By USA, Russia, Denmark (Greenland) and Norway

PAME II-2015 –Agenda Item 4.3(a)
AMSA Recommendation I(B)
HFO Project Phase III
Heavy Fuel Oil Releases from Shipping in the Arctic

Background

AMSA Report Recommendation I(B) provides in relevant part:

> *"That the Arctic states, in recognition of the unique environmental and navigational conditions in the Arctic, decide to cooperatively support efforts at the International Maritime Organization to strengthen, harmonize and regularly update international standards for vessels operating in the Arctic.*[1]

The PAME 2015-2017 Work Plan approved by Senior Arctic Officials at Iqaluit in April 2015 notes that PAME will, subject to funding, develop "a compendium of case study information on maritime incidents in the Arctic that resulted in a spill or release of HFO and the environmental impact thereof."[2] Norway, the USA and Canada volunteered to co-lead this project, which is a follow-on to the HFO Phase I and Phase II projects previously undertaken by PAME, and Norway has made available the requisite funding.

I. Introduction

Shipping in the northern Polar Regions is on the rise. As ice in the Arctic Ocean retreats and opens up sea routes,[3] commercial shipping is eager to utilize potentially faster passages for shipments between Europe, Asia and other parts of the world.[4] With increased vessel traffic in the Arctic and near-Arctic, however, comes an increased risk of incidents, including those that involve oil spills and releases. This Paper examines shipping incidents involving releases of Heavy Fuel Oil (HFO) in the Arctic and near-Arctic marine environment. Part I continues by defining the Paper's scope and explaining what HFO is. Part II identifies shipping incidents in the region involving oil or HFO releases and any resulting liability of relevant parties. The effect of HFO releases on the marine environment is described in Part III.

[1] The AOR Final Report notes that PAME is conducting a study on the environmental risks associated with the use and carriage of HFO by vessels in the Arctic and "will identify options and make recommendations – including the possible adoption of new international regulations – to mitigate those risks." Arctic Council, Arctic Ocean Review Final Report (May 2013), at p. 39.
[2] PAME Work Plan (2015-2017), available at http://www.pame.is/images/01_PAME/Work_Plan/PAME%20Work%20Plan%202015-2017.pdf.
[3] Arctic Council, Arctic Marine Shipping Assessment 2009 Report, 45 (2009) [hereinafter AMSA 2009 Report] *available at* http://www.pame.is/images/03_Projects/AMSA/AMSA_2009_report/AMSA_2009_Report_2nd_print.pdf .
[4] Chester Dawson, *Arctic Shipping Volume Rises as Ice Melts*, WALL STREET JOURNAL (Oct. 29, 2014) http://www.wsj.com/articles/arctic-cargo-shipping-volume-is-rising-as-ice-melts-1414612143.

A. Scope

Shipping incidents involving a release of HFO into the marine environment above the 55th parallel north are this Paper's main focus.[5] The areas under consideration are the Arctic and near-Arctic. For the Arctic, an important "geographical limit and a defining line is the Arctic Circle (66 degrees 33 minutes north)."[6] The near-Arctic's latitudinal boundary, for our purposes, extends to 55 degrees north. Environmental conditions in the Arctic and near-Arctic are often extreme and similar.

B. Heavy Fuel Oil

A 2010 study commissioned by PAME examined HFO and the risks associated with its use and carriage. The resulting report defined HFO as:

> oil with characteristics as specified by IMO in the amendments to MARPOL considering the protection of Antarctica from pollution from heavy grade oil, including:
> - crude oil having a density, at 15°C, higher than 900 kg/m3;
> - oil, other than crude oil, having a density, at 15°C, higher than 900 kg/m3 or a kinematic viscosity, at 50°C, higher than 180 mm2/s; or
> - bitumen, tar and their emulsions. [7]

HFO under this definition typically includes residual marine fuel or mixtures containing mainly residual fuel and some distillate fuel (such as intermediate fuel oil - IFO), [which] correspond[s] to the RM (A, B, D . . . etc.) qualities under the ISO 8217 Specification of Marine Fuel.

The crude oil refining process of fractional distillation produces HFO as a by-product.[8] As HFO contains many of the contaminants removed from lighter oils, it is much cheaper than other lighter marine fuels.[9] HFO's main use is powering marine vessel engines, and its viscosity

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[5] A few notable spills of tens of thousands of gallons, such as that of the *Selendang Ayu*, though slightly outside of 55º N, are also included in this Paper.

[6] AMSA 2009 Report, *supra* note 3, at 19.

[7] Det Norske Veritas, *Report – Heavy Fuel in the Arctic (Phase I)*, Report for PAME, Report No./DNV Reg No.: 2011-0053/ 12RJ7IW-4 Rev 00, 2011-01-18, 4–5 (2011) [hereinafter Heavy Fuel Report for PAME] *available at* http://www.pame.is/images/03_Projects/AMSA/Heavy_Fuel_in_the_Arctic/Phase_I_HFO_project_AMSA_rec_IB-Final_report.pdf ("Lighter products that do not exceed the specifications in the above definition will typically include distillate fuel - in this report referred to as marine gas oil (MGO) and marine diesel oil (MDO), or just distillates, normally corresponding to qualities within the DM(X, A, Z, B) of ISO 8217.").

[8] Fractional distillation is the separation of a mixture into its component parts, or fractions. An example is separating chemical compounds by their boiling point by heating them to a temperature at which one or more fractions of the compound will vaporize. Fractional distillation is used in oil refineries to separate crude oil into useful substances (or fractions) having different hydrocarbons of different boiling points. Craig Freudenrich, *How Oil Refining Works*, HOWSTUFFWORKS.COM *available at* http://science.howstuffworks.com/environmental/energy/oil-refining4.htm.

[9] Willie Scott, *Properties of Heavy Fuel Oil*, BRIGHT HUB ENGINEERING (June 7, 2011) *available at* http://www.brighthubengineering.com/marine-engines-machinery/73473-properties-of-heavy-fuel-oil//.

requires it to be kept at a high temperature (above pour point) both during storage and when burned, in order to ensure efficient transfer and combustion.[10] Industry terms for HFO can include "heavy fuel oil," "heavy grade oil," "heavy diesel oil," "residual fuel," "bunker," "Bunker C," or just "fuel oil."[11]

II. Shipping Incidents Involving Oil Releases and Liability from Such Releases

Table A.1 in Appendix A of this Paper lists shipping incidents identified in publicly available sources between 1970 and 2014 which involved a release or spill from a vessel of oil and any resulting liability from such release.[12] Incidents of HFO release are listed first (all those before the thick black line) and organized in reverse chronological order. As noted, Arctic and near-Arctic waters for the purposes of this Paper encompass those waters above latitude 55˚ N. In addition to the incidents reflected in Table A.1, another report commissioned by PAME has estimated the probability that vessel oil spill incidents in the Arctic are likely to occur in the future. The report noted, for example "an incident leading to an oil spill is likely to happen every second year within the Bering Sea."[13]

III. Impact of HFO on Marine Environment

Although the effect of HFO releases on the Arctic marine environment requires more study, current research identifies three key aspects that can influence the consequences of an oil, or analogous HFO, discharge into the marine environment. This section explains how two of those three aspects are affected in the Arctic: (A) the properties of the HFO itself and (B) the characteristics of the Arctic ecosystem and its animals. The third aspect – the cleanup process – is outside the scope of this paper.

