JOBS and DOLLARS OVERBOARD

The Economic Case Against Dumping U.S. Naval Vessels at Sea

BASEL ACTION NETWORK

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BAN is a 501(c)3 charitable organization of the U.S.

The Basel Action Network (BAN) is the world's only organization focused on confronting the global environmental injustice and economic inefficiency of toxic trade (toxic wastes, products and technologies) and its devastating impacts. Working at the nexus of human rights and environment, we confront the issues of environmental justice at a macro level, preventing disproportionate and unsustainable dumping of the world's toxic waste and pollution on our global village's poorest residents. At the same time we actively promote the sustainable and just solutions to our consumption and waste crises – banning waste trade, while promoting green, toxic free and democratic design of consumer products. Learn more by visiting www.ban.org or view BAN's 2009 Annual Report.

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INTRODUCTION

The National Defense Authorization Act of 2001 requires that government vessel disposals be conducted *"…in the manner that provides the best value to the Government,"* while also *"giving consideration to worker safety and the environment."* However, as discussed in this report, the Federal government has a poor record in bringing best value to the Government with respect to ship disposal.

Based on faulty analysis and traditional assumptions, the U.S. Federal government has deliberately dumped 560,000 tons of recyclable steel, aluminum and copper at sea over the past decade via the U.S. Navy and U.S. Maritime Administration (MARAD) ship disposal programs. These recyclable resources, existing within the hulls of 73 retired naval vessels, are valued at an estimated $567 million in today's commodities marketplace; however, these materials now waste away on the ocean floor with all material value forever lost. Lost too are some 20,000 jobs from the economy at large, both green recycling jobs and those indirectly related to the industry, in a time when unemployment rates are debilitating the American economy and way of life.

The Federal government's ocean dumping programs are not solely an economic conundrum; these dumping efforts also pollute the marine environment with toxic materials and heavy metals that forever alter the marine ecosystem. The U.S. government, charged with preventing environmental harm and protecting its natural resources, is guilty of strengthening the paradigm of pollution economics – that is, the practice of making provisional gains (reducing fleet size in this case) without accounting for externalized environmental costs that are forever endured by the taxpayers, the global commons and future generations.

This report explores the economic cost of the U.S. Federal government's ocean dumping practices, focusing solely on the use of ships as artificial reefs in U.S. coastal waters, and the use of ships as subjects of the Navy's SINKEX program (disposal by sinking during military target practice exercises). The Basel Action Network (BAN) will be releasing more information in 2011 that explores more fully all of the impacts from U.S. ship dumping policies, including the environmental and human health impacts, and the legal implications of the Federal government's actions.

This economic report follows the sinking of five vessels in 2010, but comes prior to four planned sinkings in 2011, including that of the Ex-ARTHUR RADFORD, Ex-NIAGARA FALLS, Ex-CONCORD and Ex-KILAUEA, all likely destined to be scuttled in waters off the U.S. eastern seaboard.

This report reviews both those costs which are accounted for by the government (ie. internalized costs) to avoid environmental damage that could be caused by ocean dumping, as well as the costs unaccounted for that are externalized to the public, labor and the greater environment. These externalized costs may not be part of the government's ledgers, but are very real nonetheless. Taken together, the economic case for halting ocean dumping of obsolete government vessels in all forms is clear.

INTERNALIZED COSTS

Artificial Reefing Program Introduction

The National Fisheries Enhancement Act of 1984 (NFEA) defines an artificial reef as *"a structure which is constructed or placed in water…for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities."* [1] There are 14 Gulf and Atlantic States with active artificial reefing programs. Florida alone has 2,400 artificial reefs comprised of sunken cars, buses, tanks, tires, oil rigs and ex-military vessels.[2] The Delaware Artificial Reef program boasts of their 4 ex-military vessels, 10 tugboats and barges, 86 tanks and armored personnel carriers, 1,100 New York City subway cars and 8,000 tons of ballasted truck tires now resting in the Delaware ocean dumping ground that covers approximately one square mile of ocean floor.

States are turning to *materials of opportunity* as a low cost reef solution to attract fish and bring economic benefits to coastal economies through increased fishing and diving opportunities. However, these materials of opportunity, which include Navy and MARAD ships, are essentially waste products, often with toxic residues. Their use is often perpetuated by those that have a waste disposal problem to solve. *"The artificial reefs have been sold by a number of specific interests that benefit from them,"* said Jack Sobel, former director of strategic conservation science and policy at the Ocean Conservancy in Washington, D.C. *"The oil industry in the Gulf of Mexico, the sports-fishing and recreational-diving industries up and down both coasts, and the people who need to dispose of old cars, bridges and boats, all make out better than the fish and sea anemones do."*[3]

Most artificial reefs are developed in areas with featureless bottom topography.[4] These artificial reef sites alter the natural habitat in order to attract fish for increased economic benefits. *"At the very least, we are altering marine habitat by sinking ships - somewhat akin to gathering a bunch of old wreck cars in the midst of a forest or grassland. This would create habitat for certain species (e.g. rats), but would definitely alter the natural ecology."*[5] The real benefit is to fishermen's ability to more easily catch fish, making the sea floor more interesting to divers and provide a cost-effective waste disposal site for those in need of dumping large volumes of waste material.

The only proven impact of artificial reefs is that they attract fish and concentrate populations for rapid harvest. The Gulf States Marine Fisheries Commission (GSMFC) suggests that concentrated populations themselves may lead to overfishing and the decline of species within the vicinity of the reef site.[6] The attracting nature of the reef may actually be detrimental to species populations, as overfishing at target sites rapidly eliminates fishery resources, and soon thereafter, all related economic benefits once attributed to sports fishing and diving tourism. Clearly, when the fishery is closed due to overfishing, so too will be the local businesses that are dependent on fishing and diving tourism.

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[1] *National Fishing Enhancement Act of 1984, Title II. Appendix B, Artificial Reefs, Public Law 98-632.*

[2] *Dodrill, Jon, Artificial Reef Program Administrator, Florida Fish and Wildlife Conservation Commission*

[3] *http://www.newsweek.com/id/142534/page/1*

[4] *Stone et al. 1974*

[5] *Georgia Straight Alliance, Artificial Reefs and Fish Habitats: What the Experts Say; http://www.georgiastrait.org/?q=node/604*

[6] *Lukens, R.R. and Selberg, 2004.*

Artificial Reefing Costs

The U.S. Maritime Administration (MARAD) recognizes *"the requirements in the BMP [National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs] to remove all solid PCBs [polychlorinated biphenyls] above the regulated limits…for purposes of creating an artificial reef could negate potential cost advantages of artificial reefing compared to conventional dismantling."*[7] In fact, Maritime Administrator David Matsuda was cited by the Washington Post in 2009 as saying artificial reefing is 3 to 5 times as costly as domestic recycling.[8]

This appears to be a newly realized viewpoint of MARAD under the Obama Administration. However the Navy has not indicated a comparable view, as evidenced by the June 8, 2010 transfer of the Ex-ARTHUR RADFORD, a 563 foot Navy Destroyer to the states of Delaware, New Jersey and Maryland for the Spring 2011 scuttling as an artificial reef. The Navy's share of the costs associated with this sinking is 200,000 times the costs to taxpayers for recycling this vessel domestically, as evidenced by a domestic recycler's unsolicited offer to the Navy to recycle the vessel at a cost of $1. The Navy did not respond to the unsolicited offer from the approved Navy recycling contractor, Esco Marine.

From 2002-2008, MARAD and the Navy disposed of four vessels at sea via artificial reefing. These four sinkings cost a total of $37.5 million dollars, for which MARAD and the Navy contributed $25.35 million, or 68% of the total costs, leaving the remaining 32% to be covered by the state artificial reefing programs. On a disposal cost per ton basis, reefing these vessels costs an average of $554/ton, for which MARAD and the Navy contributed an average of $253/ton. However, the costs to recycle these ships domestically during this same period was an average of $67/ton which would equate to a savings to the U.S. taxpayer of $21.5 million. Recycling would have also created an estimated 1,865 U.S. jobs.[9]

Disposing of vessels at sea does not bring best value to the Federal government as costly remediation requirements, combined with a lack of returns from commodity metals (see below), negates any perceived cost advantages including financial contributions from state artificial reefing programs or sports fishery encouragement.

The Ex- ARTHUR RADFORD is now being prepared for sinking as an artificial reef in spring 2011. The sinking of the RADFORD will contribute an estimated $6 million worth of recyclable materials to the depths of the sea, and forfeit approximately 228 jobs from the economy at large.
Image Source: Navy Photo ID 021127-N-3653A-004.jpg

[7] *IBID.*

[8] *http://www.washingtonpost.com/wp-dyn/content/article/2009/09/06/AR2009090601989.html*

[9] Author's calculation per information gathered from industry: Approximately 108 tons (light displacement) = 1 recycling job; 1.2 indirect jobs; 1.3 induced jobs. Indirect/induced job multipliers: *http://www.foeeurope.org/publications/2010/More_Jobs_Less_Waste_Sep2010.pdf)*

The sinking of the Ex-ORISKANY, a former aircraft carrier sunk off the coast of Florida in 2006, is a case worth exploring: the total cost of environmental remediation for the sinking of the Ex-ORISKANY was $11.89 million. Add to that $3.07 million for towing and berthing; $4.9 million for scuttling preparation and execution; and $3.74 million to develop the Prospective Risk Assessment Model (PRAM), all adding up to a total cost of $23.6 million.[10] Had the vessel been dismantled in the U.S., the recyclable scrap materials would have brought an estimated $18 million return, more than enough to compensate for the environmental remediation costs, while avoiding the costs of scuttling preparation, execution and the PRAM modeling.

