

RED TIDES

West Coast newsletter on marine biotoxins and harmful algal blooms

The Impact Of Harmful Algal Blooms On Tribes

This third edition of the *Red Tides Newsletter* is published jointly by NOAA Fisheries' Northwest Fisheries Science Center and Washington Sea Grant Program to address the problem of harmful algal blooms (HABs) on the Pacific Ocean coast of North America. The toxins produced by harmful algae, which are concentrated by shellfish through filter feeding, can make it dangerous or even deadly for humans to eat them. That tribes today are still dependent on shellfish for subsistence is a unique aspect to HAB research and monitoring on the U.S. West Coast. The impacts of HABs on the lives and livelihoods of Pacific coastal tribes are highlighted in this issue, which also describes current efforts to ensure safe supplies of shellfish for everyone. Because of the size and scope of this publication, only a representative sampling of tribal shellfish programs are presented here.

Harmful Algal Blooms and their Impacts on West Coast Tribes

For centuries, coastal tribes have relied on the sea for most of their needs. Today, shellfish from tidal flats remain an essential food source for these tribes. The shells of mussels, clams, abalone and oysters are still used to decorate woodcarvings and ceremonial apparel, as they were thousands of years ago.

Sources of Subsistence

Historically, shellfish were harvested for subsistence. They also figured prominently in celebrations and ceremonial rites. Clams and mussels were among the favored foods at potlatches — enormous feasts marked by the host's lavish distribution of food and gifts to demonstrate wealth and generosity.

Shellfish were also dried and used as goods for

trade with other tribes and European settlers. "Necklaces" made of dried horse clams and tree bark were especially favored by travelers. Native Americans chewed on these necklaces as they hiked to their villages east of the Cascade Mountains. Ancient piles of shells (called middens) in California and shell garments at Ozette, Washington, are tangible reminders of the tribal cultures that were dependent on shellfish for subsistence and cultural identity.

Many tribes continue to trade, process and sell shellfish commercially at home and abroad, bringing in substantial revenues to tribal communities. The Pacific coastal tribes' continued reliance on shellfish for subsistence, especially in remote coastal regions, is unique among the world's cultures.

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Toxins and toxic algae

Paralytic shellfish poisoning (PSP) is caused when humans eat shellfish or crabs that have accumulated toxins by filter feeding toxic algae. The toxins include saxitoxin and gonyautoxin derivatives, produced by single-celled plankton (algae) called dinoflagellates. The closure level (seafood cannot be harvested when toxin measurements are at or above this level) for PSP is 80 µg/100 g shellfish or crab meat. Domoic acid poisoning, also called amnesic shellfish poisoning (ASP), is caused when humans eat shellfish, such as razor clams, or crabs, such as Dungeness crabs, that have ingested plankton that produce a toxin. The toxin, domoic acid, is produced by a species of single-celled plankton called *Pseudo-nitzschia*. The closure level for domoic acid is 20 parts per million in seafood.

HABs and human health

Aside from the impact of HABs on local and regional economies, the significant health impacts of PSP are believed to be vastly under-reported. Since 1980, at least 183 cases of HAB-toxin related illness and three deaths have been reported in the four West Coast states (primarily in Alaska, but also in Washington, Oregon and California). In August 2000, five people were hospitalized in Washington state after eating mussels tainted with PSP. Symptoms of PSP in humans include numbness and tingling of the lips, tongue, face and extremities, difficulty talking, breathing and swallowing, and lack of muscle coordination. There is no known antidote for the biotoxin that causes PSP and treatment is restricted to artificial respiration in life-threatening situations.

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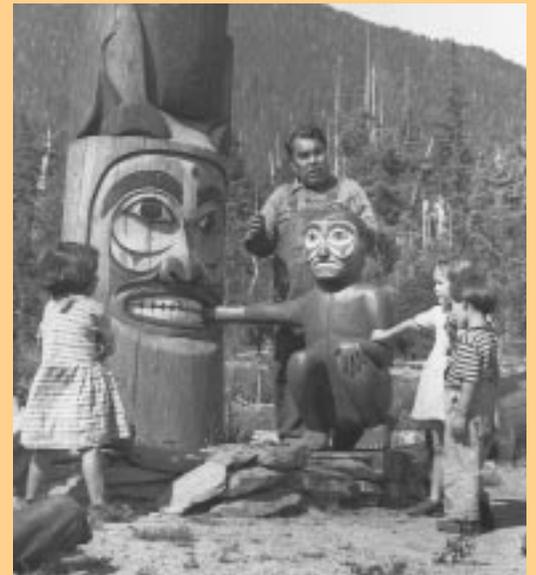
Dealing with the Dark Side

But throughout history, there has been a dark side to tribal shellfish fisheries. Coastal tribes have been affected by harmful algal blooms (or HABs), specifically from paralytic shellfish poisoning (PSP) for many centuries. Tribal elders believed they knew when to harvest to avoid the effects of HABs, and have passed this information on to many generations. However, because HABs are becoming more common and widespread along our coastlines, occurring during several months of every year, the risk of exposure to toxins in shellfish may be increasing. Indeed, HABs are difficult and sometimes almost impossible to predict.

