Rounding the Home Stretch: Learning Experiences from the Bioaccumulative Toxics in Native American Shellfish Project

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Abstract

The Swinomish Indian Tribal Community launched the Bioaccumulative Toxics in Native American Shellfish Project (BTNAS) in 2002 to investigate and elucidate concerns about chemical contamination in locally harvested seafood and possible human health effects from the harvesting and consumption of the seafood. The specific aims of the project are: (1) to determine whether Swinomish people are exposed to bioaccumulative toxicants when participating in subsistence gathering and consumption of shellfish; (2) to communicate any identified health risks in a culturally appropriate manner; (3) to develop mitigation options; and, (4) to identify major health issues on the Reservation that may be related to eating contaminated shellfish and develop hypotheses between Swinomish health problems and toxicants found. As the project enters its final year, the dynamic nature and scope of the project have provided numerous learning experiences from which other Tribes and those who work with Tribes may learn. The wide range of topics include both methodological and theoretical issues, such as the use of traditional harvesting techniques in sampling procedures, the recognition of risk factors specific to Native Americans, and the selection of culturally appropriate outreach and education efforts. In the broader scope, the BTNAS project provides an example of how Indigenous Knowledge and Western-based science can be integrated without compromising Indigenous Knowledge. The BTNAS project is funded by U.S. EPA grant #R-829467.

Introduction

In 1855, the Treaty of Point Elliot established the Swinomish Indian Tribal Community (Tribe), located near present-day La Conner, Washington. The Treaty set aside the peninsula at the southern end of Fidalgo Island, formally called Shais-quihl, as a permanent homeland for the peoples of the Skagit River Valley. An Executive Order in 1873 limited the northwest boundary of the Reservation from the head of Turner's Bay to the Swinomish Channel, taking away the land at March Point, which was originally designated within the boundaries of the Reservation. Today, the Reservation encompasses approximately 7,344 acres of land area and approximately 2,900 acres of tribally owned tidelands (Figure 1).

The members of the Swinomish Indian Tribal Community are descendants of the tribes and bands once known as the Skagit, Kikiallus, Swinamish, and Samish. Today, approximately 1,000 Native Americans live on the Reservation, of which 700 are enrolled Swinomish members. The Tribe is federally recognized and operates under the Constitution and Bylaws adopted in 1936 pursuant to the Indian Reorganization Act of 1934.

Seafood is a vital subsistence and commercial resource for the Tribe and represents an important part of the Tribe's cultural beliefs and practices (Figure 2). This resource has experienced an onslaught of chemical contamination and resultant degradation since colonialization. Numerous possible sources, both point and non-point, may be adding toxicants to the Swinomish tidelands. Two of the five major oil refineries in Washington Sate are adjacent to the Reservation. Other examples of potential sources include: agricultural fields both on and off the Reservation, rural and residential areas (e.g., application of lawn chemicals), septic systems, industrial waste facilities, landfills, municipal sewer outfalls, two marinas, long mooring docks, two boat yards, and a log storage yard. Past investigations have found several toxicants in water, sediments, and tissue samples in and adjacent to Reservation tidelands, including but not limited to heavy metals (Kent 1996; Johnson 1999; Johnson 2000b; Noffke 2000b; Donatuto 2003), polyaromatic hydrocarbons (Johnson, Serdar et al. 1997; Johnson 1999; Long, Hameedi et al. 1999; Johnson 2000a; Johnson 2000b; Noffke 2000b; Donatuto 2003), polychlorinated biphenyls (Johnson 1999; Johnson 2000b), dioxins/ furans (Yake, Singleton et al. 1998; Johnson 1999; Johnson 2000b), organotins (Johnson 2000b; Noffke 2000b), and pesticides (Johnson 2000b) . The degradation affects not only shellfish and other natural resources, but also all facets of the Tribal web of life, including physiological health, community health, economic health, and cultural, social and spiritual health (Harris and Harper 1997; Wolfley 1998; Harris and Harper 2000; ATFE 2001; Harris and Harper 2001; Arquette, Cole et al. 2002; Harper, Flett et al. 2002; Lickers 2003; Ransom 2003).