In the last several years the Navy has been preparing another massive aircraft carrier, the Ex-FORRESTAL, for ocean dumping via artificial reefing. The Navy has spent a reported $6.4 million to date[11] preparing the Ex-FORRESTAL for dumping at sea. But even this large expenditure is minimal as the Navy has not yet addressed the PCBs and other contaminants within the ships interior that will be comparable in cost to that of the Ex-ORISKANY and that of the Ex-AMERICA, mentioned in the next section.

While the Navy and MARAD share artificial reefing costs with recipient states, it is important to note that many of the state artificial reefing programs are largely funded by Federal tax dollars. Up to 75% of the funding can come from the Federal Aid in Sport Fish Restoration Program. The program provides Federal aid to the State for management and restoration of fish having *"material value in connection with sport or recreation in the marine and/or fresh waters of the United States."*[12] These funds are derived from a 10-percent excise tax on certain items of sport fishing tackle (Internal Revenue Code of 1954, sec. 4161), a 3-percent excise tax on fish finders and electric trolling motors, import duties on fishing tackle, yachts and pleasure craft, and motorboat fuel taxes authorized under the Internal Revenue Code (Sec. 9503).[13] This is a use tax, where users (i.e. fishermen) are paying for the service (i.e. fish aggregation around designated artificial reef site). However, this use tax funds programs that have not been proven to restore fish populations, as was the intent of the Federal aid program, but rather has proven to concentrate fish for harvest and population depletion *(see Fishery Resource Costs section below)*.

Senator McCain's old aircraft carrier, the Ex- FORRESTAL, awaits final disposition, expected in 2011. Though, the Navy has reportedly already spent $6.4 million to date preparing the vessel for artificial reefing. Sinking the FORRESTAL will contribute an estimated $30-$33 million worth of recyclable materials to the depths of the sea, and forfeit approximately 1,927 jobs from the economy at large.
Image Source: Navy Photo ID 021127-N-3653A-004.jpg

[10] *http://www.epa.gov/OWOW/oceans/habitat/artificialreefs/documents/introduction.html*

[11] *Roberts, Kathleen. Public Affairs Specialist, Naval Sea Systems Command*

[12] *http://www.fws.gov/laws/lawsdigest/FASPORT.HTML*

[13] *IBID.*

Table 1: Artificial Reef Costs 2006-2009

Vessel Name	Tons (LDT)	MARAD/ Navy Cost	Total Cost	MARAD/ Navy Cost/Ton	Total Cost/Ton	Average Recycling Cost/Ton	
SPIEGEL GROVE	6,553	$0	$1,300,000[14]	$0	($198)	($127)	2002
ORISKANY*	32,000	$22,600,000	$23,600,000[15]	($706)	($738)	($83)	2006
TEXAS CLIPPER	7,662	$1,500,000[16]	$4,000,000[17]	($196)	($522)	($79)	2007
VANDENBERG	11,342	$1,250,000[18]	$8,600,000[19]	($110)	($758)	$21	2008
Total	57,557	$25,350,000	$37,500,000	($253)	($554)	($67)	

**Navy vessel*
( ) = Expenditure
Source: Table developed by author using data from Navy and MARAD 2008 Report to Congress on the Progress of the Vessel Disposal Program; and http://www.whitehouse.gov/omb/expectmore/detail/10004010.2006.htm

[14] *http://www.epa.gov/OWOW/oceans/habitat/artificialreefs/documents/introduction.html*

[15] *IBID.*

[16] *Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, January 2008*

[17] *Shively, Dale, Texas Parks and Wildlife, Texas Clipper: A New Artificial Reef in the Gulf of Mexico*

[18] *Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, January 2008*

[19] *http://www.marad.dot.gov/news_room_landing_page/news_item_summary/news_item/b09_12.htm*

SINKEX Program Introduction

The Navy's SINKEX program disposes of inactive naval ships at sea with a described purpose other than mere disposal. The Navy has long claimed that this alternative purpose of fleet training, by firing on idle vessels to simulate war conditions, is essential to national security. However, some military experts claim that today such target practice is not essential for military readiness and modern warfare tactics. SINKEX is an old practice conceived at a time before computer and video simulations were developed as a science and before environmental impacts of such scuttling events were so acute.

If on-sea targets are needed for torpedo and gunnery accuracy training, as claimed by the Navy, experts advise that clean, uncontaminated barges could be substituted. In fact, during the Rim of the Pacific (RIMPAC) war games of 2010, the Navy used inflatable and biodegradable balloons called *killer tomatoes,* as targets for gunnery exercises in an effort to reduce costs and protect the marine environment during fleet training exercises. Regardless of alternative target availability, the Navy still sunk five vessels in 2010 and plans to sink a minimum of three naval vessels as targets in 2011. The Navy continues to abuse the *training* element within SINKEX to justify vessel sinking with toxic materials left onboard in violation of International Ocean dumping laws.

Sinking Navy Destroyers

The Spruance Class Destroyer fleet of 31 vessels were equipped to serve the U.S. Navy for a 35- year service life, most of which would serve through 2019 with proper maintenance and updates, yet the Bush Administration opted to accelerate their retirement and dump 25 of the 31 destroyers at sea as a means of vessel disposal rather than recycling. Only two vessels survive, the PAUL FOSTER and the Ex-ARTHUR RADFORD, with the latter being the 26th Spruance Class Destroyer slated for ocean disposal in Spring 2011. The Ex-ARTHUR RADFORD dumping now falls under the Obama Administration, who appears to be carrying on the outdated ocean dumping policies of past years.

The 25 vessels dumped contained approximately 156,000 tons of recyclable metals, including steel, aluminum and copper amongst others. In today's market, this material would be worth an estimated $155 million and over 1,600 U.S. green recycling jobs. The sinking of the Radford will contribute another $6 million of recyclable material to the depths of the sea, and forfeit nearly 228 jobs from the economy at large, in a time when U.S. jobs are scarce at best.

Ex-John Young, a Spruance Class Destroyer sunk in 2004 via SINKEX
Image Source: http://ussthorndd988.com/Thornsistership.html

SINKEX Costs

Over the course of 30 years from 1970 to 1999, 178 Navy vessels were sunk via SINKEX (disposal by sinking during military target practice exercises),[20] amounting to 8% of all Navy ship disposals during this period. However, under the Bush Administration, from 2000-2008, SINKEX accounted for approximately 62% of all Navy ship disposals. Not only did this form of disposal result in valuable recyclable metals dumped at sea, the

[20] *RAND Report Pg. 17*

Navy also incurred great financial expense to remove some, though not all, hazardous, polluting substances prior to dumping.

The Navy does not publicly share the total cost estimates for sinking vessels via SINKEX. Rather, they only report costs for environmental preparation. For example, the most expensive SINKEX on record was the sinking of the Ex-AMERICA in 2005 at a total cost of $22 million,[21] however the Navy only reported a total cost of $4 million. The 61,174 ton vessel contained approximately $30 million in recoverable scrap metals, but again the Navy's accounting methods failed to report any material value losses or opportunity cost should these materials have been recycled rather than dumped. The sinking of AMERICA essentially cost the U.S. taxpayers $52 million, not even accounting for the externalized costs to the environment.

The Navy's environmental remediation cost estimates from 2005-2008 for vessels slated for SINKEX are listed in Table 2 below. This table provides a limited means of cost comparison between SINKEX and domestic recycling as 3 of the 12 vessels listed were in fact recycled rather than sunk. The FORT FISHER is one such example; it was sold in May 2009 to International Shipbreaking Ltd (ISL), a domestic recycling operation in Brownsville, Texas, for a total of $0.02. Recycling this vessel brought significant savings to the Navy when compared to the $400,000 cost estimate for SINKEX.

ISL also purchased two other vessels in May at a total cost of $0.02 each, the Ex-SAIPAN and the Ex-AUSTIN. The Ex-SAIPAN alone will generate 250 green jobs throughout the dismantling process which will likely last one year.[22] One would suspect that the proven economic benefits of ship recycling in these clear examples would steer the Navy's ship disposal program toward ship recycling. But instead, the Navy continued to sink five vessels in 2010 via SINKEX following the successful recycling of the above mentioned vessels. The Navy's plans to sink an additional three vessels in 2011 adds to the confusion of SINKEX cost rationalization.

Another vessel, the Ex-PROTEUS was sold for recycling in 2008 to Esco Marine in Brownsville, Texas, for a total cost to the Navy of $1,431,500.[23] In comparing this to the $800,000 cost estimate for SINKEX, at first glance it appears that SINKEX is economically beneficial in this instance. However, as mentioned above in the case of the Ex-AMERICA, SINKEX cost estimates only account for environmental remediation costs and do not account for storage, towing, weaponry, fleet support and the many other costs associated with SINKEX.

If we simply consider the vessel remediation costs and estimated costs of towing ($1 million[24]) the vessel from California to Hawaii, where it would have likely taken part in the Rim of the Pacific Exercises (RIMPAC) SINKEX event, the total SINKEX costs for the Ex-PROTEUS would have been approximately $1.8 million. When this simple cost comparison is made, domestic recycling actually saved the U.S. taxpayer $368,500 (not counting externalized costs discussed below).

[21] *Navy Plans to Sink America, http://www.msnbc.msn.com/id/7081234/*

[22] *http://recenter.tamu.edu/newstalk/main.asp?a=5*

[23] *http://www.marad.dot.gov/documents/July2007ReportToCongress.pdf*

[24] *Calculated on the basis of Commercial towing estimate for the Monticello*

One final example, the Ex-MONTICELLO, a Thomaston-class dock landing ship, was sunk in July 2010 at RIMPAC at an estimated cost to the Navy of $915,548. Adding to that figure the towing cost estimate of $750,000,[25] and the Navy incurred costs of approximately $1,665,548. Taking into consideration the Ex-MONTICELLO's sister ships, the Ex-PLYMOUTH ROCK and Ex-FORT SNELLING, which were each sold to Peck Recycling of Richmond Virginia for recycling in 1995 for a positive cash flow of $268,707 each, the sinking of the MONTICELLO was done so at a surprising financial loss. In view of the fact that these exercises can take place with alternative means as described at the outset, these few examples show where SINKEX is clearly not providing a *best value* solution to the government, yet the Navy continues to mask the true costs of this ship disposal program in order to continue business as usual.