A. HFO Properties

The properties of HFO cause it to interact in unique ways with the Arctic marine environment. When oil is discharged into water, weathering processes such as evaporation, dissolution, dispersion, and water uptake/emulsification affect the oil.[14] Its lighter components evaporate, while the oil's water-soluble parts dissolve and disperse into the water column.[15]

Unlike most marine distillate fuels, which emulsify or absorb water, HFO does not emulsify.[16] Water temperature, waves and wind all affect this process to an extent, but the oil's properties are a significant factor, as well.[17] Appendix B compares the amount of distillate fuel and HFO

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[10] *Id.*
[11] Heavy Fuel Report for PAME, *supra* note 7, at 4–5.
[12] Table B.1 lists the major sources for Table A.1.
[13] Det Norske Veritas, *HFO in the Arctic – Phase 2B*, Report for PAME, DNV Doc. No./Report No.: 2013-1542-2013-1542-16G8ZQC-6/, 6 (2013) [hereinafter Heavy Fuel Report for PAME Phase 2B] *available at* http://www.pame.is/images/03_Projects/AMSA/Heavy_Fuel_in_the_Arctic/HFO%20in%20the%20Arctic%20Phase%20IIb%20final%20report%20by%20DNV_signed.pdf.
[14] Heavy Fuel Report for PAME, *supra* note 7, at 38.
[15] *Id.* at 38.
[16] *Id.* at 38–39.
[17] *Id.* at 38.

that may remain on the water's surface over time after a spill.[18] Figure B.1 shows that after three days, the distillate fuel (in this case diesel oil) has fully disappeared from the surface.[19] On the other hand, Figure B.2 shows that nearly all the HFO is still present after 20 days.[20] Little to no evaporation or dissolution has occurred, and HFO weathers very slowly.[21] Moreover, after 3–5 days, most HFO has emulsified to the maximum water content (40–80%), which results in a huge increase in the volume an oil spill recovery operation must handle.[22]

In addition, the consequences of HFO spills may to be more serious than spills of other oils.[23] HFO will break into small masses and spread more slowly because of its viscosity.[24] Moreover, HFO's tar-like consistency will cause it to stick to exposed substrates and make cleanup extremely difficult.[25] Density of some HFOs may cause them to sink in the water, rather than float on the surface like most petroleum fuels.[26]

In the 1970s, an experiment was conducted to study the effects of a simulated oil spill in the Arctic. The Beaufort Project is considered one of the most comprehensive studies of its type and involved scientists pumping "59,200 liters of oil under the ice in a remote bay in the Beaufort Sea and spen[ding] two years watching what happened."[27] A joint study between the Canadian government and the oil industry, the project studied consequences of a possible oil spill and methods of oil spill cleanup in ice-choked waters.[28] A major finding was that "oil caused adverse effects on the entire biological food chain."[29] Moreover, about one centimeter of oil remained under the ice even after two years.[30] The slow rate of biological degradation of oil at near-zero temperatures has led biologists to suggest that residue from oil spills in the Arctic Ocean might remain for at least 50 years, affecting the marine environment.[31]

B. Characteristics of the Arctic Environment and Biota

The Arctic environment possesses unique characteristics that make it more susceptible to oil and HFO spills. Typical Arctic conditions amplifying the impact of oil released include extreme temperatures and sea ice formation and movement.[32] Frigid Arctic waters cause oil to degrade

[18] *Id.* at 38–39.
[19] *Id.*
[20] *Id.*
[21] *Oil Types*, NOAA OFFICE OF RESPONSE AND RESTORATION *available at* http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/oil-types.html.
[22] Heavy Fuel Report for PAME, *supra* note 7, at 38.
[23] *Id.*
[24] Prepared by CONCAWE's Petroleum Products and Health Management Groups, *heavy fuel oils*, CONCAWE, 23 (1998) [hereinafter *heavy fuel oils*] *available at* http://www.accede.org/prestige/documentos/Tox_fuel_pesado.pdf.
[25] *Id.*
[26] *Id.*
[27] Chris Oke, *Researcher suggests Arctic oil spill would have dire consequences*, YUKON NEWS (May 21, 2010) *available at* http://www.yukon-news.com/news/researcher-suggests-arctic-oil-spill-would-have-dire-consequences.
[28] *Id.*
[29] *Id.*
[30] *Id.*
[31] Karl Magnus Eger, *Effects of Oil Spills in Arctic Waters*, ARCTIS (2010) *available at* http://www.arctis-search.com/Effects+of+Oil+Spills+in+Arctic+Waters.
[32] Heavy Fuel Report for PAME, *supra* note 7, at 40.

more slowly, leading to a longer recovery time than in warmer climates.[33] Harder to collect and pump, the viscous HFO that does emulsify will adversely affect sensitive ecosystems.[34] For example, organisms that are already under great strain, due to intense environmental conditions, may be more susceptible to additional stress from an oil release.[35] Figure D.1 in Appendix D shows the effects of oil on the marine environment and its animals.

Arctic species tend to grow slower, live longer, and have lower reproduction rates, compared to other ecosystem-regions, which have higher diversity.[36] Large natural fluctuations in populations of certain species have been observed, but human activities also contribute to headcount variance, making the populations more vulnerable when already in a reduced state.[37] Oil can destroy the ecological integrity of marine ecosystems including fisheries, marine mammals, coral reefs, ocean and shore birds, and coastal wildlife, resulting in changes in animal behavior (feeding, motility, avoidance reactions, etc.), growth, and reproduction.[38]

Specific effects of oil on waterfowl and fur-bearing mammals include coating and ingestion.[39] Arctic species, "reliant on feathers and fur to insulate against the cold, are especially vulnerable to contamination from oil that will compromise their insulating layers."[40] The animals become exposed and put at risk of hypothermia.[41] In addition, while preening their feathers or licking their fur, animals can also ingest oil.[42] Death or other biological effects, both short and long-term, will almost inevitably follow.[43]

As for fish, "damage to gill morphology" was observed several days following exposure to Bunker C fuel oil.[44] Moreover, certain northern species such as polar cod, arctic cod, saffron cod and navaga spawn under the sea ice in winter.[45] When fish larvae hatch, they eat plankton blooms in the ocean.[46] The Beaufort Project found that an oil spill also led to a massive growth in algae that destroyed the ecosystem and heated up the water and ice.[47] Thus, an oil spill in spawning areas could severely reduce the number of larvae that hatch, resulting in climate effects and implications throughout the food chain.[48] Apart from the damaging effects oil has on organisms, oil is also less accessible to response and recovery efforts in ice-covered waters.[49] Spills involving ice are more complicated to address than oil spills in open waters,[50] and as oil