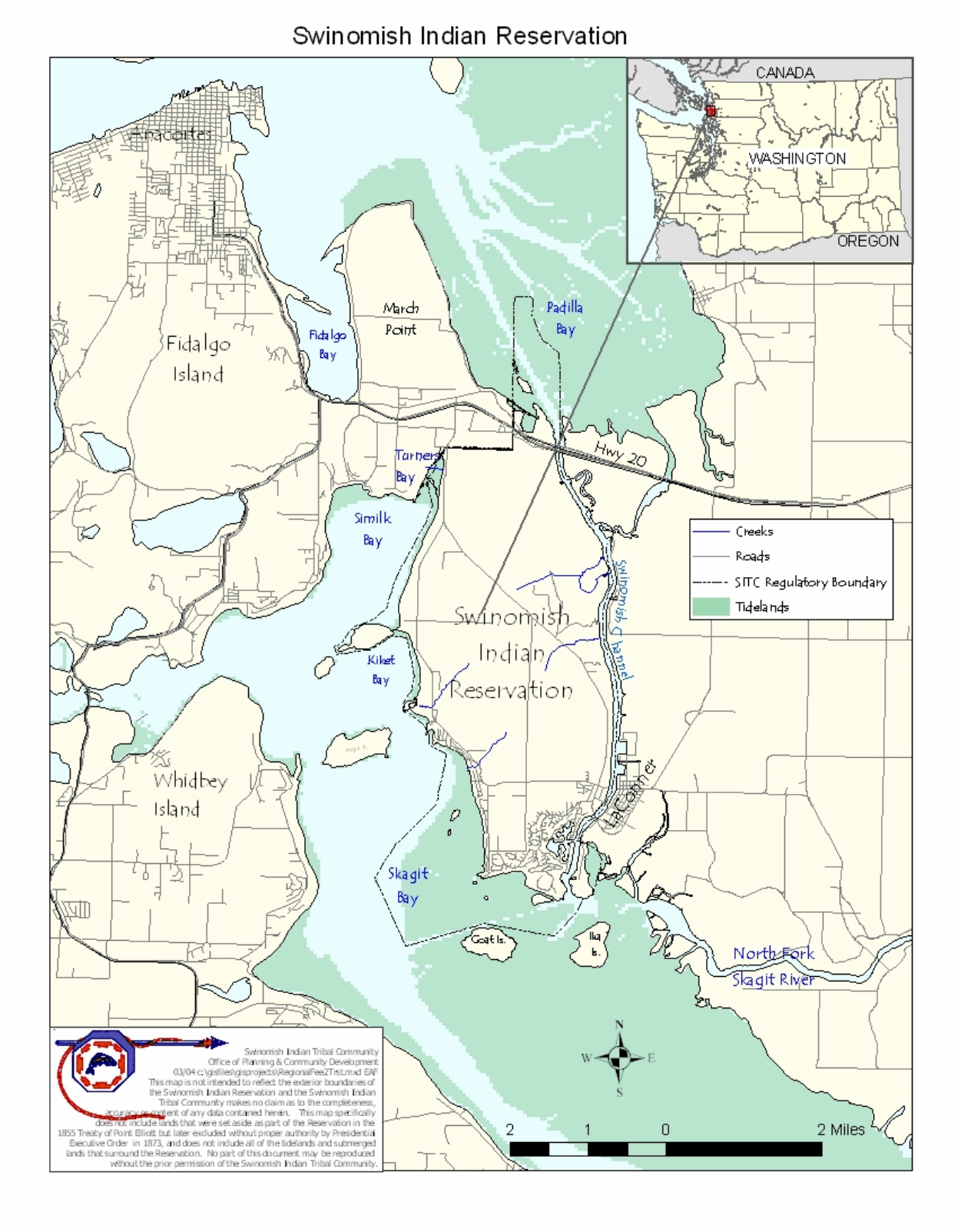

Figure 1: Regional map of the Swinomish Indian Tribal Community's Reservation

Figure 2: The Swinomish Seafood Spiral by Swinomish Tribal member Kevin Paul. Mr. Paul, an accomplished carver and painter, painted the seasonal cycle of Swinomish seafood harvest depicting the importance of seafood in Swinomish cultural beliefs and practices. He pointed out that as the seasons flow from one to the next--interconnected and building on each other—the harvest practice spirals outward, collecting more wisdom (Paul 2004).

