	Siphon Only	Siphon /Stomach	Other	Total
Manila/Littleneck clams	29	89%	8%	3%	0%	0%	100%
Horse clams	18	6%	39%	53%	3%	0%	100%
Butter clams	25	36%	60%	4%	0%	0%	100%
Geoducks	29	7%	62%	27%	0%	3%	100%
Cockles	21	14%	43%	43%	0%	0%	100%
Oysters	15	93%	7%	0%	0%	0%	100%
Mussels	5	100%	0%	0%	0%	0%	100%
		Body /Head	**Body Only**	**Head Only**			
Shrimp	29	5%	95%	0%		0%	100%
		Whole	**Crab Meat Only**	**Crab Butter Only**			
Dungeness crabs	28	18%	82%	0%		0%	100%
Red rock crabs	7	0%	100%	0%		0%	100%
		Whole	**Abductor Muscle Only**	**Gonads Only**			
Scallops	19	5%	95%	0%		0%	100%
		Whole	**Meat Only**				
Squid	4	25%	75%			0%	100%
Sea cucumber	0						100%
		Egg	**Egg and Meat**				
Sea urchin	0						100%

Note: Whole does not include shell.

Children's Consumption Patterns

Children's Consumption by Finfish and Shellfish Groups

The 31 children for whom consumption data were reported by adult respondents consumed all species of finfish listed on the children's section of the questionnaire and 13 different shellfish listed in Group E (Table T-14). However, the proportion of children who were seafood consumers and the consumption rates themselves were considerably lower than those reported for adults.

Table T-14. Children's Consumption Rate (g/kg/day) by Finfish and Shellfish Groups

		All Children (including non-consumers)					Consumers Only	
Group	**Species**	**n**	**Mean**	**SE**	**Median**	**90%tile**	**n**	**%**
Group E	Manila/Littleneck Clams	31	0.095	0.051	0.031	0.181	23	74%
	Horse Clams	31	0.022	0.013	0.000	0.048	12	39%
	Butter Clams	31	0.021	0.014	0.000	0.041	6	19%
	Geoduck	31	0.112	0.041	0.027	0.252	22	71%
	Cockles	31	0.117	0.079	0.000	0.240	10	32%
	Oysters	31	0.019	0.012	0.000	0.058	10	32%
	Mussels	31	0.001	0.001	0.000	0.000	1	3%
	Moon Snails	31	0.000		0.000	0.000	0	0%
	Shrimp	31	0.093	0.038	0.004	0.394	17	55%
	Dungeness crab	31	0.300	0.126	0.047	1.251	21	68%
	Red rock crab	31	0.007	0.003	0.000	0.046	5	16%
	Scallops	31	0.011	0.006	0.000	0.031	8	26%
	Squid	31	0.002	0.002	0.000	0.000	2	6%
	Sea urchin	31	0.000		0.000	0.000	0	0%
	Sea cucumber	31	0.000		0.000	0.000	0	0%
Group A		31	0.271	0.117	0.063	0.532	28	90%
Group B		31	0.004	0.002	0.000	0.015	5	16%
Group C		31	0.131	0.040	0.036	0.339	25	81%
Group D		31	0.030	0.011	0.010	0.081	17	55%
Group F		31	0.240	0.075	0.092	0.684	24	77%
All Finfish		31	0.677	0.168	0.306	2.110	31	100%
All Shellfish		31	0.801	0.274	0.287	2.319	28	90%
All Seafood		31	1.477	0.346	0.724	3.374	31	100%

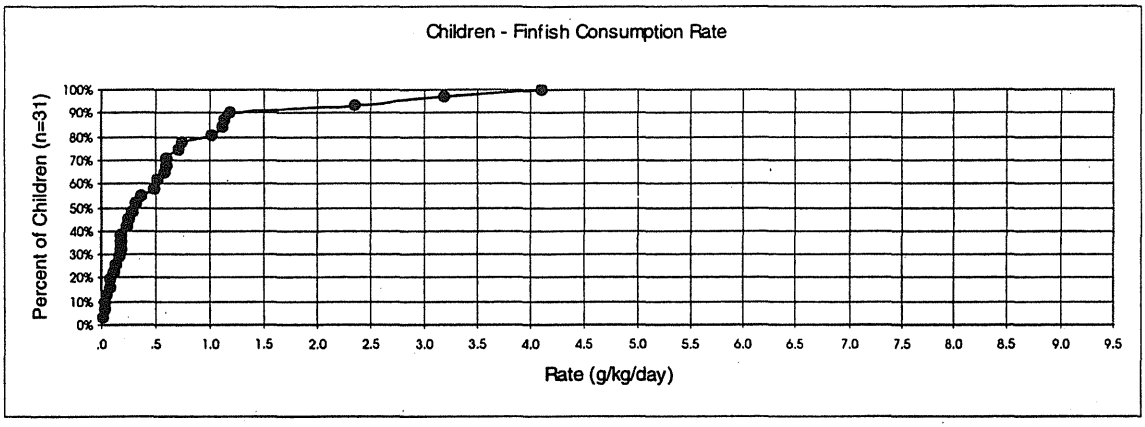
Note: Groups are comprised of finfish and shellfish reported in Figure 1 and used throughout this study.

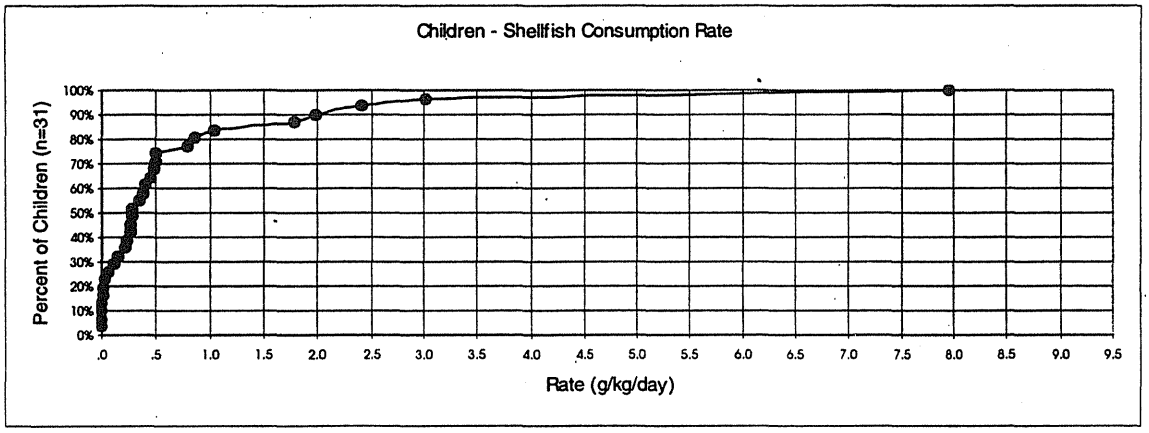
Respondents reported children's consumption of finfish by fish groupings. As reflected in Table T-14, the most frequently consumed finfish were salmon in Group A (90%), followed by cod, perch, pollock, and other finfish in Group C (81%). The highest median consumption rates (g/kg/day) were reported for salmon including steelhead in Group A (0.063 g/kg/day) and canned and fresh tuna, and other finfish in Group F (0.092 g/kg/day). Median consumption rates are provided for finfish Group C: cod, perch, pollock, sturgeon, sable fish, spiny dogfish and greenling (0.036 g/kg/day), and Group D: halibut, sole, flounder, and rockfish (0.010 g/kg/day.)