The Ex- NEW ORLEANS was sunk via SINKEX during summer 2010, along with four other vessels: the Ex- ANCHORAGE, Ex-MONTICELLO, Ex-ACADIA and Ex-SATURN. These five vessels contributed an estimated 47,521 tons of recyclable material, worth an estimated $ 29 million, to the depths of the sea, forfeiting approximately 1,692 jobs from the economy at large while unemployment rates remained steady at 9.5%.
Image Source: Australian Defense Force, RIMPAC 2010

Table 2: SINKEX Cost Estimates 2005-2008

Vessel Name	Navy SINKEX Cost Estimates
HORNE (CG 30)*	$750,000 (sunk in 2008)
JOUETT (CG 29)*	$750,000 (sunk in 2007)
PROTEUS (IX 518)*	$800,000 (recycled in 2008)
NEW ORLEANS (LPH 11)*	$800,000 (sunk in 2010)
FORT FISHER (LSD 40)*	$400,000 (recycled in 2009)
MAUNA KEA (AE 22)**	$754,550 (sunk in 2006)
MONTICELLO (LSD 35)**	$915,548 (sunk in 2010)
PYRO (AE 24)**	$754,549
FLORIKAN (ARS-9)**	$396,984 (recycled in 2010)
CLAMP (ARS-33)**	$363,484
BOLSTER (ARS-38)**	$363,484
RECLAIMER (ARS-42)**	$363,484

** Navy vessel* *** Maritime Administration vessel*
Source: 2006 & 2008 Report to Congress on the Progress of the Vessel Disposal Program

[25] *Commercial towing estimate, Compass Maritime Services*

Domestic Recycling Costs

Strict regulations and strong oversight now ensure that hazardous materials are disposed of with respect for the environment and human health in U.S. shipbreaking yards. Recycling International, an independent worldwide publication, said in 2006, *"Visits to shipbreaking yards around the world confirm that nobody upholds environmental and safety measures as stringently as the Americans."* The publication goes on to say, *"…the USA has become the world's leading 'green' recycler of marine ships…"* BAN's own site visits confirm that ship recycling in Brownsville, while not without room for improvement, is likely the best major ship recycling destination in the world. It is clear that once all externalities are accounted for, domestic recycling that provides U.S. jobs, is overwhelmingly the environmentally and economically preferred method of vessel disposal.

In 2001, the Maritime Administration presented cost estimates to Congress for domestic scrapping of 140 NDRF vessels. MARAD concluded that each vessel would cost on average $2.5 million to scrap, which equates to an average of $338 per ton. In December 2002, MARAD used these cost estimates to ask congress to include a statute in Public Law 107-314 (Bob Stump National Defense Authorization Act for Fiscal Year 2003) to allow MARAD to provide financial assistance to states for environmental preparation, towing, and/or sinking of vessels as artificial reefs in an effort to reduce ship disposal costs as if reefing were in fact cheaper. These cost estimates were also used as justification to arrange a Memorandum of Agreement with the Navy in 2003 with Congressional support to transfer MARAD vessels to the Navy for SINKEX purposes.

However, Congress was in fact misled. The 2001 cost estimates were inflated by 58%. Of the 140 vessel scrapping cost estimates, 63 were awarded scrapping contracts as of January 2008. The cost estimates for these 63 vessels amounted to $142,841,160; but the actual contracts amounted to merely $59,635,469. The actual cost per ton was $141, compared to the 2001 estimate of $338 (see Appendix A). The overinflated cost estimates of 2001 helped garner support from Congress to enact laws and amendments to allow the ocean disposal of vessels.

Indeed, recent evidence points to the fact that domestic recycling is most often the best value consideration even with externalities ignored, as evidenced in the sections discussed above. This is due to a combination of factors including commodity price increases, a steady supply of ships allowing domestic yards to maintain an active workforce and increased competition due to greater activity.

Furthermore, a well established and trained workforce allows for faster turnover of ships than other methods and thus lowers government storage and maintenance costs, which amount to approximately $20,000 per vessel annually. Obsolete vessels await disposal an average of 22 years,[26] equating to approximately $440,000 per vessel over the course of a ship's obsolete non-retention status. Maintaining the Navy inactive fleet costs taxpayers approximately $14 million annually.[27]

[26] *House of Representatives, 2000*

[27] *http://www.navytimes.com/news/2008/02/navy_shipdisposal_080223w/*

High steel prices and strong competition in the domestic scrapping industry has reduced costs (negative value) to the government from an average $79/ton in 2007 to a profit (positive value) of $21/ton in 2008.[28] Dismantling costs are well below that of artificial reefing, which cost approximately $554/ton on average, even when including vessels such as the Ex-ORISKANY in this average, in which only partial remediation was conducted.

Domestic ship recycling is economically sound: it creates U.S. jobs, provides commodities for sale and eliminates most externalities associated with non-recycling options. It is clearly a *best value* solution.

U.S. ship recycling operations in Brownsville, Texas, generate thousands of jobs throughout the dismantling and recycling processes. The dismantling alone of one single vessel, the Ex-SAIPAN, is said to bring 250 green jobs to Brownsville; jobs that are expected to last one year. These recycling jobs support the total job creation of approximately 875 jobs in the wider economy when accounting for indirect and induced employment.
Image Source: www.clui.org/lotl/v33/k.html

28 *http://www.whitehouse.gov/omb/expectmore/detail/10004010.2006.html*

EXTERNALIZED COSTS

The National Defense Authorization Act of 2001 requires that vessel disposal be conducted "*…in the manner that provides the best value to the Government,"* while also *"giving consideration to worker safety and the environment."* As discussed in the Internalized Costs section above, the Federal government has a poor record in bringing best value to the Government with respect to ship disposal. However, the best value scenario dims even further for artificial reefing and SINKEX disposal methods when one considers the hidden externalized or deferred costs associated with ocean dumping.

These hidden costs have been externalized to the environment and to the future, but are nevertheless real, and could become the liability of the polluter. It is well known that pollution prevention is far less costly than pollution remediation; in this way, not only are the true costs deferred to the future, but they are dramatically increased by this deferral. Current Federal ocean dumping policies do not account for these hidden costs. This section addresses some of the externalized costs associated with ocean dumping, however this section is in no way exhaustive of all costs externalized and deferred to future generations.

Natural Resource Costs

Productive resources such as steel, aluminum and copper are limited, yet the human need for them is virtually endless. The reality of our finite earth, coupled with our current loss of biodiversity and global warming crises, should remind us that our *"use it and then lose it"* lifestyle is unsustainable. Primary production of metals is far more damaging to ecosystem health, habitat and biodiversity due to the impacts of mining on the face of the earth, increasingly in wilderness areas in developing countries. Likewise, primary production is far more energy intensive than secondary metals recovery (e.g. recycling) and thus produces greenhouse gas emissions, air and water pollution in higher volumes. According to the University of Colorado at Boulder, recycled aluminum uses 95% less energy when compared to virgin aluminum production alone.[29] In 2008, 52% of aluminum used in North America came from primary production, with only 34% deriving from recycled material. The remaining 14% was imported.[30]

Steel is North America's top recycled material as it is both economically advantageous and environmentally preferred. Recycled steel requires 33% less energy and 32% less CO2 emissions to produce when compared to the production of steel from virgin materials alone.[31] Scrap is the steel industries single largest source of material. In fact, over the past 50 years, 50% of steel produced in the U.S. has been recycled through the steel making process.[32]

Steel recycling is paramount to the continued development of infrastructure, both within developed nations and developing nations alike.

[29] *http://recycling.colorado.edu/education_and_outreach/recycling_facts.html*

[30] *http://www.aluminum.org/Content/NavigationMenu/NewsStatistics/StatisticsReports/FactsAtAGlance/factsataglance.pdf*

[31] *Jeremiah Johnson, B.K. Reck, T. Wang and T.E. Graedel, The energy benefit of stainless steel recycling, Energy Policy. Volume 36, Issue 1, January 2008, Pages 181-192.*

[32] *http://www.recycle-steel.org/rates.html*

Steel sparked the Industrial Revolution and helped shape a nation out of the frontier; now in the 21st century, rapidly developing nations such as China and India rely on steel as their primary resource necessary to continue development. However, depletion of this valuable natural resource is imminent according to the Worldwatch Institute, which estimates that iron ore reserves could be fully depleted within 64 years based on conservative 2% growth in consumption per year.[33] World consumption of iron ore currently grows at 10% per annum on average, with the United States being one of the world's top consumer.[34]

A limited supply of steel will inevitably slow human development and diminish our options on how to build a sustainable future. Yet, the U.S. government's ongoing dumping of vessels at sea continues to remove valuable scrap metal from circulation within the domestic marketplace and necessitates environmentally damaging primary metals mining, refining and manufacture. With a surplus of obsolete ships containing millions of tons of scrap steel, it is in the best interests of everyone to responsibly manage and protect this valuable resource rather than squander it by allowing it to erode on the ocean floor.

This open pit copper mine in Bingham Canyon, Utah, is considered the world's largest man-made excavation on earth; however, it only supplies the U.S. with 18% of our annual copper need. Having operated for over 100 years, the mine's ore reserves are expected to be fully depleted by 2020.
Image Source: Flickr user arbyreed under creative commons agreement; http://www.flickr.com/photos/19779889@N00/3746214349/in/photostream/

One example of how basic metals are becoming "critical metals" is demonstrated by the limited stock of armor plating noted in December 2004 as a major cause for concern amongst army personnel in Iraq.