The Swinomish Tribe initiated the Bioaccumulative Toxics in Native American Shellfish Project (BTNAS) under the Tribe's Planning Department; one of the Planning Department's objectives is to protect the health and welfare of humans and the environment on the Reservation. The impetus behind the BTNAS project is Tribal members' heavy reliance on the Reservation's tidelands. Tribal members utilize the tidelands and associated waters for fishing, shellfish harvest, and swimming, and depend on the local environment to fulfill subsistence, cultural, social, religious, and economic needs.

Initiated in April 2002, the BTNAS project is a four-year multi-disciplinary project designed to investigate and elucidate concerns about chemical contamination in locally harvested seafood and possible human health effects from the harvesting and consumption of the seafood. The specific aims of the project are: (1) to determine whether Swinomish people are exposed to bioaccumulative toxicants when participating in subsistence gathering and consumption of shellfish; (2) to communicate any identified health risks in a culturally appropriate manner; (3) to develop mitigation options; and, (4) to identify major health issues on the Reservation that may be related to eating contaminated shellfish and develop hypotheses between Swinomish health problems and toxicants found.

Project Activities

In this section, BTNAS project activities in the first three (completed) years of the project, findings to date, and future activities during the final year of the project will be summarized in numerical order of each of the specific aims.

Specific aim #1 is being addressed in the following manner: In the first two years of the project, project personnel collected native littleneck clams (*Protothecа staminea)*, butter clams (*Saxidomus giganteus*) and associated sediment samples at 16 sites, and Dungeness crabs (*Cancer magister*) at 21 sites within Reservation boundaries and in usual

and accustomed areas[1]. Project personnel chose to sample these species because they represent the most frequently harvested and consumed types of shellfish by Swinomish Tribal members, past studies in the Puget Sound have indicated contamination in these species with which to compare findings, and relative species abundance. Sampling site locations were chosen based on the harvest frequency by Tribal members, both presently and historically, the proximity of the area to potential contamination sources, accessibility, and relative abundance of the target sample species.

Sampling techniques comprised a unique integration of stringent decontamination and quality assurance/ quality control (QA/QC) protocols as established in the Puget Sound Estuary Program guidelines (PSEP 1997a; PSEP 1997b; PSEP 1997c; PSEP 1997d) and traditional Swinomish harvesting techniques. For example, Tribal members who work for the Swinomish Water Resources Program excavated the clams using pitchforks, the traditional method, that were cleaned prior to sampling in the Swinomish Environmental Lab with Alconox soap, thoroughly rinsed in hot tap water, and soaked for a minimum of one hour with methylene chloride, then rinsed with analyte-free water, following PSEP protocols for field equipment with metal parts used to collect samples that will be analyzed for both metals and organics. The Puget Sound Estuary Program guidelines are favored over federal procedures because the methodology employed by Washington State is substantially based on federal methods with additional measures added to suit specific environmental issues in Washington State.

To determine which chemicals to analyze, the project considered any bioaccumulative contaminants found in previous studies as well as chemicals associated with potential pollution sources. Shellfish tissues and sediments were analyzed for eight heavy metals, poly-chlorinated biphenyls aroclors and congeners, polyaromatic hydrocarbons, dioxins/-furans, organotins (e.g, tributyltin), and chlorinated pesticides. The Washington Department of Ecology Manchester Laboratory in Port Orchard, Washington provided analyses of the poly-chlorinated biphenyl aroclors, heavy metals, organotins, chlorinated pesticides, and poly-aromatic hydrocarbons. The AXYS Analytical Services Group in Sidney, British Columbia, analyzed poly-chlorinated biphenyl congeners from the World Health Organization list and the dioxins/-furans. The US Environmental Protection Agency (EPA) Manchester Laboratory performed an experimental analysis of speciated arsenic on the butter clam tissues.

All labs returned the data in a timely manner and with acceptable QA/QC. An important note, however, is that tribes should carefully research each laboratory's achievable detection limits before choosing a laboratory with which to work. Obtaining results using methods and equipment generating the lowest possible detection limits are particularly crucial for tribally related research for several reasons. Tribal members engaged in subsistence activities spend a significantly greater amount of time outdoors and thus have higher exposure rates, additional exposure pathways, and longer exposure durations than the average American (Harris and Harper 1997; Harris and Harper 2001; Harper, Flett et al. 2002). Little research has been completed on the possible connections between low level, chronic exposure through traditional lifeways[2] activities and resultant effects. With additional exposure pathways and higher potentiality to exposures, lower concentrations of toxicants may adversely affect tribal health when compared to the average American. Therefore, the lowest obtainable detection limits provide more accurate concentrations with which to determine exposures when performing risk assessments.