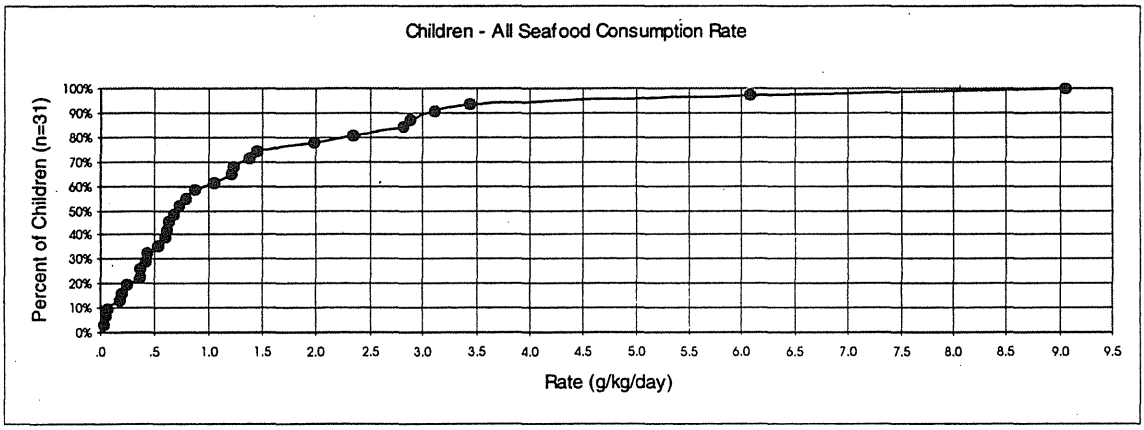
Among types of shellfish consumed (Table T-14), manila and littleneck clams were the most frequently consumed (74%), followed by geoduck (71%), Dungeness crab (68%), and shrimp (55%). Mean consumption rates include non-consumers. Mean consumption rates over 0.1 g/kg/day are reported for three species: geoduck, cockles, and Dungeness crab.

Children's consumption rates by seafood fish groups are quite diverse, ranging from a median of 0.09 g/kg/day for Group F (tuna and other finfish), and less than 0.001 for Group B (smelt and herring). The children's rates are quite skewed, with 90th and 95th percentiles that are several fold larger than the median values (refer to Figure 5). The MSE also indicates quite diverse consumption: for example, the MSE for all finfish and shellfish implies a multiplicative standard deviation of 3.7. Thus it would not be uncommon to find children in some families eating 10-20 times as much seafood as children in other families. Also of note is the relationship between childrens' and adults' consumption rates. Children consume fish at approximately half the rate of adults (a median rate of 0.7 g/kg/day for children vs. 1.7 g/kg/day for adults). The ratio of medians (children to adults) is smaller for shellfish than for finfish, indicating that the children eat a relatively smaller proportion of their seafood as shellfish than do adults.

Figure 5. Children's Consumption Rates: All Finfish, all Shellfish, all Seafood







Finfish Parts Consumed by Children

Except for smelt and herring (Group B), the main form of finfish consumption was of the fillet without skin (Table T-15). The children also had a much lower frequency of consuming head, bones, organs, or skin than did adults (3% or less for all the fish groups noted in Table T-15), and salmon eggs, with a reported mean of 10%.

Table T-15. Finfish Parts Consumed by Children (consumers only): Percent of Time Eaten in Specified Form

	Mean %	SE
Group A (n=26)		
Fillet with Skin	13%	7%
Fillet without Skin	87%	7%
Total	**100%**	
Eggs	10%	6%
Head, bones, organs, or skin	3%	2%
Group B (n=4)		
Fillet with Skin	75%	25%
Fillet without Skin	25%	25%
Total	**100%**	
Eggs	0%	
Head, bones, organs, or skin	0%	
Group C (n=24)		
Fillet with Skin	0%	
Fillet without Skin	100%	0%
Total	**100%**	
Eggs	0%	
Head, bones, organs, or skin	0%	
Group D (n=15)		
Fillet with Skin	13%	9%
Fillet without Skin	87%	9%
Total	**100%**	
Eggs	0%	
Head, bones, organs, or skin	0%	
Group F (n=20)		
Fillet with Skin	5%	5%
Fillet without Skin	95%	5%
Total	**100%**	
Eggs	0%	
Head, bones, organs, or skin	0%	

Note: Groups are comprised of finfish and shellfish reported in Figure 1 and used throughout this study.

Shellfish Parts Consumed by Children

Children's habits concerning consumption of shellfish varied across the species (Table T-16). Of the six types of shellfish listed in the first grouping in Table T-16 for which consumption by five or more children was reported, a substantial fraction of children (40% or more) ate manila and littleneck clams, butters clams, cockles, and oysters whole. Geoduck and horse clams featured a very small number of children eating the whole clam. Consumption habits for shrimp, crabs, scallops, and squid reflect that most children eat the body muscle and crab meat only.

Table T-16. Shellfish Parts Consumed By Children (consumers only): Percent of Time Eaten in Specified Form

	n	Whole	Siphon /Strap	Siphon Only	Siphon /Stomach	Other	Total
Manila/Littleneck clams	23	91%	0%	4%	4%	0%	**100%**
Horse clams	12	8%	33%	58%	0%	0%	**100%**
Butter clams	5	80%	0%	0%	20%	0%	**100%**
Geoducks	22	5%	68%	27%	0%	0%	**100%**
Cockles	10	40%	20%	40%	0%	0%	**100%**
Oysters	9	100%	0%	0%	0%	0%	**100%**
Mussels	1	100%	0%	0%	0%	0%	**100%**
		Body /Head	**Body Only**	**Head Only**			
Shrimp	17	6%	94%	0%		0%	**100%**
		Whole	**Crab Meat Only**	**Crab Butter Only**			
Dungeness crabs	20	0%	99%	0%		1%	**100%**
Red rock crabs	5	0%	100%	0%		0%	**100%**
		Whole	**Abductor Muscle Only**	**Gonads Only**			
Scallops	8	0%	100%	0%		0%	**100%**
		Whole	**Meat Only**				
Squid	2	0%	100%			0%	**100%**

Note: Whole does not include the shell.

Consumption Patterns and Practices

Preparation Methods

Table T-17, below, reports responses to questions concerning preparation methods. Categories were originally intended to be exclusive of methods which tend to seal in contaminants and those which tend to leach them out. In fact, the only useful data concerns nectar resulting from cooking shellfish, because the categories "baked, roasted...poached," "smoked, canned...raw," and "baked, steamed...poached" actually mix methods which tend to seal in contaminants with those which tend to leach them out. Nectar resulting from shellfish preparation methods was commonly used. Sixty-four percent of the respondents reported drinking the nectar and 24% reported using it in cooking, in contrast with 19% who reported that they "throw it out."

Table T-17. Seafood Preparation Practices

Species Groups	n	Baked, roasted barbecued, soup stew, poached Mean Percent	Smoked, canned, fried, dried, raw Mean percent	Baked, steamed, boiled, broiled, roasted, poached Mean percent	Use of nectar resulting from cooking shellfish		
					Use it in cooking	Drink it	Throw it out
Group A Salmon	88	65%	35%	--	--	--	--
Groups B & C Cod, smelt and herring, etc.*	86	35%	65%	--	--	--	--
Group D Halibut, sole, flounder, rockfish	76	66%	34%	--	--	--	--
Group E Clams, oysters, mussels, crab, etc.*	91	--	27%	73%	24%	64%	18%

*See Figure 1 for complete listing of finfish and shellfish groups.

Sources of Seafood Consumed

Sources of finfish and shellfish varied across the fish groups (Table T-18). For salmon (Group A), and shellfish (Group E), the predominant source was harvesting within Puget Sound by the respondent, family members or friends (a mean of 79% + 11% = 90% for salmon in Group A and 81% + 3% = 84% for shellfish in Group E). For these groups, harvesting within Puget Sound predominated over harvesting outside of Puget Sound as a source of seafood consumed.

Table T-18. Fish Sources Reported (consumers only): Percent of Fish Consumption Obtained From Specified Source

	Mean %	SE
Group A (n=88)		
Groceries	8%	2%
Harvest within Puget Sound	79%	3%
Harvest outside Puget Sound	11%	3%
Restaurants	3%	1%
Other/Unknown	0%	
Total	**100%**	
Groups B & C (n=87)		
Groceries	37%	4%
Harvest within Puget Sound	19%	4%
Harvest outside Puget Sound	3%	2%
Restaurants	41%	4%
Other/Unknown	0%	
Total	**100%**	
Group D (n=75)		
Groceries	34%	5%
Harvest within Puget Sound	23%	4%
Harvest outside Puget Sound	24%	5%
Restaurants	17%	4%
Other/Unknown	2%	1%
Total	**100%**	
Group E (n=91)		
Groceries	7%	2%
Harvest within Puget Sound	81%	3%
Harvest outside Puget Sound	3%	1%
Restaurants	8%	2%
Other/Unknown	1%	1%
Total	**100%**	

As reflected in Table T-18, respondents reported that they obtained some of the finfish which they consumed by purchase, either at grocery stores or restaurants. Purchasing of salmon (Group A) was concentrated more in grocery stores (8%) than restaurants (3%). This differs from finfish in Groups B and C. For finfish in Groups B and C, 78% were purchased, 37% from grocery stores, and 41% from restaurants, with the remainder obtained primarily from harvest locations within Puget Sound (19%). Sources for halibut, sole, flounder, and rockfish (Group D) varied. Harvesting contributed 23% + 24% = 47%, with harvesting about equally split between areas inside and outside Puget Sound. Purchasing was, by a small margin over harvesting, the majority source for finfish in Group D, with twice the frequency of reported grocery purchases (34%) as reported restaurant purchases (17%), for a total of 51% purchased.