[33] *Id.*
[34] *Id.*
[35] *Id.*
[36] *Id.* at 41.
[37] *Id.*
[38] Eger, *supra* note 31.
[39] Heavy Fuel Report for PAME *supra* note 7, at 41.
[40] *Id.*
[41] *Id.*
[42] *Id.*
[43] *Id.*
[44] *heavy fuel oils, supra* note 24, at 23 (adding that "[t]he effect of oil greatly increased when mixed with a dispersant").
[45] *Id.*
[46] *Id.*
[47] Oke, *supra* note 27.
[48] *heavy fuel oils, supra* note 24, at 23–24.
[49] Eger, *supra* note 31.
[50] *Id.*

becomes trapped underneath ice, it may be more difficult to contain or clean up with current technology.[51]

The dynamics of ice, combined with oil's longevity in the marine environment, can affect the albedo[52] of Arctic regions greatly.[53] The Heavy Fuel Report for PAME identified three major pathways HFO is inducted into the marine biota: "(i) chronic persistence of oil, biological exposure, and population impacts to species . . . (ii) delayed population impacts by sub-lethal doses . . . [and] (iii) indirect effects of trophic and interaction cascades."[54] Even several years after an oil accident, the recovery process of an ecosystem is often incomplete and may never reach its original state.[55]

Consequences of an oil release depend on many factors, including the quantity and type of oil spilled, its interaction with the marine environment and weather conditions.[56] The spill area's biological and ecological attributes, and its species' sensitivity to oil pollution, are other factors.[57] Nevertheless, rehabilitating an Arctic environment after an oil spill could be extremely challenging and "complicated by remote locations, adverse conditions, the use of marine mammals for subsistence by indigenous people, and safety concerns (dealing with an injured walrus or polar bear [for example])."[58] The cleanup techniques themselves utilized could also affect the environment.[59]

IV. USA, Russia and Denmark (Greenland) Recommendations

The USA, Russia and Denmark (Greenland) recommend that, in furtherance of the HFO Work Plan HFO Phase III project, PAME II-2015 adopt RODS that:

- invite PAME member governments, PPs and Observers to review and comment on this Paper, in particular to correct, clarify and add information to that contained in Appendix A, Table A.1;

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[51] U.S. National Academy of Sciences, *Responding to Oil Spills in the U.S. Arctic Marine Environment* (2014), available at http://www.nap.edu/catalog/18625/responding-to-oil-spills-in-the-us-arctic-marine-environment; Pew Trusts, *Arctic Standards: Recommendations on Oil Spill Prevention, Response, and Safety in the U.S. Arctic Ocean* (2013), at 1, available at http://www.pewtrusts.org/~/media/legacy/oceans_north_legacy/page_attachments/PEWArcticStandards092313.pdf.

[52] Albedo measures the reflectivity of the earth's surface by describing the fraction of solar energy reflected from the Earth back into space. Ice has a high albedo: most sunlight hitting the surface bounces back towards space. Water is much more absorbent and less reflective; if a lot of water is present, more solar radiation is absorbed by the ocean than when ice dominates. *Albedo: definition*, GLOSSARY *available at* https://www.esr.org/outreach/glossary/albedo.html.

[53] Eger, *supra* note 31 (adding that the resultant albedo change significance for the Arctic heat balance is unknown currently, but could have major consequences).

[54] Heavy Fuel Report for PAME, *supra* note 7, at 41.

[55] Eger, *supra* note 31.

[56] ITOPF, *Environmental Effects of Oil Spills*, ITOPF *available at* http://www.itopf.com/knowledge-resources/documents-guides/environmental-effects/.

[57] *Id.*

[58] Christina Nunez, *What Happens When Oil Spills in the Arctic*, NATIONAL GEOGRAPHIC (April 24, 2014) *available at* http://news.nationalgeographic.com/news/energy/2014/04/140423-national-research-council-on-oil-spills-in-arctic/.

[59] ITOPF, *supra* note 56.

- invite PAME member governments, PPs and Observers to identify additional sources of information on spills and releases of HFO from vessels in the Arctic and near-Arctic with the goal of supplementing Appendix A, Table A.1; and
- invite the USA, in consultation and cooperation with other PAME member governments, to prepare an update of this Paper for PAME I-2016.

Appendix A: Shipping Incidents and Sources

Table A.1 – Shipping Incidents Involving Oil Releases and Liability from Such Releases

Vessel **Flag** **Spill Date**	• **Spill Amount & Type** • **Spill Location**	• **Liability, If Any**
Golden Trader[60] 9/10/2011	• 205 tonnes of IFO spilled after bulk carrier Golden Trader collided with the fishing vessel Vidar. • 60 m3 recovered by Danish vessels. Larger amount of oil later went ashore on Swedish west coast and recovered by Swedish authorities. • Skagerak (Denmark and Sweden)	• No liability allocation or enforcement found.
Godafoss[61] Malaysia 2/17/2011	• Up to 200,000 gallons of HFO • Hvaler Islands off SE coast of Norway	• No liability allocation or enforcement action found.
Full City[62] Panama 7/31/2009	• 6300-9500 gallons (200-300 tons) of HFO and diesel fuel • Langesund, southern Norway	• Norwegian authorities imposed a US $39 million fine on the ship's owners.[63] Unknown if fine paid yet. • On May 3, 2010 the Nedre Telemark District Court sentenced the master and third officer of the vessel to six months' and 60 days' imprisonment, respectively.[64] Both were guilty of violating the Pollution Act due to their failure to take adequate measures to prevent pollution; the master was additionally guilty of violating the Ship Safety Act.[65]

[60] ITOPF, In Action, GOLDEN TRADER, Denmark, 2011 *available at* http://www.itopf.com/in-action/case-studies/case-study/golden-trader-denmark-2011//.

[61] *Norway Oil Spill Clean-up Products*, ALASKA WILDERNESS LEAGUE (Feb. 17, 2011) *available at* http://www.alaskawild.org/wp-content/uploads/2014/10/Norway_Spill_Factsheet_070511.pdf.

[62] *Grounded ship's oil spill called the 'worst ever' in Norway*, NEWSINENGLISH.NO (July 31, 2009) *available at* http://www.newsinenglish.no/2009/07/31/grounded-ships-oil-spill-calledthe-worst-ever-in-norway//

[63] Robert A. Clark, IN HINDSIGHT: A COMPENDIUM OF BUSINESS CONTINUITY CASE STUDIES 44 (2014).

[64] Morten Lund Mathisenet al., *Court sentences crew in the aftermath of the Full City oil spill*, INTERNATIONAL LAW OFFICE (2010) *available at* http://www.internationallawoffice.com/newsletters/detail.aspx?g=7ec1888a-017b-4d36-9a74-cc7780c4d9ce#case .