Today, tribes are assisting researchers and managers to better understand HABs. The Olympic Region Harmful Algal Bloom (ORHAB) partnership, a study of HAB impacts on Washington coastal beaches, is a collaboration of some coastal tribes with federal and state agencies and businesses. Tribes also have unique authority to use new technologies for toxin testing of their shellfish. On Washington's Olympic Peninsula, the Quileute Indian Tribe is currently testing the accuracy of "dipstick" tests, similar in complexity to home pregnancy tests, to measure the presence of toxins in their shellfish. These new tests for toxins will allow the tribe to make independent decisions about the safety of their seafood, potentially reducing the cost and inconvenience of sending samples away to state regulatory agencies for testing. The right to choose a method of toxin testing is the unique, unrestricted authority of these sovereign tribal nations. The Tribe and NWFSC researchers have partnered to develop a new rapid detection technology that will quantify the toxin domoic acid in seawater or tissue. This rapid assay will be applied as a screening tool in the Tribe's current monitoring program with hopes that it will become a regulatory assay in the near future. This groundbreaking work by the Quileutes will pave the way for other tribes, especially those living far away from State testing facilities, to ensure that shellfish are safe for consumption.



Above: ORHAB technician Anthony O'Dell collects plankton samples on a coastal beach. In the laboratory, (inset) he uses a microscope to identify and count HAB organisms in the samples.



Shellfish in Legend and Myth

"Shellfish figure prominently in Northwest Native American myths and legends. In one creation story, humankind is said to have colonized the planet after escaping from a tightly sealed clam's shell. In another, more light-hearted tale, shellfish are banished to a life in beach sand, after being sentenced by other animals for malicious gossiping. This, the story explains, is why beachwalkers frequently see small spurts of water shooting up from the sand. The clams are trying to clear the silt and seawater they've swallowed while attempting to tell their spiteful tales."

From: *Heaven on the Half Shell: The Story of the Northwest's Love Affair with the Oyster* by David G. Gordon, Nancy E. Blanton and Terry Y. Nosho (copyright 2001, Graphic Arts Center Publishing Company)

Top: The Giant Oyster Totem is a feature of Saxman Village near Ketchikan, Alaska.

The Quinault phrase *ta'a Wshi xa'iits'os* means "clam hungry," showing the strong cultural reliance on the razor clam for food.

The word geoduck comes from the Nisqually Tribe of southern Puget Sound and means "to dig deep."

The Talowa Tribe of northern California ate woodpecker tongues to combat mussel poisoning.

Left: Locations of tribes mentioned in the text.

Historic HABs

A Kikialos elder who was born around 1890 told anthropologist Sally Snyder about *sxáwq^wilə tialx^wəlc̓* – “something that poisons everything that is on the beaches” – that gave tribal members symptoms similar to food poisoning. He said that in the past this had happened frequently in his people’s territory in northern Puget Sound. Some beaches between Camano Island and south Skagit Bay were avoided for that reason. His people knew when *sxáwq^wilə tialx^wəlc̓* – would occur and explained its association with certain currents from the ocean. It was something evil that “killed and distilled” the water so it naturally poisoned the food of the Indians’ clams, mussels and crabs.” The people who ate shellfish got a disease called *cíwák*.

Snyder’s original field notes are in the Melville Jacobs Collection of the University of Washington libraries.

Thanks to Samish Indian Nation researchers for contributing this material.

Alaska’s Tribes

It’s nearly impossible to test for PSP and ASP toxins along Alaska’s entire coastline. Therefore, testing is conducted only in areas where commercial crab and shellfish harvesting operations exist. If recreational harvesting is permitted in a given area, it is because a commercial operation is nearby. Because such a small percentage of the coastline is monitored, there is at least one serious HAB-related illness to humans reported each year. In these remote coastal areas, the lure of free shellfish to tribal members and other residents outweighs the risk of harvesting them from non-certified locales.

