A. Summary

MARAD's proposed export of 13 badly deteriorated obsolete vessels laden with an estimated 698 tons of PCBs, 1,402 tons of asbestos, and over 3,300 tons of fuel oil on board to the UK for scrapping represents a needless risk that poses a risk of immediate and irreparable injury to human health and the environment.

While it is imperative to remove the floating threat the obsolete vessels from the Navy and the Maritime Administration from the James River as soon as possible, it is negligent and irresponsible to increase the overall existent risk by pushing these same dangerous vessels laden with hazardous substances many thousands of miles across open ocean to foreign shores rather than carefully eliminating the risks and recycling the vessels as close to their current location as possible.

The risk of losses, sinkings, or breaching at sea of these corroded and deteriorating vessels in coastal waterways or on the high seas is too high and a needless risk as the
United States clearly has the domestic capacity to safely recycle these same vessels domestically. MARAD was well aware that the scrapping job of the 13 vessels could be done at less cost to the taxpayer and at far less towing risk had they accomplished the deal with domestic breakers. Thus, it appears that MARAD ignored the Congressional mandate to consider towing risk as well as least cost as overarching criteria to grant scrapping contracts.

The serious risk posed by these ships *en situ* currently will be greatly exacerbated when they are moving through turbulent waters and buffeted by unpredictable weather systems across the thousands of nautical miles of rough seas of the North Atlantic in the fall of this year. Towing deteriorating, aged vessels is a high risk venture in the best of circumstances, and doing this by tandem tow – two vessels simultaneously – presents an even greater risk.

While the ships contain substantial quantities of lead, cadmium and asbestos, the greatest environmental and health threat from the transport of the vessels among the list of hazardous substances that will remain on board, stems from the 698 tons of PCBs, as well as about 3,400 tonnes of fuel oils.

698 tons of PCBs represents a very significant long-term risk to wildlife, particularly in the coastal areas of Virginia from where the ships must be removed, and in the Teesside Estuary in the United Kingdom. Both areas have important bird, fish and wildlife habitat that will be seriously threatened by the movement of the ships. PCBs entering the marine environment also represent a very significant irreparable threat to human health from fish consumption. PCBs are considered a probable carcinogen and are known to cause reproductive and development disorder and disease.

Likewise 3,400 tonnes of fuel, with some of the vessels carrying as much as 600 tonnes of heavy bunker fuel, represents potential accidental losses that pose yet another and more immediate threat to marine wildlife and habitat. The deleterious impact that heavy and light oils can have on the marine environment can be irreparable when it impacts sensitive populations. The fact that such risky transit is proposed adjacent to internationally recognized wildlife sanctuaries makes the negligence more alarming. A MARAD commissioned study on potential impacts of an oil spill in the James River shows a maximum worst-case scenario causing a $123 million clean-up cost. Already another oil spill in Maryland in 2000 caused $65 million in damages. MARAD has only required pollution insurance for up to $5 million.

A spill of oil and PCBs could have a catastrophic irreparable effect in that entire breeding populations of birds and other localized and animal populations. Fish can become contaminated with PCBs and thereby poisoning the entire food chain. PCBs are persistent organic pollutants capable of reproductive effects and are likely to alter DNA and thus genetic integrity of species. Further, they are probable carcinogens. Due to their ability to concentrate high in the food chain, humans may become the ultimate repository for the poisons that can cause irreversible diseases.
B. Seaworthiness – Fitness to Safely Traverse the Stormy North Atlantic

1. Deteriorated vessels

The 13 vessels currently readied for export to the United Kingdom are part of the National Defense Reserve Fleet (NDRF) administered by the Department of Transportation’s Maritime Administration (MARAD). MARAD, as empowered by the Federal Property and Administrative Services Act, is the agency within the federal government responsible for the disposal of all of the vessels in the National Defense Reserve Fleet (NDRF) that are not designated as “Ready Reserve Fleet” vessels.

Under the non-retention category, MARAD has approximately 150 vessels nationally on its “NDRF Disposal Priority List.” Most of these are Formerly Used Military Ships (FUMS) of a non-combat nature which have been transferred from the jurisdiction of the Navy to MARAD. This NDRF non-retention fleet is located predominately in three locations: the James River near Ft. Eustis, VA; Beaumont, TX; and Suisun Bay near Benicia, CA. The larger part of the NDRF fleet is located in the James River location and are known collectively as the James River Reserve Fleet or (JRRF). There are 62 JRRF non-retention ships containing 28 of the worst 40 vessels identified in a list of the 40 worst vessels on in the NDRF fleet as of September 2000. The JRRF vessels in total still contain over 8 million gallons of oil which poses a grave threat to the marine and estuarine environment.

Already the poor condition of the ships has caused accidental leakage to occur. According to a letter written by MARAD to the United States Environmental Protection

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1 A Report on Disposal Options for Obsolete and Inactive Ships, National Environmental Education and Training Center (NEETC), October 2002.
2 U.S. Coast Guard Powerpoint Presentation, 17 October 2000.
Agency, on 12 November 2001, MARAD cites three incidences of spills or serious threats, since 1998 and goes on to state:

“As exemplified by these and other events over the past few years, many of MARAD’s ships pose a real and significant threat to the environment because of their deteriorating condition…the environmental risks in the fleet sites will continue to mount.”

The spills referred to include:

- September 1998: EXPORT CHALLENGER began leaking from the hull and discharged approximately 4,000 gallons of fuel. All pumpable oils were removed in November 1998. Vessel remains in JRRF. The remediation and response to this spill cost the government $1,400,000.

- 16 September 1999: Hurricane Floyd made landfall near Cape Fear, NC as a category two hurricane with estimated maximum winds near 90 knots. Tropical Storm Floyd’s center passed over the greater Norfolk, Virginia area, where maximum winds were estimated at 50-70 knots. Ships were scattered and about 30 of the JRRF dragged anchor.

- 14 August 2000: Tank C-407-F of the USS DONNER started to leak. Approximately 1,000 gallons of oil were discharged. The spill extended a ½ mile oil slick. All pumpable oils were moved away from skin of ship. DONNER is still in JRRF. The remediation and response to this spill cost the government $250,000.

- 31 August 2001: 300-400 gallons of water was found leaking into the USS BUILDER engine room daily. Total oil on board the vessel is 48,000 gallons. All pumpable oils had to be removed. The remediation and response to this spill cost the government $700,000.

Referring to the above incidences, according to a letter written to President George W. Bush by Senators John Warner and George Allen of Virginia on May 1, 2002:

“... the hull failures of four ships in recent years has cost the government $3.2 million in unanticipated expenditures, and in 1999, more than 30 ships got loose during Tropical Storm Floyd. In response, the federal government invested $3 million in a new mooring system...the ships present a clear and present danger to the river and coastline...Should a large spill occur, the results would require many millions more than would be required to retire the remaining fleet.”

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5 U.S. Coast Guard Powerpoint Presentation, 17 October 2000.
6 National Geographic Questions on JRRF, 1/8/01. Available in files in offices of Basel Action Network.
7 Id.
8 Id.
The U.S. Coast Guard’s Captain of the Port (COTP) Hampton Roads has sent several letters expressing environmental and safety concerns posed by the deteriorating conditions of the JRRF in recent years. MARAD has been unable to satisfy many of these concerns given constraints in funding.9

Most of the 150 ships are obsolete and aged, and in various states of deterioration. The age of the 62 JRRF ships for example that were examined by the JRRF Hull Deterioration Study,10 ranges from 62 to 22 years of age with an average age of 48.75 years in the year 2003.

The ships’ conditions were prioritized in various studies conducted over the years. One of the recent studies created a prioritization by ranking four criteria: Total Hull Oil on board, the Date Built, the Date the ship entered the JRRF, and the Hull Condition. Each of these categories were then given certain rankings weights and the addition of all of these scores gave a total vessel score. The higher the number the more risk the ship poses to the environment.

Of the 13 vessels now contracted to depart to the UK, all are in the JRRF fleet and 11 of these appear on the priority list of 40 worst-condition vessels. The ships, their ages, hull oil quantities in long tons, the year they entered the JRRF and their hull conditions, with 1 being worst, are listed in Table 1. The total score is meant to help prioritize the ships most in need of disposal and or remediation. A mark of no entry in the registry of known PCBs does not indicate that there are no PCBs on board. Most of the ships were not tested for PCBs at the time this data was prepared.

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9 U.S. Coast Guard Powerpoint Presentation, 17 October 2000.
Table 1. MARAD Risk Scores for the 13 Ships Slated to be Exported to AbleUK

<table>
<thead>
<tr>
<th>NAME</th>
<th>Year Built</th>
<th>Year Score</th>
<th>Hull Oil</th>
<th>Oil Score</th>
<th>Date Enter JRRF</th>
<th>JRRF Score</th>
<th>Hull Cond. (1 is worst)</th>
<th>Hull Score</th>
<th>Total Score</th>
<th>On MARAD Priority List of 40 Worst?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALOOSAHATCHEE</td>
<td>1945</td>
<td>36</td>
<td>.8</td>
<td>8</td>
<td>1991</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>64</td>
<td>yes</td>
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<tr>
<td>CANISTEO</td>
<td>1945</td>
<td>36</td>
<td>5.7</td>
<td>8</td>
<td>1990</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>64</td>
<td>yes</td>
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<tr>
<td>DONNER</td>
<td>1945</td>
<td>36</td>
<td>1.8</td>
<td>8</td>
<td>1976</td>
<td>12</td>
<td>1</td>
<td>20</td>
<td>62</td>
<td>yes</td>
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<tr>
<td>MORMACMOON</td>
<td>1965</td>
<td>12</td>
<td>102.6</td>
<td>8</td>
<td>1985</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>36</td>
<td>yes</td>
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<tr>
<td>MORMACWAVE</td>
<td>1962</td>
<td>20</td>
<td>198.5</td>
<td>16</td>
<td>1985</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>52</td>
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<tr>
<td>PROTECTOR</td>
<td>1945</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>yes</td>
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<tr>
<td>AMERICAN RANGER</td>
<td>1965</td>
<td>12</td>
<td>337.6</td>
<td>24</td>
<td>1983</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>56</td>
<td>yes</td>
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<tr>
<td>AMERICAN BANKER</td>
<td>1962</td>
<td>20</td>
<td>313.4</td>
<td>24</td>
<td>1987</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>64</td>
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<tr>
<td>RIGEL</td>
<td>1955</td>
<td>--</td>
<td>15.3</td>
<td>--</td>
<td>--</td>
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<tr>
<td>COMPASS ISLAND</td>
<td>1956</td>
<td>32</td>
<td>219.7</td>
<td>24</td>
<td>1989</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>76</td>
<td>yes</td>
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<tr>
<td>SANTA CRUZ</td>
<td>1966</td>
<td>12</td>
<td>135.7</td>
<td>16</td>
<td>1984</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>48</td>
<td>yes</td>
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<tr>
<td>SANTA ISABEL</td>
<td>1967</td>
<td>12</td>
<td>407.0</td>
<td>40</td>
<td>1984</td>
<td>6</td>
<td>1</td>
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<tr>
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<td>24</td>
<td>1997</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>56</td>
<td>no</td>
</tr>
</tbody>
</table>

Sources: James River Reserve Fleet Scrapping Analysis; Rand Report.
2. **MARAD’s appraisal of the ships proposed for Export**

In a MARAD document entitled “40 Worst NDRF Scrap Ships”, MARAD provides a summary description of each of the vessels. Eleven of the ships that are proposed for imminent export to the UK are in the list of 40 worst and are described as follows:

**DONNER:** “…has hull leaks into double bottom tanks that have been patched. It has topside decks and houses that are heavily corroded causing leaking into interior spaces. There is a moderate amount of fuel on the ship (1,450 barrels).”

**MORMACMOON:** “…has no hull blanks and cathodic protection on the hull was not added until last year. The main sea valves do not hold back weather from the internal piping systems. Internal blanks have been installed on sea valve piping flanges. All topside decks and houses are heavily corroded allowing rain to enter the interior of the vessel. There is a moderate amount of fuel on the ship (990 barrels). A scrap sale contract was awarded but the ship was not moved.

**SANTA ISABEL:** “…has hull leaks into double bottom tanks. It has no hull blanks and no cathodic protection on the hull. A limited underwater hull gauging survey does not indicate any severe overall hull steel wastage. All topside decks and houses are heavily corroded allowing rain to enter the interior of the vessel. There is a large amount of fuel on the ship (3,459 barrels). A scrap contract was awarded but the ship was not removed.”

**AMERICAN RANGER:** “…has no cathodic protection and has heavy corrosion of the side shell and topside decks that is leaking. A continuous listing condition causes frequent pumping. The hull is suspected of being in poor condition. There is a large amount of fuel on the ship (3,074 barrels).”

**AMERICAN BANKER:** “…has heavy corrosion of the topside decks that is leaking. The ship has no hull blanks and cathodic protection on the hull was not added until last year. The hull is suspected of being in poor condition. Mooring bitts are damaged or missing. There is a large amount of fuel on the ship (2,551 barrels).”

**SANTA CRUZ:** “…has had cement repairs made to some fuel oil tanks and the sea chests to prevent leaking from below the water line. It has no cathodic protection and a limited underwater hull gauging survey indicates hull steel wastage of about 60% under the aft double bottom tanks. The topside decks and houses are corroded but rainwater is not leaking into the vessel’s interior. There is a moderate amount of fuel on the ship (1,076 barrels). A scrap sale contract was awarded but the ship was not removed.”

**PROTECTOR:** “…is one of the last two Liberty ships in the NDRF. The Liberty ships were built earlier than the Victory ships and were the cargo workhorses of WWII. These last two Liberties have not been scrapped because of being upgraded in

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11 MARAD_NT6\612\SHIP DISPOSAL\SCR_P LS5.DOC, September 19, 2000.
the 1970s. The ship is located at the Portsmouth Naval Shipyard and is having the engine and other major pieces removed for a historical display. The hull is in bad condition and the shipyard has agreed to keep the ship until it can be sold for scrap from its current berth. There is a large amount of fuel on the ship but the exact amount has not bee determined.”