After the labs returned the concentrations data and before the risk assessments began, EPA Region 10 data validated the analytical findings. This process took much longer than expected; the final reports from the sampling event in the second year (the crab tissue samples) were completed at the end of the third project year. The data validation procedure is imperative in order to produce defensible data; however, delays in receipt of the validated data subsequently postponed the risk assessments, dissemination of the results, and development of mitigation options. This is noted here as an important lesson learned regarding the flexibility and motivation of a project. There are always unexpected occurrences and delays, but if both project personnel and the project itself are flexible and dynamic, the project can quickly recover from set-backs and find new ways to continue toward the stated goals.

[1] Usual and accustomed areas are geographical locations outside of Reservation boundaries that Swinomish Tribal members have Treaty established legal rights to hunt, fish and gather traditional foods.
[2] Currently, the EPA Tribal Science Council and other tribal-based groups use the term traditional lifeways to describe a tribal way of life that includes subsistence practices, as governed by an Indigenous Knowledge system of values, beliefs and practices.

With the receipt of the first year's sampling data (clams tissues and sediments), health risk assessments are currently underway and initial results are available. Thus far, initial calculations have indicated that arsenic is the primary risk driver, followed by lead, mercury, and cadmium. Arsenic contributes 75-99% of the risk (both cancer and non-cancer endpoints), depending on the location of the sample. The arsenic assumptions are 1) only 10% is inorganic and toxic, and 2) that 10% is 5 times more toxic than the official IRIS values indicate, based on the evidence used to lower the drinking water standard. As for the other chemical groups analyzed, dioxins/-furans contribute approximately 10% as individual congeners and as a slightly higher percentage as total dioxins. Polychlorinated biphenyls and polyaromatic hydrocarbons are several orders of magnitude lower, but present in the large majority of the samples collected.

The risk assessments are employing the equation first formalized by the 1983 National Research Council report that defined risk to people as a function of: toxicity (hazard identification and dose response) x exposure = risk estimate (NRC 1983). However, for this project, the risk assessments are modified to include some consideration of factors and impacts relevant to tribal communities in general and the Swinomish Tribe in particular. Factors mentioned above (additional exposure pathways, higher exposure rates, and longer exposure durations than the average American) and additional considerations such as tribal-specific diets and consumption rates are included in the Swinomish risk assessment.

However, this modified risk assessment still does not adequately address the important link between culture, health and the environment that is integral to traditional lifeways beliefs and practices. Without addressing the socio-cultural factors and impacts from contaminated shellfish, the risk assessment does not depict a potentially substantial component of the risks. Traditional tribal lifestyles are inseparable from the environment, and tribal community health is essentially synonymous with environmental health. If one species or location is affected, many other species, locations, and associated human exposures and activities will be affected. Cultural factors and impacts can be as varied and diverse as lost ceremonial practices, educational opportunities, and/or family names (Harris and Harper 1997; Wolfley 1998; Harris and Harper 2000; ATFE 2001; Harris and Harper 2001; Arquette, Cole et al. 2002; Harper, Flett et al. 2002; Lickers 2003; Ransom 2003).

Many tribes contest the fact that government agencies define exposure to environmental contaminants through the policy-driven, formalized risk assessment framework. Current efforts by government agencies are underway to include some aspects of traditional lifeways into the framework (EPA 2002a; Cirone 2005). Agencies, particularly the EPA, have drafted recommendations for descriptions of tribal exposure scenarios to include in risk assessments, but the scenarios are based on readily available or predicted tribal cultural practices (Cirone 2005), which are deemed wholly inadequate by tribes who argue that factors must be context specific and include more than prepackaged scenarios. In the case of tribal lifestyles, there are no consistent guidelines or recommendations for collecting, validating, or incorporating tribal knowledge in risk assessment frameworks. Tribal socio-cultural factors have been only sporadically and marginally addressed in decision-making, and are not given the same importance as the risk assessment outcomes for the general US population. Therefore, it must be recognized that while the risk assessments employed for the BTNAS project do incorporate some tribally relevant factors, many important factors are missing. Socio-cultural qualitative factors can only be incorporated with a comprehensive overhaul of the current risk assessment framework, one that is much larger in scope than this project can produce. Such an extensive, long-term overhaul would be a paradigm shift away from the current risk assessment model and towards the concepts of multi-dimensional community health and well-being that incorporates environmental, human, socio-cultural, mental and spiritual health factors (Wolfley 1998; Arquette, Cole et al. 2002; Lickers 2003; Ransom 2003). It is germane to recognize the shortcomings of the current risk assessment framework, however, and note that results from this project will thus be lacking substantial incorporation of socio-cultural factors and impacts.

