Health Consultation

Evaluation of Blue Mussel Samples Collected in May 2006

M/V SELENDANG AYU OIL SPILL

UNALASKA, ALASKA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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UNALASKA, ALASKA

Prepared By:

The Alaska Department of Health and Social Services
Division of Public Health, Epidemiology Section
Environmental Public Health Program
under cooperative agreement with the
Agency for Toxic Substances and Disease Registry

Background and Statement of Issues

On December 8, 2004, the M/V Selendang Ayu ran aground and broke in half near Unalaska Island between Skan Bay and Spray Cape, approximately 25 air miles southwest of Dutch Harbor. An estimated 321,000 gallons of intermediate fuel oil and 14,680 gallons of marine diesel/miscellaneous oils were released to the environment. In addition, the vessel contained approximately 60 thousand tons of soybeans (1).

In March of 2005 the Unified Command for the spill response established a Selendang Ayu Subsistence Fishery Advisory Group, to evaluate whether subsistence foods in the Unalaska area were impacted by the spill. Members of the group administered a subsistence food consumption questionnaire, and sampled subsistence foods for spill-related contaminants. The Alaska Division of Public Health (ADPH), Section of Epidemiology released a report in April 2006 that interpreted the analytical results of the subsistence food sampling (2). That report recommended that additional sampling of mussels be conducted in the summer of 2006 to verify predicted reductions and/or possible fluctuations in polycyclic aromatic hydrocarbon (PAH) levels in the mussels over time.

In late May of 2006, nine blue mussel samples were collected from strategic locations to follow up on that recommendation. This report interprets the public health significance of PAH levels in blue mussels collected in May 2006.

Methods

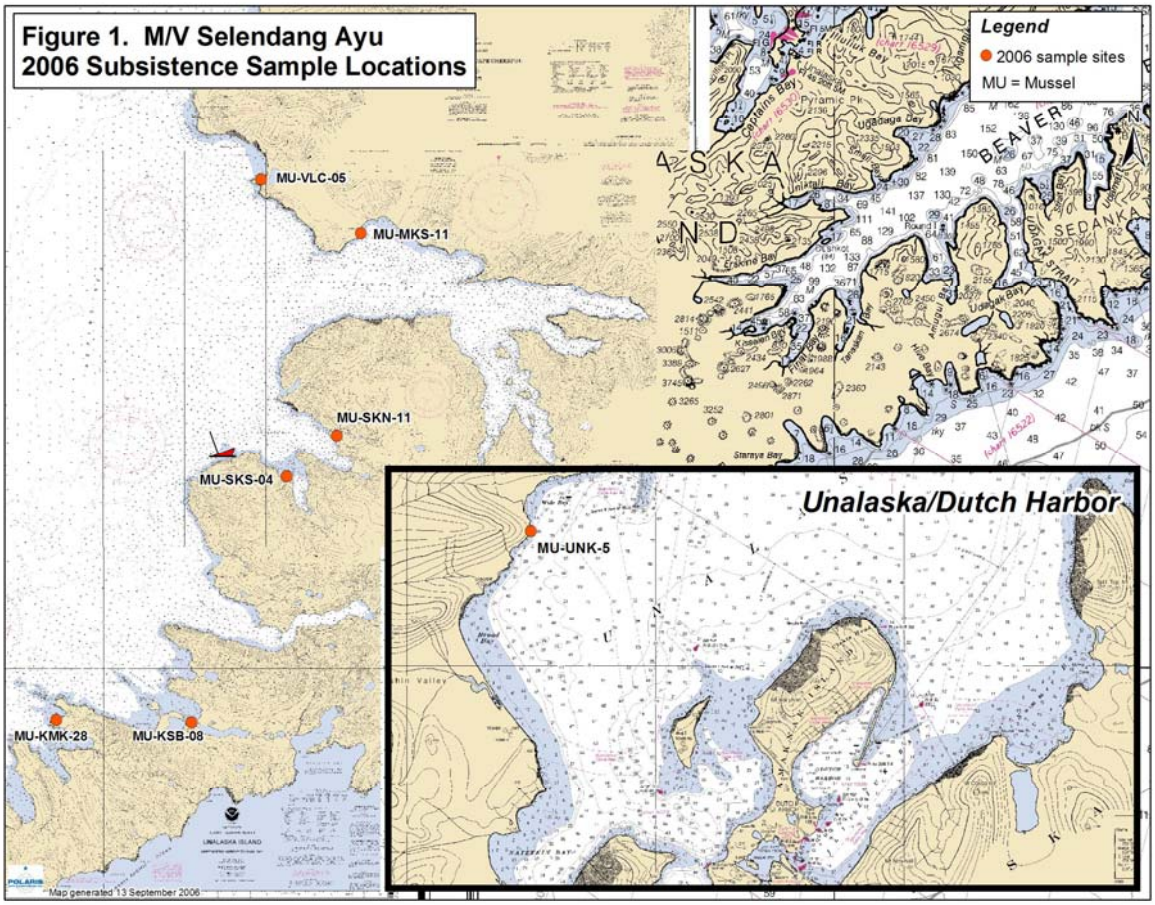
Petroleum products can contain a mixture of hundreds of organic compounds. Health concerns of exposure to oil from spills are mainly focused on PAHs due to their chemical and toxicological properties (3). Some PAHs have been classified as carcinogenic, they are relatively (compared to other compounds in oil) resistant to environmental degradation, and can accumulate in the food chain to some extent (3). Mussels were analyzed for PAHs using modified EPA method 8270c at the Woods Hole Group Analytical Laboratory in Raynham, Massachusetts.