Shellfish was primarily obtained through harvesting, with 81% harvested within Puget Sound, and 3% harvested outside Puget Sound. Purchasing was almost evenly split between restaurants (8%) and grocery stores (7%).

Seafood Consumption at Ceremonies, Gatherings, and Community Events

Ninety-two percent of the respondents reported consumption of salmon at ceremonies, gatherings, and community events. As displayed in Table T-19, adult men and women attend a substantial number of social gatherings each year. The frequency of attendance was very similar between men and women, with a mean of 12.3 gatherings per year for men, 12.5 for women, and medians of 6.5 and 6. Respondents reported that they ate clams 66% of the time, oysters 43% of the time, and crabs 47% of the time. Consumption at these gatherings of salmon, oysters, clams and crab totaled 0.168 g/kg/day, which was 6% of the total seafood consumption rate (2.707 g/kg/day, as reported in Table T-3).

Table T-19. Number of Social Gatherings Attended Per Year

Gender	n	Mean	Median	90%tile	Minimum	Maximum
Male	46	12.3	6.5	32	0	72
Female	46	12.5	6.0	32	0	59
All	**92**	**12.4**	**6.0**	**29**	**0**	**72**

Changes in Consumption Habits

A majority of the respondents (67%) reported that consumption patterns have changed over time. Of those who indicated that their consumption of finfish and shellfish had changed, almost twice as many respondents reported eating less seafood now than twenty years ago (n = 40) in contrast with those who indicated that they ate more seafood now than in the past (n = 22). A relatively small number of respondents (n = 8) explained that while their overall consumption rates had not changed, they now ate a different mix of species of finfish and/or shellfish. The difference from an even 50/50 increase/decrease split in respondents reporting changes in consumption patterns is statistically significant (p = 0.01, based on chi-squared).

Only one of the respondents reporting a change in consumption patterns declined to provide a reason. Most respondents used the open-ended question to provide more than one explanation of the change. Most explanations for changes in consumption related to changes in family composition, accessibility/availability of finfish and shellfish, and increased pollution. Because explanations of changes were multiple, the tally of reasons given below exceeds the number of respondents who reported a change in consumption patterns.

Reasons for Eating Less Seafood

Reasons provided for eating less finfish and shellfish cluster into five categories. About 50% of those who now eat less (24 of 40 respondents) said that their consumption is reduced due to pollution, including red tides, and related restrictions and regulations concerning harvesting. They also cited a perceived depletion/diminished availability of fish and shellfish resources. Twelve tribal members said that their work schedules and those of their family and friends have resulted in less time to harvest and that they therefore have less fish and shellfish available to consume. Eleven respondents indicated that changes in family composition, predominantly described as the loss of family members who fish and gather shellfish, has had a negative impact on their consumption patterns. Three respondents cited health and diminished appetite due to

age. Finally, location was cited as affecting the consumption patterns of two respondents: one reported moving from a coastal area where, in the respondent's view, fish are more abundant, and a second respondent said that consumption declined due to having lived out of state for part of the year in an area where fresh seafood is not readily available.

Reasons for Eating More Seafood

Respondents' reasons for eating more seafood are grouped in four categories. Health reasons and other changes in eating practices were cited by nine respondents, with four saying that they have come to appreciate and like seafood more since "growing up." Greater availability and increased access to finfish and shellfish was mentioned by five respondents, with the majority explaining that active harvesting by themselves, their family, or friends has made the difference. Five respondents also said that their reasons for eating more seafood now are family related. Three of the five mentioned the important connection between having more seafood and harvesting, with one putting it this way: "More children means more seafood" and another citing having "more family members who fish or harvest." Four respondents said that location has had a positive effect on their consumption of seafood, with three explaining that they have moved back home, and, the fourth, smiling, observing that, "To be able to dig on the beach is part of being here."

Reasons for Eating a Different Mix of Seafood with No Change in Overall Consumption

Two respondents reported reduced consumption of butter clams, cockles, and other clams and shellfish due to pollution. They said this reduced consumption was offset by the higher availability of geoducks from the Suquamish Tribe. Three respondents identified family harvesting practices as responsible for consuming a different mix of seafood, with two of these explaining that they or family and friends are now harvesting more oysters and shrimp.

Two respondents said that that although their overall consumption patterns had not changed, they wanted to make comments that would be included in the report of survey results. One of these respondents remarked that shellfish are more scarce than in the past. The second respondent indicated that although overall consumption was consistent, geoducks offset reduced consumption of cockles, which aren't as readily available as they were in the past.

Seafood Harvest Locations

The U&A of the Suquamish Tribe includes waters from the northern tip of Vashon Island, south of Seattle, to the Fraser River, including Haro and Rosario Straits in the San Juan Islands. Figures 6 through 9 display salmon, marine fish and shellfish management, and catch reporting areas utilized by Washington Tribes and WDFW. Suquamish Tribal members with treaty fishing rights fish for commercial, ceremonial, and subsistence purposes in eight counties, from Mason County in the South, to the boundary waters of the United States and Canada in San Juan County.

Respondents who identified harvest locations of finfish and shellfish which they consumed were shown U&A maps of the salmon, marine fish and shellfish management and catch reporting areas (hereinafter referred to as "areas") as adapted for the display booklet. The display maps

used to identify locations show management areas by designated numbers and letters such as 23A, 23B, and 23C. Responses are reported in this section by the numeric management unit without the specificity of the letter designation. For example, harvest locations in areas 23A, 23B, and 23C are reported as area 23.

Overall, most finfish and shellfish harvesting areas whose locations were reported by respondents were located inside Puget Sound.

Figure 6. Northern Puget Sound Commercial Salmon Management and Catch Reporting Areas