Risk assessment factors that can be modified within the scope of this project are the fish consumption rates. In an effort to mitigate the health risks associated with contaminated fish and shellfish, the EPA established ambient water quality criteria (AWQC) in the Clean Water Act, section 304(a). The AWQC recommends a fish consumption rate of fish and shellfish from estuarine and fresh water for an "average American" to be 6.5 grams per day (g/day) (EPA 1980). The rate originates from a mean per capita consumption rate study for both consumers and non-consumers of fish published in the 1973-1974 National Purchase Diary Survey (Javitz 1980). This rate equals approximately one fish meal per month, disregarding considerable evidence from Puget Sound tribes documenting consumption rates up to 20 times that amount (CRITFC 1994; Toy, Polissar et al. 1996; Suquamish 2003).

Initially, the BTNAS project planned to use shellfish ingestion data from two previously published reports from neighboring Puget Sound area Tribes—the Tulalip and Squaxin Island Fish consumption survey (Toy et al 1996) and the Suquamish fish consumption survey (Suquamish 2000). However, project personnel have determined that key pieces of information are absent in the available data, and that using data from other Tribes with potentially different consumption patterns would result in unacceptable uncertainties. Data gaps in previous surveys include historic consumption information, desired consumption information (i.e., the amount if seafood people would like to eat if there was no contamination and was accessible), and high-end consumer information that were either identified as outliers and eliminated or recoded to lower rates. The basic issue is how to do research in Indian Country, and whether statistical or ethnographic methods obtain more accurate results.

Some members of tribes eat a pound or more of seafood (fish, shellfish and marine mammals) per day. More accurately, traditional families eat this much, but not all tribal members may eat this much for a variety of reasons. Traditional ingestion rates are expected to be between 1-2 pounds per day of fish and shellfish (fresh, dried, all species) once the documentation is finalized. Current ingestion rates are considerably lower than traditional rates because (a) access to U&A areas is restricted, (b) people know about contamination and have reduced their intakes, and (c) because people with little time and who are limited in their mobility do not have the wherewithal to obtain and consume the healthier traditional diet that the Point Elliot Treaty was intended to preserve. This is a very important point, one that is misunderstood by federal agencies who conduct risk assessments for tribes. These agencies misconstrue the "tribal ingestion rate" as whatever tribal members currently consume (knowing that there is contamination and lacking access to original fishing areas), when in fact the fish consumption rate should reflect amounts that tribal members want to consume.

Project personnel decided to gather Swinomish-specific seafood diet data, including current and historic consumption rates and other information not gathered in previous surveys. The Swinomish Seafood Diet Interviews were designed to overcome several of the difficulties and gaps encountered in previous surveys (Donatuto and Harper 2004). First, a well-respected professional anthropologist and ethnographer has trained a Swinomish Tribal member in interview technique and style. The Swinomish interviewer was raised in the Swinomish community and is familiar with the other members. Past experience has indicated that interviewees provide more accurate responses when a familiar Tribal member asks the questions, compared to a non-Tribal member or even an unfamiliar member from a different Tribe (Harris and Harper 1997; Campbell 2003). In addition, the interviewer often conducts the interviews in the evenings and on weekends, at the convenience of the interviewees and often in their own homes. Responses tend to be more elaborate when the interviewees are in the comfort of their own homes and do not feel rushed from other commitments.