**COMPASS ISLAND:** “…has no cathodic protection and has topside decks and houses that are heavily corroded causing leaking into interior spaces. There is a moderate amount of fuel on the ship (2,125 barrels).”

**RIGEL:** “…has no cathodic protection and had a limited underwater hull gauging survey that indicates moderate hull steel wastage. There is a small amount of fuel on the ship (101 barrels). A scrap sale contract was awarded but the ship was not removed.”

**CALOOSAHATCHEE:** “…has no cathodic protection and is in fair condition with minimal fuel on the ship (10 barrels).”

**CANISTEO:** “…has no cathodic protection and is in fair condition with minimal fuel on the ship (42 barrels).”

One of the most serious concerns with respect to the ships is the fact that the steel plating of the hulls of the ship has deteriorated due to corrosion. Below the percentage of plating wastage is shown for three of the vessels of the 13 UK bound vessels. Marine expert Werner Hoyt has submitted testimony that even these figures are unduly optimistic as a ships hull is only as strong as its weakest section.\(^{12}\) The study did not focus on corrosion and wastage found at the waterline area where maximum damage is to be found.\(^{13}\)

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\(^{13}\) Id.
The Department of Transportation Office of the Inspector General (OIG) issued an audit report regarding the progress of the MARAD disposal program. The OIG stated that:

“Environmental dangers associated with MARAD's old, deteriorating ships are very real and increasing daily. These vessels are literally rotting and disintegrating as they await disposal. Some vessels have deteriorated to a point where a hammer can penetrate their hulls…. if the oil on these vessels were to enter into the water, immediate state or Federal action would be required….¹⁴

(Emphasis added)

The particular ships that are slated for first delivery, the CANISTEO and the CALOOSAHATCHEE, have, according to inspectors, many issues of concern. Observations found in the Survey Report of Guardian Nautical Services, Ltd. Performed in September 2003 at the request of the UK Maritime and Coastguard Agency,¹⁵ found that “both stern tube seals are badly corroded.” Additionally, rivets on shell plating “showed evidence of excessive corrosion, with cup-heads wasted/reduced.” Notably, the same problem was highlighted and discussed by Werner F. Hoyt, PE in his declaration regarding the structural integrity of the vessels.¹⁶

The inspection also noted that an “in-water inspection of all-around waterline area should be performed by a competent person, to assess shell plate condition. Based on that inspection, repairs must be performed where needed.”¹⁷ Additionally the report recommended the ships in their entirety be assessed for bending movements and shear forces that might affect the ship in its current condition and during the voyage across the North Atlantic.

¹⁶ Please see, declaration of Werner F. Hoyt, PE, 25 September 2003, p. 6.
¹⁷ Supra, note 12.
Finally, it is very important to note that the Risk Assessment performed by Det Norske Veritas is made virtually meaningless because it assumed ships were in normal condition. As stated in the report, “the DNV’s scope of work does not include any assessment of the suitability, or otherwise, of the MARAD ships to undertake their proposed movements across the Atlantic to Teesside. DNV has not surveyed the MARAD ships and do not make comment on their condition.”

C. High Risk of Towing

1. Losses at Sea are Common

The above information highlights that the NDRF non-retention vessels, particularly those found in the priority list, pose an elevated degree of risk in their static state. It can only be expected that under tow, on high seas, buffeted by waves, in tension, and in unsheltered and harsher sea conditions, in the unpredictable weather of the North East Atlantic, the risk of sinking, breaching or leaking will be substantially escalated. In fact towing losses for vessels bound for scrap yards are non uncommon.

Some recent towing loss incidents of ships bound for scrapping operations are highlighted below.

- **USS STODDERT**: Lost at sea during a tandem tow to scrap yards from Pearl Harbor to the Panama Canal in the beginning of January 2001 on its way to International Shipbreaking (ISB) in Brownsville, Texas. In an affidavit prepared by Paul Torres, Engineer and Mate on the tow, the “STODDERT was staunch and seaworthy prior to the tow”. Yet during the journey, the rear vessel USS COCHRANE slammed into the USS Stoddert causing it to take on water. The vessel was then scuttled intentionally by the Captain of the tugboat.18

- **USS CONSTITUTION**: Large cruise ship owned by American-Hawaii Cruises sank while being towed from Cascade General Shipyard in Portland, Oregon by Chinese tug HUA AN while bound for breakers, 700 miles north of Hawaii, November 1997.19

- **S.S. SUN**: Sank July 25th 2001, off southeast South Africa while being towed by Chinese tug HUA AN some 200 kilometers off Cape Saint Francis when she sank in 4,700 meters of water.20

- **BOREI**: Russian Fishing Trawler the BOREI sank in the southern part of the Sea of Japan, on August 8, 2002. According to the press service of the State Piscatorial Committee of the Russian Federation, two fishing vessels, the

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18 Affidavit of Paul Torres, Eng. and Mate, June 28, 2001, in files of Basel Action Network.
YASHINO and the BOREI were being tandem towed from Vladivostok to Pusan, South Korea for repairs by the tug NEVELSKY. The weather deteriorated, and the towing cable connecting the BOREI broke. The trawler was thrown against the tug and began taking on water and eventually sank.  

- **RYNDAM:** On March 3, 2003, the tug FAIRPLAY XIV began to tow the former RYNDAM to Alang, India for scrapping. The ship never made it out of the Caribbean Sea, instead tilting and then sinking. On March 16, 2003 the ship unplugged to its final resting place 7,500 feet (2,500 meters) under the Caribbean Sea.

- **USS WAYNE VICTORY:** In December 2001, the aging WAYNE VICTORY was being towed to a Texas scrap yard when, 12 miles off Miami Beach, its hull cracked open. Only $100,000 worth of emergency repairs kept it afloat and prevented a leak, Maritime Administration records show. Inside the Wayne Victory were 57,000 gallons of oil.

- **K-159:** Russian nuclear sub K-159 sank in the Barents Sea northwest of Kilden Island off the Kola Peninsula on August 30, 2003. The submarine was being towed to Polyarnoye scrap yard. Only one of the 10 crewmen on board the submarine was rescued, the other 9 were killed.

- **USS BROOKLYN:** Sold to Chile, January 9, 1951; renamed O’HIGGINS. Damaged by grounding August 12, 1975. Sunk while under tow to India for scrapping, November 3, 1992.

- **M.V. SEA:** Sank under tow for scrap yards of India, off South Africa, July 11, 2001.

- **S.S. BRITANIS/BELOFIN-1:** Sank off Cape Town, South Africa October 21, 2000. Last operated as BRITANIS but renamed BELOFIN-1 in the last years during lay up. While being towed for demolition in India or Pakistan from Tampa, Florida, a list developed. South African maritime authorities ordered the tug IRBIS to keep BRITANIS over 50 nautical miles off the coast for fear of oil pollution should she sink in coastal waters. She sank in very deep water.

2. **Tandem Towings – Dangerous and Domestically Uninsurable**

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According to the Survey Report of Guardian Nautical Services, Ltd. Performed in September 2003 at the request of the UK Maritime and Coastguard Agency, of Southampton, the first six ships will be **tandem towed** in three separate towings. This will include the CANISTEO and the CALOOSAHATCHEE, the first two proposed vessels for overseas export to Able UK. According to the report, “the tow configuration will be “Double Tow” i.e. each towed vessel will have its own towing wire leading directly to tug SUHAILI.

Tandem tows, while saving the considerable fuel costs, exacerbate the ordinarily serious risk of towing dead vessels due to the fact that they are far more difficult to control in the event of bad weather, loss of tug power, or other unforeseen circumstance. Numerous incidents have been documented where one of the towed vessels collided with the other towed vessel, sometimes causing sinkage or severe damage to a vessel hull.

According to ship towing insurance expert and President of Global Insurance Specialists LLC, Seattle, Damon Nasman, it is “we believe that it is extremely difficult, if not impossible in this market to insure any tandem scrap tows. The reason being the high level of risk involved of a loss at sea.” This view is corroborated by a statement found in a fax letter from Targe Towing Ltd. of Scotland, to the UK Secretary of State’s Representative (SOSREP)’s office of Maritime Salvage and Intervention. In that letter it is stated, “[i]t is known that some London Underwriters when represented by the former Salvage Association, did not normally approve tandem tows.”

It is unclear at this time who has agreed to insure these vessels while under tow. What is clear, according to the contract that the amount of insurance for Pollution – sudden and accidental liability would appear to be extremely low – at $5 million per occurrence. Given that just a handful of spills noted above involved but 5,000 gallons of oil and cost the government around $3.2 million, it would not be hard to envisage a total loss of a ships on-board fuel equating to much more costs for remediation and clean-up. Further, as we shall discuss later in this report, MARAD’s own worst case scenario for a spill in the James River from the JRRF fleet would entail damages of $123 million dollars. In the present situation, any costs above the $5 million would have to be born by taxpayers.

**D. Congressional Mandate - Consider towing distance, environmental and occupational risks as well as costs**

The Defense Department’s fiscal year 2001 Authorization Act (P.L. 106-398) has amended the National Marine Heritage Act to place a deadline for disposal of all of the obsolete vessels by September 30, 2006. And, very significantly, it established environmental concerns more centrally as part of the criteria to determine how and where...
the ships should be disposed. The criteria, as established by congressional mandate, are as follows:

The Secretary of Transportation shall dispose of all vessels described in paragraph (2):

(A) by September 30, 2006;
(B) in the manner that provides the best value to the Government except in any case in which obtaining the best value would require towing a vessel and such towing poses a serious threat to the environment; and
(C) in accordance with the plan of the Department of Transportation for disposal of those vessels and requirements under sections 508 and 510(i) of the Merchant Marine Act, 1936 (46 App. U.S.C. 1158, 1160(i)).

(Emphasis supplied)

Further, Section 3502 of Public Law 106-398 (114 STAT. 1654a-490), the DOD Authorization Act, FY 2001, provides as follows:

The Secretary of Transportation may scrap obsolete vessels pursuant to section 6(c)(1) of the National Maritime Heritage Act of 1994 (16 U.S.C. 5405(c)(1)) through qualified scrapping facilities, using the most expeditious scrapping methodology and location practicable. Scrapping facilities shall be selected under that section on a best available value basis consistent with the Federal Acquisition Regulation, as in effect on the date of enactment of this Act, without any predisposition toward foreign or domestic facilities taking into consideration, among other things, the ability of facilities to scrap vessels –

(1) at least cost to the Government
(2) in a timely manner
(3) giving consideration to worker safety and the environment; and
(4) in a manner that minimizes the geographic distance that a vessel must be towed when towing a vessel poses a serious threat to the environment.

(Emphasis supplied)

The clear mandate then, asks for both cost savings to the public, while respecting human health and environmental concerns. Further, the mandate calls for shortening the distance of the journey to the extent possible when towing poses a serious threat to the environment.

We have already shown that towing these particular vessels, particularly in a tandem tow, can pose a very serious threat to the environment, and yet the government has opted for a very long towing distance compared to the highly reputable options available to it domestically. We can also show, that the government has not favored domestic scrappers that present substantially less towing risks, even when they have proposed less costs to the government.
E. Domestic Ship scrapping Facilities: Less Risky and Cheaper

MARAD, rather than utilizing the standard bidding process delineated by the Federal Acquisition Regulation (FAR) utilized a procedure they called Program Research and Development Announcement or PRDA. This was a call to the private sector for solutions to the problem of the NDRF non-retention vessel disposal. This PRDA call was first issued in October of 2001 and was extended several times.33

At the NEETC conference in April 2-4, 2003 in Washington, D.C. MARAD’s Shaun Ireland reported to the conference that at that time there had been 68 proposals received in total. Of these, he reported that 20 were for foreign scrapping, 4 were for using the vessels as artificial reefs, 12 were miscellaneous, and 30 were for domestic recycling in the United States.34 Fifteen of these were said to be under evaluation as viable proposals. Of those, he reported that three, had been foreign, one in the UK, one in China and one in Mexico. We can conclude therefore that MARAD had in hand around 12 viable domestic disposal options. However he revealed at that time MARAD’s inclinations when he said that the best option from a cost-effectiveness standpoint, (assuming it was legal) was to export the vessels.35

However, MARAD has awarded contracts to domestic ship breakers in the past and very recently. Indeed, one contract was given for $2.7 million to Bay Bridge Enterprises in the Chesapeake Bay (towing minimized) in September of this year to dismantle 5 ships.36 Additionally, contracts had been awarded from 1996 to 1999 to International Shipbreaking Limited, and ESCO Marine in Brownsville Texas, D and D Steel Company, and the Bedoli Group, Inc.37

What is most shocking is that at least two domestic ship recyclers, known to be acceptable to MARAD as a safe and reliable facility, has placed bids lower than the winning bid of PRP/AbleUK for the very same ships.

According to a letter from International Shipbreaking Limited (ISL), with ship scrapping operations in Brownsville, Texas, to MARAD dated June 10, 2003, ISL proposed to handle the disposal of the same 13 ships granted to Post-Service Remediation Partners (PRP). The final contract awarded to PRP on July 25, 2003 was for $14,846,338.40.38 ISL offered to do the job on June 10, 2003 for $12,879,104. The government was required to pay in total $1,967,234 more for the ships involved by granting the deal to PRP who subcontracted the ships being disposed of by Able UK. The deal amounted to a

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34 Meeting notes of Jim Puckett, Basel Action Network.
35 Meeting notes of Jim Puckett, Basel Action Network.
36 Scott Harper, Local yard wins in bid to scrap 5 ghost Ships, The Virginian-Pilot, September 4, 2003
37 MARAD list of Sales Contracts, 02/05/2001.
choice between towing the vessels about 1,428 nautical miles to Texas as opposed to about 4,829 nautical miles to the UK across an open ocean.39

Further, BAN has copies of correspondence indicating also that the Bay Bridge Enterprises, LLC., company of Chesapeake, Virginia also offered to process the same ships for 495,000 dollars cheaper than the PRP/AbleUK contract, and this could have been accomplished with no open seas towing risks involved.

