Gulf of Alaska Keeper
Senate Environment and Public Works Subcommittee Testimony

Gulf of Alaska Keeper members began conducting large-scale marine debris cleanups in 2002. In 2006, we organized as a 501(C)(3) nonprofit to tackle the marine debris problem in the Gulf of Alaska, a region of approximately six hundred thousand-square miles. That would cover an area from Maine to Florida to Kansas. Over 9 years, GoAK crews removed 1.5 million pounds of plastic debris from 1500 miles of relatively accessible and protected Gulf of Alaska shorelines. In the past three years, GoAK's cleanup efforts have focused on the more remote and rugged outer coast where the marine-debris density is up to 30 tons of plastic per mile. In 2015, GoAK and partners collected an additional 1 million pounds of plastic from less than 60 miles of that shoreline. Cleanup costs on these remote beaches can surpass $100,000 per mile. Thousands of miles remain to be cleaned.

GoAK's marine debris work has received significant support from NOAA's Marine Debris program, the Exxon Valdez Oil Spill Trustee Council, the Government of Japan, the Alaska Legislature, the Alaska Department of Environmental Conservation, private foundations, corporations and individuals. There is no long-term dedicated funding. Consequently, cleanup organizations cannot properly plan or capitalize projects. Several Alaska organizations conduct marine debris cleanups, debris monitoring, and public awareness campaigns, but GoAK is the most active Alaskan organization and the only one whose primary focus is on marine debris remediation and removal. In addition to cleanup projects, GoAK also conducts an extensive marine-debris monitoring program and collaborates with the College of William and Mary and the University of Alaska Anchorage researchers studying the biological impacts on marine wildlife caused by the noxious chemicals, particularly phthalates, leaching from plastic marine debris.

An astounding amount of marine debris covers the Gulf of Alaska coast. Countless shipwrecks, immense quantities of creosote treated piling and power poles, loads of treated lumber, metal navigation buoys, massive metal fuel tanks and steel drums litter the shoreline. However, the most insidious debris is the vast quantity of plastic that blankets large swaths of the Gulf of Alaska coast. In a triage forced by limited resources, GoAK primarily focusses on plastic debris removal.

Plastic marine debris has several primary sources. Over 50% of the plastic debris by weight on Gulf of Alaska beaches is commercial fishing debris such as lines, nets, packing bands, fish totes, plastic pallets, crates, baskets, pot gear and buoys. Consumer products ranging from tiny plastic cosmetic beads to large appliances vastly outnumber all other plastic debris. Natural disasters such as floods, typhoons and tsunamis inject millions of tons of plastic debris into the Western Pacific, much of which ends up on Alaska's shores. Much of that debris is polystyrene and polyurethane plastic foam that is 30 to 40% of the debris by volume. Much of the foam debris is from structures destroyed by natural disasters, but a sizeable component is from freezer holds of sunken fishing vessels, lost refrigerated shipping containers, cargo spills, aquaculture buoys and deliberate dumping in the waters of developing countries. Shipping-container spills and other shipwrecks add tons more hard-plastic debris. Deliberate dumping is a

significant factor, as is debris flushed into the Pacific when typhoons, floods and other storms occur in countries with poor waste management.

Plastic marine debris pollution is one of the most significant environmental issues of our time. Everywhere scientists search in the marine environment, they find plastic debris, or the chemical components of plastic. Plastic marine debris extends from the floor of the deepest ocean through the water column to the surface. Particles of plastic are imbedded in the ice surrounding the North Pole. Every coastal shoreline has a fringe of plastic debris, from sub-micron particles to giant blocks of polyurethane or styrene foam. Monstrous pools of plastic debris circle in giant mid-ocean gyres, spewing out shore-bound debris when disturbed by storms. Nearly all marine organisms tested by scientists contain plastic particles or carry a biological load of harmful plastic chemicals. From the tiniest plankton to the greatest whales, plastic marine debris is exacting a largely unrecognized but terrible environmental toll. As scientists increasingly link the ingestion of plastic chemicals with harmful health impacts, plastic debris potentially threatens the viability of commercial fisheries. Consumption of plastic-tainted seafood and subsistence resources such as contaminated seabirds and their eggs threatens human health. Alaska's rich fisheries, among the world's most productive, could suffer devastating environmental and economic blows from plastic debris.

The Alaska Pacific tidal shoreline exceeds 30,000 miles. The Gulf of Alaska's intertidal habitat, awash in plastic debris, is a highly productive Class 1 ecosystem that provides spawning grounds and rearing nurseries for rich offshore fisheries. Plastic marine debris is a clear threat to this prolific system.

While the entire marine environment suffers from this man-made catastrophe, the Gulf of Alaska's rich coastal ecosystem has been hurt much more than most. The Ocean Conservancy recently identified China, Thailand, the Philippines, Vietnam, and Indonesia as the five countries responsible for the greatest contribution to the marine-debris problem. Judging by the amount of South Korean plastic debris on Alaskan beaches, South Korea also belongs in this group. All these countries fringe the South China Sea or abut the Western Pacific. Due to an unfortunate confluence of currents, storms and geography, the Gulf of Alaska's expansive coast receives a massive amount of the discarded plastic debris from these countries. However, while these countries and natural disasters are responsible for approximately 90% of the consumer plastic debris by <u>volume</u> on Alaska's beaches, remember that commercial fishing is responsible for at least 50% of the <u>weight</u> of plastic marine debris on our coast. We are all to blame for the marine debris problem.