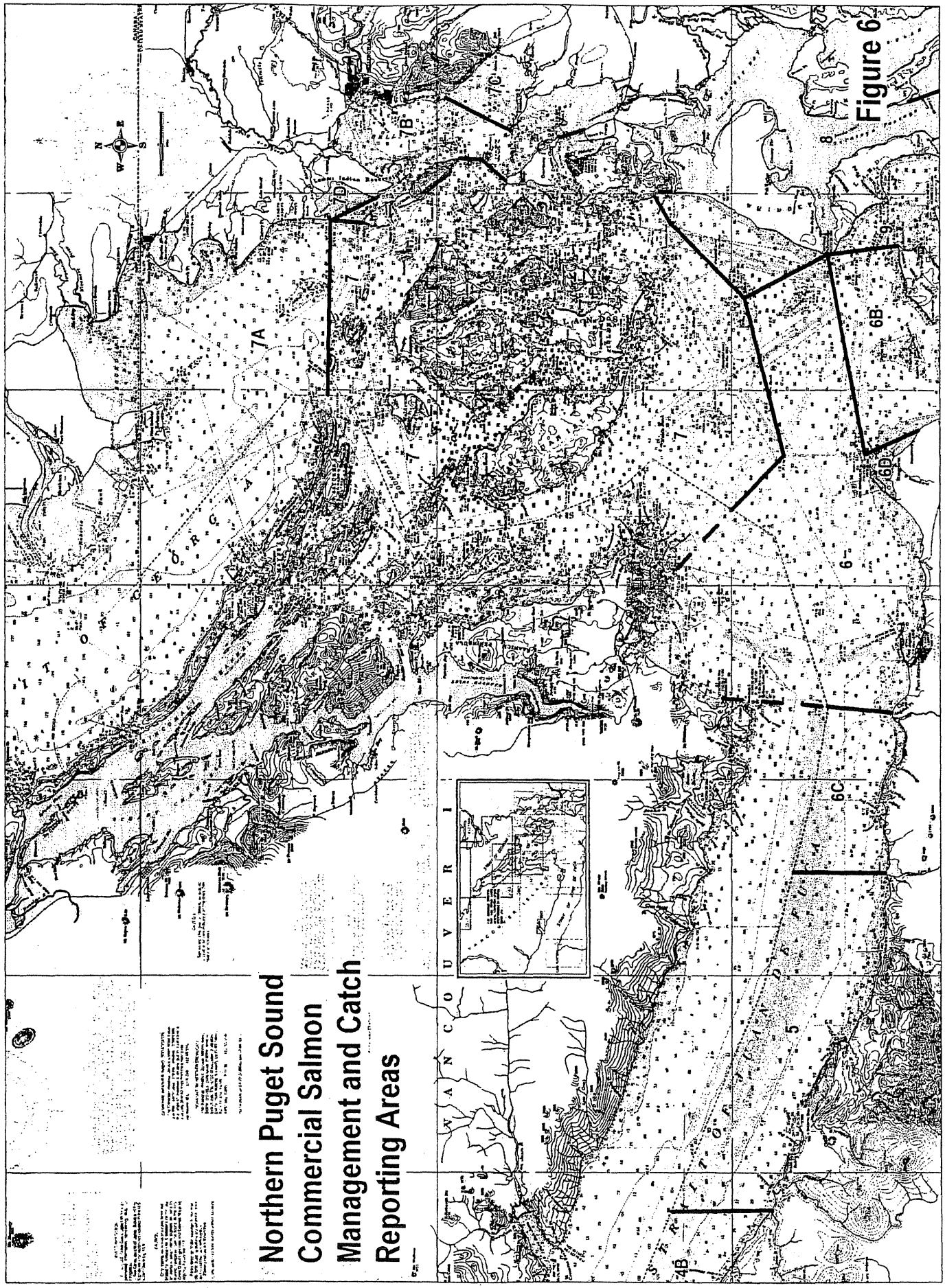
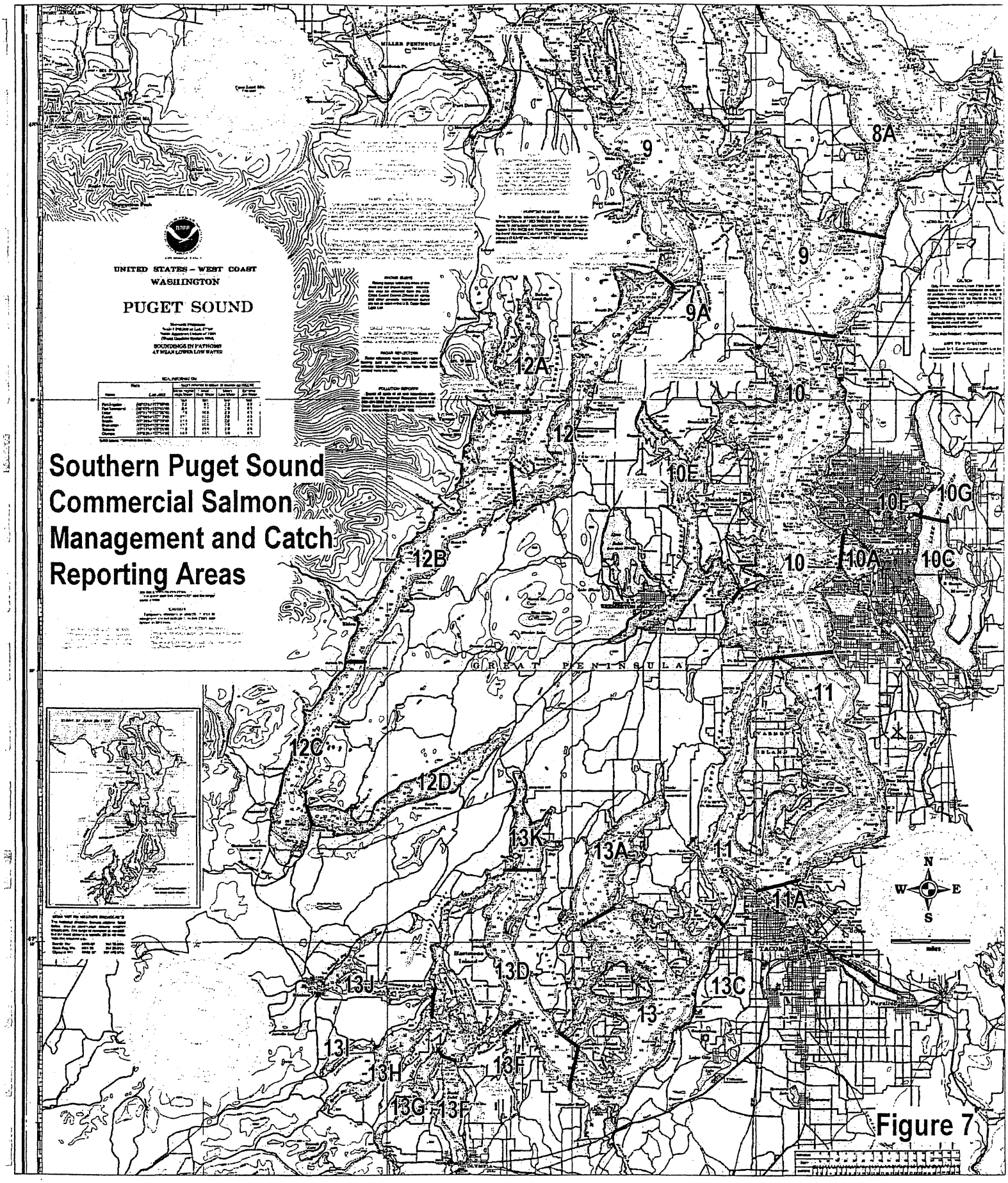


Figure 7. Southern Puget Sound Commercial Salmon Management and Catch Reporting Areas