Both of these facilities have met with MARAD’s approval with respect to health and environmental concerns. Thus, not only has MARAD seemingly ignored its mandate to consider towing risks, they have ignored the mandate to save the taxpayers of the United States money and thus achieve “Best Value”. Considering these matters, it is very difficult to understand why MARAD persists in orchestrating this dubious and dangerous export scheme.

F. Risk of Leaked PCBs, Oils and other Pollutants

1. Presence of PCBs

During the course of preparing the disposal and export of the 13 NDRF vessels, MARAD has left a trail acknowledging the existence of PCBs in most of the vessels.

In a letter dated, 15 July 2003, by MARAD notified the UK Environmental Agency of the presence of PCBs in the subject vessels.40 The relevant portion of the letter is as follows:

…[D]ue to the age of the vessels and the types of materials used in their construction, it can be assumed that non-readily removable solid PCBs in an estimated quantity of approximately 100 tons may be found in closed application including gaskets, sealants, adhesives, and cable insulation, etc.” (Emphasis supplied)

In the latest documentation however – a risk assessment prepared by the Det Norske Veritas, for Post-Service Remediation Partners LLC, it is revealed that the PCB content of the vessels could be as high as 698 tonnes on the 13 vessels, with the first two vessels, CANISTEO and CALOOSAHATCHEE containing about 68 tonnes.41 Table 2 contains the details of the tonnage of PCBs in each of the vessels indicated in the risk assessment, as well as the tonnage of some of the other hazardous substances contained in the vessels.

39 These figures provided in letter from Kevin McCabe of ISL to the Maritime Administration’s Curt Michanczyk, Program Manager of the Ship Disposal Project. June 10, 2003.
Table 2. Summary of Hazardous Material Inventories onboard the MARAD Ships (all figures in tonnes)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tr>
<td>CALOOSAHATCHEE</td>
<td>15,184</td>
<td>34.1</td>
<td>1.0</td>
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<td>1</td>
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<td>61</td>
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<td>6.80E-03</td>
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<td>75</td>
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<td>1</td>
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<td>2.72E-02</td>
<td>1,480</td>
<td>218</td>
<td>5.00E-02</td>
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| TOTAL           | 138,332      | 698.0           | 14.0                       | 1,402    | 8.85E-03| 3.45E-01                  | 2,872            | 3,540                         | 6.50E-01  |
| Average         | 10,641       | 54.0            | 1.0                        | 108      | 6.80E-04| 2.66E-02                  | 221              | 272                           | 5.00E-02  |
| Maximum         | 15,184       | 286.0           | 2.0                        | 252      | 9.07E-04| 4.54E-02                  | 1,480            | 857                           | 5.00E-02  |

Source: Marine Environmental Risk Assessment, Sept. 2003, Det Norske Veritas
Table 3. Annex I of Transfrontier Movement of the MARAD Notification No. USDC170603

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<th>Ship Name</th>
<th>Gross Weight</th>
<th>Industrial Waste</th>
<th>Asbestos</th>
<th>CFC Containers</th>
<th>Waste Water</th>
<th>Oily Water</th>
<th>Heavy Fuel</th>
<th>Diesel Fuel</th>
<th>Hydraulic Oil</th>
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<td>Tonnes</td>
<td>Tonnes</td>
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<th>Treatment</th>
<th>Treatment</th>
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<th>Re-use</th>
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</thead>
<tbody>
<tr>
<td><strong>% of Ship</strong></td>
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<td>.9%</td>
<td>.1%</td>
<td>9.0%</td>
<td>1.3%</td>
<td>.8%</td>
<td>.1%</td>
<td>2.8%</td>
<td>80.4%</td>
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<td></td>
</tr>
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</table>

While the EPA enforcement discretion letter requirements granted to MARAD requires the removal of readily available non-liquid PCBs and all known liquid PCBs the remaining PCBs on board makes for highly significant amounts which pose a grave threat to the marine environment. Later we will discuss how these PCBs can easily enter into the marine environment.

Non-liquid PCBs contaminated materials are found in great abundance on board the NDRF vessels. The materials commonly containing PCBs include, gaskets, paints, adhesives, cables, foam, cork, felt and other insulation, caulking material, rubber-like material, plastics.

2. Presence of Liquid Fuel Oil

According to Annex I of the the Notification MARAD sent to the UK for consent to the importation under the European Union Waste Shipment Regulation which in turn implements the OECD Council Decision on transboundary movements of waste for recycling, the 13 vessels in total contain Inventory for All Vessels, the Canisteo and Caloosahatchee contain 3,380 tonnes of diesel or heavy bunker fuel oil. The Canisteo and the Calossahatchee together contain contain 11.5 tonnes of oil. And these figures don’t even include the far more massive tonnage of oily waters onboard in the bilges. For a full tabulation of precisely what is on board see Table 3.

An accident involving a major oil spill, for example from the 646 tonnes of heavy bunker fuel on board the PROTECTOR, one of the 13 vessels slated to be exported, could be devastating to birds and marine life, particulary if it took place near the coast. The recent accidents involving the Exxon Valdez and the Prestige are excellent reminders of what could be at stake.

3. Other Pollutants

It is readily apparent from existing studies that even without an exhaustive inventory of hazardous substances on board, that significant impacts could befall the marine environment from the presence of toxic contaminants beyond oils and PCBs. The Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal, issued a technical guideline for ship recycling, and the guidelines provide a listing of all probable toxic materials inherent in the structure of a vessel.

42 Letter May 22, to Mr. Caponiti (MARAD) from Peter Suarez (EPA) granting “enforcement discretion”.
44 ANNEX I(Rev 1) Section 13 Transfrontier Movement Of The Marad Fleet Notification No: USDC170603.
For the purposes of this discussion we will however focus on significant hazards listed in the Det Norske Veritas (DNV) risk assessment – mercury and asbestos as well as contaminants listed in the 1997 Environmental Assessment.

a) Asbestos

Asbestos is a significant contaminant of all of the vessels. With each of the 13 averaging over 100 tonnes. The following is stated in the DNV risk assessment:

*While it is generally thought that asbestos is not harmful in the marine environment, there has been almost no actual study to show this conclusively one way or another. However, according to the risk assessment:*

Asbestos is denser than water and is non-soluble. It is highly persistent but is not known to bio-accumulate in the food chain. European Directive 87/217 on the prevention of environmental pollution by asbestos indicates a limit value of 30mg total suspended matter per cubic metre of aqueous waste.

The release of asbestos into the marine environment is unlikely to result in perceptible marine environmental impacts. However if asbestos waste is washed up onto the shore line and becomes dry, it could become airborne and become a hazard to people and other susceptible fauna.

*It should be noted that if a MARAD ship breaks up on the coastline then it is possible that significant quantities of asbestos fibres may become airborne (a typical ship contains about 100 tonnes of asbestos and the worst case ship contains over 250 tonnes of asbestos in various forms). Whilst this does not impact the marine environment, it could represent a significant public health risk.*

b) Mercury

Mercury is found in strip lighting and electrical float strips and in other applications. It is expected that the vessels also contain significant amounts of mercury, lead and cadmium in various uses. Mercury, particularly methylmercury, which can be formed in the environment from biological action on elemental mercury, is very toxic and bioaccumulative in the marine environment.\(^{46}\)

c) Cadmium

It is believed that there are hundreds or thousands of cadmium plated parts on board each of the ships. All sampling that was done for cadmium were positive. While the test was not performed it is believed that all such cadmium plated articles will fail the Toxic Characteristic Leachate Procedure.\(^{47}\)

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\(^{46}\) Marine Environmental Risk Assessment, Sept. 2003, Det Norske Veritas

d) Chromium and Lead Based Paints

It is well known that there is a high level of lead and chromate based paints used on board the vessels. Lead and Chromate paints will fail the Toxic Characteristic Leachate Procedure Test and are therefore considered hazardous waste. Exterior paints on board the vessels are in extremely poor condition, bubbling and flaking and falling in large pieces on the decks. About half of the paint on the exterior of the ship was considered to be loose. On one ship, EXPORT CHALLENGER, it was estimated that there was 17,000 pounds of toxic paint that considered to be loose or in chips.48

e) Sodium Chromate treated mud ballasts

Sodium Chromate was known to be used by the Navy to prevent corrosion in the mud ballasts. Sodium Chromate is a hazardous waste. The information about sodium chromate in the ballasts of the 13 ships is oddly absent. Since the 1997 Environmental Assessment, little has been said about this subject.49

f) Toxic Bilge waters

It is known that the ships have a tremendous amount of polluted waters which is often toxic enough to be classified as hazardous waste. This is often due to the chemical additives used to prevent corrosion.50

4. Likelihood of PCBs, Oils and Other Pollutants Entering the Marine Environment in the Event of an Accident or Incident

The Department of Transportation Office of the Inspector General (OIG) issued an audit report regarding the progress of the MARAD disposal program. The OIG stated that:

Environmental dangers associated with MARAD's old, deteriorating ships are very real and increasing daily. These vessels are literally rotting and disintegrating as they await disposal. Some vessels have deteriorated to a point where a hammer can penetrate their hulls. They contain hazardous substances such as asbestos and solid PCBs, and in some instances liquid PCBs. MARAD has designated 40 of the vessels awaiting disposal as those in "worst condition" due to their severe deterioration and threat to the environment.

If the oil on these vessels were to enter into the water, immediate state or Federal action would be required….51 (Emphasis supplied)

48 Id.
49 Id.
50 Id.
Further, a full report on the impact of an oil spill on the James River area has been accomplished. Given the assessment made by the OIG, and given the findings of the impact report which delineates the many scenarios of spills and the potential costs of such spills, see below the question on whether a spill or accident can release oils into the marine environment has already been answered. Clearly if this can happen as it already has, when the ships are static, then it is far more likely to happen when a ship is buffeted on the high seas and the ship’s weak plating is breached due to its deterioration and wastage under the stresses of current and weather.

What is less well understood is how the estimated 100 tonnes of PCB content on board the 13 vessels is likely to enter the marine environment. MARAD has claimed in their legal brief that PCBs are less likely to enter or threaten the marine environment than liquid PCBs.

This sounds logical until one really considers the subject. The likelihood of PCBs entering the environment is more likely than one would at first expect. The United States Environmental Protection Agency has required that MARAD demand that prior to export the contractor remove all transformers and large high and low voltage capacitors, hydraulic and heat transfer fluids containing PCBs greater than 50 parts per million (ppm) in concentration. However, it remains unclear whether all of the liquids on board the vessels that may contain PCBs have ever been tested for PCBs. For example, we have not been able to ascertain whether or not anyone has ever tested the fuel or the bilge waters for PCBs. There is no requirement to test or remove these potentially contaminated liquids and there is no evidence in the available documentation that such testing of bilge and fuels has been done. Likewise, EPA has required the removal of all solid PCBs that are readily removable in the actual ships. According to the EPA, “readily removable” means the PCBs or PCB item can be removed in a cost effective and efficient fashion without significant risks to human health and the environment, and without compromising ship integrity or seaworthiness. Objects are not readily removable if the objects must be removed by heat, chemical stripping, scraping, abrasive blasting, or similar process. With a definition like this it remains unclear what readily removable really meant to those tasked with removing some of the PCBs. In any case, these requirements will leave the following potential sources of PCBs on board the ships:

a) Liquid PCBs in less than 50 ppm concentrations. (e.g. fuel, transformer and other oils and bilge waters)

This category can be quite significant if PCBs are found in the considerable quantities of fuel oil present on board some of the 13 vessels. Even at lower concentrations the

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total volume of discharged PCBs could represent a very significant contaminant in a sensitive marine environment. Such sources would very easily enter the marine environment in the event of a sinking or breaching of the hull.

b) Liquid PCBs present in fuel oil or bilge waters greater than 50 ppm concentrations but untested

While it is unlikely that diesel or bunker fuels or bilge waters would have been contaminated with PCBs it is still possible. Thus it is imperative that testing of all liquids and not just ones that were manufactured to contain PCBs be done to ascertain PCB content. To our knowledge this has not been done for fuel oils or bilge waters. Such sources would very easily enter the marine environment in the event of a sinking or breaching of the hull.

c) Solid PCBs greater than 50 ppm that were not readily removable

While one might think that solid PCBs would not be readily dispersed into the marine environment one must realize that the solid PCBs consist of old deteriorating gaskets, paints, adhesives, rubber devices and electrical insulation. Due to the age of the vessels this material can be presumed to be flaking, powdering, and crumbling. Indeed it is estimated that on one ship alone as much as 17,000 pounds of loose paint was encountered (see above). As such the material can actually be easily be dispersed into the marine environment.

d) Solid PCBs that are less than 50 ppm

Likewise, there may be a considerable quantity of PCB material in less than 50ppm concentrations. While one might think that solid PCBs would not be readily dispersed into the marine environment one must realize that the solid PCBs consist of old deteriorating gaskets, paints, rubber devices and electrical insulation. Due to the age of the vessels this material can be presumed to be flaking, powdering, and crumbling. As such the material can actually be easily be dispersed into the marine environment.

e) Liquid PCBs greater than 50ppm that were supposed to be removed but were not found prior to export.