Spc. Thomas Wilson of the Tennessee National Guard told Donald Rumsfeld, Secretary of Defense in 2004, that troops in Kuwait were forced to rummage through landfills for scrap metal to rig armor for their vehicles before storming Iraq.[35] When asked about the shortage or armor plating in vehicles operating in Iraq, Rumsfeld responded *"It's essentially a matter of physics. It isn't a matter of money. It isn't a matter on the part of the Army of desire. It's a matter of production and capability of doing it."*[36] As of December 2004, of the 30,000 wheeled vehicles U.S. troops operated throughout the Middle East and Central Asia, approximately 8,000 lacked armored protection.[37] This shortage of armor plating, including the benign and peaceful use of such material, will continue to escalate if natural resources are not preserved, reused, recycled and recycled again.

Over the past decade alone, the Federal government has sunk 73 vessels at sea, amounting to 560,000 tons of recyclable material, worth an estimated half a billion dollars in scrap metal. Appendix B shows this list of vessels and their combined material

[33] *Brown, Lester Plan B 2.0, New York: W.W. Norton, 2006. p. 109*

[34] *http://www.reuters.com/article/pressRelease/idUS141349+01-Feb-2008+PRN20080201*

[35] *http://www.latimes.com/news/nationworld/iraq/complete/la-fg-armor10dec10,1,308448.story?page=1*

[36] *IBID.*

[37] *IBID.*

weight. Nearly all vessels listed in Appendix B are Surface Combatant class vessels. Using the recovery indices for different ship types per the 2001 RAND Report, *Disposal Options for Ships,* a report sponsored by the Navy itself, one can use parametric estimating to define the material composition within each vessel and the estimated value of recyclable materials that were dumped at sea.

Referencing both Tables 3 and Table 4, and the current commodity price index, one can estimate the total material value lost over the past decade to the Federal government's ocean dumping programs. With 73 vessels weighing a combined 625,049 tons, only 9% of which was waste, 568,795 tons of material was recyclable, worth an estimated $567,144,461. Essentially, the Federal government dumped half a billion dollars at sea without accounting for any material value loss. On top of this astonishing figure, the Navy also paid substantial amounts to conduct each ocean dumping exercise. And of course this figure does not include further externalized costs due to pollution damage.

Table 3: Vessel Composition and Material Value of Vessels Dumped at Sea 2000-2010

	Ferrous	Aluminum	Copper & Copper Alloys	Lead	Waste	Total
% of Total Vessel Light Displacement	79%	4%	4%	4%	9%	100%
Material weight (ldt)	493,789	25,002	25,002	25,002	56,254	625,049
Commodity Price Index	$400/ton	$2/pound	$3.60/pound	$1/pound	$0	
Material Value	$197,515,484	$112,008,781	$201,615,805	$56,004,390	$0	$567,144,461

Note: 2,240 pounds = 1 long ton
See Appendix B for list of vessels

Air Pollution Costs

The ocean disposal of naval vessels discards valuable material that would otherwise be recycled to reduce virgin resource extraction and refining and related CO2 emissions, as discussed in the previous section. Under a cap and trade model, carbon is a factor in assigning monetary value to various activities. Increasing value is assigned to activities or products that reduce or offset CO2. Therefore, recycled material has a higher value than virgin resources as it requires less energy and CO2 emissions to produce the same product.

For every tonne (1 long ton = 1.01604691 tonnes*)* of recycled copper, 13 to 19.7 tonnes of CO2 emission equivalents are curbed (see Table 4). Similarly, for every tonne of recycled copper, 346.04 tonnes of hidden flow waste equivalents

are curbed. Hidden flow waste is associated with extraction and processing of resources, but is typically unaccounted for in the waste stream. Hidden flow waste typically accounts for 2/3 of a product's impact; these hidden flows are in the form of mining waste, devastated forests, ruined agricultural land, or leachate-producing landfills. [38]

According to the Navy, the Ex- FORRESTAL aircraft carrier alone contains approximately 40,000 tons of recyclable material that can reenter the U.S. market to offset primary production. Referencing Table 4 to make calculations in Table 5, it is revealed that recycling the Ex- FORRESTAL would prevent 73,726 tonnes (162,538,007 pounds) of CO2 from entering the atmosphere. This is equivalent to removing 14,097 passenger vehicles from the road for a year;[39] the equivalent of preventing 385 railcars of coal from burning in a coal fired-power plant;[40] the equivalent emissions from electricity use of 8,947 homes for one year.[41] The curbed CO2 emissions would otherwise require over 15,000 acres of pine or fir forests for adequate carbon sequestration,[42] or 1,890,410 tree seedlings grown for 10 years.[43]

The energy savings and related CO2 emissions curbed by recycling the Ex- FORRESTAL, as compared to the ocean disposal option can be represented as carbon credits with a related monetary value. 73,726 tonnes of CO2 emissions would be curbed by recycling the vessel; this is the equivalent of 171,456 barrels of oil consumed,[44] or 8,293,138 gallons of gasoline.[45] If we use crude oil as our energy equivalency, we see an energy savings value of approximately $14.3 million (171,456 barrels of crude oil x $83.42 per barrel[46]). However, if we use the retail value of gasoline as our energy equivalency, we see an energy savings value of approximately $23.7 million (8,293,138 gallons of gasoline x $2.86 per gallon[47]). These energy equivalencies serve as examples and do not necessarily represent actual values for curbed CO2 emissions due to the fact that energy savings are likely related to a combination of fossil fuels, including crude oil, gasoline and coal. The Navy has spent a reported $6.4 million to date[48] preparing the Ex-FORRESTAL for dumping at sea; however, the Navy claims this vessel's fate is still undetermined.

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[38] Waste & Climate Change Background document for the ISWA & DAKOFA conference on Waste & Climate Change 3-4 December 2009 in Copenhagen - to be held in connection to the UN Climate Summit COP 15 in Copenhagen 7-18 December 2009

*[39] 8.89*10^{-3} metric tons CO_2/gallon gasoline * 11,720 VMT $_{car/truck\ average}$ * 1/20.4 miles per gallon $_{car/truck\ average}$ * 1 CO_2, CH_4, and N_2O/0.977 CO_2 =* ***5.23 metric tons CO_2E /vehicle/year***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

*[40] 22.68 mmbtu/metric ton coal * 25.34 kg C/mmbtu * 44g CO_2/12g C * 90.89 metric tons coal/railcar * 1 metric ton/1000 kg =* ***191.5 metric tons CO_2/railcar year***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

*[41] 12,773 kWh per home * 1,422.40 lbs CO_2 per megawatt-hour delivered * 1 mWh/1000 kWh * 1 metric ton/2204.6 lb =* ***8.24 metric tons CO_2/home.***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

[42] ***4.69 metric tons of CO_2 per acre of pine or fir forests***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

*[43] 23.2 lbs C/tree * (44 units CO_2 / 12 units C) * 1 metric ton / 2204.6 lbs =* ***0.039 metric ton CO_2 per urban tree***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

*[44] 5.80 mmbtu/barrel * 20.33 kg C/mmbtu * 44 g CO_2/12 g C * 1 metric ton/1000 kg =* ***0.43 metric tons CO_2/barrel***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

*[45] 2,425 grams C/gallon * 100% oxidation factor * 44 g CO_2/12 g C * 1 metric ton/1,000,000 g =* ***8.89*10^{-3} metric tons CO_2/gallon of gasoline***
http://www.epa.gov/cleanenergy/energy-resources/refs.html

[46] Crude Oil and Commodity Prices, 4/21/2010, http://www.oil-price.net/

[47] US Energy Information Administration, 4/19/2010, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp

[48] Roberts, Kathleen. Public Affairs Specialist, Naval Sea Systems Command

Table 4: C02 Emissions and Hidden Flow Savings from Recycling

Material Type	Saved CO2 emissions in recycling compared with virgin manufacture (t/t)	Saved 'hidden flow generation' in recycling compared with virgin manufacture (t/t)
Copper	13-19.7	346.04
Aluminum	4.6-12.4	36.15
Steel	0.9-1.3	7.85

Source: Waste & Climate Change Background document for the ISWA & DAKOFA conference on Waste & Climate Change 3-4 December 2009 in Copenhagen - to be held in connection to the UN Climate Summit COP 15 in Copenhagen 7-18 December 2009

Table 5: Ex-FORRESTAL CO2 Emissions and Hidden Flow Savings from Recycling

Material Type	Quantity (tonne)	CO2 per tonne of virgin material (tonne)	Hidden flow waste generation per tonne (tonne)	CO2 Emissions avoided by recycling (tonne)	Hidden flow impacts avoided by recycling (tonne)
Copper	445	19.7	346.04	8,766.5	153,987.8
Brass	208	19.7	346.04	4,097.6	71,976.32
Copper-Nickel	182	19.7	346.04	3,585.4	62,979.28
Ferrous Steel	30,976	1.3	7.85	40,268.8	243,161.6
High Tensile Strength Steel	6,864	1.3	7.85	8,923.2	53,882.4
Aluminum	652	12.4	36.15	8,084.8	23,569.8
Total	**39,326**			**73,726**	**609,557**

Table developed by author using data from:
Navy Request For Proposal, June 2009 (Solicitation #: N00024-09-R-4224); and Waste & Climate Change Background document for the ISWA & DAKOFA conference on Waste & Climate Change 3-4 December 2009 in Copenhagen - to be held in connection to the UN Climate Summit COP 15 in Copenhagen 7-18 December 2009
Note: 1 long ton = 1.01604691 tonne

Fishery Resource Costs

Some coastal states are investing in artificial reef programs in an attempt to rebuild or enhance fisheries to sustainable levels. Rebuilding efforts are crucial to respond to past or current overfishing practices, which, according to the National Oceanic Atmospheric Administration (NOAA), still occurs in 48 fisheries in U.S. waters to date.[49] Worldwide, 52% of the world's fisheries are fully exploited, and 24% are overexploited, depleted or recovering from depletion.[50] Unless the current situation improves, stocks of all species currently fished for food are predicted to collapse by 2048.[51] Artificial reefs are not part of the overfishing solution; they are part of the problem.