[65] *Id.*

Selendang Ayu[66] Iceland 12/8/2004	• About 336,000 gallons: 321,052 of IFO &14,680 of marine diesel/other oils[67] • Bering Sea (near Unalaska Island, Alaska; just outside near-Arctic at 53° N)[68]	• In August 2007, the Selendang Ayu's Singaporean owner, IMC Shipping Co. Pte. Ltd. (IMC), pleaded guilty to two counts of violating the Refuse Act and one count of violating the Migratory Bird Treaty Act. IMC was fined $10 million in U.S. District Court.[69] • In April 2009, the state of Alaska settled with IMC and another party, Ayu Navigation. Both will pay the state almost $845,000 to settle oil spill, wreck removal and lost fish tax claims.[70] • The vessel owners have paid at least $9 million as of 2015.[71]
Fu Shan Hai[72] China 5/31/2003	• 1680 tons of HFO, 110 tons of diesel oil, 35 tons of lubricating oil[73] • Remaining oil was recovered by the wreck in 2013. • Bulk carrier sank after colliding with Polish container ship Gdynia northwest of the Danish Island of Bornholm in the Baltic Sea.[74]	• Claims for pollution damage have been settled, including Swedish and Danish claims.

[66] Parker Associates Inc., *Report on the Selendang Ayu Incident* (2005) *available at* http://www.aleutiansriskassessment.com/documents/SelendangAyu.pdf.
[67] National Transportation Safety Board, *Marine Accident Brief [for the Selendang Ayu]*, 1 (2009) *available at* https://app.ntsb.gov/doclib/reports/2006/MAB0601.pdf .
[68] *Id.*
[69] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/1242/518435 ("The penalty includes $4 million in community service, including $3 million to assess risks for shipping hazards where the Selendang Ayu went aground along the Great Circle Route and $1 million for the Alaska Maritime National Wildlife Refuge").
[70] *Selendang Ayu settlement reached*, KUCB (April 28, 2009) *available at* http://kucb.org/news/article/selendang-ayu-settlement-reached/ ("The $845,000 penalty is in addition to the $100 million spent by the companies for the cleanup, a $9 million federal criminal penalty and $2.5 million reimbursed to the state for its cleanup costs.").
[71] DJ Summers, *IMO lists Aleutian buffer zones; IUU task force releases plan*, ALASKA JOURNAL OF COMMERCE (Mar. 19, 2015) *available at* http://www.alaskajournal.com/Alaska-Journal-of-Commerce/March-Issue-4-2015/IMO-lists-Aleutian-buffer-zones-IUU-task-force-releases-plan/.
[72] International Maritime Organization, *Are HNS Spills More Dangerous than Oil Spills?*, 56 (2009) *available at* http://www.imo.org/OurWork/Environment/PollutionResponse/Documents/White%20paper%20Interspill%202006%20R%20and%20D%20Forum.pdf .
[73] *Volume I. Improvement of the Emergency Oil Spill Response System under the Arctic Conditions for Protection of Sensitive Coastal Areas (Case Study: the Barents and the White Seas)*, UNEP/GEF Project Russian Federation – Support to the National Programme of Action for the Protection of the Arctic Marine Environment, 17 (2010) [hereinafter *Volume I*] *available at* http://www.nefco.org/sites/nefco.viestinta.org/files/Oil%20Spills%20Final%20Report_eng.pdf.
[74] *Id.*

Tanker Baltic Carrier[75] Marshall Islands 3/29/2001	• 74,600 gallons (2350 tons) of HFO • Baltic Sea (East of Falster Island, Denmark)	• As of 9/27/2002, claims for pollution damage have been settled for DKr 55 million (about $7.9 million USD).[76] Further claims totaling DKr 43 million (about $6.2 million USD) are being assessed.[77]
M/V Kuroshima[78] Panama 11/26/1997	• 38,976 gallons of Bunker • Summer Bay near Unalaska Island, Alaska (just outside near-Arctic at 54°N)[79]	• The "Kuroshima Restoration Plan" was developed by federal and state natural resource trustees in consultation with the Qawalangin Tribe of Unalaska to restore native seabird populations impacted by the spill.[80] Kuroshima Shipping, the vessel owner, agreed to stipulations with government authorities about its participation in the restoration.[81]
Tanker Volgoneft 263[82] USSR 5/14/1990	• 25, 400 gallons (800 tons) HFO • Baltic Sea, Sweden	• As of August 1990, the Swedish Government has taken legal action against the vessel owner in the Court of Kalmar, claiming compensation for oil pollution damage of an undisclosed amount.[83] • The vessel was covered by a State guarantee in accordance with Article VII.12 of the Civil Liability Convention and the limitation amount is estimated at SKr3 million ($350,000 USD)[84]

[75] Gilles Vinent et al., *Accident of the Oil Tanker "Baltic Carrier" Off the Danish Coastline Final Report*, 2 (2001) *available at* http://csd.bg/fileadmin/user_upload/AnnexesCD/Annex%2078.pdf .

[76] Note by the Director, *Incidents Involving the 1992 Fund Baltic Carrier*, International Oil Pollution Compensation Fund 1992, Executive Committee 18th session (FUND/EXC.18/10), 1 (2002).

[77] *Id.*

[78] Alaska Department of Environmental Conservation Division of Spill Prevention and response, *Summary of Oil and Hazardous Substance Spills by Subarea (July 1, 1995 – June 30, 2005)*, 6 (2007) [hereinafter ADEC Summary] *available at* https://dec.alaska.gov/spar/perp/docs/10year_rpt/10Yr_Subareas_FINAL.pdf.

[79] *Summer Bay: United States*, GEOGRAPHICAL NAMES *available at* http://www.geographic.org/geographic_names/usaname.php?uni=1419304&fid=usageo_1319.

[80] NOAA et al., *Final Restoration Plan and Environmental Assessment for the M/V Kuroshima Oil Spill Summer Bay, Unalaska, Alaska*, (2002) *available at* http://www.darrp.noaa.gov/northwest/kuro/pdf/kurofrp0.pdf.

[81] *Id.*

[82] International Oil Pollution Compensation Funds, *Incidents Involving the IOPC Funds 2012*, 91 (2012) *available at* http://www.iopcfunds.org/uploads/tx_iopcpublications/incidents2012_e.pdf .

[83] Note by the Director, *Information on And Approval of Settlement of Claims*, International Oil Pollution Compensation Fund 1992, Executive Committee 24th session (FUND/EXC.24/4), 18 (1990).