The MARAD/PRP contract discusses the possibility that liquid PCBs exceeding 50ppm could be found and that if that is indeed the case, then they would need to be incinerated. Thus despite, the conditions imposed by EPA in their enforcement discretion letter, they have anticipated the likelihood that not all PCBs, liquid or otherwise, exceeding 50ppm will be found. Any liquid PCBs have a great risk of leaking into the marine environment in the event of a breached hull or sinking.

As can be seen, despite assurances of removal of PCBs, found in the EPA grant of “enforcement discretion” letter and in the MARAD/PRP contract, it is highly likely that a
serious PCB threat remains both from a standpoint of total quantities on board (100 tonnes) and from a standpoint of availability and dispersability to the marine environment.

The notion that liquid PCBs pose a greater threat to the marine environment denies the chemical properties of PCBs. They were used and coveted for their propensity not to solidify. When placed into a solid or non-liquid matrix, they still retained that quality and easily leach out into the environment.\textsuperscript{54}

Losses of the ship at sea can fall into two categories – retrievable and irretrievable.

In a retrievable accident, the ship becomes awash with sea or river water and then is brought back to the surface. In such an event, it is likely that transformer and capacitor and hydraulic fluids will not have been lost to the marine environment as they are invariably in sealed and containerized units. However crumbling, powdering, fragmenting chips and fluff will easily wash into the environment and become lost. Thus it is that in this scenario, it is likely that solid PCBs may indeed present more PCBs entering the marine environment than those in liquid form.

In an irretrievable accident, it is expected that the persistence of PCBs in a deep sea environment will render them toxic and non degraded for a very long time. It is expected therefore in this scenario that PCBs in solid form would be equally as susceptible to entering the marine environment. That is in due time, they will all enter the marine environment slowly but surely.

Thus the notion that liquid PCBs present more of a threat to the marine environment than non-liquid PCBs is simply untrue.

5. PCB Leakage – Toxic Impact to Communities and the Environment

Polychlorinated biphenyls (PCBs) have undergone extensive scrutiny the world over. (Please see attachments 1 and 2 for a good summary of data on the effects of PCBs on humans and wildlife)

PCBs are known to have a high degree of chemical stability, resistance to thermal breakdown, and resistance to many oxidants and other chemicals - characteristics the ushered the usage of PCBs as coolants and lubricants in transformers, capacitors, and other electrical equipment.\textsuperscript{55}

\textsuperscript{54} Conversation between Jim Puckett of BAN and Dr. Peter Defur, PCB expert. October 8, 2003.
\textsuperscript{55} UNEP, Guidelines for Identification and Management of PCBs and PCB containing materials. August 1999. p. 3.
PCBs do not occur naturally and enter the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.\(^{56}\)

As PCBs are very stable they do not readily break down in the environment, and are able to persist for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In a study involving arctic living Inuit, it was revealed that the arctic people's PCB concentrations overall were up to 70 times greater than the pooled sample from the southern part of Canada.\(^{57}\) This fact illustrates how PCBs ignore geographic barriers considering that there is no PCB manufacturing that occurs in the Arctic.

Due to the persistent nature of PCBs, they are taken up by small organisms and fish in water. The cycle continues when other animals that eats these organisms and aquatic animals as food, resulting in a bio-magnification of PCB content higher up in the food chain. This phenomenon is known as bioaccumulation. PCBs, thus, accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.\(^{58}\)

The Fox River Fact Sheet (Attachment 2) contains a summary of some of the alarming reproductive and developmental effects of PCBs on wildlife.

“The most common route of human exposure to PCBs is through eating PCB contaminated fish. The EPA estimates an increased cancer risk as high as 1 in 2500 for people eating certain species of fish from the Hudson River; thousand times higher than the EPA’s goal for protection.”\(^{59}\)

One of the more vulnerable populations to PCBs are children. “In a study of Dutch children, PCB levels were tied to an increased prevalence of ear infections and chickenpox and with lowered immune system function, and thus greater susceptibility to disease.”\(^{60}\)

Air may also be a source of human exposure to PCBs. “By one estimate, residents of the Hudson Valley may inhale as many PCBs as they would get by eating one contaminated fish per year.”\(^{61}\)

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\(^{60}\) Id.

\(^{61}\) Id.
The Clearwater Fact Sheet (Attachment 1) provides a summary of the known effects of PCBs on human health.

There is a chorus of agreement not only among US authorities, but also among global authorities - the U.S. EPA, the International Agency for Research on Cancer, the National Toxicology Program, the Institute for Occupational Safety and Health - all consider PCBs as probable human carcinogens. The global acknowledgement of the dangers posed by PCBs is to such an extent that PCBs is one of the identified persistent organic pollutants slated for global elimination under the Stockholm Convention on Persistent Organic Pollutants.63

Not only are PCBs probable carcinogens, PCBs have also exhibited non-carcinogenic properties. Chronic low-level PCB exposures reported include liver damage, endocrine effects, reproductive and developmental defects. “Children born to women who worked in PCB factories showed decreased birth weight and a significant decrease in gestational age with increasing exposures to PCBs.”64

The dangers posed by the release of PCBs through any leakage of the NDRF vessels are real. More palpable still is the harm any PCB contamination will inflict not only on the Teesside community where the vessels will be dismantled and disposed of, but also to the James River community, and ultimately to the global community and environment, given the persistence and bioaccumulative properties of PCBs.

6. Fuel and Bunker Oils

Petroleum products, such as fuel and bunker oils, have different compositions that may produce varied impact on the environment. Adding to this complexity is the need for further studies into long-term effect of petroleum products into the marine environment. Notwithstanding the paucity of extensive data on this issue, an Australian government sponsored study provides a cautionary remark with regard to large scale releases of oil to the environment.65 The study mentions that large incidents of spillage “…have the potential to cause immense damage, particularly to intertidal and subtidal ecosystems such as coral reefs, mangroves, seagrass communities and so on. Additionally, major

64 UNEP, Guidelines for Identification and Management of PCBs and PCB containing materials. August 1999. p. 3.
spills at sea may have less obvious but serious long-term consequences for marine communities, such as detrimental effects on planktonic phases of marine organisms."\textsuperscript{66}

An area of concern with regard to fuel oil leaks from the NDRF vessels in the James River and similarly situated areas is the possibility of the oil leaching into the groundwater. The high molecular weight of aliphatic components of fuel oils that have been released through leakage from ships have very low water solubility and will not volatilize from soils or surface waters. Thus, these “heavier components may be absorbed to particulate organic matter or settle to the sediment,”\textsuperscript{67} and are the most likely to leach through the soil into the groundwater.\textsuperscript{68}

Another area of concern with regard to oil that may be present in the two NDRF vessels, are "dirty" bunker oils, called as such because of the presence of hazardous liquid wastes as additives in such oils. Some oil suppliers have mixed hazardous wastes such as heavily PCB-contaminated transformer oils and organic acids in bunker oils thereby increasing the environmental risk from combustion and leakage.\textsuperscript{69} Basel Guidelines on ship dismantling also mentions the specter of PCB contamination in oil, as included in the Basel shipbreaking guidelines gray list of substances in ships.

7. Vicinity of Sensitive and Important Marine Habitat in Coastal Areas in Virginia and in the Teesside, UK.

In a letter from the Coast Guard to MARAD, Mr. Shrinner, Captain of Port Hampton Roads, describes to Mr. Nuns Jain, director of MARAD’s South Atlantic Region some of the environmental treasures threatened by the JRRF fleet:

“...the James River has become an important corridor for commercial traffic as well as an area exhibiting a resurgence of native wildlife. Recent studies by the National Oceanographic and Atmospheric Association (NOAA) classify the waters surrounding the James River Reserve Fleet as Shellfish Seeding and Producing Beds. These waters harbor significant oyster and hard clam producing beds which nurture critical life stages of the organisms. The fleet is also contained within the Bowen Wildlife Management Area, a region that supports several inter-tidal marshes and threatened species. Consequently, any oil spills from the Fleet will potentially impact the area’s natural resources and possibly impede commercial traffic during clean-up operations.”\textsuperscript{70}

There are actually four very significant areas immediately near the ghost fleet itself, that can be harmed by spills. These include the Ragged Island Wildlife Management

\textsuperscript{66} Id.
\textsuperscript{67} Virginia Department of Health DIVISION OF HEALTH HAZARDS CONTROL, Fuel Oil, p. 3, available at www.vdh.state.va.us/HHControl/fueloill.PDF
\textsuperscript{68} Id.
\textsuperscript{70} Letter from Captain Schinner (Coast Guard) to Mr. Jain (MARAD), 4 September 1998.
Area, the Bowen Wildlife Management area, the Hog Island Game Refuge and the Shellfish and Producing Beds.\footnote{71}{U.S. Coast Guard Powerpoint Presentation, 17 October 2000.}

Depending on the route the ships take, many other coastal areas are at risk in the United States. Perhaps of greatest concern however is the entire mouth area of the Chesapeake Bay as well as the Virginia Seaside Heritage Program area including the Chincoteague National Wildlife Refuge, and the Eastern Shore of Virginia National Wildlife Refuge, just outside of the mouth of Chesapeake Bay.

In the UK the Able facility is located very near the Teesmouth and Cleveland Coast Special Protection Area (SPA) Marine Site, which itself forms part of the Natura 2000 network. The site was designated under the Wild Birds Directive (79/409/EEC) as it supports significant numbers of internationally important wild birds, the boundaries of the site being extended in 2000. The Teesmouth and Cleveland Coast SPA and Ramsar (Internationally recognised site of importance for wetlands and waterfowl under Ramsar Convention on Wetlands) sites cover an area of 1247.31 hectares (English Nature, 2000).\footnote{72}{Declaration of Mike Elliott, Federal District Court, September 26, 2003. Presented in BAN v. MARAD and EPA.}

8. Nuclear Power Stations – Cooling Water Threats

Both site of the Ghost Fleet as well as the Able UK facility are very close to nuclear power stations – the Surrey Nuclear Plant in Virginia, USA and the Hartlepool Power Station in the UK (See Figure 2). Both of these plants rely on cooling water to prevent catastrophic events that could result in releases of radiation. The presence of “Bunker C” heavy fuel oil in the cooling water intake channels of these plants could very well cause serious problems with the functioning of the reactors, and increase risk of reactor malfunction and catastrophic radiation releases.

Figure 2. Surrey Nuclear Plant and Reserve Fleet site.
9. Lack of Containment of PCBs and other Pollutants at AbleUK

In its enforcement discretion letter, the EPA enumerated several statements they believed to be fact. Among others they alleged that there would be in time for the arrival of the vessels a 24 acre basin that could be enclosed to serve as a dry-dock.

“AbleUK has a 24-acre basin that can be sealed and drained similar to a dry dock.”73

Indeed this is also a requirement in the contract:

“Upon arrival at the recycling facility in Teesside, UK, all vessels will be safely moored and continuously monitored by the Contractor while afloat and prior to being dry-docked in the dismantling basin.”74

However the fact is that the seawall or bund to complete seal the basin and drain it does not exist and the authorizations and permits to complete it do not exist. This was made abundantly clear when the local authority of Hartlepool issued the following media statement:

“Having thoroughly examined the scope and validity of previous planning permissions granted for Able UK’s Graythorp site, we have notified Able UK that in our view there is no valid planning permission to allow for the construction of the proposed dam and the reinstatement of the dock gates, to provide a dry dock.

“We have therefore advised Able UK that it would need to submit to the Council a formal planning application for the proposed dam and the reinstatement of the dock gates.

“In the light of our latest decision, we have advised Able UK’s solicitors that if Able UK requires dry dock facilities in order to carry out its proposed ships’ decommissioning, then the required planning permissions are not in place.”75

As a result of these kinds of statements we are now hearing from MARAD that they may in fact not bother with a bund after all. In the first Declaration of Mr. Curt Michanczyk in which he changed the tune to:

"Having this planning permission [for bund] is not a MARAD contractual requirement. It was something that was proposed by AbleUK as a cost-effective means of dismantling and recycling the vessels. However the dismantling and recycling of the vessels can be accomplished without the bund."

73 EPA Enforcement discretion letter to James Caponiti from John Peter Suarez. May 22, 2003
74 Section C1.7 Contract Modification., between MARAD and PRP, October 3, 2003.
75 Press notice PRO39316. 7 October 2003. Issued by Hartlepool Council’s Public Relations Unit.
In any case, it has become abundantly clear that there is a real likelihood that even the very difficult and dangerous shipbreaking operation itself will take place on the water (without a drydock), along side a quay or pier. In this event the likelihood of PCBs entering the marine and estuarine environment of the Teesside area is amplified.

Containment is the most important principle with respect to environmentally sound management of ships for dismantling and this fact is iterated in the Basel Convention’s Technical Guidelines. Numerous references in these guidelines refer to containment and the need for concrete floors with controlled drainage.\footnote{Basel Convention Technical Guidelines for the Environmentally Sound Management on the Full and Partial Dismantling of Ships, Appendix B, December 2002.}

The US EPA also assumed that the nearest residential area from Teesside Environmental Reclamation and Recycling Facility (TERRC), the facility that will be managing and storing the hazardous wastes collected from the NDRF vessels, is 1-2 kilometers and that this would somehow be enough distance to prevent the residents of Teesside from receiving the harmful effects of the hazardous materials reclaimed from the vessels.

However, the UK Environment Agency (EA) conducts an Operator and Pollution risk Appraisal (OPRA) for waste\footnote{See, http://216.31.193.171/asp/1_about_wasteopra.asp, last visited 20 September 2003.}. The OPRA was developed to appraise the environmental risks from waste management facilities regulated by the EA and the performance of operators who manage the facilities.

The environmental appraisal under OPRA looks at several attributes, and one pertinent to this issue is on Human Dwellings. This attribute indicates the sensitivity of the human receptors and the distance from the facility. The EA will assign a score for each attribute, and a score ranging from one, for Human Dwellings, means there is low risk and a score of 20 would mean high risk. The TRRC facility scored a 15 for Human Dwellings\footnote{See, http://216.31.193.171/asp/1_search_details.asp?tblname=waste_opra&regis_wml=60078, last visited 20 September 2003.}, signifying that the facility poses a moderately high risk.