Second, it is often difficult or impossible to conduct conventional, quantitative-based surveys in indigenous communities (e.g., (Nadasdy in press)). Many interviewees prefer the flowing, conversational style of knowledge transmission as opposed to the closed-end question and answer format. Therefore, the interviewer uses a combination of quantitative and open-ended questions, and uses the flexibility to steer the conversation in a manner suited to the interviewee rather than forcing the interviewee to answer scripted questions in a particular sequence. The first preference is to follow a sequence of questions, but a more ethnographic or journalistic style is also relied on according to the rapport established with the interviewee. This open format allows the interviewee to provide illustrative examples or "stories," exploring through conversation related issues such as the historic harvests, seasonal patterns, and geographic or land use changes over time.

Third, the interviews are recorded on tape and then transcribed so that the interviewer does not feel confined by written answers, as many tribal members prefer to speak rather than write (Campbell 2003). Fourth, all information is presented first to the interviewer for accuracy verification and editing once the interview is transcribed. This gives the interviewee an opportunity to ensure that his or her information is accurately represented. Once the interviews are complete and the interviewees have confirmed their accuracy, the information will be given to the Swinomish Cultural Resources Committee. Information that the Committee deems as culturally sensitive proprietary data will not be released beyond the control of the Tribe. Finally, a report will be written and presented to the Swinomish Senate for approval before the data is used in the risk assessment or published. This three-tiered approach to consent in a tribal community is considered the most respectful and ethical method of collecting data about local knowledge (Menzies 2004). If the interviewee, the Cultural Resources Committee, and/ or the Swinomish Senate deem any data to be culturally sensitive and therefore inappropriate for outside audiences, it will be struck from the publishable record. The project is currently in the interview collection stage.

As part of BTNAS **Specific Aim #2**, the Swinomish Environmental Education Program was formed. This program has several facets, involving outreach and education in the local schools, in the Swinomish and in the local surrounding community via presentation, newsletters, and videos. Since children are excellent educators of their parents, interactive presentations in the local schools and community are conducted. The Swinomish Environmental Educator, an Alaskan Native who was raised in the local area and is familiar with the Swinomish community, was trained at the University of Washington's School of Public Health and Community Medicine by the Community Outreach and Education Program Manager. The Program Manager trained the Environmental Educator in the use of Tox in a Box®, an educational toolkit and corresponding program developed at the University of Washington. The Tox in a Box® program provides school-aged children information about chemicals and environmental health, and how to apply that knowledge to everyday life individually and in the local community. It can be tailored to any class age, from kindergarten through twelfth grade, and caters to a wide range of environmental studies and basic toxicological applications. There are many hands-on science experiments designed to engage students at all grade levels. To date, the Environmental Educator has presented in several local classrooms and to community groups such as the La Conner Boys and Girls Club, at the Swinomish Health Fair, and at the Anacortes Marine Ecology Days. She has also lead field trips to the Reservation wetlands. The presentation evaluation forms received from both students and teachers praise her presentations and she consistently receives requests for follow-up and continuing presentations.

The Swinomish Environmental Education Program also prints articles in the Swinomish monthly newsletter, Kee-yoks. The articles, titled Healthy Home, describe common chemicals and ways to reduce exposure in the community. The BTNAS project also publishes project updates to inform the community of the project's standing and findings to date in Kee-yoks. Updates are also provided to the Swinomish Indian Senate on a regular basis and at the annual Swinomish General Council meeting.

The BTNAS project has also focused on video media for outreach and education purposes. The main focus of the video-related outreach and education activities centers on a project initiated with the non-profit group 911 Media Arts Center, based in Seattle, Washington. The program, called Native Lens, is a 12-week workshop that meets on weekends with a group of Swinomish youth and provides extensive training on the use and techniques of filmmaking. The goal of the program is to "introduce Native youth to media as an art form and vehicle for self-expression…We want them to leave empowered to produce engaging and professional-caliber media on their own and in their own image" (Dunn 2000; 2004). When they have completed the Native Lens workshop (in June 2005), the group of Swinomish youth will be given their first "assignment" of filming short videos about chemicals in the local environment. These films will be aired at a premiere in conjunction with a Swinomish community gathering and dinner to celebrate the youths' accomplishments and also provide a venue to disseminate the final BTNAS project findings to the community at the conclusion of the granting period.