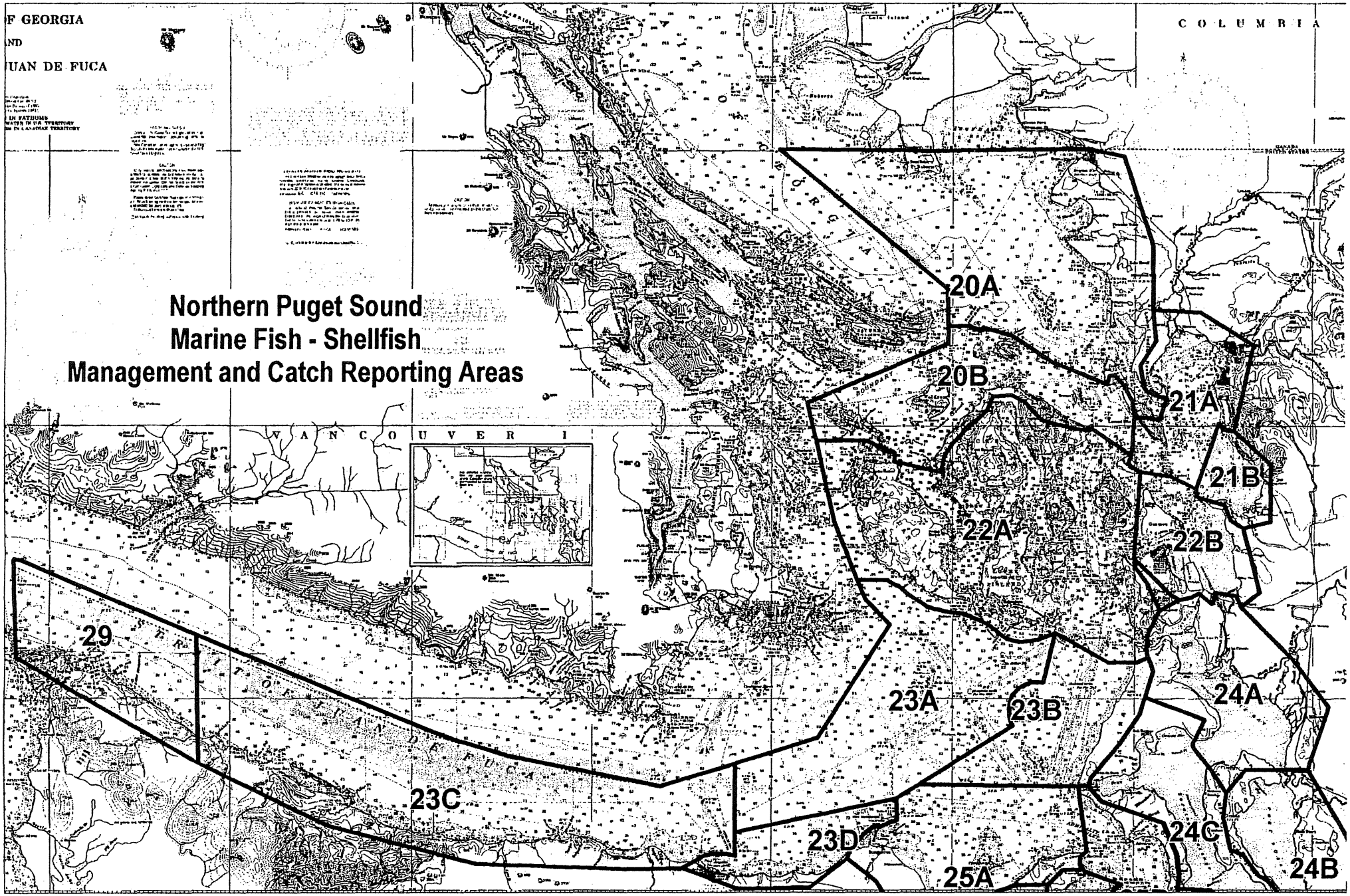
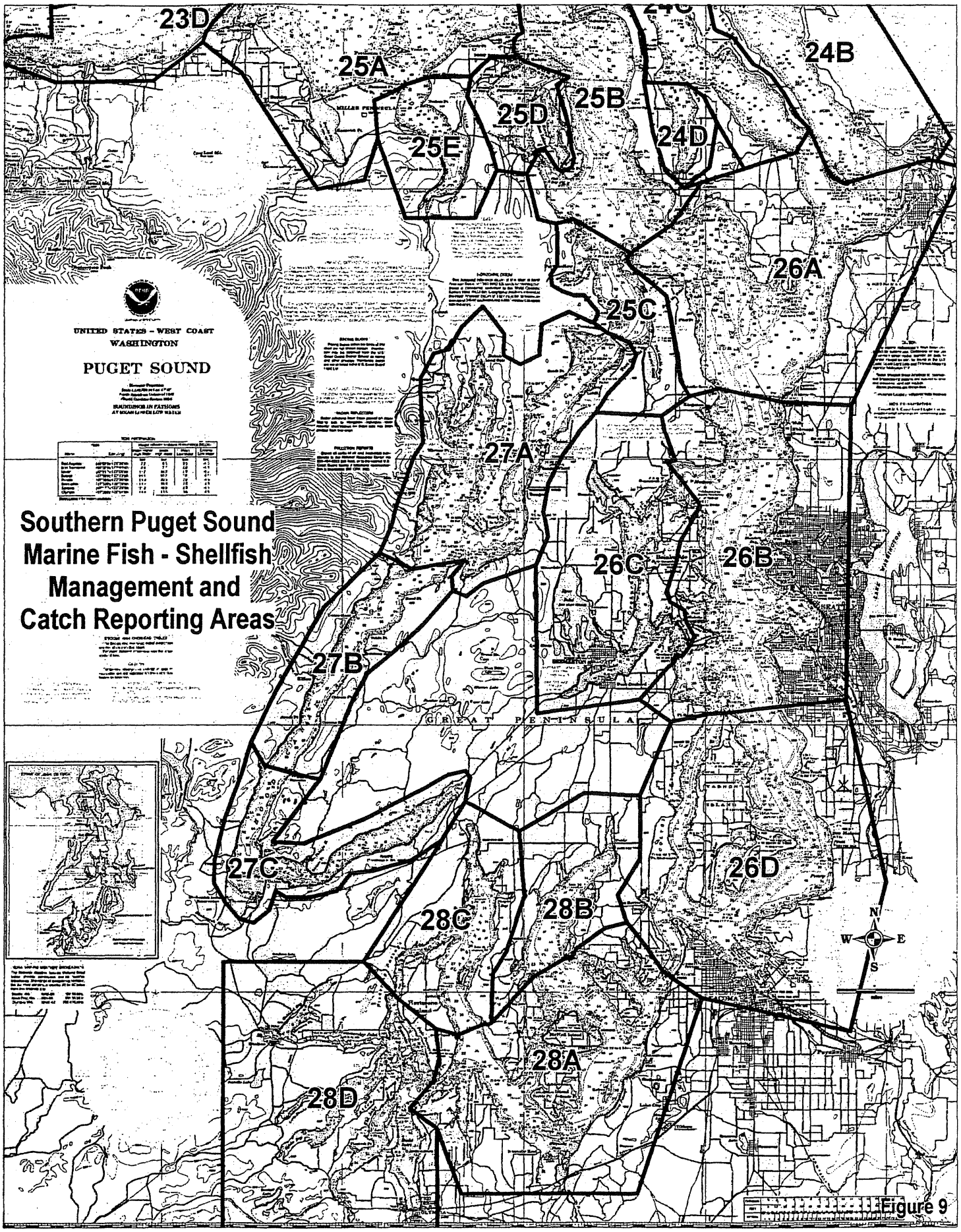


Figure 8. Northern Puget Sound Marine Fish – Shellfish Management and Catch Reporting Areas

Figure 9. Southern Puget Sound Marine Fish – Shellfish Management and Catch Reporting Areas



Finfish Harvest Locations

Table T-20, below, provides data on the areas from which Pacific Salmon and other marine fish consumed by respondents were harvested.

Table T-20. Harvest Locations of Finfish by Reported by Respondents by Management and Catch Reporting Area

	Salmon and Marine Fish Management and Catch Reporting Areas																
	6	7	8	9	10	11	12	20	21	22	23	24	25	26**	27	OPS*	Total
Group A Salmon, incl. Steelhead	8	21	4	11	55	2	9	-	-	-	-	-	-	1	-	18	129
Groups B and C Cod Perch Pollock Sturgeon Sablefish Spiny dog-fish Greenling Smelt Herring	1	2	-	-	-	-	-	3	2	2	4	2	2	18	2	8	46
Group D Halibut Sole Flounder Rockfish	2	-	-	-	-	-	-	3	3	3	4	1	2	9	1	20	48
Totals***	11	23	4	11	55	2	9	6	5	5	8	3	4	28	3	46	223

*Outside Puget Sound.

**One respondent reported harvesting salmon in area 26, which is an area number used only for marine fish and shellfish.

***Total number of times each area was reported by all respondents for all finfish Groups.

Salmon catch areas within Puget Sound are numbered 6 through 12 (Figures 6 and 7). Salmon harvest locations within Puget Sound received 86% of the Tribal number of catch areas mentioned. Respondents identified area 10 most frequently as the harvest location of salmon which they consumed (Group A). The second area reported most frequently for salmon was area 7, followed by areas 9, 12, 6, 8, and 11.

Marine fish and shellfish areas are numbered 20 through 27 (Figures 8 and 9). Area 26 is the most frequently identified area for herring, smelt, cod, perch, pollock, sturgeon, sable fish, spiny dogfish, and greenling (Groups B and C). This area is in the Greater Seattle and North Kitsap Peninsular waters, and accounts for 39% of the total harvest location identifications for finfish consumed in Groups B and C.

Most of the halibut, sole, flounder, and rockfish (Group D) consumed by respondents and harvested within Puget Sound was reported as having come from area 26. This area ranges from the northern tip of Vashon Island in King County to the Port Townsend region in Mason County.

As Table T-20 reflects, some of the finfish consumed by respondents was harvested outside of Puget Sound. Locations outside Puget Sound were most frequently mentioned for halibut, sole, flounder, and rockfish consumed and identified in Group D (n = 20, 43%). Finfish in Groups B and C, including smelt, herring, cod and other finfish, received eight mentions, for 17%. Harvest locations outside of Puget Sound for salmon (Group A) received 18 mentions, for 14%.

Shellfish Harvest Locations

Table T-21 displays harvest locations of shellfish consumed, including manila and littleneck clams, geoducks, cockles, oysters, mussels, shrimp, crab, scallops, squid, sea urchin, and sea cucumber.

Shellfish harvest locations receiving the highest number of mentions were manila and littleneck clams together with geoducks (n = 90), crab (n = 69), oysters (n = 60), shrimp (n = 59), and cockles (n = 57). Fewer area mentions were provided for mussels (n = 13), scallops (n = 12), and squid (n = 10). Sea cucumber and sea urchin received the lowest number of area identifications (n = 6 and n = 5, respectively).