[84] *Id.*

Milos Reefer[85] Greece 11/15/1989	• 237,343 gallons of IFO & diesel fuel • Bering Sea (near NE corner of St. Matthew Island, Alaska)	• No liability allocation or enforcement action found.
T/V Oriental Crane[86] Sierra Leone 12/12/1988	• 7,600 gallons of Bunker oil • Nikiski, Alaska	• No liability allocation or enforcement action found.
Globe Asimi[87] Gibraltar 11/22/1981	• Several thousand tons of HFO spilled into the Port of Klaipeda, USSR. The HFO later drifted out to sea • Port of Klaipeda, USSR	• Pollution damage reported to be approximately£ 800 million but no damage suffered in the territory of any Fund Member State.
Antonio Gramsci[88] USSR 2/6/1987	• 600-700 tons of crude oil released after tanker grounded near Borga on south coast of Finland • Borga, Finland	• USSR claims for environmental damage settled for £426,430.
M/V Kurdistan[89] Britain 3/15/1979	• 6,000 tons (43,900 barrels) of Bunker C • Cabot Strait, Newfoundland, Canada	• No liability allocation or enforcement action found.
Antonio Gramsci[90] USSR 2/27/1979	• 5,500 tons of crude oil spilled after tanker grounded. • Ventspils, USSR in the Baltic Sea	• Sweden claimed 112 million Swedish crowns for clean-up operations; IOPC paid 90 million Swedish Crowns, minus the Swedish share in the shipowner's sum (about 4 million Swedish Crowns), plus interest.[91]

[85] David H. Dickey, *Notable Oil Spills in U.S. Waters Calendar Years 1989-2011*, Dep't of homeland Security & US Coast Guard (2012).
[86] ADEC Summary, *supra* note 77, at 23.
[87] International Oil Pollution Compensation Fund, Annual Report 1984, at p. 8, *available at* http://www.iopcfunds.org/uploads/tx_iopcpublications/1984_ENGLISH_ANNUAL_REPORT.pdf.
[88] International Oil Pollution Compensation Fund, Information on and Approval of Settlement of Claims (Antonio Gramsci Incident), FUND/EXC.24/3 (1 August 1990).
[89] *Kurdistan*, CENTER FOR TANKSHIP EXCELLENCE *available at* http://www.c4tx.org/ctx/job/cdb/precis.php5?key=19790315_001.
[90] International Oil Pollution Compensation Fund, Report on the Activities of the International Oil Pollution Compensation Fund during 1978 and 1979, at p. 2, *available at* http://www.iopcfunds.org/uploads/tx_iopcpublications/1978___1979_ANNUAL_REPORT.pdf.
[91] International Oil Pollution Compensation Fund, Report on the Activities of the International Oil Pollution Compensation Fund During 1980, at p. 2, *available at* http://www.iopcfunds.org/uploads/tx_iopcpublications/1980_ENGLISH_ANNUAL_REPORT.pdf.

		• Environmental impacts were small although a large area was contamined.[92]
T/V Tsesis[93] Russia (Soviet Union) 10/26/1977	• 1100 tons of #5 Fuel Oil and Bunker C • Sodertalje, Sweden	• No liability allocation or enforcement action found.
Arrow[94] Liberia 2/4/1970	• 10,000 tons of Bunker C • Chedabucto Bay, Nova Scotia, Canada	• No liability allocation or enforcement action found.
F/V Devon[95] US 5/14/2014	• 2,000 gallons of diesel fuel • Nushagak River, approximately 12 miles upriver from Dillingham, Alaska	• No liability allocation or enforcement action found.
F/V Naknek Spirit[96] [Unknown] 7/6/2013	• Up to 500 gallons of diesel fuel • Poe Bay, Passage Canal, Prince William Sound, Alaska	• Responsible Party has assumed full control and responsibility for the incident.[97]
F/V Mary Kay[98] US 7/27/2012	• 2,450 gallons of diesel fuel • Cape Chacon, SE Alaska	• No liability allocation or enforcement action found.
M/V Monterrey[99] Liberia 6/9/2012	• 1,000–8,000 gallons of diesel fuel • Puffin Island in Chiniak Bay, Kodiak, Alaska	• No liability allocation or enforcement action found.
Tug Aries[100] US 6/26/2011	• 29,000 gallons of diesel, lube oil, & hydraulic oil • Bering Sea (95 miles east of St. Paul Island, Alaska)	• No liability allocation or enforcement action found.
Crowley Tug Pathfinder[101] US 12/23/2009	• 6,410 gallons of diesel fuel • Bligh Reef, Prince William Sound, Alaska	• No liability allocation or enforcement action found.

[92] Erik Bonsdorff, *The Antonio Gramsci Oil Spill: Impact on the Littoral and Benthic Ecosystems,* Marine Pollution Bulletin, Vol. 12, No. 9, pp. 301-305 (1981), *available at* https://www.abo.fi/fakultet/media/16577/bonsdorff1981_marpollutbull12.pdf.
[93] James S. Mattson, *Oil Spills*, MATTSONLAW.COM *available at* http://mattsonlaw.com/environment/oil_spills/oil_spills.htm.
[94] Potomac Research, Incorporated, *Arrow Navships 0995-008-1010*, Dep't of the Navy Naval Ship systems Command *available at* http://www.supsalv.org/SalvReports/ARROW.pdf.
[95] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8759.
[96] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8625.
[97] *Id.*
[98] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8484.
[99]NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8460.
[100] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8329.
[101] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/8166.

Petrozavodsk[102] Russia 5/11/2009	• 2400 gallons (75 tons) of fuel (unspecified if HFO) • Barents Sea (Bear Island, Norway)	• No liability allocation or enforcement action found.
Collision between Tug Pacific Challenger & Barge SCT282[103] Tug & Barge: US 5/27/2009	• 125 gallons of fuel • Cook Inlet, Nikiski, Alaska	• No liability allocation or enforcement action found.
F/V Icy Mist[104] US 2/25/2009	• 2,850 gallons of diesel fuel & hydraulic oil • North of Akutan Island, Alaska	• No liability allocation or enforcement action found.
Monarch[105] US 2/15/2009	• 38,000 gallons of diesel fuel & 2,000 gallons of lubricating oil • Granite Point Platform in Cook Inlet, Alaska	• No liability allocation or enforcement action found.
F/V American Way[106] US 1/6/2009	• 200-500 gallons of diesel fuel; • Aghiyuk Island, SW of Kodiak Island, Alaska	• No liability allocation or enforcement action found.
M/V Nunaniq[107] US 10/2/2008	• 50-300 gallons of diesel #1 fuel (not HFO) • Mekoryuk Bay, Alaska	• No liability allocation or enforcement action found.
L/C Saltery Provider[108] [Unknown] 8/18/2008	• 100 gallons of diesel fuel • West side of Clarence Strait in Saltery Cove, Alaska	• No liability allocation or enforcement action found.
F/V Nordic Viking[109] US 7/22/2007	• 3500 gallons diesel fuel • Prince William Sound, Alaska	• In 2008, Nordic Viking, LLC, the vessel owner, reached an agreement with the state of Alaska. It paid a $17,500 fine to Alaska's oil spill response fund, implemented drug and