Alaska Natives are predominantly exposed to PSP toxins. Their subsistence use and inclusion of butter clams, cockles and other bivalves in tribal ceremonies pose health risks to their communities. No toxin-monitoring program is required to assess the quality of their non-commercial shellfish harvests in a timely manner. Because Alaska does not have an agency charged with monitoring the recreational and subsistence use of shellfish, these sampling and testing costs must be paid by the harvester.

Is a resistance to toxins built up in people who have eaten shellfish for many years? Evidence says no. Long-term residents of Alaska (23 years or more) are nearly 12 times more likely to report symptoms of PSP than are people who have recently moved to the state. Alaska Natives are also nearly 12 times more likely to report symptoms of PSP than are non-natives. To guard against these effects of PSP, participants in Alaska Native ceremonies frequently eat canned or certified clam products that are deemed safer to eat.

British Columbia’s First Nations

In British Columbia, about half of all commercial harvest licenses (over 1,000 total) belong to members of Canadian First Nations. Many of the First Nations have been working closely with the Canadian Food Inspection Agency (CFIA) and their Marine Toxin Monitoring Program. Within this program, First Nations are partners and have begun running their own monitoring programs. The Heiltsuk Nation, on the central coast of BC, manages its own intertidal shellfish fishery. After a PSP outbreak a few years ago, they had to dispose of a large quantity of their harvest. Since then, the Heiltsuk have deferred their harvest to months when there is a lower likelihood of HABs. In the past, the Haida’s razor clam harvests in the northern part of the BC coast have been closed due to ASP for almost one year.

British Columbia’s north coast provides another obstacle for monitoring HABs. Because the region is very remote and can only be reached by planes and vessels, monitoring cannot occur along the entire coastline. Therefore, First Nations in this area continue to harvest, even with the risk of PSP. However, the Nisga’a nation has begun to work with the CFIA by designating beaches that are important for their food, social and ceremonial harvests. With this information, the CFIA will set up monitoring stations to help the Nisga’a determine when harvesting is safe. As First Nations continue to collaborate with the CFIA to submit samples for monitoring, the increased knowledge will better protect the resources and members of the First Nations.



Washington's Tribes

The geographic remoteness of the Quinault, Quileute, and Makah tribes of Washington has been a major consideration, affecting the cost, timeliness and resources for domoic acid monitoring and testing. Members of the Quinault Indian Nation know first-hand the economic damage that a HAB outbreak can cause. In 1998, a large domoic acid episode resulted in the cessation of clam harvesting from this tribe's coastal beaches. Today, the effects of this shutdown are still being felt. Because clams were not available to sell in 1998, the markets that purchased from Quinault Tribal Enterprises, which processes fish and shellfish for commercial markets, found other suppliers. When the beaches finally reopened and shellfish harvesting resumed, the Quinaults had to spend precious time and money looking for new clam buyers. Many individuals who supplement their incomes by participating in commercial clam digs also lost money because of the closure. Subsistence harvesting of shellfish is also a concern for the Quinaults. They are currently working with ORHAB (see page 7) to monitor for the presence of the toxin, domoic acid, in coastal waters and in shellfish from their beaches.

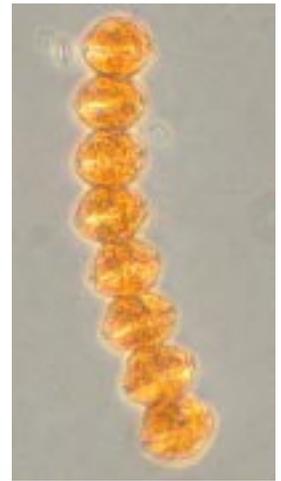
The Quileute Indian Tribe's Dungeness crab fishery experienced similar setbacks in 1998. During that year's HAB outbreak, the toxin level in crab viscera was above the regulatory limit of 30 parts per million. To avoid a complete closure of the fishery, crab processors removed the gut. Fishermen received very low prices for the eviscerated crabs and ended up losing half of the money they typically would have earned. Other tribal fishermen

opted to not fish at all until the toxin levels in crab were undetectable. They were not willing to risk having the product's reputation compromised with their customers.

