Stakeholder Comments to the ARRT Science & Technology Committee regarding Revision of the Dispersant Guidelines

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Prepared on behalf of
Prince William Sound Regional Citizens' Advisory Council

Introduction

Chemical dispersants are substances applied to spilled oil that disperse oil into the water column rather than leaving it floating on the surface in a slick. The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has long endorsed mechanical recovery as the primary tool to combat an oil spill. Unlike dispersant use, mechanical recovery with booms and skimmers removes oil from the water.

Current state and federal laws and regulations hold that dispersants should be used only if it is clear that mechanical cleanup methods such as booming and skimming will not work. PWSRCAC supports these laws, opposes efforts to loosen these restrictions, and urges regulatory agencies to take a conservative approach towards the use of dispersants.

PWSRCAC promotes research and testing to increase knowledge about dispersants and the environmental consequences of their use. Among PWSRCAC's concerns is the scarcity of reliable scientific data about the efficiency, toxicity, and persistence of dispersants and dispersed oil in Prince William Sound (PWS) and Gulf of Alaska conditions.

A conclusive demonstration has not shown that chemical dispersants work in the extremely cold waters of PWS. Although effort has been put into evaluating chemical dispersant use over the last 30 years, it appears that a good portion of this effort was conducted by the formulators of dispersants and not by independently funded surfactant scientists.

Background

Over the last 35 years, the National Research Council (NRC) has conducted three studies on oil in the marine environment*: (1) Petroleum in the Marine Environment* (NRC 1975); (2) *Oil in the Sea: Inputs, Fates and Effects* (NRC 1985); and (3) *Oil in the Sea III: Inputs, Fates and Effects* (NRC, 2003). The NRC has also conducted two studies regarding the use of chemical dispersants as an oil spill counter measure at sea: *Using Oil Spill Dispersants on the Sea* (NRC, 1989), and *Oil Spill Dispersants: Efficacy and Effects* (NRC, 2005). The most recent U.S. Public Health Service

Toxicology Profile for Polycyclic Aromatic Hydrocarbons (PAH) was published by the Agency for Toxic Substances and Disease Registry (ASTDR) in 1995 (ATSDR, 1995).

Since 1997, PWSRCAC has maintained an active, independent program including research, policy review, and several topical status reviews ("white papers"). A summary of PWSRCAC's Chemical Dispersants Program for the period 1997 to April 2006 can be found on the PWSRCAC website (PWSRCAC, 2006). In September 2008, Dr. Merv Fingas completed *A Review of Literature Related to Oil Spill Dispersants: 1997-2008* (Fingas, 2008) which is also found on the PWSRCAC website.

Taken as a whole, these documents provide a valuable assessment of PWSRCAC's current knowledge regarding the efficacy and environmental effects of using chemical dispersants as an oil spill countermeasure in the marine environment.

However, PWSRCAC has continuing concerns in four areas which either were not considered or did not receive adequate consideration in these reports:

1. Physical constraints on dispersant effectiveness in northern waters, especially temperature, salinity, and resurfacing.
2. Oceanographic differences between the Alaska Region waters and those of other National Response Team (NRT) Regions, especially with regard to productivity and critical habitat/species identification.
3. Distribution, degradation, and sequestration of dispersed and non-dispersed oil.
4. The long-term adverse affects of short-term exposures of critical biota to persistent PAH.

Physical constraints on dispersant effectiveness in northern waters, especially temperature, salinity, and resurfacing.

In his 2004 report for PWSRCAC, *Dispersants, Salinity and Prince William Sound* (Fingas, 2004), Dr. Merv Fingas provided a comprehensive discussion of the effects of salinity and temperature on dispersant effectiveness.

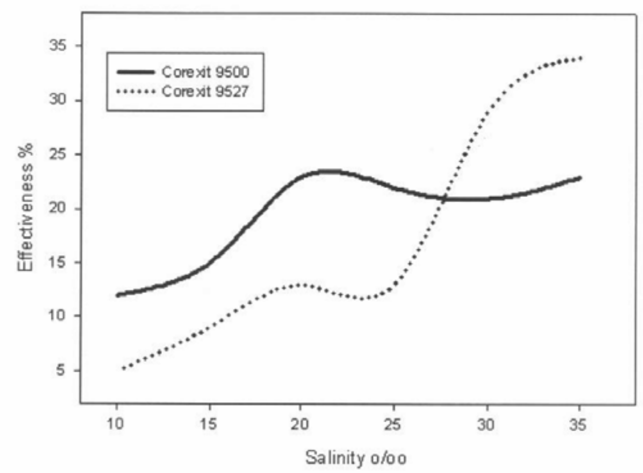

Figure 1: Effectiveness of Corexit 9500 and 9527 on Alaska North Slope crude oil as a function of salinity. (Figure 9 from Fingas, 2004)

Some of the important conclusions drawn in this report are:

a) Dispersant effectiveness peaks in waters with a salinity ranging from 20 to 40 o/oo (parts per thousandths). This may depend on the type of dispersant. Corexit 9500 appears to be less sensitive to salinity but still peaks at about 35 o/oo. Corexit 9527 is more sensitive to salinity and appears to peak at about 25 o/oo with some oils and at about 35 o/oo with others.

b) The findings in the dispersant literature discussed in these comments are in agreement with those in the theoretical and basic surfactant literature. The effect of ionic strength and salinity on both hydrophilic-lipophilic balance and stability is the reason for the decreased effectiveness noted at low salinities and the same decrease at high salinities above a certain peak of about 20 to 40 o/oo.

c) The waters in PWS are sometimes low in salinity, often less than 15 o/oo, especially near river outfalls and in bays or during heavy rainfall events. This will result in lower dispersant effectiveness.