Table T-21. Harvest Locations of Shellfish Reported by Respondents by Management and Catch Reporting Area

Shellfish Species (Group E)	Shellfish Harvest Management and Catch Reporting Area									
	20	21	22	23	24	25	26	27	OPS*	Total
Clams, Geoducks	-	-	-	1	-	14	64	9	2	90
Cockles	-	-	-	-	-	5	46	6	-	57
Oysters	-	-	-	-	-	13	28	17	2	60
Mussels	-	-	-	1	1	-	8	-	3	13
Shrimp	-	-	1	-	-	7	17	31	3	59
Crab	1	2	-	1	1	9	39	11	5	69
Scallops	-	-	-	-	1	3	5	-	3	12
Squid	-	-	-	-	-	-	9	-	1	10
Sea urchin	1	-	1	-	-	1	2	-	-	5
Sea cucumber	-	-	-	-	-	-	5	-	1	6
Total**	2	2	2	3	3	52	223	74	20	381

*Outside Puget Sound.

**Total number of times each area was reported by all respondents for all shellfish.

Areas 25, 26, and 27 are the most frequently reported harvest locations for all species of shellfish consumed by respondents. Only two species of shellfish consumed by tribal members were identified as having been harvested in one area only within Puget Sound: squid and sea cucumbers harvested in area 26 in lower portions of the San Juan Islands. With the exception of crabs, respondents collectively identified from three to five areas as harvest locations of shellfish which they consumed.

Area 26 is the most frequently mentioned location of harvest of clams and geoducks consumed by respondents (n = 64), along with area 25, in the Seattle/Edmonds/Kingston regions as the second most frequently mentioned area (n = 14). Respondents reported that cockles, a favored shellfish among tribal members, were predominantly harvested in the home area, area 26, although areas 25 and 27 were mentioned 5 and 6 times, respectively. These same three areas were most frequently identified harvest location of oysters. Areas 25, 26, and 27 also constituted the most frequently mentioned harvest locations of shrimp and crabs consumed by respondents. Although most of the mussels consumed by tribal members originated in area 26, areas 23 and 24 were also identified as harvest locations within Puget Sound.

Of the 20 mentions of shellfish harvest locations outside of Puget Sound, crab was the most frequently mentioned (n = 5), followed by shrimp, scallops, and mussels (all n = 3), clams and geoducks (n = 2), and squid and sea cucumber, for one mention each. Of the shellfish listed in Table T-21, cockles and sea urchins were the only shellfish consumed for which no harvest locations were reported as occurring outside of Puget Sound.

Discussion

Significance of the Study

The results of the Suquamish survey support the contention that there are differences in seafood consumption among Puget Sound tribes. The shellfish consumption rate reported in the Suquamish study is higher than has been reported in other studies to date, as is the mean consumption rate for all seafood (finfish and shellfish). The Suquamish Tribe anticipates using survey results in discussing cleanup standards of contaminated sites within the Suquamish Tribe's U&A with federal and state agencies as well as private parties and other stakeholders. Tables presented in Appendix C which report consumption rate data for consumers only have been generated for use in human health risk assessments. It is anticipated that a comparison of consumption rates reported in this study with those used by U. S. Environmental Protection Agency (EPA) will enrich discussions concerning human health risk assessments, EPA's trust obligations to tribes, and environmental justice in the broad sense.

One of the attributes of this study is that the report provides consumption rates by individual type of finfish and shellfish. In addition, complete data are provided for adult participants by age and gender, for consumers only, and for all respondents. The tribe anticipates that results will stimulate further research and investigation of seafood consumption patterns, including the development of refined methods for gaining insight into consumption patterns and practices. It is anticipated that the data provided for women of child bearing years will be especially useful in human health risk assessments.

Participation Rate

Allowing for some attrition, an initial sample of 160 adults was generated to provide for a target sample size of n=150. Of the 160 adults included in the initial sample, 18 were removed from the survey as "ineligible" due to having moved out of the survey area (n=12) and living in institutional settings (nursing homes and treatment centers) during the survey period (n=6).

The participation rate of 64.8% was calculated on the basis of 92 respondents out of a total of 142 potentially eligible adults on the list of those selected into the sample. Of the 50 non-respondents, five declined. Among the 45 who were not interviewed are a number of respondents who expressed the desire to participate but who were unable to keep scheduled appointments two to three times due to their work schedules. In other cases, members of the project team were unable to contact respondents for a variety of reasons, including wrong address; discrepancies in telephone service, such as wrong number or number no longer in service; no response to letters, or no way to contact respondents through friends, family, or associates. It is possible that some of the respondents in the latter category may have been declared ineligible for a variety of reasons, including having moved out of the survey area. For example, some tribal members continue to hold post office boxes within the survey area post offices though they have moved out of the survey area. In such cases, the lack of a "returned" letter precluded the survey team from declaring such cases as "ineligible." Hence, the response rate of 64.8% may be considered conservative in terms of eligibility considerations.

A comparison of Tables T-1 and T-2 shows that 32% (92/284) of the potentially eligible population were included in the survey. Among males, the inclusion rates for ages 16-42, 43-54, and 55+ were 24%, 34%, and 44%, respectively. The difference in inclusion rates across ages was not statistically significant ($p = 0.1$), based on chi-squared. For females, the inclusion rates were 39%, 24%, and 35% ($p = 0.5$). There is no pattern of over or under-inclusion common to both genders.

Participants who required more contacts before a successful interview had approximately the same consumption rate as those who were easier to reach. This finding provides support for the suggestion that those who were eligible and selected into the sample but could not be interviewed were similar in their consumption rate to those who had one or several contacts and were interviewed. Adult participants were classified according to the number of contacts required prior to the interview. Sixty participants required only one contact prior to the interview and 13 required two; six participants required three contacts, and 13 required four or more contacts prior to the interview. The multiple contacts were needed for "no show" and other reasons. Spearman correlation coefficient between the number of contacts and each participant's consumption rate for all seafood, all finfish, and all shellfish were all weak: less than ± 0.11. These very low correlations suggest that it is likely that the consumption rates of individuals who were not interviewed at all (i.e. exceeded our maximum effort to contact and obtain an interview) were similar to those who were contacted and interviewed. Boxplots also showed no trend in consumption rates across the number of contacts.

The response rate of 65% among those eligible and invited to participate is considered adequate. Commonly, a response rate of less than 60% raises questions about the validity of the data as representing the population sampled. The Suquamish response rate of 64.8% is just over that threshold. Two analyses that were carried out suggest that the non-respondents may have similar consumption rates to the respondents. As discussed above, it was found that the consumption rate was not at all correlated with the difficulty of reaching a respondent to participate in an interview. As discussed under "Reliability and Representation," it was found that respondents whose answers were considered generally "less reliable" had very similar consumption rates to those whose answers were considered "very reliable." The non-respondents could be considered as falling further along the dimension of ease of access to people's experience and opinions, compared to those who did participate in the survey. Our findings suggest that consumption rates do not vary along that dimension.

Twenty-four Hour Dietary Recall

As an additional validation step, total seafood consumption rates reported for the day preceding the interview were compared with the rates reported for year-round consumption. A majority of the 92 participants reported no seafood consumption the day before (55%). Mean consumption was 1.5 g/kg/day in the preceding day, compared to 2.7 from the full survey. The two sets of rates were positively correlated (Spearman's rho = 0.41, $p < 0.001$). The positive and significant correlation indicates some consistence between the dietary recall and the body of the questionnaire for consumption rates. However, the lower mean consumption rate for the dietary recall suggests that a brief set of questions does not uncover all forms of consumption.

Comparison with Recent Washington State Seafood Consumption Surveys

This survey adds to knowledge gained from three other seafood consumption surveys conducted among Tribal and Asian Islander populations in the Columbia River and Puget Sound area within the last five years.