The Quileutes harvest razor clams, California mussels, butter clams and other varieties of clams on their beaches. Before special ceremonies (such as namings or potlatches) or the tribe's annual elder's week, shellfish harvesters contact resource managers, requesting that testing be done ahead of time to determine if the shellfish are safe to eat. Because of the havoc domoic acid has been causing on beaches since 1991, the Quileute tribe began collecting water samples for toxic phytoplankton counts and shellfish samples for toxin testing in order to protect gatherers and consumers. The shellfish samples are currently sent to the state for costly testing that takes time to process. This means that essential information about toxin levels cannot be determined in a quick manner. Therefore, warnings are posted at beaches for sustained periods after high levels of domoic acid have been detected. These warnings have been increasing in frequency over time. Although shellfish gatherers were initially skeptical, they now follow the warnings and can even call a resource hotline to receive information on toxin levels and closures. The State of Washington Department of Health also relies on the Quileute testing. The Quileute Tribe's HAB monitoring program, which began in 1991, is quite successful, due in part to a fruitful partnership with NOAA researchers.

Unlike the Quinaults and Quileutes, the Makah Nation does not harvest shellfish commercially. However, there are future prospects for a commercial mussel industry, where mussel rafts would be placed in offshore

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Above: Alexandrium, the planktonic organism associated with PSP seen here, highly magnified, as a chain of eight cells.





Quick Turnaround Testing

A new rapid screening method has been developed by Jellet Biotek. It permits testing for the presence of toxins in shellfish harvest areas and provides results in less than one hour.

Known as the “rapid test for PSP,” this method will be validated for toxin testing in razor clams and seawater collaboratively by the Quileute Tribe, the Northwest Fisheries Science Center and the National Ocean Service of NOAA.

The tribe recently opened a new lab in LaPush that provides the equipment to prepare and test shellfish samples. Soon, when the lab is fully operational, it may no longer be necessary to send most of the tribe’s shellfish samples to Olympia, pay \$500 per batch of tests and wait up to a week for test results.

“Our goal is to have a test that all tribal people, not just technicians can use,” says Mitch Lesoing, marine biologist for the Quileute Tribe. “Eventually, tribal members who have collected shellfish that day can come into the lab, test them and know within an hour if they are safe to eat.”

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oceanic waters. The Makah mussel operation would be closely monitored by the Washington State Department of Health. For now, the Makah subsistence harvesting of mussels and a variety of clams bears the brunt of the impacts from HABs. More than half of the Makah population depends on these harvests in the wintertime, especially during periods when fishing does not occur. The Makah are also working with ORHAB to monitor domoic acid levels in water samples taken from Neah Bay and Makah Bay.

While ASP is a major problem for Washington coastal tribes, PSP remains the main concern for tribes residing in Puget Sound and along the Strait of Juan de Fuca. HABs have generated health hazards of major concern for the Puyallup, Suquamish, Lummi and S’Klallam tribes, especially because of their interest in commercial geoduck harvesting. Continuous monitoring for HABs is now commonplace along Puget Sound, as are closures of harvest sites and the posting of warning signs.

Predicting levels of PSP toxins in geoducks (the main shellfish harvested in Puget Sound) is difficult. Frank Cox, from the Washington State Department of Health, refers to toxin levels in geoducks as the “light-switch syndrome”—on again, off again, with no predictability. The viscera of geoduck clams (which tend to have high toxin levels) are tested for PSP and harvesting is stopped if a level of at least 80 micrograms of toxin per 100 grams of shellfish tissue is found in the samples.

PSP has caused problems for the Puyallup Tribe’s commercial geoduck fishery. Previously, all harvesting of geoducks has been suspended due to PSP toxins for up to three months at a time. Half of the harvesting is now done in the summer, before a possible PSP outbreak, to decrease the economic impact of HABs on tribal members. The Suquamish Tribe also has a commercial harvest for geoducks that is being severely impacted by PSP. Due to PSP, the harvest area is typically closed for about six months of the year.

The Jamestown S’Klallam Tribe operates a commercial geoduck fishery, along with its harvest of oysters and Dungeness crab. Approximately 150,000 to 200,000 pounds of geoduck are shipped each year to China (the tribe’s largest buyer), other Pacific Rim countries and other global marketplaces. The fishery must include routine testing for toxins due to the threat of fluctuating PSP levels. PSP testing occurs on Mondays and a harvest will not take place until the sample is returned free of PSP toxin. Using this method, any recalls of geoducks or geoduck products can be avoided. Economic losses can occur when PSP shuts down the harvest time for geoducks, possibly limiting a part of the tribe’s quotas. Gathering geoducks may also be limited to periods of the year when their market is small or non-existent, dropping the per-pound price of these shellfish. In the history of the Jamestown S’Klallam and Lower Elwha Klallam geoduck fisheries, only four or five geoduck recalls have occurred. A total of about 5,000 pounds of geoducks were recalled, costing the tribes about \$30,000.