Swinomish Tribal Communications Department Coordinator believes that television constitutes one of the most widely used forms of news acquisition and entertainment by Tribal members. He states that television is a high priority among Tribal members, with cable access often purchased over more basic items . With this in mind, one of the chosen avenues for outreach in the Swinomish community is through television programming on the Swinomish cable access channel. Throughout the initial phases of the project, a Swinomish cameraperson has filmed segments of advisory board meetings, collection of shellfish specimens, Tox in a Box® presentations and other relevant activities. In the final year of the project, the footage will be edited into one or more public service announcements that will provide project results, a documentary of the project targeted at outside audiences, and into an educational special. All of these will air on the Swinomish cable channel.

Another useful avenue for outreach and education is the project's tribal advisory board. The tribal advisory board is comprised of representatives from other Puget Sound area Tribes. The tribal advisory board meets a minimum of once a year to share information and insight on respective projects and findings. The collaborative atmosphere has fostered discussions on how to fill data gaps, future projects, and potential partnerships. Each member benefits from the expertise of the other members.

Finally, in order to fulfill a grant requirement, the BTNAS project initiated a project evaluation. Although a self-evaluation would have been adequate, project personnel decided to perform a comprehensive, independent evaluation, one that addressed more than whether or not the project met its stated goals. This decision was based on

two issues; first, past research endeavors spearheaded by Tribes were heavily scrutinized for the validity, repeatability and defensibility of project results because some researchers felt that academic or federal agency professionals should only undertake such projects. This belief perpetuates the legacy of colonialization and is inaccurate. Second, the project personnel desired a more thorough study of the project's successes and failures so that others could learn from them.

The BTNAS mid-term evaluation was completed in the third year of the project (Moore 2004). The evaluation provides insight into the effectiveness of the project in accomplishing its goals thus far, how the goals are accomplished (e.g. timeliness and competency), what challenges have been faced, and the level of the project's flexibility. The results of the mid-term evaluation were positive. The final evaluation, to be performed at the conclusion of the grant period, will provide project members and the Swinomish community with an independent view of the culmination of their work.

Discussion regarding **Specific Aim #3**, development of mitigation options, has begun within the tribal advisory board based in initial findings. However, no concrete recommendations will be produced until the risk assessments are completed. Enactment of **Specific Aim #4**--to identify major health issues on the Reservation that may be related to eating contaminated shellfish and develop hypotheses between Swinomish health problems and toxicants found--has also been postponed, awaiting completion of the risk assessments.

Conclusion

Over the past three years, the BTNAS project has met with and tackled a variety of issues, including producing defensible data, postponing risk assessments due to delayed data acquisition, and creation and enactment of methods to collect tribal seafood dietary information. Specifically, the following lessons can be gleaned from this project to date: first, current risk assessments to not adequately depict the tribal view of health, which includes socio-cultural, environmental, mental and spiritual components. Some quantitative factors can be modified to for tribal needs, but an extensive overhaul of the risk assessment framework is required to truly elucidate a fuller spectrum of risks from exposure to toxicants when practicing traditional lifeways. Therefore, any assessment findings will be produced with caveats stating the current framework shortfalls and that when a more comprehensive framework is produced the data ought to be reexamined. Second, collection methods should be a combination of stringent QA/QC and tribal traditional methods. Third, the importance of flexibility in the project, particularly in light of unexpected delays. Fourth, seeking out laboratories with the lowest obtainable detection limits. Fifth, the inadequacies of current fish consumption survey methods and how to remedy them, in part, with conversational, qualitative interviews and true informed consent. Sixth, the success of video-related activities, for adults and children, in outreach and education in tribal communities. Seventh, the advantage of a tribal advisory board to share findings and build a foundation of information that other tribes can use to further their own projects. Eighth, the importance of an independent, thorough project evaluation.

The eight lessons all help to illustrate the broader topic of how projects can integrate Indigenous Knowledge and Western-based science. Integration is currently a hot topic; however, care must be taken to ensure that Indigenous Knowledge and Western-based science achieve an equitable balance. Even those with the best intentions may unconsciously subsume Indigenous Knowledge by placing it in a framework designed for and by Western-based science. Equity is a crucial issue. Western-based science methodologies and practices such as risk assessment inherently marginalize any knowledge that does not fit its uniform shape and function, thus delegitimizing those concerns by dismissing them (Cruikshank 1998; Brody 2000; Ellen and Harris 2000). As mentioned in lesson one, perhaps the most important of the lessons stated here, only by creating a new risk assessment framework can both knowledge types be provided a more equitable environment that situates and evaluates them on parallel levels of importance.

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