The Gulf States Marine Fisheries Commission (GSMFC) suggests artificial reefs do not protect and enhance species of fish, but rather attract species of fish.[52] The attracting nature of the artificial reef can in fact be detrimental to species populations as concentrated populations can lead to fishing targets and thus overfishing, leading to a probable decline of species within the vicinity of the reef site.[53]

Jeff Tinsman, the artificial reef coordinator for the Delaware Department of Natural Resources stated, *"Artificial reefs are very popular with fishermen; they know they do provide a high concentration of fish available for harvest."*[54] Further, Tinsman said that the sinking of 600 subway cars off the coast of Delaware to create an artificial reef increased the number of annual angling trips from 300 to 13,000.[55] This dramatic increase of pressure on fishery resources should signal a warning, clearly, if fisheries are depleted due to the rapid harvest of concentrated fish populations, overfishing will reduce tourist dollars to nothing when depleted fisheries are closed for recovery.

The decline of fish stock in U.S. waters and globally are a direct result of overfishing which has dramatic economic impacts. Cod stocks in Newfoundland, Canada serve as a stark reminder of such immediate yet everlasting effects. In 1990, 110,000 people were employed in the fishing and fish processing industry. But in 1992, the cod fishery collapsed and 40,000

The Ex-Vandenberg was sunk in the Florida Keys National Marine Sanctuary in 2009 at a cost of $8.6 million. The vessel is a popular fishing destination as it is said to attract fish away from the protection of natural coral reefs within the marine sanctuary itself. However, it is well known that fish aggregation at a marked site can exacerbate the problem of overfishing, as concentrated fish populations can be easily and more rapidly harvested.
Image Source: http://www.nileguide.com/destination/blog/florida-keys/2010/05/29/vandenberg-artificial-reef-celebrates-first-birthday/

[49] *Noaa Fisheries Service Begins Process To End Overfishing By 2010, New Magnuson-Stevens Act*

[50] *FAO (2004) State of World Fisheries and Aquaculture (SOFIA) - SOFIA 2004. FAO Fisheries Department*

[51] *Worm, B. et al (2006) Impacts of biodiversity loss on ocean ecosystem services. Science, 314: 787*

[52] *Lukens, R.R. and Selberg, 2004.*

[53] *IBID.*

[54] *http://news.nationalgeographic.com/news/2006/08/060818-subway-reef.html*

[55] *http://www.reuters.com/article/idUSN1643767620080517*

jobs were lost.[56] To date, the cod fishery has not yet recovered and research suggests the ecosystem has changed substantially, meaning that the cod may never return.

Take also into consideration the California salmon fishery closure, which came as a result of decades of environmental degradation. According to State official estimates, the fishery closure led to an economic loss of $279 million in 2009 alone.[57] Clearly, the economic impacts of fish resource depletion are much greater than the potential short-term economic boost to regional economies from enhanced fishing opportunities.

The U.S. currently imports 60% of its seafood, resulting in a trade deficit of more than $7 billion annually, second only to oil among natural products being imported.[58] NOAA is working to end overfishing in U.S. waters by 2010, as required by the Magnuson Stevens Act through sustainable management practices. However, artificial reefs that increase fishing opportunities are counterproductive to the Act's goals and have not been scientifically justified to increase fishery resources, but have rather been documented to exploit resources by providing concentrated populations leading to the inevitable ecological and economic collapse of such fisheries.

Delaware's Toxic Reefs

Delaware has added new reef structure materials *"…as quickly as the artificial reef program can get its collective claws around suitable material."* This aggressive sinking campaign is geared to increase fishing and diving opportunities. However, the 2009 Delaware Fish Consumption Advisory states that in Delaware Atlantic Coastal Waters, NO CONSUMPTION is advisable for women of childbearing age and children, with all other groups advised to eat no more than one meal per year of the following fish: white perch, American eel, channel catfish, white catfish, bluefish-greater than 14 inches, weakfish and striped bass due to polychlorinated biphenyl (PCB) contamination.

It's important to note that the Delaware Artificial Reef Program states *"gamefish such as bluefish, striped bass and weakfish are attracted to baitfish, which congregate around reef structures."* In effect, the gamefish that anglers are seeking to catch at the artificial reef sites, are in fact not advisable for human consumption due to PCB contamination.

PCBs have been implicated as toxic agents that have dioxin-like properties that can lead to carcinogenic effects in humans (U.S. EPA 1996). Yet, the EPA fully acknowledges that PCBs leach into the marine environment from sunken vessels and accumulate in the bodies of fish, which are then transferred through the food web to humans as humans digest contaminated fish. PCB's ability to accumulate in the environment and in organisms means that organisms at higher trophic levels (higher in the food chain), such as humans, are at higher risk of toxic exposure to PCBs than marine organisms themselves.

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56 *http://www.panda.org/about_our_earth/blue_planet/problems/problems_fishing/*

57 *http://www.sundancechannel.com/sunfiltered/2009/12/federal-agencies-issue-plan-to-ease-water-crisis-in-californias-bay-delta/*

58 *http://www.economics.noaa.gov/?goal=ecosystems&file=events/overfishing*

Future Remediation Costs

The disaster of the Osborne Reef in Broward County, Florida should serve as an example of future unforeseen costs. Two million tires were intentionally dumped in 1972, covering 36 acres of ocean floor with the intention of creating an artificial reef. Not surprisingly, the tires did not create an artificial reef, but rather inflicted harm to nearby coral reefs when storms, hurricanes and currents propelled tires into natural reefs, devastating the marine environment. The dumping site was labeled an environmental disaster. In 2001, a tire removal pilot study removed 1,600 tires at a cost of $17.00/tire.[59] Due to the magnitude of the project and the total projected cost of $34 million to remove all 2 million tires, little progress has been made to abate this underwater wasteland.

In 2001, New York City Metropolitan Transportation Authority (MTA) offered up 1,300 Redbird subway cars and disposed of 23 million pounds of scrap metal on the ocean floor, saving a reported $11 to $13 million in disposal costs. The so-called savings were based on an estimated costs for proper land-based disposal due to the required asbestos remediation, which the MTA avoided by simply dumping at sea. States such as Delaware welcomed this dumping as it was *free* material for the supposed benefit of artificial reefs, while other states such as New Jersey and Maryland turned the cars away when MTA acknowledged the asbestos contamination. New Jersey Governor Donald DiFrancesco, said at the time, *"While I strongly support the artificial reef program, I believe we must err on the side of safety and the environment."*

The Osborne Reef off the coast of Ft. Lauderdale, Florida is comprised of 2 million tires intentionally sunk in 1972. In 2007, U.S. military forces began clean-up of this environmental disaster, however clean-up efforts have only removed a reported 73,000 tires to date.
Image Source: Navy Combat Camera Dive Ex-East

New Jersey later opted to sink newer stainless steel subway cars that were apparently free of asbestos. The cars were expected to last 20 years in the submerged environment; however 90% of these cars collapsed entirely on the ocean floor months after deployment in 2008.[60] Their utility as an artificial reef was rendered minimal. Meanwhile the asbestos, lead paint and host of other toxic compounds aboard the Redbird vessels will continue polluting the ocean beyond the expected lifespan of the artificial reef. States such as Delaware are incurring minimal costs to sink waste material such as subway cars and naval vessels, yet the hidden costs to the environment have yet to be accounted for and part of these costs may include future remediation. States do not have reserve funds for future abatement responsibilities, which suggest the Federal government may bear the financial burden in years to come.

Sunken naval vessels are much like tires and subway cars. They are merely a solid waste material that is being disposed of on the ocean floor with *artificial reef* being the justification.

[59] *http://www.dep.state.fl.us/waste/quick_topics/publications/shw/tires/reef/Osborne-History_18Aug09.pdf*

[60] *http://www.state.nj.us/dep/fgw/pdf/2010/reef_news10.pdf*

However, the ocean floor may not be the final resting place of these waste materials, as future remedial efforts will likely be required when science determines actual risks to the environment and human health.

It is very important to note that vessels have short underwater life spans as artificial reefs, estimated at 60 years.[61] The limited 60 year lifespan of a vessel as an artificial reef means that liabilities from contamination that can be remediated will remain an economic consideration of the initial dumping. These costs far outstrip any perceived benefits to fisheries. As Jack Sobel, said, *"There's little evidence that artificial reefs have a net benefit."* [62]

Turning back to the Ex-ORISKANY, it is important to note that despite the clean-up costs, the clean-up was not complete. The $11.89 million cost for environmental remediation left intact an estimated 700 pounds of solid PCBs found in approximately 362,200 pounds of electric cable insulation, 31,700 pounds of fiberglass bulkhead insulation and 284,000 pounds of contaminated paint all left onboard for sinking.[63] Some material, such as the electric cable insulation, sampled as high as 19,000 ppm with an average of 1,500 ppm.[64] Legal PCB levels under the Toxic Substances Control Act (TSCA) are equal to or less than 50 ppm.

The Navy claimed that the estimated 680,000 pounds of PCB contaminated material, existing in hundreds of compartments at various levels below the main deck, was not accessible unless the vessel was fully dismantled. Rather than dismantling and recycling the vessel at an approved domestic facility, the Navy identified remediation of these PCBs as cost-prohibitive and sought an exception to TSCA via a risk-based disposal permit from the EPA. The Navy developed the Prospective Risk Assessment Model (PRAM) and conducted a study at a cost of $3.74 million to illustrate a limited risk to human health and the environment from the ocean disposal of PCBs during the sinking of this vessel.