The EA also appraises the facility operator’s ability to manage the environmental risks (Operator Assessment), and the level of management control (Operator Management). TRRC’s Operator Assessment score was a low 9.5\footnote{For this attribute, inspection scores range from 0 (which is deemed compliant with UK Environmental Agency requirements) to 15 (which is an emergency situation on site). Supra note 8.}, and for Operator Management an average score of 5.\footnote{Scores range from 10 (which means there is no control mechanism) to 1 (which means there is an accredited management system).}

From a resident’s perspective, the Operator Assessment and Operator Management scores of TRRC brings nothing but cold comfort considering the volume and the nature of the wastes being shipped to their community.
G. Cost of Oil Spill Cleanup

The Maritime Administration, South Atlantic Region, commissioned an oil spill modeling study to assess the potential consequences of a hypothetical oil spill from the NDRF in the James River.\textsuperscript{81} One of the objectives of the study was to determine the costs of oil spill response and cleanup.

The study was forthcoming in its assessment that actual costs of cleanup can occasionally exceed forecasted costs by a significant amount. The study attributes this fact to several factors, political and social pressure for the cleanup, the sensitivity of the affected areas, ineffectual response, etc. Beneath all of the stated reasons, however, is the most cogent explanation, and that is the incalculable force of nature and how this would interact with the pollutants. Currents can suddenly change spreading the oil spill further than expected, changes in weather pattern, etc.

The study based its assessment on the Potomac Electric Power Company (PEPCO) pipeline which spilled approximately 2,500 barrels of oil into the Patuxent River and surrounding wetlands of Swanson Creek, Maryland on April 7, 2000. The PEPCO pipeline spill, according to the study, has obvious parallels to the James River because of the proximity of the location and the oil types.\textsuperscript{82} From these parallels, the study arrived at the following table on the worst-case cleanup costs for the JRRF:\textsuperscript{83}

<table>
<thead>
<tr>
<th>Spill Scenario</th>
<th>Spill Size</th>
<th>Worst-Case Cleanup Costs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Diesel</td>
<td>1,000 gallons</td>
<td>$2,000,000</td>
</tr>
<tr>
<td></td>
<td>10,000 gallons</td>
<td>$2,200,000</td>
</tr>
<tr>
<td></td>
<td>303,750 gallons</td>
<td>$7,200,000</td>
</tr>
<tr>
<td>No. 6 Fuel</td>
<td>1,000 gallons</td>
<td>$2,800,000</td>
</tr>
<tr>
<td></td>
<td>10,000 gallons</td>
<td>$6,500,000</td>
</tr>
<tr>
<td></td>
<td>262,939 gallons</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>Maximum Worst-Case For No. 6 Fuel Oil</td>
<td>262,939 gallons</td>
<td>$123,000,000</td>
</tr>
</tbody>
</table>

*Costs for US Coast Guard-directed spill response operation.

The figures presented above highlights the inadequacy of the indemnity and insurance provision of the MARAD/PRP contract - $5 million for comprehensive general liability, $5 million for pollution, etc.\textsuperscript{84}

\textsuperscript{81} Assessment of the Potential Impacts of Oil Spills from the National Defense Reserve Fleet, Prepared by Research Planning, Inc., et. al., February 2002.
\textsuperscript{82} Supra, note 68 at 64.
\textsuperscript{83} Id., p. 63.
\textsuperscript{84} Supra, note 40 at 27.
Conclusion

Governments, and human beings, are often called upon to look at risks and make an appropriate determination on how to address the risk faced. There is a monumental divide, however, from a risk that must be necessarily faced, from one that is needlessly taken. Lives of innocents and the environment are at stake in bridging the two choices. Given the irreparable consequences of what is at stake, prudence and common sense dictates that we utilize available alternatives to avoid the risk that is needlessly taken, and that is not to allow the towing of the decrepit, obsolete, naval vessels across the tempestuous North Atlantic.

--- END ---
Annexes:

Attachment 1

Clearwater Fact Sheet 12
www.clearwater.org

What Are The Human Health Effects Of PCBs?

Polychlorinated biphenyls are a group of 209 different chemicals, which share a common structure but vary in the number of attached chlorine atoms. General Electric dumped an estimated 1.3 million pounds of different types of PCBs into the Hudson River from 1946 until 1977, when they were banned. The international treaty on Persistent Organic Pollutants, drafted by 122 nations in Johannesburg in December 2000, targeted PCBs as one of the ‘dirty dozen’ chemicals to be phased out worldwide.

PCBs are a probable human carcinogen.

The International Agency for Research on Cancer and the Environmental Protection Agency classify PCBs as a probable human carcinogen. The National Toxicology Program has concluded that PCBs are reasonably likely to cause cancer in humans. The National Institute for Occupational Safety and Health has determined that PCBs are a potential occupational carcinogen.

Studies of PCBs in humans have found increased rates of melanomas, liver cancer, gall bladder cancer, biliary tract cancer, gastrointestinal tract cancer, and brain cancer, [1] and may be linked to breast cancer. PCBs are known to cause a variety of types of cancer in rats, mice, and other study animals. [2]

Why are PCBs called a ‘probable’ carcinogen?

EPA’s regulations on cancer-causing chemicals use the term ‘probable’ when a chemical is known to cause cancer in animals and where there is evidence that suggests that it causes cancer in humans but which is not conclusive. Because you can’t feed chemicals to humans to see how they respond, it is much more difficult to demonstrate carcinogenicity in humans than in animals. Instead, studies are undertaken of groups who have been exposed to a chemical, and if they suffer from more cancers than would be expected at normal levels, this may indicate that the chemical was a carcinogen.

However, there are many difficulties doing these studies: small numbers of people known to be exposed to a chemical; the fact that people suffer from many cancers without any chemical exposure; the fact that in some cases these people were exposed to a number of other chemicals; and the need to demonstrate high cancer rates that cannot be random in order to draw conclusions. Thus the term ‘probable’ reflects the limited nature of the studies, and it is rare that a carcinogen is so effective that it can be called a ‘known’ human carcinogen.
The fact that PCBs are called a `probable´ carcinogen should not be taken as a sign that they are benign.

**Acute toxic effects.**

People exposed directly to high levels of PCBs, either via the skin, by consumption, or in the air, have experienced irritation of the nose and lungs, skin irritations such as severe acne (chloracne) and rashes, and eye problems. [3]

**PCBs cause developmental effects.**

Women exposed to PCBs before or during pregnancy can give birth to children with significant neurological and motor control problems, including lowered IQ and poor short-term memory.

A group of children in Michigan whose mothers had been exposed to PCBs were found to have decreased birth weight and head size, lowered performance on standardized memory, psychomotor and behavioral tests, and lowered IQ. These effects lasted through at least 7 years. [4] A group of women occupationally exposed to PCBs in upstate New York had shorter pregnancies and gave birth to children with lower birth weight. [5] Another study, of the children of women who ate contaminated Lake Ontario fish, found significant performance impairments on a standardized behavioral assessment test. [6]

Exposure of one form of PCB to rats resulted in retarded growth, delayed puberty, decreased sperm counts, and genital malformations. [7] In other studies, exposure of PCBs to rats in utero led to behavioral and psychomotor effects that lasted into adulthood. [8]

**PCBs disrupt hormone function.**

PCBs with only a few chlorine atoms can mimic the body´s natural hormones, especially estrogen. Women who consumed PCB-contaminated fish from Lake Ontario were found to have shortened menstrual cycles. [9] PCBs are also thought to play a role in reduced sperm counts, altered sex organs, premature puberty, and changed sex ratios of children. More highly chlorinated PCBs (with more chlorine atoms) act like dioxins in altering the metabolism of sex steroids in the body, changing the normal levels of estrogens and testosterone. [11] PCBs tend to change in the body and in the environment from more highly chlorinated to lower-chlorinated forms, increasing their estrogenic effects.

**Immune system and thyroid effects.**

In a study of adolescents Mohawk males in New York State, PCBs were shown to upset the balance of thyroid hormones, which may affect growth as well as intellectual and behavioral development. [12]
Like dioxin, PCBs bind to receptors that control immune system function, disturbing the amounts of some immune system elements like lymphocytes and T cells. [13]

In a study of Dutch children, PCB levels were tied to an increased prevalence of ear infections and chickenpox and with lowered immune system function, and thus greater susceptibility to disease. [14]

**Eating fish is the major route of exposure to PCBs.**

The most common route of exposure to PCBs is from eating contaminated fish. The EPA estimates an increased cancer risk as high as 1 in 2500 for people eating certain species of fish from the Hudson River; thousand times higher than the EPA’s goal for protection. [15]

Air near a contaminated site may also be polluted by PCBs. By one estimate, residents of the Hudson Valley may inhale as many PCBs as they would get by eating one contaminated fish per year. [16] Although small amounts of PCBs can enter the body from swimming in highly contaminated water, this is unlikely to be significant except in the most extreme cases.

Municipalities that use the Hudson River as a drinking water source carefully monitor the water for PCBs, and there are no detectable levels in the water supplies. [17] PCBs accumulate in the body and in the ecosystem.

Once PCBs enter a person’s (or animal’s) body, they tend to be absorbed into fat tissue and remain there.

Unlike water-soluble chemicals, they are not excreted, so the body accumulates PCBs over years. This means that PCBs also accumulate via the food chain: a small fish may absorb PCBs in water or by eating plankton, and these PCBs are stored in its body fat. When a larger fish eats the small fish, it also eats and absorbs all the PCBs that have built up in the small fish. In this way, larger fish and animals can build up a highly concentrated store of PCBs. Some types of PCBs may degrade into nontoxic form while they are stored in the body, but this process can take many years.

In the same way, PCBs accumulate in women and pass on to their infants through breast milk. This accumulation means that nursing infants may ingest PCB levels much higher than the levels in fish and other foods consumed by their mothers. [18]

PCBs have been found all over the world, including significant amounts in the Arctic and Antarctic, far from any sources. In fact, several studies have found very high levels of PCBs in the blood and breast milk of Inuit women. [19] It is thought that PCBs spread through the air, after evaporating from contaminated water and sediments, as well as through the water.
For More Information

For more information on PCB health effects, we recommend starting with these two papers:


For details on the EPA’s risk assessment for human health in the Hudson Valley, and for details of the proposed cleanup plan, see


Footnotes
[16] David Carpenter, personal communication.
[17] www.pokwater.org

References


Wildlife Reproductive Effects of PCBs

Fact Sheet of Fox River Watch
www.foxriverwatch.org

Introduction

PCBs cause a variety of serious reproductive problems in several types of wildlife (mammal, bird, fish, reptile, crustacean, insect), which shows that PCBs are affecting reproductive traits shared by the wide range of creatures. Human beings share a similar reproductive biochemistry; therefore, these wildlife health risks should serve as a warning of potential human effects.

Summary of Effects

This is not a complete list of all such research, only a sample. For additional study results, visit the TOXNET databases.

Marine Mammals

- females unable to reproduce
- decreased testosterone
- impaired reproductive function
- impaired immune function
- mass mortality due to infections
- female mice fed Beluga Whale blubber had altered ovulation structures, which affects reproduction
- Beluga Whales have low calf production and/or low survival to adulthood
- Belugas on the St. Lawrence River (downstream from Lake Michigan) had higher levels of PCBs
- The Beluga fetuses had 10% higher concentrations of organochlorines (including PCBs) compared to the mothers
- The source of PCBs is likely global distillation from lower latitudes.
- The failure of the Beluga population to recover may be due to contamination by organochlorine compounds (including PCBs)
• Belugas had morphological lesions on the thyroid and adrenal glands, (which may affect reproduction)

Polar Bears

• Four hermaphroditic polar bears were found in Svalbard, Sweden, in 1996.
• PCB, dioxin and furan levels were similar in polar bear and human breast milk
• polar bear fat tissues contained about 21 ppm PCBs
• human fat tissues contained 0.25 to 5.58 ppm PCBs

Mink

• delayed onset of estrus (breeding condition)
• reduced whelping rate
• litter deaths
• lower weight pups
• immune system changes
• weight differences in kidney, liver, brain, spleen, heart, and thyroid gland
• increased periportal diffuse vacuolar hepatocellular lipidosis
• long term effects

Rabbits

• PCBs accumulated selectively in ovarian, oviductal and uterine tissues
the mix of PCBs in the blood serum were different from those in the follicular fluid surrounding the ovaries
• increased preimplantation embryo mortality

Guinea Pigs

• delayed sexual maturation
• vaginal opening at older age and for shorter duration (breeding maturity)
• lower testis weights
• no testosterone difference
• growth retardation
• induced enzymes
• inhibited progesterone metabolism and changed the hormonal balance
• different tissues respond differently to PCBs

Turtles

• sex reversal
• altered sexual characteristics in male turtles
• PCBs accumulate selectively in the testes
• decrease in populations possible due to reproductive effects
Birds

- depression of sexual characteristics in males
- delayed egg laying and diminished laying capacity
- reduced breaking strength in eggs
- reduced testis weights (3 studies)
- decreased testes seminiferous epithelium
- smaller nuclear volume of Leydig cells
- lower estradiol in females
- inhibited hormone binding in a dose-dependent manner (especially in ducks and rabbits)
- smaller combs and wattles
- weight loss
- no change in adrenals
- reduced testes
- increased embryo mortality (2 studies)
- increased abnormalities

Fish

- sac fry mortality
- death of zebrafish larvae
- reduced number of oocytes in females
- induced liver enzyme activity
- altered sex ratios
- severe gonadal abnormalities
- inconsistent or extremely limited development of eggs (2 studies)
- testicular abnormalities (3 studies)
- altered steroids
- abnormal gills and livers
- PCBs tend to accumulate in the ovaries, testes, liver and kidneys (2 studies)

Sea Stars, Insects and Crustaceans

- reduced reproduction
- egg maturation delayed
- disturbed development of embryos
- reduced survival, increased mortality

The Wildlife Studies

Overall Statement: from Fox GA. Wildlife as sentinels of human health effects in the Great Lakes--St. Lawrence basin. Environ Health Perspect. 2001 Dec;109 Suppl 6:853-
"There is no existing formal, long-term program for gathering evidence of the incidence and severity of the health effects of toxic substances in wildlife. However, research-based studies of bald eagles, herring gulls, night herons, tree swallows, snapping turtles, mink, and beluga over the past 30 years have revealed a broad spectrum of health effects in the Great Lakes-St. Lawrence basin including thyroid and other endocrine disorders, metabolic diseases, altered immune function, reproductive impairment, developmental toxicity, genotoxicity, and cancer. These effects occurred most often and were most severe in the most contaminated sites (Green Bay, Saginaw Bay, Lake Ontario, the St. Lawrence estuary, and more recently, Lake Erie), some of which are International Joint Commission-designated Areas of Concern (AOCs). In all cases, a strong argument can be made for an environmental etiology, and in many cases for the involvement of persistent organic pollutants, particularly polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, and polycyclic aromatic hydrocarbons. For some, the association with particular contaminants is consistent with controlled studies, and in some, dose-response relationships were documented. The biologic significance of these health impairments to the affected species is currently unclear, but they resemble those observed with increased incidence in human subpopulations in one or more AOCs. Formalizing health effects monitoring of sentinel wildlife species by the parties to the Canada-USA Great Lakes Water Quality Agreement is required. This would facilitate the optimal use of sentinel wildlife health data in a larger, epidemiologic weight-of-evidence context upon which to base decisions and policies regarding the effects of chemical exposures on human populations."