Subsistence and ceremonial harvests are also a concern during PSP outbreaks. Subsistence harvests for the Jamestown S’Klallam consist of butter, littleneck, horse and manila clams. Butter clams are often laden with PSP toxins, making monitoring difficult. As such, this fishery

is limited to subsistence. To avoid the toxin in shellfish at a particular site, the Suquamish shift harvests of all species to other locations. If shellfish test positive for PSP before harvesting for ceremonies, the tribe may harvest at another locale. For the Puyallup, beach closures in the summer months have impacted the use of clams for ceremonial dinners, a custom at weddings and funerals. The cultural loss of traditional tribal activities is one that cannot be measured in dollars and cents.

The Lummi Nation has not had a beach closure from PSP in the last three or four years. When closures did take place, they were generally during the month of July and occurred on a regular basis. Oyster, clam and cockle

harvests were impacted during these times, but no long-term economic impacts were felt. Members of the Lummi Nation seldom harvest clams, oysters and crabs recreationally. Instead, their shellfish are obtained from aquaculture activities.



Oregon’s Indigenous Shellfishers

The Coos-Suislaw tribe on Coos Bay, the Siletz tribe on the Oregon coast at Lincoln City, and the Yakima tribe on the Columbia River have traditionally been shellfish-harvesting tribes. The Siletz tribe has a commercial seafood processing operation through which they currently sell smoked oyster products. Siletz tribal members live throughout Oregon and beyond, however, there is still a large and proud population of Siletz on the Oregon Coast. The Siletz Tribe receives a portion of all sales of Siletz Tribal Smokehouse-brand products. These funds are earmarked for tribal members and economic development.



Upper left: Plastic “dipsticks” used in the rapid test for PSP. Upper right: Canned razor clams from the Quinault Tribe. Above: A net filled with razor clams, collected on the Washington coast.



Introducing ORHAB

The Olympic Region Harmful Algal Bloom (ORHAB) Partnership has been in existence only since the summer of 1999.

However, it has already enhanced our understanding of the processes that govern the timing and spatial distributions of

toxin-producing *Pseudo-nitzschia* cells and their transport to coastal shellfish.

ORHAB was organized to develop collaboration and cooperation among federal, state and local management agencies, coastal Indian tribes, marine resource-based businesses, public interest groups and academic institutions. The ORHAB partnership investigates the origins of blooms of toxic algae, monitors where and when the blooms occur, assesses the environmental conditions conducive to blooms and toxification of intertidal shellfish population, and explores methods that can be used to reduce HAB impacts on humans and the environment.

Through such actions, ORHAB aims to build local self-sufficiency in mitigating impacts of harmful algal blooms, by providing improved tools for protecting public health, building consumer confidence in fishery products, and enhancing revenues for coastal communities in the Olympic region.

The Makah and Quinault Tribes, the Pacific Shellfish Institute and Washington State Departments of Fish and Wildlife and Ecology do ORHAB sampling at seven locations on the Washington coast with major razor clam beds and oyster or mussel aquaculture operations. Water samples are collected each week and tested for toxin, chlorophyll and nutrients.

ORHAB technicians are an essential link to effective communication on the 300 miles of remote coastline. They share all information collected with other ORHAB partners to assist managers in making decisions about coastal shellfish closures. In addition, razor clams are sampled and tested for domoic acid.

At the present time, ORHAB is focused on monitoring the toxic organism *Pseudo-nitzschia* and the toxin, domoic acid, produced by some *Pseudo-nitzschia* species. Domoic acid causes neurological damage and fatalities in humans, marine mammals and seabirds. However, ORHAB researchers will also study PSP during those years when it is a problem on Washington's open coast.



Native Californians and Kal ko-o

Historically, Klamath, Modoc and Yurok tribes depended on foods from the ocean and local rivers. These tribes would not eat shellfish when bioluminescence was evident in ocean waters, suggesting an awareness of the relationship between bioluminescence and shellfish toxicity.

"From time immemorial it has been the custom among coastal tribes of Indians, particularly the Pomo, to place sentries on watch for *Kal ko-o* (mussel poison)," wrote Karl F. Meyer, H. Sommer and P. Schoeholz in a 1928 issue of *the Journal of Preventative Medicine*. "Luminescence of the waves, which appeared rarely and then only during very hot weather, caused shellfishing to be forbidden for two days; those eating shellfish caught at such times suffered sickness and death."