A fish consumption survey of four tribes in the Columbia River Basin conducted by the Columbia River Inter-Tribal Fish Commission (CRITFC) reported an adult mean fish consumption rate of 63.2 grams/day (g/day) for fish consumers (CRITFC). Two Puget Sound tribes, the Tulalip Tribes and Squaxin Island Tribe, reported mean adult consumption rates of 48.8 g/day for finfish; 22.3 g/day for shellfish, and 72.9 g/day for all fish (including shellfish). A fish consumption survey of Asian and Pacific Islander populations in King County, Washington reported an adult mean consumption rate of 119.3 g/day for all seafood (Sechena et al.). The mean adult consumption rates reported here for the Suquamish Tribe converted to g/day for comparison with other studies are 81.1 g/day for finfish, 132.7 g/day for shellfish, and 213.9 g/day for all seafood. The Suquamish Tribe's rates represent the highest seafood consumption rates reported in studies conducted thus far in Washington State.

The fish consumption studies involving tribes also reported fish consumption for children under six years of age. The mean fish consumption rate reported for children in CRITFC survey was 19.6 g/day. The survey of the Tulalip Tribes and Squaxin Island Tribe reported a child's mean fish consumption rate of 2.7 g/day (Toy et al.). The total seafood consumption rate reported here for the Suquamish Tribe is 24.8 g/day, which is similar to the rate reported in the CRITFC survey.

In this study, a common unit of grams/per kilogram body weight/day (g/kg/day) was used to report the consumption rate. The common unit of g/kg/day was also used in the and Tulalip Tribes Squaxin Island Tribe survey (Toy et al.) and the survey of Asian and Pacific Island populations in King County (Sechena et al.). This allows a valid comparison across gender, age groups, and other demographics.

The survey instrument developed by CRITFC subsequently served as the basis for the Squaxin Island Tribe and Tulalip Tribes survey, the Suquamish Tribe survey, and the survey of seafood consumption by members of the Asian and Pacific Islander populations in King County. Using a well tested/validated survey instrument adds to the strengths of this study.

Reliability and Representation

Consumption rates of adult respondents whom interviewers reported as "very reliable" were compared with those who received a lesser rating, such as "generally reliable." There was no statistically significant difference in the consumption rate for all seafood, all finfish, and all shellfish, based on the Mann-Whitney test. P-values were all 0.5 or larger for the 77 "very reliable" respondents versus the 15 respondents with lesser rated reliability, almost all of whom were rated "as generally reliable."

Consumption rates reported for children under six years of age may be a conservative estimate of true consumption, which may be larger. The consumption rates between children whose adult respondent reported "yes" versus "no" to the question on whether they prepared the majority of the children's meals were compared. There was no statistically significant difference between "yes" or "no" respondents in the children's consumption rate for all seafood, all finfish, and all shellfish. However, children whose adult respondent did prepare the majority of meals reported somewhat higher children's consumption rates than those who did not prepare the majority of meals. The power of this study is low to detect small to moderate differences among sub-groups from a total of 31 children. Thus, though the difference between the "yes" and "no" groups is not statistically significant, it is possible that the children whose adult respondents did not prepare seafood for them may have underreported consumption.

The Spearman correlation coefficient between adult respondents' reports on the percent of time that they ate with a child or children and the child/children's consumption rates was calculated. All correlations were nearly zero (less than 0.03 in magnitude) and not statistically significant.

Non-consumption of Seafood by Tribal Members

It was noted that all of the Tribal members selected to participate in the survey and who agreed to the interview consumed seafood. This suggests that the percentage of non-seafood consumers among the Suquamish Tribe could be very low. A 95% upper bound for the percentage of non-consumers would be 3% based on the binomial distribution.

Fish Preparation

Many environmental contaminants found in fish are lipophilic and accumulate in the fatty tissues of fish such as the skin and the eggs. Examples of these types of contaminants include polychlorinated biphenyls (PCBs) and DDT. Recently, EPA and ATSDR developed general guidance on ways in which to reduce exposures to contaminants by cleaning and preparing fish (ATSDR and EPA, 1998). This guidance recommends removing the parts of fish that accumulate contaminants, such as the skin, fat, and internal organs before cooking or smoking. The guidance also advises cooking fish so that the fat can drip away, and eating smaller, younger fish, which tend to be less contaminated.

The majority of respondents in this survey did not report eating parts of finfish that accumulate lipophilic environmental contaminants. Adults reported eating fish skin, eggs, or head, bones, and organs most frequently from salmon (Group A).

Female respondents (ages 16 through 42) most at risk to the effects of some environmental contaminants due to possible exposures during pregnancy reported consuming fish skin, eggs, or head, bones, and organs less frequently than all adults combined. Female respondents in this age group also reported eating whole shellfish less frequently than did all adults combined.

The majority of adults reported eating several shellfish species whole, which can include parts of the shellfish that accumulate contaminants. Respondents reported eating manila and littleneck clams and butter clams whole the majority of the time. Survey results indicate that these

shellfish also have the highest mean consumption rates of all of the types of finfish and shellfish. Adult respondents also reported drinking the nectar resulting from the cooking of shellfish a majority of the time. The Suquamish Tribe and other treaty fishing tribes work with the WDFW and DOH to regulate the harvest of shellfish on certified beaches and aquatic areas. Regulations are also in place to protect against harmful buildup of biological and chemical contaminants in shellfish. Given the high consumption rate of shellfish reported in this survey, EPA and ATSDR may wish to consider incorporating shellfish preparation and consumption suggestions in guidance brochures and reports.

Assessment of Consumption Rates Among Children Under Six Years of Age

Assessing the consumption rates of children under six years of age is challenging and involves some very special considerations. Factors lending to the complexity of the task in this survey were the sample size and statistical dependence introduced by multiple children within the same household with reporting by a single adult including cases where adult respondents who were not present at all meals and did not always prepare food for the children for whom they were reporting.

While the sample size of children is small, results of this survey provide some insight into the consumption rates of children in the Suquamish Tribe. Twenty-one households provided information on seafood consumption habits of 31 children. All 31 children for whom consumption data were provided ate some type of finfish and/or shellfish. The consumption rates for children were considerably lower than those reported for adults. Children, in contrast to adults, ate more finfish than shellfish. Consumption patterns were similar for children in the same household, suggesting that access to adults for any intervention to change diet would affect children in a "wholesale" manner. The fact that there is potentially some small imprecision and bias is acknowledged. Also recognized is the possibility that children's consumption may be more varied within a household than reported here, and that the relative uniformity of reported consumption occurs from the response coming from a single adult respondent rather than from true uniformity of consumption rates.

In support of the validity of the children's data, the correlation was close to zero between: a) the percent of meals that an adult was present while the child was eating and b) the consumption rates. Also, the mean of 70% of the time that adult respondents were present at meals is substantial, such that, on the average, the respondents would be very familiar with the children's eating habits. The higher rate reported for those adult respondents who prepared meals for children versus those who did not suggests that there may be some under-reporting of children's consumption by adult respondents who do not prepare the food.

Changes in Seafood Consumption Patterns over Time

Respondents who indicated that their seafood consumption patterns and habits had changed over time utilized the open-ended question to speak in general and also in particular about changes in availability and accessibility.

In many cases, respondents reported reasons for increases, decreases, and changes in consumption patterns which reflected elements of cultural traditions surrounding family harvesting activities and practices of sharing. Also discernible was the importance of harvesting rather than purchasing seafood.

Frequently, responses demonstrated the interdependence and multiplicity of factors that have caused Suquamish Tribal members to eat less seafood now than in the past. Reasons provided by respondents for reduced consumption underscore the importance of having harvesters within the family. Interviewer notes include phrases such as: "father no longer fishes or harvests;" "used to go claming with grandparents, now they've passed on...;" "less salmon because we're not fishing anymore...;" "don't harvest as much as I used to because of [my] job...and get less from friends who fish and harvest." Paraphrasing the words of one particular respondent helps impart what many related of their experiences and their thoughts. The interviewer listened as a quiet, reflective person talked, the words and thoughts coming out slowly enough to wrap around one another in a complete way:

> We used to eat lingcod, sole, rockfish, flounder, and I caught Grunters for my grandfather. All of my brothers used to fish; now, only one of us can because the fish are diminishing in number... The water is not clean. Septics are malfunctioning... There's pollution from the Navy, and the filling at Keyport had a big effect...Beaches are dug out... We need to reseed and enhance our beaches in order to have the number of clams we need and are used to... We eat more geoduck now, because more are available to us, but we used to dry oysters and clams; they're good for teething...[2]

Another tribal member, when relating a multiplicity of reasons for eating less fish and shellfish now than in the past emphasized restrictions related to red tides, pollution, sewers, and storm drain out. The respondent referred to an old rule, which s/he said s/he still follows and which is still heard around the reservation. The context in which the rule was given is also provided.[3]

> Before everything changed, we lived on the water, and were aware of every change because the beach was part of our every day life. We would know when the birds were not there. Then, we would say, " 'Don't eat the clams until you see the crows and the seagulls eating.' " That's one of the old timers' rules...