The EPA and its Science Advisory Board accepted the Navy's conclusions that the risks associated with sinking the vessel were negligible and that the sinking would result in a *material value* to sports fisheries. On this basis, the EPA issued the risk-based disposal permit for the sinking of the PCB contaminated vessel. However, the environmental implications of such a decision are still yet to be fully realized, but future remediation costs are probable.

Tanks are pushed off a barge in South Carolina; artificial reefs are the justified ocean disposal purpose.
Image Source: U.S. Army Environmental Command flickr photostream

[61] *Lukens, R.R. and Selberg, 2004.*

[62] *http://www.reuters.com/article/idUSN2943349920070709*

[63] *http://www.sdafs.org/flafs/PDF/October%202008%20issue.pdf*

[64] *http://www.sdafs.org/flafs/PDF/October%202008%20issue.pdf*

Job Loss Costs

On Feb. 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) and allocated $787 billion in Federal funds to spur economic activity and create jobs in America. Yet current Federal ocean dumping practices forfeit the creation of dynamic green jobs, in stark contrast to ARRA's intentions of job creation and economic growth.

While ocean disposal simply transfers waste to its final resting place, recycling gives new life to salvageable materials while also creating new job opportunities. Furthermore, recycling has the ability to create jobs including downstream trade jobs many times over when material is reconstituted for use a third and fourth time round etc.

The Ex-SAIPAN, a 27,000-ton, Tarawa-class amphibious assault ship launched in 1974, is currently being recycled in Brownsville, Texas. The project will last approximately one year, and will employ 250 people throughout the dismantling process.[65] This single vessel will generate millions of dollars of economic growth and will stimulate the local economy. This recycled material will then be sold and reused to manufacture new products, generating more jobs in fabrication, transport and resale within one use cycle. This entire process is repeated at the end of a product lifecycle, constantly creating jobs.

Using parametric estimations for warship content by weight, per Table 3 and Appendix B, and the Ex- SAIPAN job creation estimates mentioned above, one can generate a job loss estimate to give context to the labor force impacts from the ocean dumping of naval vessels over the past decade. As a rough approximation, for every 108 tons of material existing within a Combatant class vessel, approximately one U.S. green ship recycling job is created.[66] When looking over the past decade in which the Federal Government has disposed of 625,049 tons of material at sea of which only 9% was actual waste, (565,711 tons could have been fully recycled) the Federal government squandered away, at the very least, 5,787 direct green recycling jobs lost across the sector. For every 1 recycling job lost, 1.2 'indirect' jobs were also lost (6,944 jobs) and 1.3 'induced' jobs were lost (7,523 jobs) in the wider economy,[67] adding up to a total job loss estimate of 20,254 jobs. Indirect jobs are those created as a result of the

President Obama and Vice President Biden speak on creating jobs with ARRA funds; however they fail to recognize the many instances where government waste actually eliminates such job opportunities. One example is the dumping of retired Navy vessels at sea rather than recycling to create immediate job relief. In fact, Vice President Biden's home state of Delaware, along with the neighboring states of New Jersey and Maryland, are preparing the Ex-ARTHUR RADFORD for ocean disposal in spring 2011. This sinking will send hundreds of jobs to the depths of the sea.
Image Source: White House Photo/Pete Souza

[65] *http://recenter.tamu.edu/newstalk/main.asp?a=5*

[66] *Author's calculation per information gathered from industry: Approximately 108 tons (light displacement) = 1 recycling job*

[67] *http://www.foeeurope.org/publications/2010/More_Jobs_Less_Waste_Sep2010.pdf*

industry purchasing goods and services from other types of businesses (accounting, legal, office supply companies, etc.). Induced jobs are those created as a result of the industry employees and indirect employees spending their wages to bolster another round of economic activity.

Recycling these naval assets brings a high job creation return on investment. With 73 ships, containing 565,711 tons of recyclable material valued at $567 million, more than 20,000 jobs could have been created. Compare this to President Obama's January 2010 announcement in which $2.3 billion in Federal tax credits was expected to create 17,000 new green jobs.[68] Clearly, recycling makes job sense, particularly in a time when U.S. unemployment rates continue to hover around 10%.

[68] *http://www.csmonitor.com/Business/new-economy/2010/0108/Obama-to-create-17-000-green-jobs.-What-s-a-green-job*

CONCLUSION

Ocean disposal of obsolete government ships is currently being justified by what proves to be a series of faulty economic analyses and traditional assumptions. What is true is that artificial reefing and SINKEX involve the ocean dumping of toxic waste with the underlying motivation being the cheap disposal of such waste. The secondary motives of national security, in the case of SINKEX, or fisheries enhancement, in the case of reefing, are upon second examination, faulty or overstated. Ocean disposal simply moves waste and any harm stemming there from one area of the environment to another, not a clear act of disposal, but rather an act of pollution distribution and cost externalization. At the same time it loses forever, precious resources and jobs. These economic costs are scuttled just like the pollution, overboard.

The notion that our seas are vast enough and our natural world resilient enough to act as our dumping ground has long passed. We know now that contaminants do not assimilate innocuously into the environment but in fact are often persistent (as in PCBs), or immortal (as in heavy metals) and that these contaminants do not just diffuse, but rather bioconcentrate and contaminate the marine food chain for years to come.

Our old ships need to be managed in a more rational, sustainable and economic manner than has been our habit. By prioritizing cost internalization through environmentally sound recycling here at home, the government can create the win win win scenario of protecting the environment, stimulating the economy and creating U.S. jobs.

We urge the government as a matter of economic obligation to taxpayers and future generations to reconsider future ocean disposal plans and choose recycling over ocean dumping.

APPENDIX A

MARAD Scrapping Cost Estimates vs. Actual Costs 2001-2008

Vessel	Tons	2001 Scrapping Cost Estimate	Actual Cost	Over-Estimated Difference
Lynch	1,200	(408,000)	(544,418)	-136,418
Mirfak	2,036	(692,240)	(414,768)	277,472
Mormacdawn	7,545	(2,565,300)	(778,837)	1,786,463
Caloosahatchee	10,000	(3,400,000)	(1,489,895)	1,910,105
Canisteo	10,000	(3,400,000)	(1,551,082)	1,848,918
Canopus	12,000	(4,080,000)	(1,825,194)	2,254,806
Compass Island	4,500	(1,530,000)	(2,049,691)	-519,691
Rigel	8,097	(2,752,980)	(1,171,232)	1,581,748
Catawba Victory	4,518	(1,536,120)	(1,103,206)	432,914
Marine Fiddler	8,199	(2,787,660)	(1,258,890)	1,528,770
Robert Conrad	1,200	(408,000)	(99,000)	309,000
Opportune	1,530	(520,200)	(135,490)	384,710
Petrel	1,653	(562,020)	(166,500)	395,520
Albert Watts	9,000	(3,060,000)	(3,452,193)	-392,193
Santa Elena	8,912	(3,030,080)	(1,349,185)	1,680,895
Patch	12,535	(4,261,900)	(2,732,541)	1,529,359
Wayne Victory	4,442	(1,510,280)	(901,759)	608,521
Wood County	4,164	(1,415,760)	(789,716)	626,044
Export Challenger	7,080	(2,407,200)	(2,473,600)	-66,400
Lauderdale	6,600	(2,244,000)	(985,620)	1,258,380
General Walker	12,451	(4,233,340)	(1,365,350)	2,867,990
General Darby	12,657	(4,303,380)	(1,137,878)	3,165,502
Neosho	9,400	(3,196,000)	(1)	3,195,999
Sunbird	1,653	(562,020)	(85,920)	476,100
Protector	3,500	(1,190,000)	(533,042)	656,958
Tiogo County	2,628	(893,520)	(1,122,850)	-229,330
Wabash	1,980	(673,200)	(1,366,580)	-693,380
Mizar	2,036	(692,240)	(243,900)	448,340
Wahkiakum County	2,686	(913,240)	(1,102,850)	-189,610
Neptune	5,251	(1,785,340)	(398,601)	1,386,739
Waccamaw	11,000	(3,740,000)	(496,319)	3,243,681
Connecticut	9,856	(3,351,040)	(1,299,327)	2,051,713
Marshfield	6,700	(2,278,000)	(335,000)	1,943,000
Nemasket	1,998	(679,320)	(1,252,367)	-573,047
Mormacwave	8,268	(2,811,120)	(1,396,095)	1,415,025
Naeco	8,359	(2,842,060)	500	2,842,560
Builder	7,000	(1,600,000)	(1,613,349)	-13,349
Pawcatuck	9,486	(3,225,240)	(569,373)	2,655,867
Point Loma	9,415	(3,201,100)	(897,792)	2,303,308
Florence	7,789	(2,648,260)	(996,992)	1,651,268
Gilmore	9,734	(3,309,560)	(742,675)	2,566,885
Murphy	4,929	(1,675,860)	5,550	1,681,410
Beaujolias	7,414	(2,520,760)	(1,047,137)	1,473,623

Saugatuck	5,252	(1,785,680)	(549,999)	1,235,681
Orion	9,734	(3,309,560)	(734,230)	2,575,330
Hannibal Victory	4,612	(1,568,080)	(978,698)	589,382
Barnard Victory	4,609	(1,567,060)	(1,442,804)	124,256
Occidental Victory	4,567	(1,552,780)	(1,191,987)	360,793
Sioux Falls Victory	4,490	(1,526,600)	(978,698)	547,902
Mississinewa	9,400	(3,196,000)	(0.02)	3,196,000
Vulcan	9,140	(3,107,600)	(494,000)	2,613,600
Jason	9,140	(3,107,600)	(1,426,035)	1,681,565
Queens Victory	4,566	(1,552,440)	(1,180,000)	372,440
Hunley	10,500	(3,570,000)	1,500	3,571,500
Empire State	8,240	(2,801,600)	(851,194)	1,950,406
Hoist	1,505	(511,700)	(95,000)	416,700
Cape Charles	5,876	(1,997,840)	(488,965)	1,508,875
American Banker	10,048	(3,416,320)	(1,302,877)	2,113,443
Santa Cruz	9,099	(3,039,660)	(1,009,885)	2,029,775
American Ranger	7,545	(2,565,300)	(796,600)	1,768,700
Santa Isabel	9,982	(3,393,880)	(970,772)	2,423,108
Mormacmoon	7,545	(2,565,300)	(1,309,853)	1,255,447
Donner	5,323	(1,809,820)	(565,207)	1,244,613
TOTAL	**422,574**	**($142,841,160)**	**($59,635,469)**	**$83,205,691**

( ) = MARAD Expense **- = Underestimate**	2001 Estimated Average Price/ton **$338**	Actual Price/ton **$141**	Overestimated Difference **58%**

Source: Table developed by author using data from Navy and MARAD 2001-2008 Reports to Congress on the Progress of the Vessel Disposal Program.