Today, California's commercial shellfish industry is relatively small, with about 12 to 16 companies, none of which are tribally owned, that could potentially be impacted by PSP and ASP. Only rarely have toxins in mussels increased to levels that require closure of the all recreational shellfish harvesting activities on the California coast.

Upper left: ORHAB scientists meet with members of the Quinault Tribal Council in January 2001.

Upper right: During a class sponsored by the Northwest Indian College and ORHAB, University of Washington professor Rita Horner shows students how to collect phytoplankton. Center: ORHAB researchers (including Dr. Horner) prepare to gather samples with a phytoplankton net.

Health Impacts of Domoic Acid

A new pilot study is looking at the potential health effects of domoic acid on infant, adult and elderly members of the Quileute Tribe. The study is a collaboration between the University of Maryland and the Quileute Tribe, with funding from the Seattle-based Bullitt Foundation.

Data from the study will help researchers determine which of the three subsets of the tribal population are more susceptible to domoic acid in razor clams — a favored food in the Quileute diet. A proposal for funding an expansion of this study, to also include the Quinault, Makah and Haida tribes, will soon be submitted to the National Institute of Environmental Health Sciences by the University of Maryland, the tribes, NWFSC, and the University of Washington.

Biotoxin Hotline Phone Numbers

Alaska	800.731.1312 (within Alaska only)
British Columbia	604.666.2828 (PSP information)
Washington	800.562.5632
Oregon	503.986.4728
California	510.540.2605
Hawaii	808.586.4725 (Food Branch)
.....	808.586.4586 (Epidemiology Branch)

Tribal Shellfish and Treaty Rights

“The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians, in common with all citizens of the United States; and of erecting temporary houses for the purposes of curing; together with the privilege of hunting and gathering roots and berries on open and unclaimed lands. Provided, however, that they shall not take shellfish from any beds staked or cultivated by citizens.”

— Treaty of Point No Point, January 26, 1855

In the 1850s, Native American tribes in the Pacific Northwest signed treaties with the United States government. Under these treaties, the tribes signed over the titles to their lands. However, they reserved the right to fish and harvest shellfish in their usual and accustomed (U & A) grounds, as described in Article IV of the Treaty of Point No Point. Washington State sold most of its tidelands to private owners many years after the treaties had been signed. Since tidelands were no longer public, tribes were denied or unable to exercise their treaty rights to harvest shellfish from them.

While the Boldt decision of 1974 restored the tribes’ fishing rights, their shellfish rights were not included. In 1989, Western Washington tribes filed a case in Federal court to uphold their treaty shellfish rights. Today, Tribes are entitled to half the naturally occurring shellfish, not to any cultivated production.

Public and private tidelands are subject to treaty harvest, except for shellfish contained in artificial beds. Since this ruling, tribes have participated in management and monitoring of these resources as co—managers.

How do these rulings affect the daily lives of tribes? One example can be seen in the co-management of razor clam beaches on the Washington coast by tribes, Olympic National Park and Washington Department of Fish and Wildlife. Each year, these co-managers determine the total population of razor clams at Kalaloch beach on the central Washington coast. An estimate of the total razor clam population is made by surveying a part of the beach before each harvest season, and 50 percent of this total estimated resource is allocated for harvest. From this total harvest allotment, half can be harvested by the tribe exercising their U & A harvest right and the other half by the general public.

The Tenth International Conference on Harmful Algae will be held on October 21-25, 2002 at the Tradewinds Island Grand Resort and Conference Center on St. Pete Beach, Florida. For more information, see the conference Web site at www.XHAB2002.com

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You can keep up to date on West Coast HAB issues through the NWFSC's Web site (www.nwfsc.noaa.gov/hab), which features recent HAB findings from a variety of researchers, state reports on sampling and HAB occurrences, and links to many other relevant sites, including the ORHAB Web site.

We acknowledge the following colleagues for their contributions to this newsletter: Russel Barsh, Charlotte Clausing, Andrea Copping, Vince Cook, Frank Cox, Kelly Curtis, David G. Gordon, Sarah Howlett, Mitch Lesoing, Tony Meyer, Lynn Muench, Melissa O'Neill, Ray Ralonde, Robyn Ricks, Klaus Schallie, Joe Schumacker, John Stein, Derrick Toba, Paul Williams, Fran Wiltshusen and David Winfrey. Cover photograph, "The Mussel Gatherer" is by Edward S. Curtis, from the collection of Northwestern University.

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