**Marine Mammals**

**Study #1: female mice fed Beluga Whale blubber had altered ovulation structures, which affects reproduction. The toxic potential of naturally relevant mixtures of PCBs and other organohalogens on the reproductive system of C57Bl/6 female mice was assessed.**

Mice were fed diets in which lipids were replaced by blubber of beluga whales from a highly contaminated population of the Saint Lawrence River, and a less contaminated population from the Arctic Ocean. Ratios of blubber from both sources were mixed in order to perform a dose-response study. Control mice were fed diets for 90 d in which fat was replaced by corn oil or beef tallow. There were no significant effects of diets on body, liver, spleen or thymus weights. Similarly ovulation occurred in all control and experimental groups. However, Graafian follicles from ovaries of mice fed contaminated diets showed abnormal development of oocytes. Cumulus granulosa cells bind normally to the oocyte prior to ovulation and are essential for sperm penetration and fertilization. These cells were absent in both Graafian follicles and ovulated oocytes in the oviduct of all groups fed contaminated diets. Oviducts of these mice revealed evidence of epithelial degeneration. These results suggest the female mouse reproductive system is sensitive to
organohalogens and illustrate the toxic potential of contaminant mixtures as found in the less contaminated Arctic population. (Ruby et al, 2003)

**Study #2 : Beluga Whales have low calf production and/or low survival to adulthood**

Belugas on the St. Lawrence River (downstream from Lake Michigan) had higher levels of PCBs.

An epidemiologic study was carried out over a period of 9 years on an isolated population of beluga whales (Delphinapterus leucas) residing in the St. Lawrence estuary (Quebec, Canada). More than 100 individual deaths were aged, and/or autopsied and analyzed for toxic compounds, and the population was surveyed for size and structure. Arctic belugas and other species of whales and seals from the St. Lawrence were used for comparison. Population dynamics: Population size appeared to be stable and modeling showed this stable pattern to result from low calf production and/or low survival to adulthood. Toxicology: St. Lawrence belugas had higher or much higher levels of mercury, lead, PCBs, DDT, Mirex, benzo(a)pyrene metabolites, equivalent levels of dioxins, furans, and PAH metabolites, and much lower levels of cadmium than Arctic belugas. In other St. Lawrence cetaceans, levels of PCBs and DDT were inversely related to body size, as resulting from differences in metabolic [incomplete abstract] (Beland et al, 1993)

**Study #3 : The Beluga fetuses had 10% higher concentrations of organochlorines (including PCBs) compared to the mothers. The source of PCBs is likely global distillation from lower latitudes.**

Beluga whales bioaccumulate organochlorines from their environment. Blubber samples of Beluga Whales from Alaska's north coast contain organochlorines, including Toxaphene (polychlorinated camphenes) PCBs, DDTs and chlordane. Toxaphene was the organochlorine pesticide found in the highest concentration in all samples with the exception of the 6 year old male where PCBs were highest. The source of these organochlorines is likely global distillation from lower latitudes. Males had higher concentrations than females and the oldest male had higher concentration than the younger male. Females exhibit a decrease in concentrations with age. The fetus had about 10% higher concentrations for all organochlorines compared to the mother. Transplacental transfer of organochlorines and lactation lower the contaminant concentration in females. Older females have lower contaminate concentrations likely due to continual reproductive success. Consumption of older males will expose humans to higher levels of organochlorines. (Wade et al, 1997)

**Study #4 : The failure of the Beluga population to recover may be due to contamination by organochlorine compounds (including PCBs). Belugas had morphological lesions on the thyroid and adrenal glands, (which may affect reproduction).**

A small isolated population of beluga whales (Delphinapterus leucas) that are highly contaminated by pollutants, mostly of industrial origin, resides in the St. Lawrence
estuary, Quebec, Canada. Overhunting in the first half of the century was the probable cause for this population to dwindle from several thousand animals to the current estimate of 500. The failure of the population to recover might be due to contamination by organochlorine compounds, which are known to lead to reproductive failure and immunosuppression in domestic and laboratory animals and seals. Functional and morphological changes have been demonstrated in thyroid gland and adrenal cortex in many species exposed to organochlorinated compounds, including seals. Morphological lesions, although different, were also found in belugas. Functional evaluation of thyroid and adrenal glands of contaminated (St. Lawrence) versus much less contaminated (Arctic) belugas is currently under way. Necropsy of St. Lawrence belugas showed numerous severe and disseminated infections with rather mildly pathogenic bacteria, which suggests immunosuppression. Organochlorine compounds and other contaminants found in beluga whales cause immunosuppression in a variety of animal species including seals. Thirty-seven percent of all the tumors reported in cetaceans were observed in St. Lawrence beluga whales. This could be explained by two different mechanisms: high exposure to environmental carcinogens and suppression of immunosurveillance against tumors. Overall, St. Lawrence belugas might well represent the risk associated with long-term exposure to pollutants present in their environment and might be a good model to predict health problems that could emerge in highly exposed human populations over time. (DeGuise et al, 1995)

**Study #5: females unable to reproduce.**

The environmental poisons DDT and PCB (polychlorinated biphenyls) upset the balance in sex hormones. DDT or PCB may have caused the considerable reduction in sexual reproduction capacity which has been observed in ringed seal (Phoca hispida) in the Bay of Bothnia during the last 10 yr. Earlier studies showed that seals in the Baltic Sea (of which the Bay of Bothnia is the northernmost part) carry very high burdens of DDT and PCB. In this study, pregnant seals had much lower content of these compounds than non-pregnant animals did. Females carrying over 70 mg PCB/kg of extractable fat are apparently unable to reproduce. Only 19% of the gray seals (Halichoerus grypus) in the Baltic proper have less than 70 mg PCB compared with 25% in the Bay of Bothnia. For ringed seal the values range from 39% up to 54% in the northernmost part of the Bay of Bothnia. Because the seal populations have been greatly reduced it is urgent to protect seals as much as possible. (Helle et al, 1976)

**Study #6: decreased testosterone**

The increasing residue levels of PCBs and DDE in the blubber of dalli-type Dall's porpoises were found to have a negative effect on the testosterone levels in blood. Decrease in the levels of testosterone was statistically significant with increase in DDE concentrations. The results obtained suggest that the present levels of environmental contamination by persistent organochlorines can cause an imbalance of sex hormones and subsequent reproductive abnormalities in wild. The other hormone measured, aldosterone, which has no sexual function, was independent of the effects of both PCBs and DDE. (Subramanian et al, 1987)
Study #7: impaired reproduction function, impaired immune function, mass mortality due to infections

Many wildlife species may be exposed to biologically active concentrations of endocrine-disrupting chemicals. There is strong evidence obtained from laboratory studies showing the potential of several environmental chemicals to cause endocrine disruption at environmentally realistic exposure levels. In wildlife populations, associations have been reported between reproductive and developmental effects and endocrine-disrupting chemicals. In the aquatic environment, effects have been observed in mammals, birds, reptiles, fish, and mollusks from Europe, North America, and other areas. The observed abnormalities vary from subtle changes to permanent alterations, including disturbed sex differentiation with feminized or masculinized sex organs, changed sexual behavior, and altered immune function. For most reported effects in wildlife, however, the evidence for a causal link with endocrine disruption is weak or nonexisting. Crucial in establishing causal evidence for chemical-induced wildlife effects appeared semifield or laboratory studies using the wildlife species of concern. Impaired reproduction and development causally linked to endocrine-disrupting chemicals are well documented in a number of species and have resulted in local or regional population changes. These include:

- Masculinization (imposex) in female marine snails by tributyltin, a biocide used in antifouling paints, is probably the clearest case of endocrine disruption caused by an environmental chemical. The dogwhelk is particularly sensitive, and imposex has resulted in decline or extinction of local populations worldwide, including coastal areas all over Europe and the open North Sea. DDE-induced egg-shell thinning in birds has caused severe population declines in a number of raptor species in Europe and North America. Endocrine-disrupting chemicals have adversely affected a variety of fish species. In the vicinity of certain sources (e.g., effluents of water treatment plants) and in the most contaminated areas is this exposure causally linked with the effects on reproductive organs that could have implications for fish populations. However, there is also a more widespread occurrence of endocrine disruption in fish in the U.K., where estrogenic effects have been demonstrated in freshwater systems, in estuaries, and in coastal areas. In mammals, the best evidence comes from the-field studies on Baltic gray and ringed seals, and from the Dutch semifield studies on harbor seals, where both reproduction and immune functions have been impaired by PCBs in the food chain. Reproduction effects resulted in population declines, whereas impaired immune function has likely contributed to the mass mortalities due to morbillivirus infections. Distorted sex organ development and function in alligators has been related to a major pesticide spill into a lake in Florida, U.S.A. The observed estrogenic/antiandrogenic effects in this reptile have been causally linked in experimental studies with alligator eggs to the DDT complex. Although most observed effects currently reported concern heavily polluted areas, endocrine disruption is a potential global problem. This is exemplified by the widespread occurrence of imposex in marine snails and the recent findings of high levels of persistent potential endocrine-disrupting chemicals in several marine mammalian species inhabiting oceanic waters. (Vos et al, 2000)
**Polar Bears**

**Study #1**: Four hermaphroditic polar bears were found in Svalbard, Sweden, in 1996.

During research on polar bears (Ursus maritimus) at Svalbard in April 1996, we captured two yearlings with a normal vaginal opening and a 20 mm penis containing a baculum. The penis was located caudal to the location in a normal male and was concealed within the vaginal opening by a single pair of labia. The urethral opening was situated laterally about 5 mm from the distal end of the penis. Neither of the yearlings showed signs of a Y chromosome, so both bears were regarded as female pseudohermaphrodites. On separate occasions in two bears, we recorded aberrant genitalia morphology with a high degree of chlortal hypertrophy in Svalbard, which we also classified as female pseudohermaphroditism. The observed rate of female pseudohermaphroditism in this area was 1.5% (4/269). Pseudohermaphroditism in this polar bear population could result from excessive androgen excretion by the mother caused by a tumor, or it could be a result of endocrine disruption from environmental (incomplete abstract) (Wiig et al, 1998)

**Study #2**: PCB, dioxin and furan levels were similar in polar bear and human breast milk

Polychlorinated dibenzo-p-dioxins (PCDD), dibenzofurans (PCDF) and non-ortho substituted biphenyls (PCB, CB) were determined in 6 polar bear milk samples from Svalbard (Norway). For these compounds, no data for polar bears have been reported before from this region. Most of the PCDD congeners were found at detectable levels. Concentrations expressed as 2,3,7,8-TCDD equivalents (Nordic model) were in the order of 1-3 pg/g-1 fat (0.2-1.6 pg ml-1 milk) is comparable with ringed and harp seal blubber from the same region. On whole milk basis, concentrations were similar to those found in human milk. An estimation of the daily uptake via milk showed that the intake is lower for polar bears compared to humans. As in human milk, relatively high levels of OCDD were found in some polar bear milk samples. The PCDD/PCDF congener pattern in the milk was different to that found in polar bear fat from the Canadian Arctic. Non-ortho substituted PCB levels in polar bear milk were simil (incomplete abstract) (Oehme et al, 1995)