APPENDIX B

Naval Vessels Disposed At Sea, 2000-2010

Sink Date	Vessel Name	Action	Light Displacement (Long Tons)
2000	USS Worden	SINKEX	5,905
2000	USS Gaffey	SINKEX	9,676
2000	USS Buchanan	SINKEX	3,640
2000	USS Ramsey	SINKEX	2,643
2001	USS Reeves	SINKEX	5,829
2001	USS Gaum	SINKEX	13,549
2002	Caron (DD 970)	SINKEX	6,810
2002	Towers (DDG 9)	SINKEX	3,190
2002	Hoarold E Holt (FF 1074)	SINKEX	3,225
2002	White Plains (AFS 4)	SINKEX	9,797
2002	Rathburne (FF 1057)	SINKEX	3,305
2002	Wainwright (CG 28)	SINKEX	5,340
2002	Hepburn (FF 1055)	SINKEX	3,238
2003	Yosemite (AD 19)	SINKEX	11,205
2003	Dixon (AS 37)	SINKEX	13,967
2003	Samual Gompers (AD 37)	SINKEX	13,458
2003	Ingersoll (DD 990)	SINKEX	6,373
2003	Downes (FF 1070)	SINKEX	3,187
2003	Leftwich (DD 984)	SINKEX	6,516
2003	Bigelow (DD 942)	SINKEX	6,649
2004	Portland (LSD 37)	SINKEX	8,615
2004	Decatur (DDG 31)	SINKEX	2,967
2004	Barbour County (LST 1195)	SINKEX	4,982
2004	(IX 542)	SINKEX	600
2004	Inchon (MCS 12)	SINKEX	14,152
2004	Peoria (LST 1183)	SINKEX	5,152
2004	Conserver (ARS 39)	SINKEX	1,497
2004	USS Peterson (DD 969)	SINKEX	6,929
2004	USS John Young (DD 973)	SINKEX	6,722
2004	USS Kinkaid (DD 965)	SINKEX	6,952
2004	USS Harry W. Hill (DD 986)	SINKEX	6,278
2004	USS Nicholson (DD 982)	SINKEX	6,745
2004	USS Hayler (DD 997)	SINKEX	7,467
2004	USS Schenectady (LST 1185)	SINKEX	5,008
2005	Deyo (DD 989)	SINKEX	6,870
2005	Elliot (DD 967)	SINKEX	7,028
2005	USS America (CV 66)	SINKEX	61,174
2005	USS Guadalcanal (LPH 7)	SINKEX	13,465
2005	USS Mount Vernon (LSD 39)	SINKEX	8,762
2005	USS William H. Standley (CG 32)	SINKEX	7,388
2005	USS Oldendorf (DD 972)	SINKEX	7,086
2005	USS Fife (DD 991)	SINKEX	6,646
2005	USS Briscoe (DD 977)	SINKEX	6,765
2006	Comte De Grasse (DD 974)	SINKEX	6,579
2006	Stump (DD 978)	SINKEX	6,636
2006	USS O'Brien (DD 975)	SINKEX	6,877
2006	USNS Butte (T-AE 27)	SINKEX	10,524
2006	USS Mauna Kea (AE 22)	SINKEX	9,286
2006	USS Belleau Wood (LHA 3)	SINKEX	26,520
2006	USNS Mars (T-AFS 1)	SINKEX	9,852

2006	USS Thorn (DD 988)	SINKEX	6,721
2006	USS Valley Forge (CG 50)	SINKEX	7,396
2006	USS Spruance (DD 963)	SINKEX	6,649
2007	La Salle (AGF 3)	SINKEX	9,559
2007	Sailfish (SS 572)	SINKEX	2,030
2007	USS Knox (FF 1052)	SINKEX	3,200
2007	USS Jouett (CG 29)	SINKEX	5,340
2008	Spica (AFS 9)	SINKEX	10,205
2008	USS David R. Ray (DD 971)	SINKEX	6,671
2008	USS Horne (CG 30)	SINKEX	5,340
2008	USS Fletcher (DD 992)	SINKEX	6,593
2008	USS Cushing (DD 985)	SINKEX	7,121
2008	USS O'Bannon (DD 987)	SINKEX	7,039
2009	USS Conolly (DD 979)	SINKEX	6,600
2010	USS Acadia (AD 42)	SINKEX	13,526
2010	USS New Orleans	SINKEX	13,285
2010	USS Monticello	SINKEX	6,880
2010	USS Anchorage	SINKEX	8,325
2010	USNS Saturn	SINKEX	10,205
2002	USS Spiegel Grove	Artificial Reefing	8,899
2006	USS Oriskany	Artificial Reefing	32,519
2007	USS Texas Clipper	Artificial Reefing	7,970
2008	USS Vandenberg	Artificial Reefing	9,950
		Total	**625,049**

SOURCES

Adams, J.A. and S. Slaughter-Williams. 1988. The effects of PCBs on fertilization and morphology in *Arbacia punctulata*. Water Air Soil Pullot. 38: 299-310.

Agency for Toxic Substances & Disease Registry; http://www.atsdr.cdc.gov/hac/pha/pha.asp?docid=1159&pg=2

American Institute of Fishery Research Biologists Briefs, The Rediscovery of the Free Lunch and Spontaneous Generation: "Is Artificial Reef Construction Out of Control," 1987.

Annex A, Stockholm Convention on Persistent Organic Pollutants.

Article III (2), Decision C(87)2/Final, Convention on the Organization for Economic Cooperation and Development.

Article V, Convention on the Organization for Economic Cooperation and Development.

Belanger, S.E., D.S. Cherry, and J. Cairns, Jr. 1990. Functional and pathological impairment of Japanese Medaka (*Oryzias latipes*) by long-term asbestos exposure. Aquat. Toxicol. 17: 133-154

Belanger, S.E., K. Schurr, D.A. Allen, and A.F. Gohara. 1986. Effects of chrysotile asbestos on coho salmon and green sunfish: evidence of pathological stress. Environ. Res. 39: 74-85.

Brouwer, A., P.J.H. Reijnders, and J.H. Koeman. 1989. Polychlorinated biphenol (PCB)-contaminated fish induces vitamin A and thyroid hormone deficiency in the common seal. Aquatic Toxicology. 15: 99-106.

Brown, Lester Plan B 2.0, New York: W.W. Norton, 2006. p. 109

Clark, R.B. 1992. Marine Pollution. Clarendon Press, Oxford, 172.

Clayton, Mark, March 19, 2008. The Christian Science Monitor*, Ships sail to scrap yards via legal loophole*

Coale, K.H., S.E. Fitzwater, R.M. Gordon, K.S. Johnson, and R.T. Barber. 1996. Control of community growth and export production by upwelled iron in the equatorial Pacific Ocean. Lett. Nature 379: 621-624.

Crude Oil and Commodity Prices, 4/21/2010, http://www.oil-price.net/

DAKOFA - Danish Competence Centre on Waste

Decision Memorandum – EPA Regulation of PCBs on Vessels Used for Navy Sinking Exercises, September 7, 1999

den Beston, P.J., J.M.L. Elenbaas, J.R. Maas, S.J. Dieleman, H.J. Herwig, and P.A. Voogt. 1991. Effects of cadmium and polychlorinated biphenyls on steroid metabolism and cytochrome P-450 monooxygenase system in the sea star *Asterias rubens L.*

AquaticToxicology. 20: 95-100.

Divemaster News, USS Hoyt Vandenberg Still to be Sunk, August 17, 2008. http://www.divemaster.com/diving-news/uss-hoyt-vandenberg-still-to-be-sunk_32823.html

Dodrill, Jon and Turpin, Robert. PCB Monitoring on the ORISKANY Reef (Pat II. Initial Sampling Event). 2008. http://www.sdafs.org/FLAFS/PDF/October%202008%20issue.pdf

Dodrill, Jon, Artificial Reef Program Administrator, Florida Fish and Wildlife Conservation Commission, ARTIFICIAL REEF PROGRAM SUMMARY OVERVIEW, September 2007

EPA, 2001; A Guide for Ship Scrappers: Tips for Regulatory Compliance; Appendix A, A-7

EPA's comments on DoD's FY04 Legislative Proposals to the National Defense Authorization Act: http://www.cpeo.org/pubs/EPA%20RRPI%20Response.pdf

EPA, Consumer Factsheet on: Polychlorinated Byphenils. http://www.epa.gov/safewater/contaminants/dw_contamfs/pcbs.html

EPA, Habitat Protection: Final Guidance. http://www.epa.gov/OWOW/oceans/habitat/artificialreefs/documents/introduction.html

EPA, Terms of Environment: Glossary, Abbreviations, and Acronyms (Revised December 1997)

EPA/NAVY Memorandum of Agreement, Ocean Disposal, 1996. http://peoships.crane.navy.mil/inactiveships/pdf/1996_EPA_Agreement.pdf

Executive Order 13101--Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1998_register&docid=fr16se98-113

FAO (2004) State of World Fisheries and Aquaculture (SOFIA) - SOFIA 2004. FAO Fisheries Department

Federal Register/Vol. 73, No. 126/Monday, June 30, 2008/Notices

Feldman, Bob. War on Earth, Dollars and Sense, March/April 2003. Also see the Military Toxics Project, www.miltoxproj.org.