GAK1 is the northernmost station in the University of Alaska's Gulf of Alaska transect which provides long-term data on the Alaska Gyre and Alaska Coastal Current (ACC). GAK1 is located in Harding Gateway at the mouth of Resurrection Bay. It is 15 nautical miles (Nmi) south of Seward and 2.5 Nmi from the nearest point on the Aialik Peninsula. The values given are mean values, not extremes. As reported by Fingas, waters near rivers or glaciers are often lower than 15 o/oo. It is not unusual for the salinity of nearshore waters to shift 10 o/oo within a few days of hot weather or to drop following a strong mixing event.

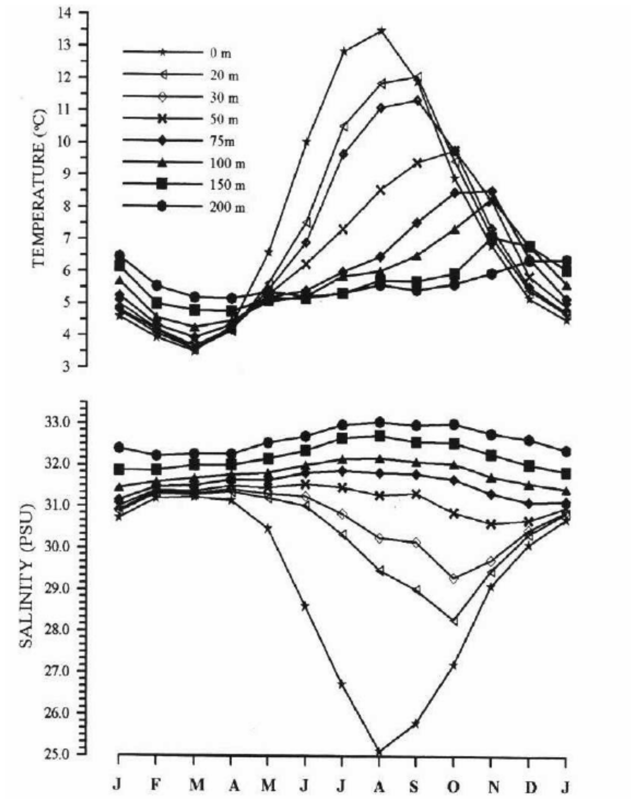

Figure 2: The mean annual cycle of temperature and salinity at various depths at station GAK 1 on the inner shelf of the northern Gulf of Alaska. Monthly estimates are based on data collected from 1970 through 1999. (Figure 15 from EVOSTC, 2001)

A variety of dispersant efficacy testing has been conducted at the Ohmsett test tank operated by the U.S. Minerals Management Service in New Jersey. Beginning in 2002, PWSRCAC sent observers to a number of tests intended to demonstrate the ability to disperse Alaska North Slope crude oil (ANS) into near freezing water with Corexit 9500 or 9527.

These observers have consistently reported several technical concerns about the test protocols used. These concerns are well documented in a series of reports on the PWSRCAC Dispersant web pages. One of these concerns is the inability to accurately assess the nature and degree of resurfacing of the dispersed oil.

Dr. Merv Fingas' report entitled *Stability and Resurfacing of Dispersed Oil* (Fingas, 2005) includes a wealth of both empirical and theoretical data. Dr. Fingas concludes that there is a vast body of information and experimentation and a broad consensus on the stability of emulsions. Crude oil-in-water dispersions are similar to many other types of emulsions in that the dispersions are stable under some conditions for a period of hours. During this time, destabilization processes are underway that result in oil resurfacing. Dr. Fingas' study concludes that the average half-life for ANS dispersed with either Corexit 9500 or 9527 is 15 hours**.**