[102] *Volume I supra* note 72, at 18.
[103] Naomi Klouda, *Barge spills fuel near Kikiski – Incident demonstrates how even small oil spills are treated*, THE MOUTH OF THE KENAI (June 3, 2009) *available at* https://redoubtreporter.wordpress.com/2009/06/03/barge-spills-fuel-near-nikiski-—-incident-demonstrates-how-even-small-oil-spills-are-treated/.
[104] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/7983 .
[105] Dickey, *supra* note 84.
[106] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/7945.
[107] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/.
[108] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/.
[109] State of Alaska Office of Special Prosecutions & Dep't of Environmental Conservation, *Dale R. Pruitt Pleads Guilty to Prohibited Operation and Oil Pollution Charges Related to F/V Nordic Viking Grounding* (Aug. 8, 2008) *available at* https://dec.alaska.gov/das/ecu/newsItems/Dale%20Pruitt%20press%20release.pdf.

		alcohol testing on other fishing boats operated by its members, and engaged in a supplemental environmental project that contributed $10,000 to the Gulf of Alaska Keeper's marine debris clean-up program. • In the same year, Captain Dale R. Pruitt pled guilty to criminal charges of (1) operating a boat in a negligent or reckless manner and (2) oil pollution. For the two charges, he was sentenced to a one-year suspended imposition of sentence, had to successfully complete a state-approved alcohol treatment program, in addition to 15 days of jail time (plus 75 days of suspended jail time), 40 hours of community work service and four years of probation (SOA v. Dale R. Pruitt, 3CO-S08-098 CR).[110]
T/V Seabulk Pride[111] US 2/2/2006	• 84 gallons of gasoline • Cook Inlet, Alaska	• Companies involved, Seabulk Tankers and Tesoro, have signed an agreement with the State of Alaska to address civil oil spill claims and alleged violations of the Cook Inlet winter ice rules. Under the agreement's terms, Seabulk and Tesoro have paid the state $429,870 (representing an oil spill civil assessment of $5,000; civil assessments of $360,000; and $64,870 reimbursing the state's response and investigation costs). The companies do not admit to any violations.[112]
P/V Clipper Odyssey [Unknown][113] 8/1/2004	• 3,000-5,000 gallons of diesel fuel • Baby Islands just east of Unalaska Island, Alaska	• No liability allocation or enforcement action found.
F/V Windy Bay[114]	• 35,000 gallons of diesel fuel • Prince William Sound, Alaska	• Oil Spill Liability Trust Fund (OSLTF) bore entire cost of cleaning

[110] *Id.*
[111] State of Alaska Department of Law, *State Reaches Settlement on Seabulk Pride Spill & Grounding* (July 1, 2010) *available at* http://law.alaska.gov/press/releases/2010/070110-SeabulkPride.html.
[112] *Id.*
[113] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/1200.
[114] Dep't of Environmental Conservation Division of Spill Prevention and Response, *Major Oil Spills to Coastal Waters available at* https://dec.alaska.gov/spar/perp/bigspills.htm.

US 8/4/2001		up spill: $3,396,000. No liability mentioned.[115]
Tug Barge Annahootz[116] US 9/1/1994	• 500 gallons of diesel fuel • Cook Inlet, Alaska	• No liability allocation or enforcement action found.
T/V Eastern Lion[117] [Unknown] 5/21/1994	• 8,400 gallons of crude oil (unknown if HFO) • Port Valdez, Alaska	• No liability allocation or enforcement action found.
Braer[118] [Unknown] 1/5/1993	• 25,000,000 gallons (85,000 tons) of Norwegian light crude • Shetland Islands, United Kingdom	• Under the UK's Civil Liability Convention, "the liability limit for [Braer] owners could be $8 million for pollution damage, including cleanup costs. . . . [An] agreement that victims of . . . a spill should be compensated from the International Oil Pollution Compensation Fund [IOPCF] [also exists]."[119] • By 2005, at least GBP47 million paid by IOPCF; the ship's liability insurer Skuld, had paid GBP 6.2 million (about $11.22 million USD) to claimants.[120]
Shin Yang Ho[121] South Korea 6/27/1990	• 60,000 gallons of fuel oil • Bristol Bay, Alaska	• No liability allocation or enforcement action found.

[115] U.S. Coast Guard, *Oil Pollution Act Liability Limits in 2013*, Report to Congress, 18 (2013) *available at* https://www.uscg.mil/npfc/docs/PDFs/Reports/Liability_Limits_Report_2013.pdf.
[116] John Whitney, *Cook Inlet, Alaska Oceanographic and Ice Conditions and NOAA's 18-Year Oil Spill Response History 1984-2001*, HAZMAT Report 2003-01, 92 (2002) *available at* http://docs.lib.noaa.gov/noaa_documents/NOS/HMRA/HAZMAT_report_2003-01.pdf.
[117] *Major Oil Spills to Coastal Waters supra* note 108.
[118] *Shetland Oil Spill*, TED CASE STUDIES (1997) *available at* http://www1.american.edu/ted/SHETLAND.HTM.
[119] *Id.* (citing *Braer Crude Oil Tanker Splits as Weather Hinders Containment*, Oil & Gas Journal, 27 (1993)).
[120] *Braer*, TANKERS, BIG OIL AND POLLUTION *available at* http://www.oilpollutionliability.com/braer/.
[121] Dickey, *supra* note 84.

Exxon Valdez[122] US 3/24/1989	• 10, 900,000 gallons of Prudhoe Bay Crude (unknown if HFO) • Bligh Reef in Prince William Sound, Alaska	• In 2008 the United States Supreme Court further reduced estimated damages to just over $500 million. More than $2 billion has been spent by Exxon on cleanup and recovery. Exxon has paid at least $1 billion in damages.[123]
Yardarm Knot[124] [Unknown] 2/19/1989	• 97,000 gallons of diesel fuel • Bering Sea (near St. Paul Island, Alaska)	• No liability allocation or enforcement action found.
Thompson Pass[125] US 1/3/1989	• 71,400 gallons of crude oil (unknown if HFO) • Prince William Sound, Alaska	• No liability allocation or enforcement action found.
T/V Glacier Bay[126] US 7/2/1987	• 207,000 gallons of crude oil (unknown if HFO) • Cook Inlet, Alaska	• No liability allocation or enforcement action found.
M/V Vashon[127] [Unknown] 6/7/1986	• 5,200 gallons of diesel fuel • Johnson Cove, Prince of Wales Island, Alaska	• No liability allocation or enforcement action found.

[122] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/6683.
[123] *Exxon Valdez Oil Spill (1989)*, THE NEW YORK TIMES (Aug. 3, 2010) *available at* http://topics.nytimes.com/top/reference/timestopics/subjects/e/exxon_valdez_oil_spill_1989/index.html.
[124] Dickey, *supra* note 84.
[125] *Id.*
[126] *Major Oil Spills to Coastal Waters, supra* note 108.
[127] NOAA IncidentNews: http://incidentnews.noaa.gov/incident/6365.