**Study #3**: polar bear fat tissues contained about 21 ppm PCBs, human fat tissues contained 0.25 to 5.58 ppm PCBs

Adipose tissues from two common porpoises (Phocaena phocaena), five bearded seals (Erignathus barbatus), five ringed seals (Phoca hispida), five hooded seals (Cystophora cristata), two arctic foxes (Alopex lagopus), one polar bear (Ursus maritimus), and one sheep (Ovis aries) shot on the west coast of Greenland were analyzed by electron capture gas chromatography for polychlorinated hydrocarbons. Studies were also made on adipose tissue from king eider (Somateria spectabilis), common eider (Somateria mollissima), harlequin duck (Histrionicus histrionicus), long tailed duck (Glangula hyemalis), purple sandpiper (Calidris maritima), Brunnich's guillemot (Uria lomvia),
cormorant (Phalocrocorax carbo), ptarmigan (Lagopus mutus), and raven (Corvus corax), as well as adipose tissue from six female Greenlanders. Among the birds, raw p,p'-DDE concentrations ranged from 0.8 ppm (eider duck) to 13.9 ppm (raven), while PCB concentrations ranged from 2.0 ppm (eider duck) to 37.1 ppm (raven); the p,p'-DDE and PCB concentrations were significantly correlated. p,p'-DDT and p,p'-DDD were not traced, and lindane was found in trace amounts in 1/3 of the birds. Among the mammals, lindane concentrations ranged from 0.003 ppm (hooded seal) to 0.053 ppm (bearded seal), heptachlor was found in concentrations of 0.001 ppm (ringed seal) to 0.039 ppm (bearded seal), aldrin ranged from 0.028 ppm (hooded seal) to 3.06 ppm (polar bear), heptachloroepoxide was found in concentrations of 0.026 ppm (ringed seal) to 0.49 ppm (polar bear), raw p,p'-DDE ranged from 0.14 ppm (arctic fox) to 1.25 ppm (polar bear), and PCB ranged from 0.9 ppm (ringed seal) to 21.0 ppm (polar bear). In the human samples, PCB ranged from 0.25-5.58 ppm, p,p'-DDE ranged from 0.04-0.52 ppm, and the other compounds were found only in trace amounts. (Clausen et al, 1976)

Mink Studies

Study #1: delayed onset of estrus (breeding condition), reduced whelping rate, litter deaths, lower weight pups, immune system changes, weight differences in kidney, liver, brain, spleen, heart, and thyroid gland, increased periportal diffuse vacuolar hepatocellular lipidosis, long term effects

This study was conducted to determine the multigenerational effects of consumption of PCB-contaminated carp (Cyprinus carpio) from Saginaw Bay (Lake Huron) on mink (Mustela vison) reproduction and health and to examine selected biomarkers as potential indicators of polyhalogenated hydrocarbon toxicity in mink. The mink were fed diets formulated to provide 0 (control), 0.25, 0.5, or 1.0 ppm polychlorinated biphenyls (PCBs) through substitution of Saginaw Bay carp for ocean fish in the diets. To determine whether the effects of PCB exposure were permanent, half of the parental (P1) animals were switched from their respective treatment diets to the control diet after whelping the first of two F1 generations. Effects of in utero and lactational exposure to PCBs on subsequent reproductive performance of the F1 animals were examined by switching half of the first-year F1 offspring (kits) to the control diet at weaning, while the other half was continued on their parental diet (continuous exposure). Continuous exposure to 0.25 ppm, or more, of PCBs delayed the onset of estrus (as determined by vulvar swelling and time of mating) and lessened the whelping rate. Litters whelped by females continually exposed to 0.5 ppm, or more, of PCBs had greater mortality and lesser body weights than controls. Continuous exposure to 1.0 ppm PCBs had a variable effect on serum T4 and T3 concentrations. Compared to the controls, there were significant differences in kidney, liver, brain, spleen, heart, and thyroid gland weights of the mink continually exposed to 1.0 ppm PCBs. There was an increase in the incidence of periportal and diffuse vacuolar hepatocellular lipidosis in the P1 mink with continuous exposure to increasing concentrations of PCBs. Plasma and liver PCB concentrations of the adult and kit mink were, in general, directly related to the dietary concentration of PCBs and the duration and time of exposure. Short-term parental exposure to PCBs had detrimental effects on survival of subsequent generations of mink conceived months after the parents were
placed on "clean" feed. The lowest observed adverse effect level (LOAEL) for dietary PCBs in this study was 0.25 ppm. (Restum et al, 1998)

Rabbit Studies

Study #1: PCBs accumulated selectively in ovarian, oviductal and uterine tissues; the mix of PCBs in the blood serum were different from those in the follicular fluid surrounding the ovaries

The female rabbit was used to study (i) accumulation of lipophilic chlorinated hydrocarbons in genital tract tissues and (ii) subsequent morphological and functional effects after long-term low-dose exposure. Polychlorinated biphenyl (PCB), 1,1-di(p-chlorophenyl)-2,2,2-trichloroethane (DDT) and gamma-hexachlorocyclohexane (gamma-HCH) (dosages: 4, 3 and 0.8 mg per kg body weight, respectively) and a combination of these three components (and dosages) were administered to sexually mature rabbits over a period of 12-15 weeks. The animals were killed shortly before and at various times after ovulation. Accumulation of chlorinated hydrocarbons was high in ovarian, oviductal and uterine tissues, in follicular fluid and clearly detectable in uterine secretions. In follicular fluid, the concentration and patterns of congeners and isomers of PCB and DDT were distinctly different from serum. DDT- and gamma-HCH-treated animals showed a significantly reduced ovulation rate (P < 0.002 and 0.05, respectively). (Lindenau et al, 1994)

Study #2: increased preimplantation embryo mortality, study used PCB commercial mixture Aroclor 1260

Oral application of a commercial PCB mixture (Aroclor 1260) to female rabbits (4 mg/kg BW for 14 weeks) resulted in a significant accumulation of PCB in 6 day old blastocysts and in an increased preimplantation embryo mortality (Seiler, Fischer, Lindenau, Beier, 1993). In present study the direct embryotoxicity of PCB was investigated employing embryo in vitro culture. Three day old rabbit morulae were cultured in BSM II supplemented with 1.5% BSA under 5% O2. They were exposed to 100, 10 or 1 ug Aroclor 1260/mL medium for 24 h. The organochlorines had been dissolved in 1% DMSO before addition to the medium. Controls were cultured in PCB-free DMSO-containing medium. For retrospective analysis of the actual exposure, the PCB concentration of the culture media was determined after culture. 100 ug PCB led to a complete degeneration of the exposed embryos (n = 47 embryos, 3 replicates). Following exposure to 10 ug (n = 53, 3 replicates) only a few morulae developed into blastocysts. The others were either arrested in the morulae stage or were degenerated. Cell proliferation (measured by incorporation of tritiated thymidine) of the non-degenerated embryos was approximately 20% of that of corresponding control embryos. Compared with non-exposed controls, addition of 1 ug PCB/mL (n = 32, 2 replicates) showed either no or only a slight impairment of development. (Lindenau et al, 1993)

Guinea Pig Studies
Study #1: delayed sexual maturation, vaginal opening at older age and for shorter duration, lower testis weights, no testosterone difference, growth retardation, study used Clophen A50 commercial mix of PCBs

Female and male guinea pigs exposed to polychlorinated biphenyls (PCBs) in utero and via mother's milk showed growth retardation and signs of delayed onset of sexual maturation. In female young exposed to PCBs first vaginal opening occurred at a significantly older age and was of shorter duration compared with control females. The age at the first ovulation did not differ significantly between PCB-exposed females and control females. Male young exposed to PCBs had significantly lower absolute and relative testis weights at 3 months of age compared with control males. No differences in plasma testosterone concentrations were observed. (Lundkvist, 1990)

Study #2: induced enzymes, inhibited progesterone metabolism and changed the hormonal balance, different tissues respond differently to PCBs, study used PCB commercial mixture Aroclor 1254

The effects of Aroclor-1254 on the metabolism of progesterone by cytochrome-P-450 in adrenal and testes microsomes were studied. Male guinea-pigs were given four intraperitoneal injections of 80mg/kg Aroclor-1254, and microsomal fractions of liver, adrenal, and testes were prepared after 48 hours. For in-vitro studies, microsomes were treated with 2.7, 6.6 or 13.3 micromoles Aroclor-1254 for 10 and 20 minutes. Hepatic microsomal cytochrome-P-450 increased two times after Aroclor-1254 treatment, while a 30% decrease in adrenal microsomal cytochrome-P-450 content was noted. An overall inhibitory effect of Aroclor-1254 on progesterone metabolism in adrenal microsomes was observed in-vivo, specifically a three fold decrease in the production of 11-deoxycortisol and 11-deoxycorticosterone. Consistent results were demonstrated with the in-vitro studies. No effects of Aroclor-1254 treatment on the metabolism of progesterone in testes microsomes were observed in-vivo or in-vitro. The authors conclude that different steroidogenic tissues respond differently to Aroclor-1254. (Goldman et al, 1990)

Turtle Studies

Study #1: sex reversal

Polychlorinated biphenyls (PCBs) are widespread, low-level environmental pollutants associated with adverse health effects such as immune suppression and teratogenicity. There is increasing evidence that some PCB compounds are capable of disrupting reproductive and endocrine function in fish, birds, and mammals, including humans, particularly during development. Research on the mechanism through which these compounds act to alter reproductive function indicates estrogenic activity, whereby the compounds may be altering sexual differentiation. Here we demonstrate the estrogenic effect of some PCBs by reversing gonadal sex in a reptile species that exhibits temperature-dependent sex determination. [The researchers showed that turtle embryos can be sexually reversed (male to female) by estrogenic PCBs.] (Bergeron et al, 1994)
Study #2: altered sexual characteristics in male turtles

Recent research has suggested that contaminants in the environment may influence sex differentiation and reproductive endocrine function in wildlife. Concentrations of organochlorine contaminants (total polychlorinated biphenyls, pesticides) were higher in the blood plasma of snapping turtles from contaminated sites than in those from reference sites. The ratio of the precloacal length to the posterior lobe of the plastron (PPR) is sexually dimorphic in snapping turtles. There were significant reductions in the PPR at three contaminated sites versus two reference sites. The magnitude of the response was such that a significantly higher proportion of PPRs of males from a contaminated site (Cootes Paradise) overlapped with those of females than PPRs of males from a reference site (Lake Sasajewun). Observers can incorrectly identify the sex of turtles at the contaminated site based on secondary sexual characteristics alone. Unlike the changes to the morphology, there were few changes in 17 beta-estradio (abstract incomplete) (de Solla et al, 1998)

Study #3: PCBs accumulate selectively in the testes, decrease in populations possible due to reproductive effects, study used PCB 105

Despite the fact that PCB congeners exhibit very different biochemical activities, it has been necessary, due to former difficulties in separation and quantitation, to assess toxic hazard to tissues in terms of the concentration of the PCB mixture present. This approach is justifiable provided that a dynamic equilibrium is established among all tissues for each congener. Recent biochemical studies, involving individual congeners indicate that this may not always be the case. Toxic PCB congeners, isostereomers of TCDD, are electron acceptors capable of binding to cytoplasmic protein (Ah receptor) and other cellular macromolecules associated with a particular tissue. Specific Congener analysis of snapping turtle tissues has indicated the possible selective disposition of 2,3,3',4,4'-pentachlorobiphenyl in the testes, a situation which may lead to a surreptitious decrease in the population of that species, considering the longevity and wide distribution of these reptiles. (Olafsson et al, 1987)

Bird Studies

Study #1: decreased testes weight, depression of sexual characteristics in males, several other health effects

A study was carried out to determine the effects of DDT, endrin, and various polychlorinated biphenyls on cardiovascular physiology and hematology as well as some toxicological symptoms of the domestic fowl at both lethal and sublethal levels. A significant increase in hematocrit values and hemoglobin concentration were observed in female adult Single Comb White Leghorn chickens when DDT (2000 ppm) was incorporated into the diet. In contrast, endrin (16-20 ppm) caused a significant increase in these two parameters. Total erythrocyte concentration showed the same trend as HCT values and hemoglobin concentration. In acute dosage experiments endrin infusion (8
mg/kg body weight) produced marked bradycardia and hypertension. These cardiovascular changes were accompanied by convulsions and salivation, indicating stimulation of parasympathetic and sympathetic nervous systems. No significant differences in packed cell volume, total erythrocyte concentration, and hemoglobin concentration were observed before or after endrin infusion in SCWL females.