Mussel samples were not collected for organoleptic analysis or Paralytic Shellfish Poisoning (PSP) testing in 2006. Testing in 2005 determined that no petroleum odor was detectable in chitons with elevated PAH concentrations in Humpy Cove. Testing in 2005 adequately established the risk posed by PSP toxin, as several mussel samples collected in Skan Bay in the spill area had PSP toxin concentrations above the commercial closure level (2). No beaches on Unalaska Island are approved for shellfish collection due to the risk of PSP.

Subsistence foods sampling

Five sampling sites for spring 2006 were chosen because they had been previously sampled in 2005, and were located in or near beach segments that did not meet cleanup endpoints by the end of 2005 operations (Figure 1). These sampling locations included Makushin Bay (MKS-11), North Scan Bay (SKN-11), South Scan Bay (SKS-04), Kashega Bay (KSB-08) and Kismaliuk Bay (KMK-28). The other two sampling sites were chosen because they were subsistence areas not sampled in 2005, located on

shorelines that had been lightly oiled during the initial incident. These sites included Wide Bay (UNK05 in Unalaska Bay), and Volcano Bay (VLC-05).



Determination of benzo(a)pyrene equivalents

Each subsistence sample analyzed for PAHs was evaluated for its overall carcinogenic potency by calculating benzo(a)pyrene (BaP) equivalents as done previously for the M/V Selendang Ayu (2), Exxon Valdez (3), M/V Kuroshima (4), and New Carissa (Coos Bay, Oregon) (5) oil spills. For each sample, the carcinogenic potency of each PAH compound was expressed relative to BaP and then summed for an overall estimate of BaP-like activity. PAHs that were not detected were assigned a value of zero. The California Environmental Protection Agency has established BaP Potency Equivalency Factors for 21 PAHs/derivatives (6); the seven that were analyzed for in this project are shown in Table 1.

Table 1. Benzo(a)pyrene Potency Equivalency Factors for polycyclic aromatic hydrocarbons

Compound	BaP equivalent
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenzo(a,h)anthracene	1.0
Indeno[1,2,3-cd]pyrene	0.1

*Source: CA EPA, 1999

Risk-based screening criteria

Risk-based screening criteria (i.e., the concentration that is reasonably considered safe) were calculated for each subsistence food to compare to the concentration of carcinogenic PAHs (i.e, BaP equivalents) detected in each sample. The risk-based screening criteria were calculated using the following formula and the standard assumptions in Table 2, as follows:

Risk-based screening criteria (µg/kg) = RL x BW x AT x CF_1 x CF_2/(SF x ED x CR)

Table 2. Input variables for risk-based screening criteria.