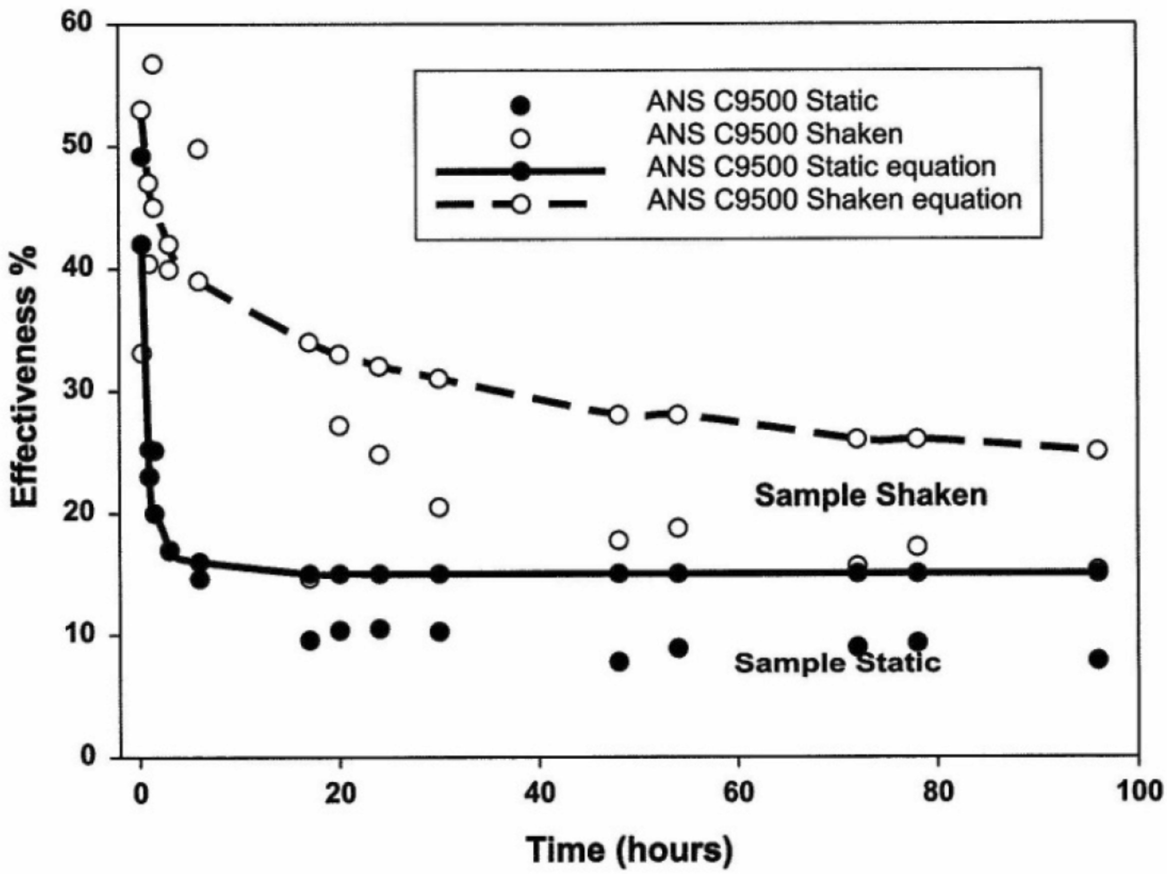

Figure 3: Decrease in the effectiveness of Corexit 9500 in dispersing ANS due to resurfacing over time. The circles are observed values from laboratory flask tests. The lines are derived from the model presented by Fingas. (Figure 9 from Fingas 2005).

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Thus, 30 hours of quiet weather would be sufficient to allow 75% of the dispersed oil to resurface.

Oceanographic differences between the Alaska Region waters and those of other NRT Regions, especially with regard to productivity, and critical habitat/species identification.

There has been a strong tendency to try to use the same strategies developed in temperate and sub-tropical regions for oil spill countermeasures in Alaskan waters. As these environmental conditions are vastly different, PWSRCAC has concerns that this reliance could result in catastrophic errors in decision making.

Most temperate coastal ecosystems are driven by fresh water input from nutrient-rich lakes, rivers, and streams. These nutrients are then deposited in coastal estuaries, deltas, and salt marshes. These become nursery areas for many species and are critical habitats for many coastal species. The gradual movement of critical nutrients from these highly-productive, nearshore sanctuaries drives much of the coastal productivity in temperate and sub-tropical habitats.

In stark contrast, major rivers and streams of the Alaska Region carry large volumes of fresh water and heavy loads of suspended particulate matter but very low levels of organic nutrients. The northern oceans support a very high level of productivity. This productivity is supported by up-welling of nutrients transported north by deep ocean currents from tropical regions. This bottom-up forcing leads to high seasonal production of plankton, some of which is carried into the shore zone to support growth of tidal and shallow benthic organisms.

There are exceptions to both of these models. However, the models' applications are widespread enough to suggest two separate approaches in determining the importance of protecting the nearshore environment during an oil spill response.

One concrete, oil spill-related example of these systemic differences is illustrated by the bird mortality of temperate zone oil spills as compared to the *Exxon Valdez* oil spill (EVOS). Whereas temperate zone incidents usually cause significant mortality to shorebirds, ducks, gulls, and terns, two-thirds of the birds killed by EVOS were alcids; only 0.1 percent were shorebirds; and 15 percent were gulls terns and petrels. Eighty-seven percent of the alcids were murres (Hunt, 2003).

As typical of most alcids, murres spend most of their lives either at sea or on the steep rocks where they nest. The term "nest" is used loosely because a single egg is usually laid on an open ledge well above any oil which might come ashore. Murres are deep diving seabirds capable of dives to 200 meters. They generally rest on the water between dives. Since they do not come ashore to dry their feathers, they must preen fairly constantly to maintain their waterproof capabilities. In dispersed oil, murres dive repeatedly through the oil-water mixture followed by ingestion of dispersed oil during preening. That such a large portion of bird mortality caused by EVOS was to pelagic feeding alcids rather than to surface and shore feeding birds should be a strong indication of the need to protect that pelagic environment.

EVOS proved that oil on the shoreline is unsightly, causes substantial shore zone mortality, and disrupts traditional and customary uses of the nearshore habitat. However, decimation of the shore zone may not be as catastrophic as a major perturbation in pelagic productivity. In choosing incident response options, the following should be considered:

1. How important is the production in the threatened habitat to the overall productivity of the ecosystem?
2. Will the additional risk to the pelagic habitat be counter balanced by benefits to the near shore habitat?
3. Will the response option lead to persistence of oil-derived PAH in a biologically available form?

4. What are the relative impacts of the response options on traditional and customary use of the resources in the potentially impacted habitats?

The Alaska Region has more coast line and more continental shelf than all other NRT Regions combined. The oceanography of much of the region, however, is only understood on a fairly coarse scale. PWS and the Alaskan Gyre/Alaska Coastal Current are among the best studied areas.

The EVOS Trustee Council (EVOSTC) has undertaken two large studies focusing on the ocean dynamics of these areas: The Prince William Sound Ecosystem Assessment (SEA) project, and the Gulf of Alaska Ecosystem Monitoring and Research (GEM) program. The former project lasted five years while the latter was reviewed by NRC (NRC, 2002) but only some individual components of the program were ever started. The Alaska Ocean Observing System (AOOS) is using the PWS system as a pilot.

Most of these studies have only reached the stage of documenting the substantial seasonal and inter-annual variation which occur in most parameters in PWS and surrounding waters. Not surprisingly, surface currents do not follow the deep PWS currents. Some events are driven by local events such as weather and fresh water inputs, while other changes are driven by the broad-scale climatic events altering the Alaska Gyre such as the position of the Aleutian Low and the Pacific Decadal Oscillation (PDO). Periodic shoaling of the deep ocean up-welling along the ACC can cause a fairly abrupt shallow density (salinity) gradient even well off-shore (Trites, 2007).

The SEA project demonstrated that location and timing of primary plankton blooms, and subsequent zooplankton blooms can annually move about PWS in a manner which has so far defied modeling.

As shown in Figure 4, many marine species may spawn in one location before migrating either as plankton or feeding on plankton, to a second nursery area. Once maturing to young adults, they undertake a second migration to preferred adult habitat. With a few exceptions (such as Pacific salmon), the mature adults undertake annual migrations back and forth to the spawning site. For sessile benthic organisms, adult populations mature at the spawning site (Waller, 1996). The two highlighted stages are generally considered the most sensitive life stages, and therefore, the most critical habitat.