Toxicologic symptoms observed in cockerels after chronic oral administration (50-200 ppm) of various PCBs included depressed body weight and feed intake; general edema and hydropericardium; increased liver weight and decreased heart, spleen, and testes weight; depression of sexual characteristics; and some mortality. (Iturri, 1974)

**Study #2 : delayed egg laying and diminished laying capacity, reduced breaking strength in eggs, reduced testis weights, decreased testes seminiferous epithelium, smaller nuclear volume of Leydig cells, increased liver weight, lower estrodiol in females, study used PCB commercial mixture Clophen A 60**

Male and female Japanese quail were fed PCB (polychlorinated biphenyl) (Clophen A 60) in concentrations of 0, 50, 100 and 150 ppm for 3 wk during the maturation period (2nd to 4th wk of life). The effects of PCB on gondal histology, sex hormone concentrations in plasma and gonads and plasma Ca levels were investigated. PCB effects on subsequent reproductive processes were measured by evaluating laying capacity, egg, eggshell and semen analysis. In females, no PCB effects were detected on ovary and oviduct weight, nuclear volume and lipid content of the thecal gland cells and on plasma 17beta-estradiol and Ca content. Liver weights were increased in all PCB-treated groups. PCB caused delayed laying and a diminished laying capacity. Egg and shell weights were not affected by PCB treatment or were higher in PCB groups. The breaking strength of the eggs was reduced after PCB ingestion. In males, PCB treatment resulted in a trend towards reduced testis weights, a significantly decreased amount of the testes' seminiferous epithelium and a smaller nuclear volume of the Leydig cells. The lipid content of the latter was not affected and plasma Ca levels were unchanged. Liver weights in all treatment groups were increased. Plasma concentrations of testosterone (T) and 5 alpha-dihydrotestosterone (DHT) or DHT content in the testes were not affected by PCB. T levels in testes were significantly higher after 50 ppm treatment. PCB showed no effect on the percentage of dead spermatozoa in the ejaculates. In another experiment, which consisted of feeding 0 and 150 ppm Clophen, beginning in the 1st wk of life, plasma sex hormone concentrations were measured during the whole experiment from day 24-42 of life. In females, progestosterone levels were not greatly affected by PCB but 17 beta-estradiol appeared to be lower before sexual maturity and was more unstable in the PCB group when egg laying occurred. In males, T concentrations or DHT plasma levels were not significantly altered. (BIESSMANN, 1982)

**Study #3 : inhibited hormone binding in a dose-dependent manner (especially in ducks and rabbits), study used Aroclor 1242**

The effects of DDE isomers, Aroclor-1242, and chlordane on progesterone/cytoplasmic binding in the eggshell gland mucosa of birds and the uterine mucosa of rabbits were studied in-vitro. Eggshell gland mucosa cytosol obtained from Indian-Runner-ducks,
Swedish-Rouen-ducks, and White-Leghorn-hens and the uterine mucosa of rabbits were incubated with 0 to 110x10(-6) molar (M) p,p'-DDE, o,o'-DDE, aroclor-1242, or chlordane. The effects on binding of tritium labeled progesterone to the cytoplasmic receptor were assessed. In untreated cytosol the extent of progesterone receptor binding was significantly higher in hens and rabbits than in the ducks. The DDE isomers, Aroclor-1242, and chlordane inhibited progesterone cytosolic receptor binding in a dose dependent manner. The largest inhibitory effects occurred in ducks and rabbits. o,o'-DDE was more potent than p,p'-DDE in the hens and ducks. In rabbits, the inhibitory effects of o,o'-DDE and p,p'-DDE were similar except at the 110x10(-6)M dose, where o,o'-DDE had a greater effect. Aroclor-1242 and chlordane inhibited progesterone cytosolic receptor binding to a greater extent in ducks. Shell gland mucosa cytosol from hens was incubated with 1x10(-6) to 5x10(-5)M p,p'-DDE, o,o'-DDE, and the calmodulin inhibitors calmidazolium and trifluoperazine. The effects on progesterone cytoplasmic receptor binding were evaluated. Calmidazolium and trifluoperazine inhibited progesterone cytosolic receptor binding to about the same extent as p,p'-DDE, but to a lesser extent than o,o'-DDE. (Lundholm, 1988)

Study #4: smaller combs and wattles, high mortality, weight loss, increased liver weight no change in adrenals, reduced testes, study used PCB commercial mixture Aroclor 1254

The results of some metabolic studies of PCBs (specifically Aroclor 1254) in White Leghorn cockerels are presented in a letter to the editor. Cockerels given 500 ppm PCBs from 1 day of age in a commercial ration had noticeably smaller combs and wattles. Mortality was high, the birds dying between the third and tenth weeks of feeding. At 250 ppm, mortality appeared only by the 13th week of the trial. Six groups of six birds each were then tested to ascertain the PCB effects on body weight, liver, comb, testes and the adrenals. They were fed at 250 ppm for 6, 9 and 13 weeks. Body weight did not show any appreciable change until the ninth week when it was 3/4 of that of the controls; by week 13, the PCB-fed cockerels weighed less than 2/3 as much as did the controls. Liver weights were slightly higher throughout the experiment than in the controls; in terms of the percentage of total body weight, an appreciable increase was noted towards the 13th week. There was no change in the adrenals. The combs showed the striking change already mentioned. Testicular weights were similar between controls and the test birds at 6 weeks. During the next 3 weeks to the 13th week, a significant difference developed, the testes of the PCB-treated birds weighing only [missing percentage] the amount of those of the controls. The slowing of the comb growth appeared before the similar effect in the testes. Data for the results are tabulated. The present observation makes evident the need for further studies of the effects of PCBs on the hormonal system of birds. (Platonow, 1971)

Study #5: increased embryo mortality, increased abnormalities, lower body weights, bursa weights, and liver weights, increased spleen and heart weights, study used PCBs 77, 105 and 126.
Great Lakes waterbird populations have experienced less-than-expected hatchability of eggs and a greater-than-expected incidence of developmental abnormalities. Such deleterious effects have been attributed to polyhalogenated hydrocarbons such as polychlorinated biphenyls (PCBs). PCBs are of primary concern since they are present in significant quantities in the environment. Specific PCB congeners, 3,3',4,4',5-pentachlorobiphenyl (PCB 126), 3,3',4,4'-tetrachlorobiphenyl (PCB 77), and 2,3,3',4,4'-pentachlorobiphenyl (PCB 105), were injected (singly or in combination) into the yolks of White Leghorn chicken (Gallus domesticus) eggs prior to incubation. Teratogenicity was assessed in dead embryos and in hatchlings. Hatchlings were raised for 3 wk to assess body weight gain and mortality. At the end of the 3-wk period, chicks were subjected to necropsy and the brain, bursa, heart, liver, spleen, and testes were removed and weighed. All 3 congeners caused increased embryo mortality, with approximately 50% mortality occurring at 0.6, 8.8, and 5592 micrograms/kg egg for congeners 126, 77, and 105, respectively. All three congeners also produced significantly more abnormalities than the vehicle. Chicks from PCB-injected eggs had lower body weights at wk 2 and 3 of age. Congener 126 caused lower relative bursa weights, congener 77 caused greater relative spleen weights and lower relative liver weights, and all three congeners caused relative heart weights to be greater when compared to control. (Powell et al, 1996)

Fish Studies

Study #1: sac fry mortality

Early life stages of fish are more sensitive than adults to the lethal effects of polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and biphenyls (PCBs). Part per trillion concentrations of structurally related PCDD, PCDF, and PCB congeners in lake trout (Salvelinus namaycush) and rainbow trout (Oncorhynchus mykiss) eggs manifest toxicity by sac fry mortality associated with yolk sac edema and hemorrhages. In addition, selected PCDD and PCB congeners are more and less potent, respectively, in producing fish early life stage mortality than would be predicted based on their toxic potency in mammals, underscoring the need to determine fish-specific toxic potencies for individual PCDD, PCDF, and PCB congeners known to occur in fish in the environment. Although environmental levels of PCDDs, PCDFs, and PCBs do not produce overt lethality in adult fish, their combined presence in feral fish eggs may pose an increased risk to early life stage survival and, ultimately, to feral fish populations. (Walker et al, 1992)

Study #2: death of zebrafish larvae, reduced egg production, reduced number of oocytes in females, induced liver enzyme activity

Zebrafish (Danio rerio) were orally exposed to a mixture of 20 PCBs in three different dose levels (0.008, 0.08, and 0.4 microg of each congener per gram of freeze-dried chironomids). Generally, the PCBs accumulated in a dose-related manner. After 13 weeks of exposure body, liver, and ovary weights, as well as the liver and ovary somatic index, were significantly lower in exposed groups. In addition, the PCB mixture was an
effective inducer of hepatic EROD activity. The reproduction study performed with exposed females and unexposed males after 9 weeks revealed that median survival time for larvae was only 7.7 days in the high-dose group as compared with 14 days in controls. Furthermore, egg production was reduced in all three groups exposed. No differences in hatching frequency or median hatching time were recorded. Histologically, females in both the intermediate and high-dose groups contained a reduced number of mature oocytes. The present study demonstrates that the potency of the mixture of selected PCBs induces hepatic EROD activity and has a clearly negative effect on zebrafish reproduction. (Orn et al, 1998)

Study #3: altered sex ratios, severe gonadal abnormalities, inconsistent or extremely limited development of eggs, study used PCB commercial mixture Aroclor 1260

Aqueous exposure of newly hatched rainbow trout (Oncorhynchus mykiss) larvae to Aroclor 1260 resulted in altered sex ratios and severe gonadal abnormalities in juvenile females. The proportion of females decreased from 41.9% in combined controls to 31.6 to 36.1% in groups that accumulated 2.5 µg/g Aroclor 1260 after 3-h immersions, although this decrease was not statistically significant (p = 0.057). A total of 18.2% of the females in the treatment group that accumulated 2.1 µg/g Aroclor 1260 had abnormal gonads as compared to 2.7% in combined controls (p = 0.001). Abnormalities were characterized by inconsistent or extremely limited development of oocytes. Although further work is required to validate these results, this study suggests that environmentally realistic tissue concentrations of Aroclor 1260 may disrupt sexual development in female trout. (Matta et al, 1998)

Study #4: testicular abnormalities, testes selectively accumulate PCBs, study used PCB commercial mixture Aroclor 1254

Cod were fed herring containing Aroclor 1254, a polychlorinated biphenyl (PCB), at diet levels of 0, 1, 5, 10, 25, and 50 microgram/g for a period of 5 1/2 months. Histological examinations of the gonads of surviving male fish revealed various testicular abnormalities in 9 of 17 PCB-fed fish but in none of four experimental control and four stock control fish. The abnormalities were observed in testes that were either at functional maturity or in a stage of rapid spermatogenic proliferation but not in testes that were sexually immature or regressed. The testicular abnormalities included disorganization of lobules and spermatogenic elements, inhibition of spermatogenesis, fibrosis of lobule walls, fatty necrosis, and, in one case, total disintegration of the elements in many lobules. There was a significant uptake of PCB by testicular and liver tissues of fish that were fed the higher levels (greater than 1 microgram/g) of Aroclor 1254. (Sangalang et al, 1981)

Study #5: altered steroids, abnormal testes, abnormal gills and livers, study used PCB commercial mixture Aroclor 1254
The effects of diet levels of 1, 5, 10, 25 and 50 micrograms Aroclor 1254/g on the Atlantic cod Gadus morhua were determined after a feeding period of 5 1/2 months. Altered steroid biosynthetic patterns in vitro were observed in the testes and head kidneys (adrenal homologue) of the fish that were fed various levels of PCB in vivo. Histological examination of tissues revealed abnormalities in the testes, gills, and livers of the PCB-fed fish. Various testicular abnormalities including slight-to-marked derangement of lobules, hyperplasia of lobule walls and disintegration and/or fatty necrosis of spermatogenic elements were observed in the testes of PCB-fed fish. Hyperplasia of the epithelial layer of the secondary lamellae was observed in the gills of fish on the 5 to 50 micrograms Aroclor 1254/g diet. Fatty degeneration was observed in the livers of all PCB-fed fish. The PCB content of testes, livers and head kidneys were directly proportional to the level of Aroclor 1254 in the diet. It is apparent (incomplete abstract) (Freeman et al, 1982)

**Study #6 : PCBs tend to accumulate in the ovaries, testes, liver and kidneys**

The contamination of Baltic herring and pike from six different areas of the Turku archipelago (the southwestern coast of Finland) with DDT, DDE, TDE, and PCB was studied. Herring muscle contained an average of 0. 38 ppm total DDT and 0. 31 ppm PCB on a fresh tissue basis; however, the values obtained for individual fish specimens showed large variations, depending primarily on differences in the fat content of the individual. The range of DDT and PCB concentrations in the herring from the Turku archipelago was similar to that found in herring from the Gulf of Bothnia. Pike muscle contained an average of 0. 04 ppm total DDT and 0. 05 ppm PCBs on a fresh weight basis. There were local differences in the residue concentrations of the samples. The chlorinated hydrocarbons tended to accumulate in the liver and ovaries of the pike and to a lesser degree in the testes and kidneys. Total DDT and PCB concentrations in the ovaries reached 100 ppm and 190 ppm, respectively. (Linko et al, 1974)

*Sea Stars, Insects and Crustaceans*

**Study #1 : reduced reproduction, mortality, study used PCB commercial mixtures Aroclor 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268**

Continuous-flow and static bioassays were conducted at 28 degrees C, with survival and reproduction as measures of relative toxicity of 8 polychlorinated biphenyls (PCBs), Aroclor 1221 (A-1221), A-1232, A-1242, A-1248, A-1254, A-1260, A-1262 and A-1268. Three PCB-mixture bioassays were also conducted. Aroclor 1248 was the most toxic to Daphnia magna of the 8 Aroclors tested in static tests; the 3-wk LC50 was 25 mu g/1. Aroclor 1254 was the most toxic PCB to Daphnia under continuous-flow conditions with a 3-wk LC50 of 1.3 mu g/1. Ninety-six-h LC50 values for A-1242, and A-1246 on Gammarus pseudolimnaeus in continuous-flow tests were 73 and 20 mu g/1. Survival after 60 days was 52% at 8.7 mu/1 1242 and 53% at 5.1 mu g/1 A-1248. Reproduction and survival of young were good at 2.8 mu g/1 A-1242 and 2.2 mu g/1 A-1248. The midge Tanytarsus dissimilis, in continuous-flow tests, did not emerge in abundance.
above 5.1 µg/l A-1248 or 3.5 µg/l A-1254. The 3-wk LC50 for Aroclor 1254 was 0.65 µg/l for larvae and 0.45 µg/l for pupae. Tissue residues in Gammarus pseudolimnaeus ranged from 4.9 µg/g A-1254 in control animals to 552 µg/g A-1248 in scuds held for 60 days in water containing 5.1 µg/l A-1248. (NEBEKER et al, 1974)

Study #2: egg maturation delayed, disturbed development of embryos, reduced survival study used PCB commercial mixture Clophen A50

In semifield experiments sea stars, Asterias rubens, were exposed to 25 micrograms Cd/liter or fed with mussels containing 0.6 microgram/g wet wt PCBs (Clophen A50). After 5 months of exposure, Cd concentrations in testes and ovaries were respectively 17 and 50 times higher than those in unexposed sea stars. PCB concentrations were respectively 7 and 9 times higher. With spermatozoa obtained from Cd- or PCB-exposed sea stars, normal fertilization could be achieved. However, maturation of oocytes from Cd-exposed animals was delayed and early development of embryos from Cd- or PCB-exposed animals was disturbed. Due to aberrations during the early development only 24 and 30% of the embryos obtained from Cd- or PCB-exposed sea stars, respectively, had developed to normal bipinnaria larvae after 1 week. (den Besten et al, 1989)

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