RL	Acceptable risk level[a]	1.0E-06	
BW	Body weight, adult[b]	70	kg
AT	Averaging time[c]	70	years
CF_1	Conversion factor	1000	ug/mg
CF_2	Conversion factor	1000	g/kg
SF	USEPA slope factor	7.3	(1/mg/kg-day)
ED	Exposure duration[d]	3	years
CR	Consumption rate	see Table 3	g/day

[a]US EPA's risk management range for excess cancer risk above background is one-in-one-million (10^{-6}) to one-in-ten thousand (10^{-4}) (7). 10^{-6} excess cancer risk equates to one excess cancer in a population of one million people. This is a theoretical estimate that is based on very conservative mathematical calculations. The true risk could be much lower, even zero. To put this in perspective, for the United States it is estimated that men have an almost 1 in 2 lifetime risk of developing cancer and females have about a 1 in 3 lifetime risk (8).

[b]Standard default for adult body weight (7)

[c]Standard default for life expectancy (7)

[d]Estimated maximum residence time for oil (3,5)

Site-specific consumption rates for blue mussels were gathered from two sources: the Selendang Ayu consumption survey conducted in 2005 (2) and a survey conducted by the Alaska Department of Fish and Game (ADF&G), Division of Subsistence in 1994 for Unalaska (9). Based on these ingestion rates, a risk-based screening value was calculated (Table 3). The ADF&G ingestion rates were greater than the ingestion rates determined from the Selendang Ayu subsistence food questionnaire for all foods sampled; therefore,

the calculated risk-based screening criteria were lower. To be conservative, the risk-based screening criteria based on the ADF&G ingestion rates were used for comparison to the total BaP equivalents for each sample.

Table 3. Upper 95th confidence interval of the mean ingestion rate (g/day) and risk-based screening criteria for the M/V Selendang Ayu oil spill near Unalaska, Alaska.

Resource	Spill Task Force survey (2005) ingestion rate[a] g/day	Risk-based screening criteria ug/kg	ADF&G (1994) ingestion rate g/day	Risk-based screening criteria ug/kg
blue mussels	1.5	145.3	11.9	18.8

[a]the injestion rate for blue mussels represents all shellfish (i.e., razor, butter, steamer clams; blue mussels, and cockles)

Results and Discussion

Total PAHs and total BaP equivalents are shown for each blue mussel sample in Table 4. No sample had a total BaP equivalent value that exceeded the blue mussel-specific risk-based screening criteria of 18.8 μg/kg. Therefore, PAHs in blue mussels in the areas sampled do not pose a cancer risk to subsistence consumers. These results confirm the prediction from our previous report that "the levels of PAHs in subsistence food resources are expected to decline in the future, therefore; any small risk associated with exposure to PAHs through consumption of subsistence resources near the spill zone should either remain constant or decline over time" (2). For example, BaP equivalents in blue mussels collected from North Skan Bay (SKN-11) declined from 35 μg/kg in April 2005 to 0.19 μg/kg in May 2006. This decline is likely due both to remediation activities and natural attenuation of residual contamination.

Table 4. Total polycyclic aromatic hydrocarbons (PAHs) and total benzo(a)pyrene equivalents in blue mussels near Unalaska, Alaska

Collection Date	Location ID	Sample ID	Total PAHs	Total benzo(a)pyrene equivalents	Risk-based screening concentration
			ug/kg		
5/24/2006	Skan Bay	SKN-11 North 5-24-06	613	0.19	18.8
5/24/2006	Skan Bay	SKN-11 South 5-24-06	467	0.17	18.8
5/26/2006	Wide Bay	MU-UNK0526May06	2.3	0.027	18.8
5/26/2006	Wide Bay	MU-UNK0526May06 (Dup)	2.4	0.032	18.8
5/26/2006	Volcano Bay	MU-VLC05-26May06	2.9	0.037	18.8
5/26/2006	Makushin Bay	MU-MKS11-26May06	51	0.088	18.8
5/26/2006	Skan Bay	MU-SKS04-26May06	159	0.076	18.8
5/26/2006	Kashega Bay	MU-KSB08-26May06	3.1	0.037	18.8
5/26/2006	Kismaliuk Bay	MU-KMK28-26May06	14	0.050	18.8

PAHs are ubiquitous in the environment, and ingestion of food is the main source of PAH exposure for non-smokers of the general population. PAHs are present in cooked and smoked meats and fish, grain products, fruits, and vegetables. For smokers, smoking a pack of cigarettes a day approximately doubles PAH exposure (10).