Seafood Consumption at Ceremonies, Gatherings, and Community Events

At the outset of the study, ATSDR expressed interest in data on total consumption of seafood at ceremonies, gatherings, and community events of salmon, oysters, clams and crabs and on the typical "mix" or combination provided at such events. This survey presents quantitative data for the first subject of interest and qualitative data on the second topic.

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[2] Permission to incorporate this response was given to the study manager by the respondent. The respondent also read the entire section in draft form and approved the use and placement of the remarks.

[3]The Cultural Affairs Specialist of the Suquamish Tribe assisted the study manager to ensure that the context, though brief, was sufficient to convey the tone and meaning of the actual rule in quotations.

Seafood consumption data at these events was reported as 0.168 g/kg/day, which equates to 6% of the total seafood mean consumption rate (2.707 g/kg/day). The questionnaire did not ask respondents to identify a typical mix or combination of seafood served at ceremonies, gatherings, and community events. Suquamish Elders and tribal members of the project team indicated that there is not a typical combination or mix; rather, the quantity and variety of seafood varies for a number of reasons. Availability of salmon may depend in part on the time of year and whether the tribe has been able to harvest and preserve a sufficient number of salmon that may be needed by tribal members for ceremonial purposes throughout the year. "Red tides" may preclude the harvest of shellfish. Family members may serve seafood which they may have been "gifted" from the coastal areas in quantities that may not otherwise obtain.

The survey yielded another insight into quantities of seafood consumed at these events, which confirms continued respect for a strong cultural tradition. During periodic project team discussions, interviewers noted that younger respondents, when asked about their seafood consumption patterns at gatherings, frequently smiled. Interviewers' notes on the questionnaire included respondents' comments that their portion sizes varied depending upon how many Tribal Elders were present and the quantity of the various types of finfish and shellfish served. If Dungeness crab or oysters, for example, were plentiful, younger respondents said that their portion sizes would be closer to what would be typical for them at any given meal. On the other hand, if there were a limited quantity, they would take little or none until and unless they were satisfied that Tribal Elders and older adults had eaten as much as they desired.

Timing of Conduct of the Survey Interviews

At the outset of the study, ATSDR requested that survey interviews be conducted during salmon "runs," i.e., during the time that adult salmon were returning to native streams within the Tribe's U&A to spawn. Due to the reach of the U&A, this meant that the survey could be conducted anytime between early July, when sockeye enter the Straits of Juan de Fuca, and the end of December, when the last of the chum runs enter Chico Creek and other native streams on and near the reservation area, or even including selected periods in December, January, and February, for returning steelhead.

Because shellfish harvesting is generally allowed throughout the year, the project team was not concerned with the introduction of seasonal bias. Commercial digs are scheduled throughout the year by the Suquamish Tribe for participation by individual harvesters, and harvesting for subsistence and ceremonial purposes is typically limited only by restrictions due to health concerns. Although tides are favorable during the summer months for harvesting of clams, including geoducks, there has been a long tradition of harvesting at night during the low tides during the remaining months of the year.

Confidence Intervals and Standard Errors

Ninety-five percent confidence intervals for the mean based on the normal distribution and standard errors of the mean are presented for a number of the consumption rates. Standard errors have been calculated without use of the finite population correction. Percentiles are preferable to the mean to characterize fish consumption. The standard errors and confidence intervals are

presented for completeness. We have chosen to view this sample as a selection from a "superpopulation" rather than simply a sample from the Suquamish Tribe at a certain moment in its history. While it is of social and historic interest to characterize this tribe at a certain point in time, it is likely that these data will be used to provide consumption estimates for the Suquamish Tribe at other times. Thus this sample is considered as being drawn from a distribution representing three sources of variation: the day-to-day variation in individuals' habits of reporting about their consumption, variation in consumption across the individuals of the population, and year-to-year variation in the true consumption of individuals. Hence, the sample is drawn from a theoretically infinite population, and the finite population correction would simply be a multiplicative factor of unity. The estimates can be applied to this tribe considered at other times, providing that there are no known changes of a major sort in factors affecting seafood consumption.

Confidence Intervals for Percentiles

Approximate 95% confidence bounds for percentiles can be obtained by dividing or multiplying the observed percentile by a multiplier to yield the lower or upper confidence limit, respectively. The multiplier is based on a lognormal model. The approximation is good to the extent that the actual distribution approximates the lognormal distribution. The value of C in the multiplier equation is 1.25 for the median, 1.71 for the 10^{th} or 90^{th} percentile and 2.12 for the 5^{th} or 95^{th} percentile.

$$\text{Multiplier} = \exp\{1.96*(C/n^{0.5}) * [\log_e(SE^2 * n/\text{mean}^2)+1]^{0.5}\}$$

The quantities mean, SE and n are the observed mean, standard error, and sample size of the natural data and not of the logarithm, respectively. For example, an approximate 95% confidence interval for the median (50^{th} percentile) of total seafood consumption, 1.672 g/kg/day, is calculated based on n = 92, (mean) = 2.707, SE = 0.336 and C = 1.25. The multiplier of the median value is 1.27 in the equation above, and the approximate 95% confidence interval is 1.32 to 2.13 g/kg/day. Again, these intervals should be taken as rough.

The multiplier equation is based on the variance of percentiles (Kendall and Stuart, 236-237) and an expression for the standard deviation of the normal distribution in terms of the mean and standard deviation of the corresponding lognormal distribution. If the distribution of consumption rates is not similar to the lognormal, for example, due to a spike of zero rates, then the confidence interval would only be a very rough guide to variability.

Treatment and Effect of Large Consumption Rates

A number of high consumption rates were included in calculations of the mean, standard errors and percentiles, in contrast to some preceding surveys (e.g.,Toy et al.) where high values were considered as outliers and were truncated to a smaller value, such as the mean plus three standard deviations.

In the Suquamish survey, these high values were believed to reflect actual high consumption and were not treated as outliers. In fact, the high values have no influence on the percentiles reported

here for all seafood groupings (A - G) and all larger groups (all finfish, all shellfish, all seafood) with the single exception of "all finfish," where the 95th percentile would be slightly higher due to the inclusion of the high consumption rate reported by one respondent (4.570 g/kg/day) rather than the value that would have been used had it been truncated. Thus, percentiles are virtually unaffected by the use of these large consumption rates and calculations of percentiles.

It is possible that mean consumption rate may have been affected, though these changes would be small. For example, if the two highest consumption rates for all seafood reported by two individuals (18.4 and 14.8 g/kg/day) had been truncated to the mean plus three standard deviations (12.364), the revised consumption rate would have been 2.61 instead of 2.71, a minor difference. For Group G, if the one high rate reported (1.344 g/kg/day) had been truncated to the mean plus three standard deviations (0.78), the mean would have been revised to 0.45 g/kg/day rather than 0.52 g/kg/day, a 14% decrease.

Statistical Dependence among Adults and Children within the Same Household

Statistical dependence among adults and children within the same household has not been included in the calculations of percentiles, means, standard errors and confidence intervals. For children, standard errors would be somewhat larger if dependence were taken into account. The calculation would be specific to each finfish and shellfish group and each individual type of finfish and shellfish reported, and has not been included in our results. Also, noted in the text is that the distributions of consumption rates are not normal ("bell shaped") and that this may also have a substantial influence on the validity of standard errors and confidence intervals. The non-normality would not affect means and percentiles. All of the confidence intervals are based on the assumption of asymptotic normality, which may not be particularly valid if there are a large number of non-consumers (a spike with a zero rate) and just a few consumers, which did happen for some of the individual type of finfish and shellfish species and seafood groups.

Adjustment of Consumption Rates for Body Weight

Adjustments of consumption rates for body weight may not be considered necessary. Consumption rates in grams per day not adjusted for body weight have very little correlation with body weight among adults. Given that the body weight may not play a particular role in consumption, the body weight should be carefully specified as a factor if the consumption rate per unit body weight reported in this survey is converted to total consumption for risk assessment or other purposes.

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