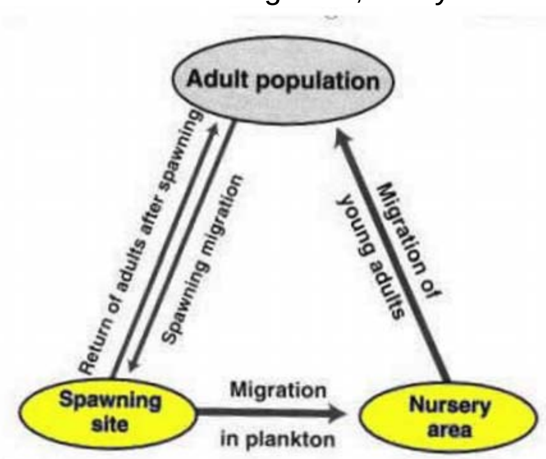


Figure 4: Migration triangle followed by many marine species during their life cycles

The difficulty for the oil spill response planner arises from the fact that the spawning and nursery areas are not static but may move in response to poorly identified sources of environmental stress. There are many variations to this model. For example, herring spawn near shore, preferably on kelp beds, then the fry migrate following the zooplankton produced by offshore up-welling. Adults migrate further offshore before returning to spawn. In contrast, many flatfish spawn in deep water but juveniles migrate to shallower bays to mature. Many benthic organisms spawn in one location and their planktonic offspring are carried by currents to a second nursery location. Thus, the oil spill response planner has two choices: either kill the biota in the intertidal and nearshore nursery areas, or kill the planktonic early life stage of these species and those juveniles feeding on the plankton.

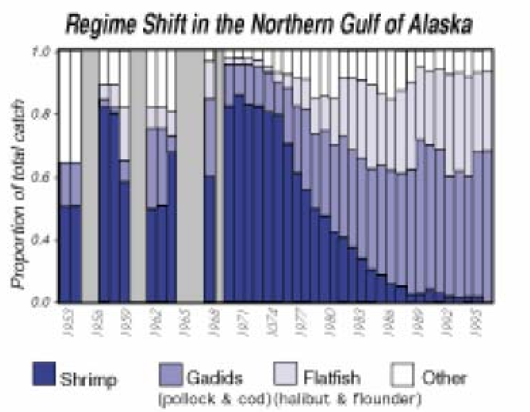
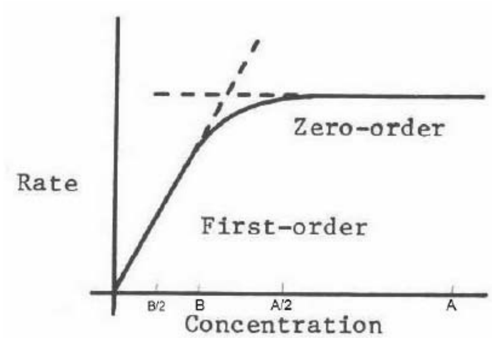


Figure 5: Regime shift in the northern Gulf of *Alaska. (Figure 1 from EVOSTC, 2009)*

There are many declining, threatened, and endangered species of marine mammals and sea birds in the Alaska Region. Several studies have concluded that a contributing factor in these declines is the limited availability of high calorie forage fish. Trites and coworkers (2007) recently studied the role of ocean climate changes on the decline of Stellar sea lions. Anderson also looked at the correlation between the PDO and major regime shifts in the north Pacific.

Thirty years of trawl surveys demonstrate the sensitivity of species composition of the northern Gulf of Alaska to relatively minor climate changes. These changes correlate well with changes in the PDO principle component analysis. However, other relatively minor perturbations in productivity such as large scale input of dispersed oil might also tip this delicate balance in PWS and the Gulf of Alaska. The question of balancing the impacts of oil spill response options is largely one of degree.

The acute lethal affects of a variety of crude oils are fairly well documented for a number of species found in Alaskan intertidal communities. However, relatively little is published regarding the dose-response for Alaskan crude oils on a community population level. That is, at what degree of oiling do the adverse affects on each specific type of intertidal community reach a maximum beyond which further oiling causes little or no additional adverse impact? Although each species clearly has its own dose-response characteristics, the curve in Figure 6 can be used as a rough approximation of the expected overall affect.



Reaction rate vs concentration for a surface area-limited process.

Figure 6: Typical kinetics for surface area limited processes

In this case, the extent of toxic affect is considered rather than "rate". If oil amount "A" reaches the shore, clearly reduction of the amount of oiling by half (to A/2) would not provide a beneficial effect. On the other hand, if the initial amount of oiling was projected to be "B," reducing the amount of oiling to B/2 by using alternative counter measures would reduce the toxic affect by almost half.

A great deal of discussion has taken place regarding the unexpected persistence of relatively unweathered oil in some beach types 20 years after EVOS. Although EVOSTC is sponsoring studies to better characterize these beach segments, sufficient data is not available to characterize specific shore types as sensitive habitat due to probable persistence of oil.

As described in the next section of these comments, there is good evidence that oil-derived PAH from subsurface sedimentation may be retained in shallow sediments. Both of these types of persistent oil appear to be biologically available to a significant extent.

Degradation and sequestration of dispersed and non-dispersed oil.

Most data on the degradation of crude oil components has been obtained from systems neither as cold nor as pristine as most marine waters in the Alaska Region. One means of classifying bacteria is by growth temperature ranges. The two classes of bacteria which grow at ocean temperatures are psychrophiles and mesophiles.