FORRESTAL Museum President, Mr. William H. Natter, Jr., letter to USS FORRESTAL Museum members

Foti, Frank J. 2000. Statement of Frank J. Foti, President and Chief Executive Officer, Cascade General, Inc., before the U.S. House Transportation and Infrastructure Committee Subcommittee on Coast Guard and Maritime Transportation.

Froescheis, Oliver, Ralf Looser, Gregor M. Cailliet, Walter M. Jarman and Karlheinz Ballschmiter, 2000. The deep-sea as a final global sink of semivolatile persistent organic

pollutants? Part I: PCBs in surface and deep-sea dwelling fish of the North and South Atlantic and the Monterey Bay Canyon (California), Chemosphere, Volume 40, Issue 6, March 2000, Pages 651-660.

Frost, B.W. 1996. Phytoplankton bloom on iron rations. Nature 383: 475-476.

Georgia Straight Alliance, Artificial Reefs and Fish Habitats: What the Experts Say http://www.georgiastrait.org/?q=node/604

Government Accountability Office, Federal Surplus Ships: Government Efforts to Address the Growing Backlog of Ships Awaiting Disposal; October 1998.

Government Accountability Office: Improved Program Management Needed to Address Timely Disposal of Obsolete Ships, March 2005; http://www.gao.gov/new.items/d05264.pdf

Hazen and Sawyer Associates. 2001. Socioeconomic study of reefs in southeast Florida. Report for Broward, Palm Beach , Miami-Dae, and Monroe Counties, the Florida Fish and Wildlife Conservation Commission and the National Oceanic and Atmospheric Administration. Pg 259

Hess, Rushworth, Hynes, Peters; Rand Report, Disposal Options for Ships, 2001

House of Representatives, Subcommittee on Coast Guard and Maritime Transportation, Committee on Transportation and Infrastructure, Washington, D.C. Wednesday, May 24, 2000. http://commdocs.house.gov/committees/trans/hpw106-93.000/hpw106-93_1.HTM

International Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1985. http://www.austlii.edu.au/au/other/dfat/treaties/1985/16.html

Kawasaki, T. 1984. The distribution and behavior of fishes in the artificial reef fishing grounds; IJI, *Biological* process in the ocean; R. Marushige, ed. Koseisha Koseikaku, Tokyo, pp. 197-200. (Engl. transl. by T. Otsu, 1987, 7 p., Transl. No. 109)

Leach Rate Study, Prospective Risk Assessment Model for ex-ORISKANY, US Navy Resource Conservation and Recovery Act, 40 CFR part 261.2(b)(1)

Lukens, R.R. and Selberg, C. February 2004. Guidelines for Marine Artificial Reef Materials, Second Edition. GSMFC. Ocean Springs, MS. http://www.gsmfc.org/publications/GSMFC%20Number%20121.pdf

Mackay, D., W.Y. Shiu, and K.C. Ma, 1992. Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals, Vol. I, Monoaromatic Hydrocarbons, Chlorobenzens, and PCBs. Lewis Publishers, Boca Raton, FL, 697pp.

Maritime Administration, Report on the Program for Scrapping Obsolete Vessels, Report MA-2000-067, March 10, 2000.

Matsunaga, K., Y. Suzuki, K. Kuma, and I. Kudo. 1994. Diffusion of Fe(II) from an iron propagation cage and its effect on tissue iron and pigments of macroalgae on the cage.

J.Appl. Phycol. 6: 397-403.

Mille, Keith; FWC Division of Marine Fisheries Management Artificial Reef Program

Monterey Bay National Marine Sanctuary Site Characterization – Biological Communities and Assemblages – Pelagic Zone. http://montereybay.noaa.gov/sitechar/pelagic5.html

National Defense Reserve Fleet Inventory, February 28, 2010; http://www.marad.dot.gov/documents/NDRF_Inventory.pdf

National Fishing Enhancement Act of 1984, Title II. Appendix B, Artificial Reefs, Public Law 98-632

National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs, May 2006

Naval Sea Systems Command Report to Congress. Report on Plan for Disposal of Certain Vessels Stricken from the Naval Vessel Register (NVR). April 2009.

Navy Inactive Ships Program, Frequently Asked Questions, Artificial Reefing http://peoships.crane.navy.mil/inactiveships/Artificial_Reefing/FAQ_reefing.htm

Navy Ship Disposal Faq. http://peoships.crane.navy.mil/inactiveships/Ship_Disposal/FAQ_disposal.htm

New Rules Project, A Program of the Institute of Local Self-Reliance

Nijkerk, Alfred, March 2006. Shipbreaking International, *Shipbreaking USA*.

NOAA FISHERIES SERVICE BEGINS PROCESS TO END OVERFISHING BY 2010, New Magnuson-Stevens Act First Step to Implementation / Comments Sought

Official letter from Carol Browner, EPA Administrator, to Richard Danzig, Secretary of the Navy, September 13, 1999.

Olsen, Erik, New York Times, Out of Commission Above Water, but Not Below It, August 18, 2008. http://www.nytimes.com/2008/08/19/science/earth/19ship.html

Opdal, A.F., Godo, O.R., Bergstad, O.A., Fiksen, O, 2007. Distribution, identity, and possible processes sustaining meso- and bathypelagic scattering layers on the northern Mid-Atlantic Ridge

ORISKANY Post-sinking Monitoring Study 3 ½ year progress report data, 2006-2009

1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 29 December 1972. http://www.austlii.edu.au/au/other/dfat/treaties/2006/11.html

Public Law 103-451; National Maritime Heritage Act, 1994

Public Law 106–398; National Defense Authorization, 2001

Public Law 107-314

Public Law 92-402

Report of the Interagency Panel on Ship Scrapping, 1998

Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009 (Page A-4)

Report to Congress on the Progress of the Vessel Disposal Program, Department of Transportation, Maritime Administration, October 2005

Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, 2001

Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, 2002

Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, 2007

Report to Congress on the Progress of the Vessel Disposal Program, US Department of Transportation, Maritime Administration, January 2008

Roberts, Kathleen. Public Affairs Specialist, Naval Sea Systems Command

Shively, Dale, Texas Parks and Wildlife, *Texas Clipper: A New Artificial Reef in the Gulf of Mexico*

Sterner, G.R.; Naval Sea Systems Command; Official Correspondence with Captain Charles Wendt, USAF; Subject: "Resumption of Sinking Exercises" (5 August 1994); http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA323505&Location=U2&doc=GetTRDoc.pdf (pg. 5).

Stockholm Convention on Persistent Organic Pollutants. 1997. http://www.pops.int/documents/convtext/convtext_en.pdf

Takeda, S. 1998. Influence of iron availability on nutrient consumption ratio of diatoms in oceanic waters. Nature 393: 774-777.

Tazmanian Aquaculture and Fisheries Institute http://www.redmap.org.au/resources/impact-of-climate-change-on-the-marine-environment/upwelling-and-downwelling

TCC Artificial Reef Subcommittee. January 1997. Guidelines for Marine Artificial Reef Materials. GSMFC. Ocean Springs, MS.

Thompson, D.R. 1990. Metal levels in marine vertebrates. In R.W. Furness and P.S. Rainbow (eds.), Heavy Metals in the Marine Environment. CRC Press, Inc., Boca Raton, pp 143- 183.

Tomczak, M.,1998. Shelf and Coastal Oceanography.

http://www.es.flinders.edu.au/~mattom/ShelfCoast/notes/chapter06.html

Tungett, David, Captain US Navy, Program Manager, Navy Inactive Ships Program in letter to USS FORRESTAL Musuem President, Mr. William H. Natter, Jr., 11 October 2006

U.S. Maritime Administration, Notice of Assessment, Suisun Bay, June 2008

U.S. Office of Management and Budget, Maritime Administration Ship Disposal Program, www.whitehouse.gov/omb/expectmore/detail/10004010.2006.html

United States Government Accountability Office (GAO). 2005. Maritime Administration: Improved Program Management Needed to Address Timely Disposal of Obsolete Ships. March 2005. GAO-05-264. Report to the Ranking Minority Member, Subcommittee on Readiness, Committee on Armed Services.

Vogel, Steve. U.S. Forced to Pay Recyclers to Take Old Merchant Ships, The Washington Post, September 7, 2009. http://www.washingtonpost.com/wp-dyn/content/article/2009/09/06/AR2009090601989.html

Waste & Climate Change Background document for the ISWA & DAKOFA conference on Waste & Climate Change 3-4 December 2009 in Copenhagen - *to be held in connection to the UN Climate Summit COP 15 in Copenhagen 7-18 December 2009*

Wells, M.L. N.M. Price, and K.W. Bruland. 1995. Iron chemistry in seawater and its relationship to phytoplankton: a workshop report. Mar. Chem. 48: 157-182.

Woodhead, A.D., R.B. Setlow, and V. Pond. 1983. The effects of chronic exposure to asbestos fibers in the Amazon molly, *Poecelia Formosa*. Environ. International. 9:173-176

Yamane, T., Status and future plans of artificial reef projects in Japan. Bull. Mar. Sci. 43.