There are no rational options other than to confront the marine debris problem. This desecration of the oceans must stop. How? This is an international issue and in the case of Alaska is a problem that originates in foreign countries or from offshore fisheries largely controlled by foreign or Lower 48 fishing companies. Clearly, MARPOL Annex V, the international treaty that bans plastic dumping in the ocean, must be strengthened and enforcement of its prohibition strongly supported. There is virtually no enforcement now. The preventable sources of marine debris such as poor onshore waste management, intentional dumping, harmful commercial fishing practices, and reckless commercial cargo-shipping industry practices can be addressed through education and the imposition of taxes to internalize the

cost of cleaning up derelict fishing gear or lost shipping-container cargo. Public education can help reduce the use of plastics and promote appropriate disposal and recycling options.

However, even with perfect education and compliance, marine debris will always be a problem because of natural disasters, container spills and shipwrecks. Support for aggressive industrial-scale initial debris removal is critically important on an ongoing basis. All federal and state land-management agencies with coastal habitat must be required to include funding for maintenance cleanups in their annual budgets. They must not have the discretion to ignore this issue. Plastic debris cannot continue to pile upon critical intertidal habitat. It is not inert. It will pollute and harm sensitive habitat and wildlife for generations.

Because of the international component of the marine-debris problem, particularly in Alaska, the Federal government must take the lead on this issue by facilitating an international response and providing significant funding to remove the debris that has already landed on our shores. Conservatively, it will take at least $100,000,000 to clean the most heavily impacted Alaskan shorelines. While GoAK strongly supports NOAA's Marine Debris Program, we recommend that additional Federal money for marine-debris removal be provided in block grants directly to state agencies such as Alaska's Department of Environmental Conservation.

Adapted from Proofs for publication in Archives of Environmental Contamination and Toxicology (in press 2016):

TISSUE PHTHALATE LEVELS CORRELATE WITH CHANGES IN IMMUNE GENE EXPRESSION IN A POPULATION OF JUVENILE WILD SALMON

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ABSTRACT

Phthalates have detrimental effects on health and have been shown to dysregulate the immune system of mammals, birds, and fish. We recently reported that di(2-ethylhexyl) phthalate exposure reduces the abundance and inhibits the proliferation of rainbow trout (*Oncorhynchus mykiss*) IgM^+ B lymphocytes and expression of secreted immunoglobulin heavy-chain mu transcripts in an *in vitro* culture system. We proposed that phthalates act as immunomodulators by modifying the normal B cell-activation pathways by accelerating B cell differentiation while suppressing plasmablast expansion, thus resulting in fewer IgM-secreting plasma cells. This hypothesis was tested here in an *in vivo* field study of juvenile Dolly Varden (*Salvelinus malma*) from a plastic-polluted lake in the Gulf of Alaska. Fish tissues were analyzed for both phthalate levels using liquid chromatography-coupled tandem mass spectrometry and for changes in immune gene expression using reverse transcriptase-real time polymerase chain reaction. Results showed that fish with higher tissue levels of di(2-ethylhexyl) phthalate, di(*n*-butyl) phthalate, and/or dimethyl phthalate expressed significantly fewer secreted and membrane-bound immunoglobulin heavy-chain mu and Blimp1 transcripts in their hematopoietic tissue. This suggests that *in vivo* uptake of phthalates in fish changes the expression of B cell-specific genes. **Chronic exposure to phthalates likely dysregulates normal B-lymphoid development and antibody responses in salmonids and may increase susceptibility to infection. Given the conserved nature of B-lineage cells in vertebrate animals, other marine species may be similarly affected by chronic phthalate exposure.**

Phthalate levels in fish tissues (in ppb):

JUVENILES

	GI		LIVER		MUSCLE	
	Dolly V *EI 2013*	***LOD***	Dolly V *EI 2014*	***LOD***	Dolly V *EI, 2014*	***LOD***
DEHP	91.5 +/- 37.0	6.8	97.0 +/- 32.0	1.36	122.3 +/- 24.2	9.8
DMP	9.0 +/- 1.6	6.3	ND	ND	11.1 +/- 0.58	4.1
DBP	87.7 +/- 21.6	2.1	ND	ND	5.6 +/- 1.3	3.9
BBP	18.7 +/- 8.2	4.3	15.1 +/- 5.0	0.96	1.2 +/- 0.28	0.84
DEP	7.8 +/- 4.0	5.6	50.4 +/- 16.7	1.39	<LOD	1.3
DNoP	24.2 +/- 7.5	3.6	<LOD	1.8	ND	
Total:	**238.9**		**162.5**		**140.2**	

ADULTS

	LIVER Coho		LIVER Halibut		MUSCLE Coho		MUSCLE Halibut	
	PWS 2010	***LOD***	*CI 2010*	***LOD***	*PWS 2010*	***LOD***	*CI 2010*	***LOD***
DEHP	<LOD	2.4	<LOD	2.4	3.0 +/- 0.92	2.4	4.9 +/- 1.4	2.4
DMP	2.5 +/- 0.8	1.5	<LOD	1.5	<LOD	1.5	<LOD	1.5
DBP	32.6 +/- 29.1	0.13	51.8 +/- 25.2	0.13	8.7 +/- 5.1	0.13	35.8 +/- 25.8	0.13
BBP	<LOD	2	<LOD	2	<LOD	2	<LOD	2
DEP	<LOD	0.67	<LOD	0.67	<LOD	0.67	<LOD	0.67
DNoP	<LOD	1.6	<LOD	1.6	<LOD	1.6	<LOD	1.6
Total:	**35.1**		**51.8**		**12.0**		**41.2**	

TABLE I. Phthalate levels in fish tissues. Values are in ng/g tissue and are averages +/- SE. Gastrointestinal: GI. Dolly Varden, DV. EI, Elizabeth Island. CI, Cook Inlet, PWS, Prince William Sound. ND, not done. LOD: Limit of Detection.

Figure 3. Expression of antibody-producing genes in hematopoietic tissues of salmon is reduced in the presence of phthalates (Martins et al, 2016, in press):