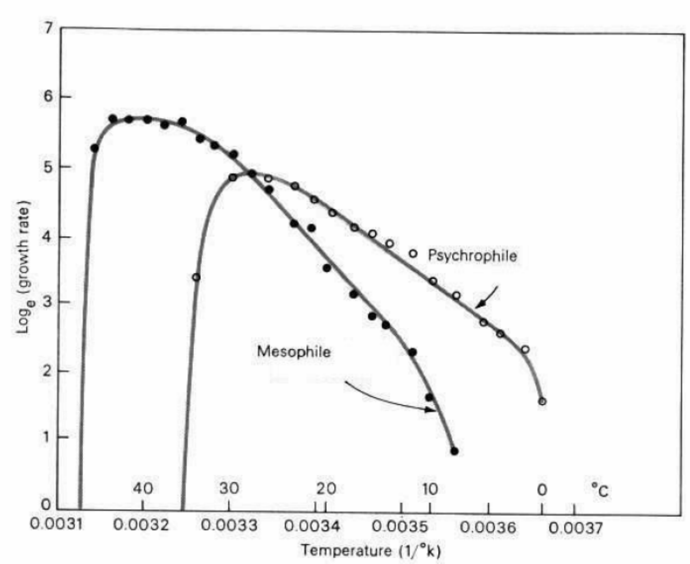


Figure 7: An Arrhenius plot showing the relative growth rates of a psychrophilic pseudomonad and the mesophile E. coli. (modified from Figure 20-2 in Jay, 1978)

The phychrophile dies above 35°C, and the mesophile does not exhibit significant growth below 8°C. Both classes of organisms exhibit a relatively linear relationship between growth rate and temperature through the central part of their growth range. As an average, this is generally considered a doubling of the growth rate for each increase of 5°C. Thus, if a mixture of marine bacteria degraded a sample of oil at 25°C in the Gulf of Mexico in one day, it would take the same mixture at least two weeks to degrade the same amount of oil at 5°C in the Gulf of Alaska.

Many oil-degrading organisms are psychrophilic pseudomonads. These usually carry the genes for the enzymes necessary to degrade oil-derived hydrocarbons on an extra-chromosomal piece of DNA called an episome. Bacteria not growing on oil will tend to lose this episome along with the ability to metabolize oil. Once exposed to oil, the bacteria can regain the episome from the small portion of the population retaining the episome. This is not unusual but does require actively growing bacteria.

Class	Biodegradation Susceptibility
n-Alkanes	$C_3 \sim C_8$-C_{12} > C_6-$C_8 \sim C_{12}$-C_{15} > $C_{6-} \sim C_{15+}$
Branched alkanes	Monomethyl > polymethyl > highly branched (e.g., pristane>>2,3,4-trimethylpentane)
Acyclic Isoprenoids	Lower molecular weight (e.g., C_{10}) > higher molecular weight (e.g., C_{20}). Acyclic isoprenoids degraded before major alteration of polycyclic biomarkers.
Alkylated benzenes and PAHs	1-Ring > 2-Ring > 3-Ring > 4-Ring. Methyl and dimethyl > trimethyl or extended alkylated species

Figure 8: Classes of crude oil-derived hydrocarbons in order from most susceptible to degradation to least. (Derived from Figure 11-11, Prince, 2007).

Bioenergetics dictates that oil-degrading bacteria will metabolize the most susceptible hydrocarbons first, followed by the next most susceptible hydrocarbons, and will only then start degrading the most metabolically stable hydrocarbons afterwards. As shown in Figure 8, this means that alkanes will be degraded first followed by branched alkanes, and only then the mono- and di-aromatics, and finally the three-ringed and greater PAH.

It is widely accepted that the most acutely toxic fractions of crude oil are the alkane fraction, especially benzene, toluene, ethylbenzene, and xylene (BTEX). The genotoxic effects of four- and five-ringed PAH have been well studied (ATSDR, 1995). This toxicity is often expressed as cancer or birth abnormalities. These chronic affects are primarily caused by unalkylated PAH which are found at comparatively low concentrations in crude oil, but are high in combustion by-products such as soot from in-situ burning.

As will be discussed in the next section of these comments, the last decade has seen several detailed studies describing the particularly insidious toxicity of short exposures to very low concentrations of alkylated three-ringed PAH.

The total PAH fraction of weathered ANS is no more than five percent of the oil. Thus, detoxifying these PAH requires degrading organisms to break down 95 percent of the remaining oil before achieving any significant reduction in chronic toxicity.

One of the few on-going studies on the degradation of ANS-derived hydrocarbons occurs in the Biological Treatment Tanks (BTT) of the Ballast Water Treatment Facility (BWTF) at the Alyeska Marine Terminal. In 2004 and 2005, Payne and co-workers undertook a study for PWSRCAC to document the effectiveness of biological treatment at this facility (Payne, 2005). The BTT is the final step of the BWTF processing of oily ballast water from inbound tankers. The tanks are at ambient temperature using indigenous bacteria maintained by a continuous throughput of treated ballast water. Inorganic nutrients are added to facilitate the degradation.

Benzene	$t_{1/2}$ @ 15.5 °C	$t_{1/2}$ @ 5.5 °C	$t_{1/2}$ @ 5.5 °C / 15.5 °C
C-0 (B)	n/d	0.64	-
C-1 (T)	n/d	0.84	-
C-2 (E+X)	n/d	0.87	-
Naphthalene (N)			
C-0	0.19	1.11	5.84
C-1	0.25	6.03	24.12
C-2	0.68	61.89	91.01
Phen/Anthr (P)			
C-0	0.64	123.78	193.41
C-1	1.81	*	*
C-2	14.0	*	*
P/N:			
C-0	3.37	111.51	33.12
C-1	7.24	*	*
C-2	20.54	*	*

Degradation rates were determined for each group of hydrocarbons - in September 2004 at a water temperature of 15.5°C and in January 2005 of 5.5°C. Data was tested for both zero-order and first-order fits. The best correlation was obtained for a first-order model of degradation. Observed degradation of monoaromatics at the summer temperature were too fast to determine accurately. No statistically significant degradation of alkylphenanthrenes was measured at the winter temperature.