Table A.2 – Main Sources for Table A.1

Sources	
1.	NOAA IncidentNews: http://incidentnews.noaa.gov/ (last visited April 16, 2015).
2.	David H. Dickey, *Notable Oil Spills in U.S. Waters Calendar Years 1989-2011*, Dep't of homeland Security & US Coast Guard (2012).
3.	Alaska Department of Environmental Conservation Division of Spill Prevention and response, *Summary of Oil and Hazardous Substance Spills by Subarea (July 1, 1995 – June 30, 2005)* (2007) [hereinafter ADEC Summary] available *at* https://dec.alaska.gov/spar/perp/docs/10year_rpt/10Yr_Subareas_FINAL.pdf (last visited April 16, 2015).
4.	*Volume I. Improvement of the Emergency Oil Spill Response System under the Arctic Conditions for Protection of Sensitive Coastal Areas (Case Study: the Barents and the White Seas)*, UNEP/GEF Project Russian Federation – Support to the National Programme of Action for the Protection of the Arctic Marine Environment (2010) [hereinafter *Volume I*] *available at* http://www.nefco.org/sites/nefco.viestinta.org/files/Oil%20Spills%20Final%20Report_eng.pdf (last visited April 16, 2015).
5.	*Major Oil Spills to Coastal Waters*, Dep't of Environmental Conservation Division of Spill Prevention and Response *available at* https://dec.alaska.gov/spar/perp/bigspills.htm (last visited April 16, 2015).

Appendix B: Mass balance of marine diesel oil and HFO (IF-180-NS) on water[128]

Figure B.1 – Marine Diesel Oil

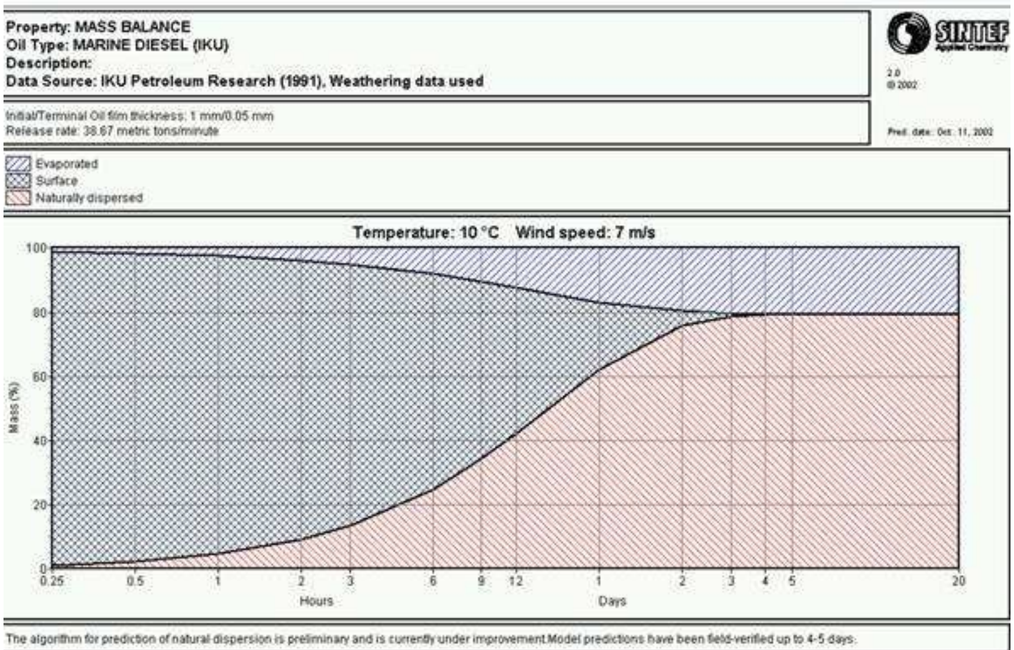
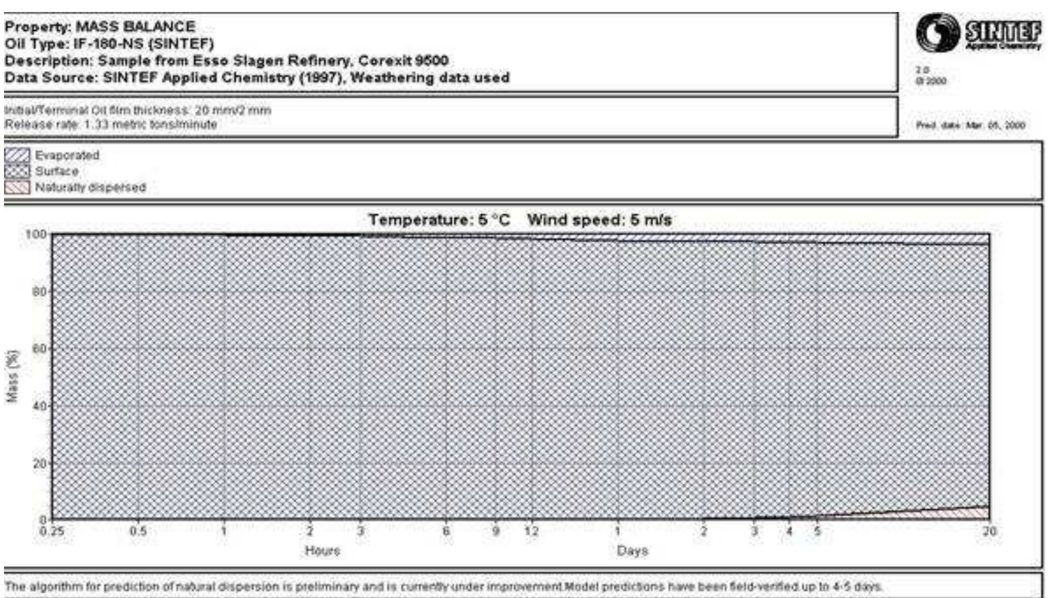