Following the M/V Selendang Ayu oil spill, PAHs were measured in shellfish because they are nonmobile filter feeders with limited capacity to metabolize/excrete PAHs. Fish and marine mammals are much less helpful indicators of site-specific PAH contamination because they will avoid oiled areas, and they have the ability to metabolize and excrete PAHs rather than bioaccumulating them.

In the previous evaluation of subsistence resources following the M/V Selendang Ayu oil spill (2), eight of 10 composite blue mussel samples were positive for PSP toxins and two samples from Skan Bay had PSP toxin concentrations greater than the level allowed for commercial sale. Due to PSP concerns, there is currently an ongoing advisory in the state against the gathering and consumption of shellfish except at approved beaches. **There are no approved beaches in the Unalaska/Dutch Harbor area.** The ADPH considers the health hazard from PSP to be much more serious than any health hazards associated with PAH exposure at the levels currently found in mussels in the area.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe

dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Paralytic shellfish poisoning can be harmful to a child's health, or even fatal. It is important for adults to teach children about the dangers of paralytic shellfish poisoning, and how important it is not to consume shellfish collected from unapproved beaches in Alaska.

Conclusions

1. PAHs are not present in mussels from sampled beaches at levels of health concern. PAH levels did not exceed risk-based screening values in any of the samples, so consumption of mussels from these areas does not pose a cancer risk.
2. Benzo(a)pyrene equivalents in blue mussels from the area most heavily impacted by the spill, Skan Bay North, declined nearly 200-fold during the period from April 2005 to May 2006.
3. Paralytic shellfish poisoning, a natural phenomenon unrelated to the Selendang Ayu oil spill, poses a serious health risk to shellfish consumers in the Unalaska/Dutch Harbor area.

Recommendations

1. To err on the side of safety, subsistence gatherers should avoid consumption of foods on which oil can be seen, smelled or tasted. This advice is similar to that given following the Exxon Valdez oil spill and the M/V Kuroshima oil spill, and presents a common sense and conservative approach that is protective of public health.
2. No additional sampling of subsistence foods for PAH contamination related to the M/V Selendang Ayu oil spill is warranted or recommended.
3. Villagers should adhere to the statewide advisory for paralytic shellfish poisoning, and they should not collect shellfish from beaches that have not been approved. **There are no approved beaches in the Unalaska/Dutch Harbor area.**

Public Health Action Plan

Actions undertaken:

- State agencies, federal agencies and the Responsible Party created a unified incident command to oversee cleanup operations. During cleanup operations, 476 miles of shoreline was inspected for oil impact. At the peak of cleanup operations more than 200 shoreline workers, 23 vessels and three aircraft were involved in removing the oil from approximately 37 miles of impacted shoreline. Response operations began immediately following the grounding of the M/V Selendang

Ayu in December 2004 and continued into February 2005 with removal of the oil still in the ships tanks, protective booming of shoreline that had not been oiled and the start of shoreline cleanup. Operations resumed again in April 2005 and continued until weather forced a temporary hold on operations at the end of September. Cleanup of the last three and a half miles of shoreline was completed when operations started again in May 2006 and concluded the end of June 2006.

- Following the initial round of subsistence food sampling and analysis, results were presented at an annual meeting of the Qawalangin tribe on June 17, 2006. The presentation consisted of a video made by Scott Arnold, toxicologist for the Alaska Division of Public Health, and an accompanying Powerpoint presentation.

Actions planned:

- Our health educator will conduct an informal needs assessment to determine what outreach and communication efforts may be needed at this site. This will entail contacting community leaders, including representatives of the Qawalangin tribe, to identify any ongoing health concerns related to the spill and need for education about PSP. These contacts will occur within one month of this Health Consultation's release to the community.
- Further health education activities will be conducted if found to be warranted during the informal needs assessment.
- The Alaska Department of Environmental Conservation will continue to issue periodic press releases to communicate their ongoing statewide advisory for PSP, which warns the public not to collect shellfish from unapproved beaches. A statewide PSP advisory is issued statewide at least once per year in a press release, and additional targeted advisories are released as needed.

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Certification

This Health Consultation (M/V Selendang Ayu Oil Spill) was prepared by the Alaska Department of Health and Social Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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