The half lives and ratios listed in the table above illustrate two important points. First, that the observed rates in winter conditions are much slower than would have been predicted by the "doubling of the rate for each five degrees" rule discussed in the first paragraph of this section. Second, under winter conditions there is virtually no degradation of phenanthrenes even under these nutrient-enhanced growth conditions.

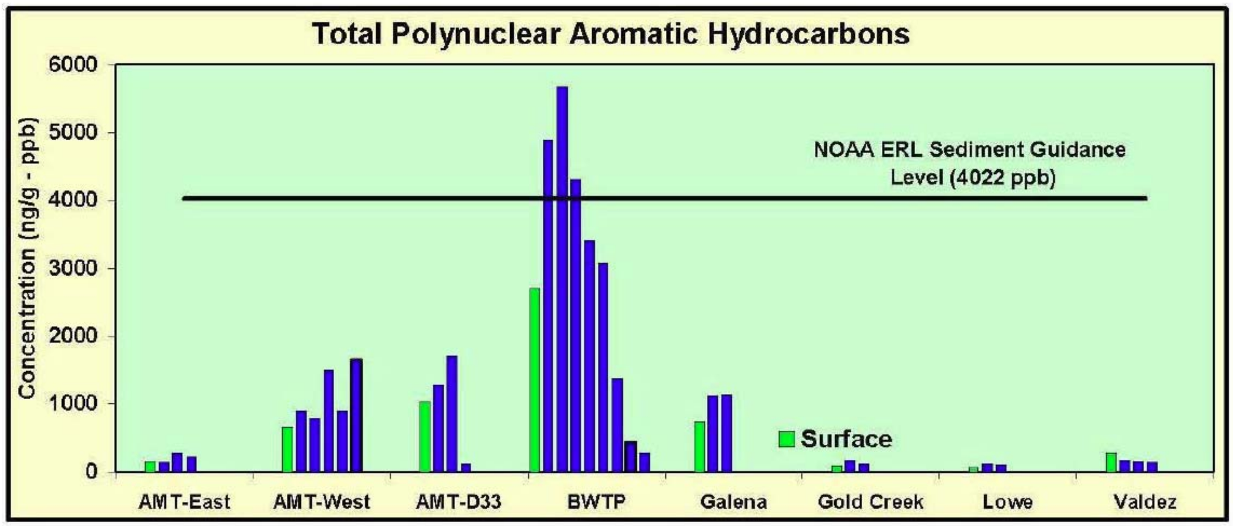


Figure 9: Total PAH concentrations found in sediment core samples taken at various locations in Port Valdez, AK. Analyses are for 2 cm increments with the surface on the left, (from Figure 25 in Savoie, 2005).

A parallel study (Savoie, 2005) was conducted to evaluate the sedimentation of oil-derived hydrocarbons onto the bottom of Port Valdez with a particular emphasis on sediment cores taken near the outflow from the BTT.

The core taken closest to the BTT outflow pipe has total PAH levels in the sediment substantially higher than the outflow water. The highest concentrations are in the 2-8 cm sediments and appear to be readily available to benthic organisms.

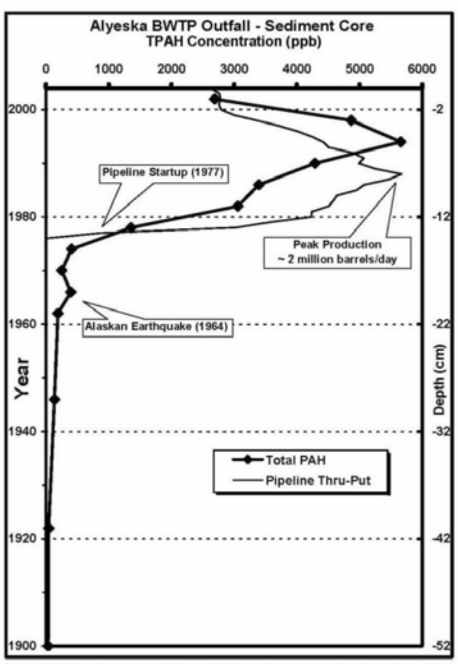


Figure 10: BWTP sediment core profile for total PAH showing the start up of the Trans-Alaska Pipeline and the 1964 earthquake. (From Figure 27 in Savoie, 2005)

The 1977 startup of the TAPS pipeline and the 1964 earthquake should be noted. Total PAH levels in the sediment near the outflow of the BTT fairly closely parallel the oil production through the Alyeska Marine Terminal. The lag between maximum sediment total PAH and maximum production may be due to an on-going reduction in the earlier deposition of total PAH by continuing biodegradation.

The long term adverse affects of short term exposures of critical biota to persistent PAH.

Starting with the NOAA Fisheries-Auke Bay Laboratory studies in the mid-1990's, there has been a growing awareness that weathered crude oil contains hydrocarbons that can have long-lasting adverse affects when brought into contact with early-life stage herring or pink salmon. Now, 20 years after EVOS, several persistent and unexpected adverse affects of the spilled oil are still being manifested. Some of these appear to be causally connected to the "lingering oil" which is still persisting in the substrate of some beaches within PWS. These include the limited "recovery" of sea otters, harlequin ducks, and pigeon guillemots within the same geographic area as the 'lingering oil'.

Other adverse affects, especially those to Pacific herring and killer whales, are less easy to attribute to "lingering oil." Some investigators have suggested long-term adverse affects from short-term exposures to liquid surface oil. It is known that the severe weather event following day two of the EVOS response caused substantial amounts of physically-dispersed oil to enter the water column. It seems just as reasonable that the lasting toxic effects seen in Pacific herring and killer whales were caused by several day exposures to dispersed subsurface oil rather than transient exposure to surface oil.

There currently exists a consensus that the toxicity of chemically-dispersed oil is not significantly greater than the combined toxicities of oil and dispersants. However, use of chemical dispersants does cause greater amounts of oil in smaller, more biologically available droplets into the water column than generally seen by physical dispersion alone. Hence, there is an increase in adverse toxic affects in the water column following chemical dispersion.