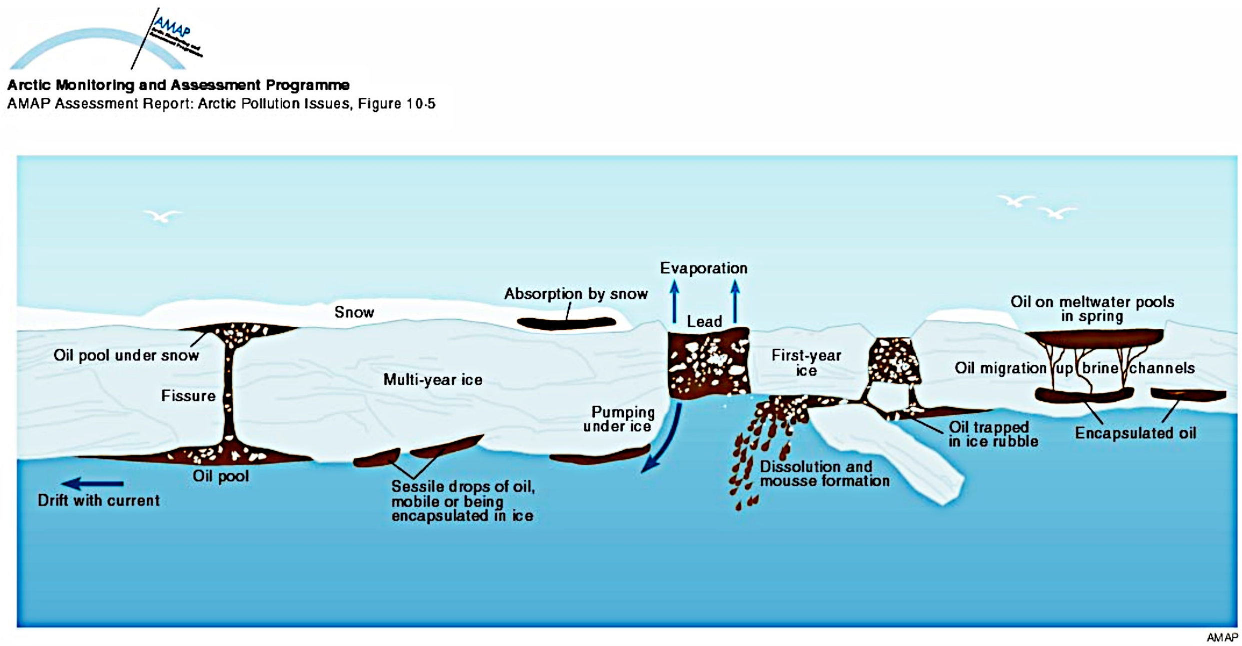
Figure B.2[129] – HFO (IF-180-NS)



[128] Heavy Fuel Report for PAME, *supra* note 7, at 38–39.
[129] Although the temperature and wind speed differ in the two examples, these variances are not enough to account for the huge disparity in dispersed oil particles between the two oils.

Appendix C

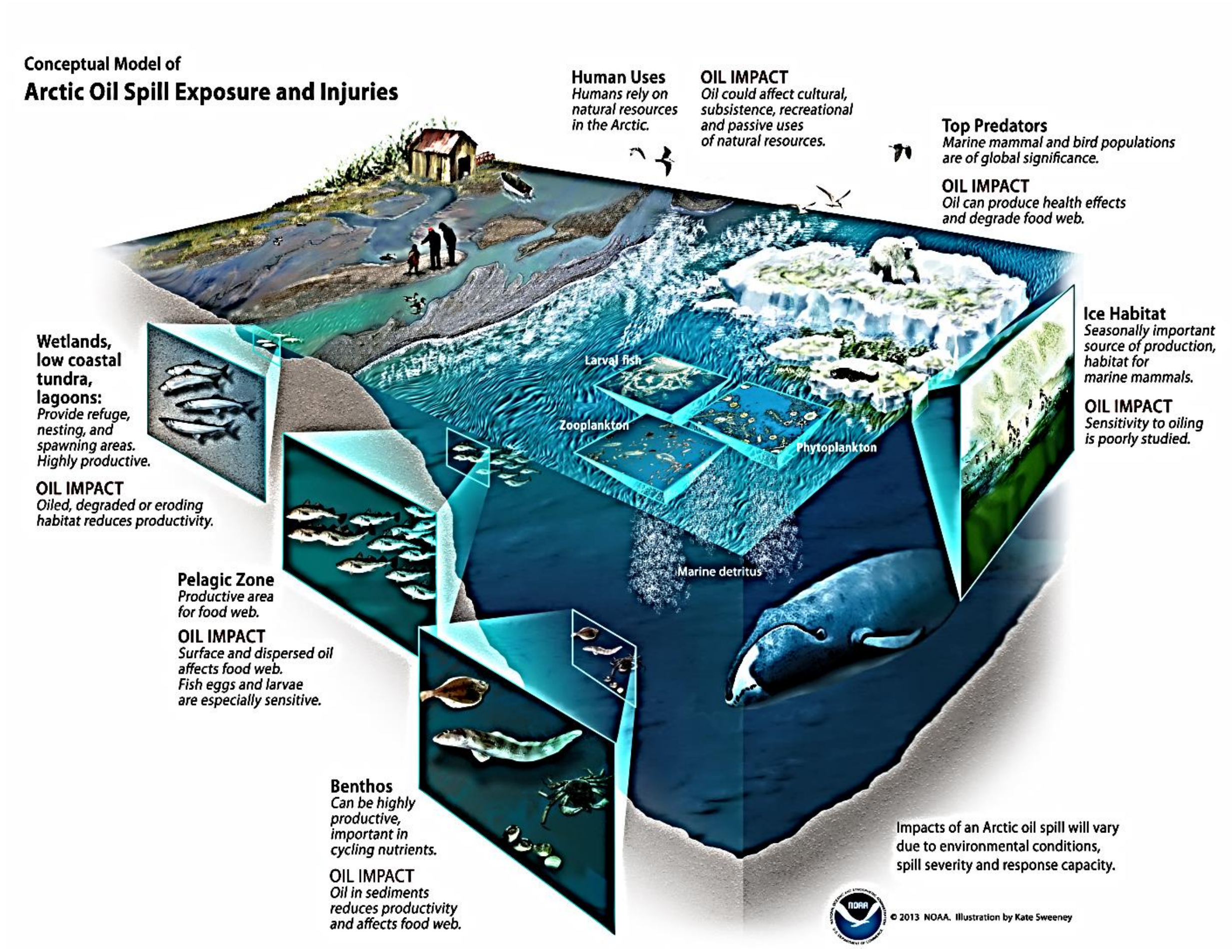
Figure C.1[130] – Oil and Ice Interaction



130 *Sequence of Oil-Ice Interaction Including Drops Under the Ice, New Ice Growth Below the Oil, Oil Appearing on the Surface in the Spring, Wind Herding of Oil on Melt Pools, and the Appearance of Emulsified Oil on Top of the Ice*, AMAP (2007) *available at* http://www.amap.no/documents/doc/sequence-of-oil-ice-interaction-including-drops-under-the-ice-new-ice-growth-below-the-oil-oil-appearing-on-the-surface-in-the-spring-wind-herding-of-oil-on-melt-pools-and-the-appearance-of-emulsified-oil-on-top-of-the-ice/361.

Appendix D

Figure D.1[131] – The Effects of Oil on Arctic Marine Animals



[131] Kate Sweeney, *Conceptual Model of Arctic Oil Spill Exposure and Injuries*, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION *available at* http://response.restoration.noaa.gov/sites/default/files/arctic-food-webs-human-uses-oil-impacts-illustration_noaa_katesweeney.jpg.