Several groups are currently investigating the toxicity seen in early life stage fish to extremely low concentrations of chemically- or physically-dispersed oil. These include Rice and coworkers at NOAA Fisheries – Auke Bay Laboratory, Incardona and coworkers with NOAA Fisheries Seattle, and Hodson and coworkers at Queens University, ON Canada.

One of the early manifestations of this toxicity is a cardiac edema resulting in a bluish cardiac sac. This expression of toxicity is often referred to as "Blue Sac Disease". There is growing evidence that the initial toxic event is the binding of three-ringed PAH to a specific receptor on the cardiac membrane, disrupting the normal function of that receptor. This adverse affect does not require metabolic activation, and does not appear to act through the Aryl Hydrocarbon Receptor (AHR) so it does not increase the biomarker CYP 1A.

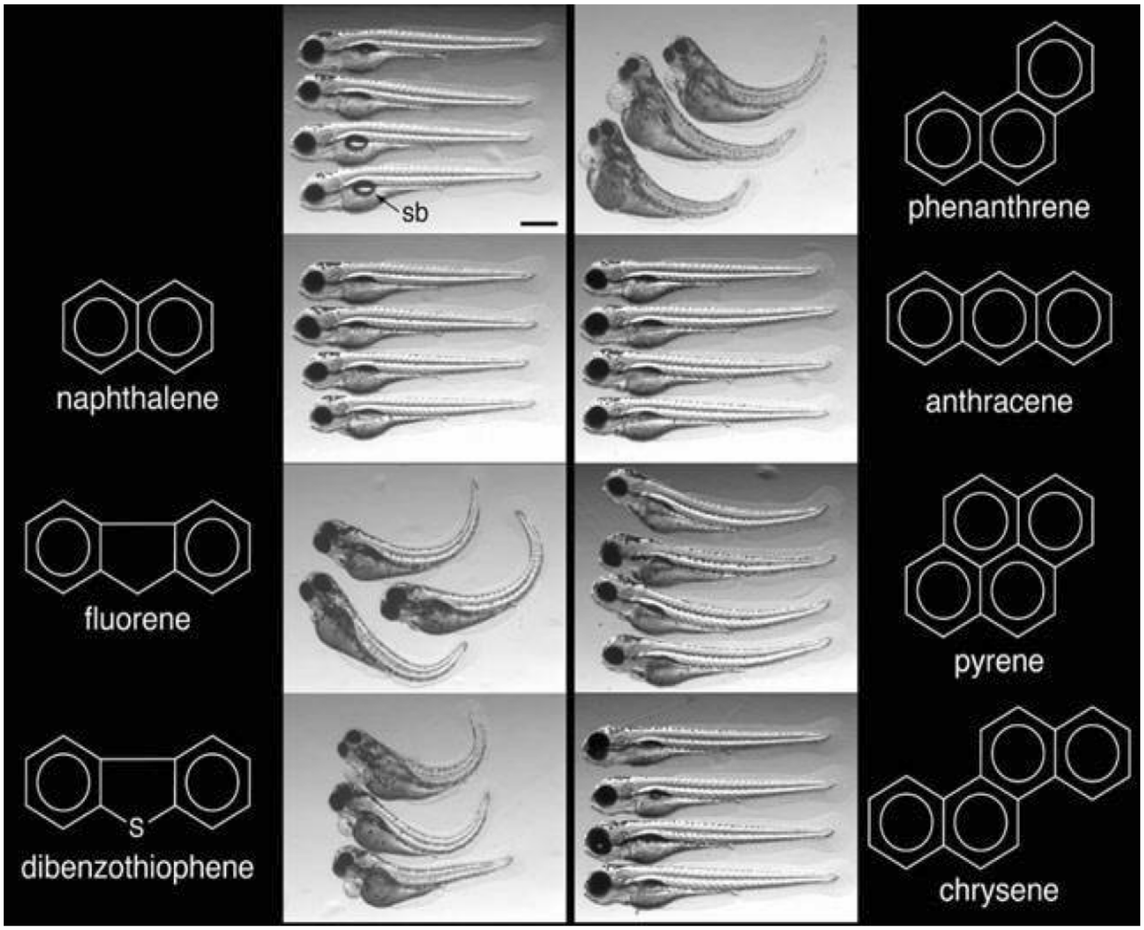


Figure 11: Expression of cardiac edema and spinal deformation in zebra fish fry exposed to < 300 ppb PAH concentrations as a water accommodated fraction. Normal fish are pictured at the top left. Other fry are pictured next to the PAH used. Note the pronounced cardiac edema and spinal deformation seen in fish exposed to fluorene, dibenzothiophene, and phenanthrene. Some spinal curvature was seen following exposure to pyrene, but no adverse affects were expressed following exposure to other two- or four-ringed PAH. (Incardona, 2007)

Compound	Solubility (mg/L)
Benzene	1700
Toluene	530
Ethylbenzene	170
p-Xylene	150
Naphthalene	30
1-Methyl naphthalene	28
1,3-Dimethyl naphthalene	8
1,3,6-Trimethyl naphthalene	2
Phenanthrene	1
Fluorene	2
Dibenzothiophene	1.1
Chrysene	0.002

Figure 12: Solubility of some aromatic oil components (Table 4-2 from NRC, 2003)

As shown in Figure 12, the solubilities of phenanthrene, fluorine, and dibenzothiophene are all between 1-2 parts per million. The toxic affects shown for these PAH occur at concentrations substantially below solubility. Thus, toxic exposures do not require exposure to actual oil droplets which might facilitate colonization by degrading bacteria.

Incardona has shown a strong genetic similarity of the zebra fish cardiac receptor and that in the mammalian heart membrane. While genetic homology is not sufficient to assume similar toxicity, it does suggest further examination for possible toxic manifestations of three-ringed PAH in other life stages and other species than fish.

PWSRCAC is currently a partner in a collaborative effort with the Center for Offshore Oil and Gas Environmental Research (COOGER); the DFO aquaculture research facility in St. Andrews, New Brunswick; Hodson and coworkers at Queens University; and U.S.EPA on a project to assess the toxicity of chemically- and physically-dispersed ANS.

Figure 13: Wave tank located at BIO in Dartmouth, NS, Canada. This tank is collaboratively administered by DFO-COOGER in Canada and the U.S. EPA. It is 60 m long by 0.5 m wide and 2 m deep. The normal operating depth is 1.5 m.

This project is using the wave tank pictured in Figure 13 to generate environmentally relevant dispersed oil samples which can be shunted through toxicity test aquaria adjacent to the wave tank. Tests will use various life stages of fish raised at St. Andrews.

ARRT/STC Process Concerns

PWSRCAC representatives have been communicating in detail with the ARRT Co-chairs and the STC for the past year regarding good public process and information coordination. It is critical to the validity of public agency policy documents, such as the dispersants guidelines currently under revision, that their development be done through a clearly-understandable and documented process that involves all stakeholders.

PWSRCAC has reviewed the comments of the North Slope Borough (NSB) and the Department of Interior (DOI) on the proposed dispersants workgroup process, and note that they share a desire for a clear, understandable process involving all stakeholders. PWSRCAC also appreciates that these two organizations lay out concrete proposals for how the dispersants workgroup process can move forward successfully.

It is PWSRCAC's opinion that the NSB concept of a clear scope of work being developed and agreed to by all stakeholders in order to plan the way forward for the effort is a very critical to this public process. Such a plan fits within the concept of the ARRT work flow process and would address the concerns laid out in comments by the NSB, DOI, and PWSRCAC. The scope of work should clearly define stages of development and review where the full Science and Technology Committee (including stakeholders) vet the work product and process, especially if a drafting group is used.

If the initial drafting of the revised dispersant guidelines are to be done by a small drafting group, it is PWSRCAC's opinion the group should either be expanded to be more broadly representative so that it includes a better balance of public stakeholders, or if it remains smaller, the group should include only agency representatives and not representatives of industry, the environmental community, or any other stakeholder entity.

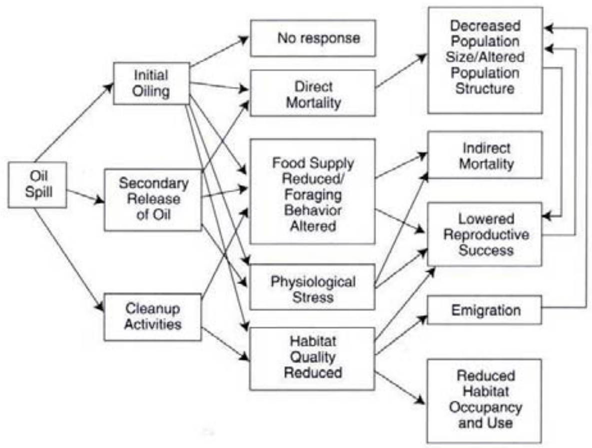
In addition, the evaluation and interpretation of scientific information used for the workgroup process should be done by scientists knowledgeable in the field.

Conclusions

PWSRCAC strongly supports the continued reliance on mechanical recovery as the primary strategy for oil spill response. Even though operational limitations and gaps in response capabilities almost assure there will be some damage to parts of the intertidal ecosystem, PWSRCAC feels that to assume dispersion of oil into the water column will product a better outcome should be avoided. Reasonable caution requires that commitment to a response strategy should not be determined until all feasible precautions have been taken to avoid low frequency but possibly catastrophic outcomes.

The effectiveness of chemical dispersant countermeasures is highly dependent on both oil and dispersant types as well as on a variety of environmental parameters. Water temperature, salinity, wave energy, weathering of the oil, and the tendency of the oil are all critical parameters. The highly-variable nature of these parameters on both a seasonal and interannual basis, especially in Alaska Region waters, dictates that these parameters be measured on an incident-specific basis rather than by predictive modeling.

The affects of oil in the marine biological environment are usually complex. This is not conducive to quick decision making. This is especially true in Alaska region waters where much of the onshore productivity is driven by bottom-driven, off shore production. In its Oil in the Sea III report, the NRC committee described many of these links by the following diagram (NRC, 2003):



Early oil spill response research concentrated on assessing acute toxic affects following the path from oiling to direct mortality to population level affects. Recent research has focused on the complex associations leading to chronic and indirect affects and raises substantial concerns. These studies provide convincing evidence of direct mortality and long-term behavioral affects on many fish species from short-term exposures to dispersed oil. There are also clearly unexpected and unexplained adverse affects persisting in a number of apex predators which were apparently caused by exposure to EVOS oil. PWSRCAC acknowledges that the evidence of the adverse indirect and chronic affects of dispersed oil on species other than fish is suggestive and not conclusive. However, PWSRCAC feels the strength of evidence is sufficient to urge caution.

Faced with these complex uncertainties, it is essential to have a well-planned, comprehensive chemical and biological monitoring program in place to assist in decision making regarding possible use of chemical dispersants. This monitoring plan should be implemented before dispersant application is authorized, and continue during dispersant application and for several days following application. The U.S. Coast Guard SMART protocols provide a good place to start. However, monitoring should be modified to address the unique environmental sensitivities of Alaska region marine waters.

The Dispersant Use Position Statement, approved by the PWSRCAC Board of Directors at its May 2006 meeting, is as follows:

> After years of observing dispersant trials, dispersant effectiveness monitoring, advising and sponsoring independent research regarding chemical dispersant use, it is the position of the Prince William Sound Regional Citizens' Advisory Council (the Council) that dispersants should not be used on Alaska North Slope crude oil spills in the waters of our region. Until such time as chemical dispersant effectiveness is demonstrated in our region and shown to minimize adverse effects on the environment, the Council does not support dispersant use as an oil spill

response option. Mechanical recovery and containment of crude oil spilled at sea should remain the primary methodology employed in our region.

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