PELAGIC PLASTIC
Paper Prepared For AB 259 (Krekorian),
AB 820 (Karnette), & AB 904 (Feuer)
From Algalita Marine Research Foundation (AMRF)

April 9, 2007

"California has a proud history and tradition of protecting our ocean. And we have the same kind of proud history and tradition of leading the country in our efforts to make sure that all of our oceans are clean, safe and productive." [1] Arnold Schwarzenegger
Governor, State of California

"The base of the marine food chain is being displaced by a non-digestible, non-nutritive component which is actually out-weighing and out-numbering the natural food. That is our core issue." Charles Moore
Captain, ORV *Alguita;* Founder, AMRF

INTRODUCTION

AMRF respectfully submits its views on the subject ABs, in hopes that this will help clarify how important an issue they address. (AMRF, www.algalita.org, is a 501(c) 3 non-profit dedicated for the last several years to the study of the effects of marine debris generated by humans on the oceans.)

Representatives from AMRF recently attended a public workshop held by the US Commission on Ocean Policy and provided public comment (see Appendix A). This Commission's report as well as that of the Pew Oceans Commission has concluded that our oceans are in trouble. Both reports state the need for action. If passed, this suite of legislation will help curb the amount of plastic marine debris and dangerous pollution entering the ocean.

In 2004, the State of California funded a $500,000 grant (the Plastic Debris Project) to Algalita Marine Research Foundation to investigate the various ways plastics were escaping during the plastic manufacturing process. On February 8, 2007, the Governor's Ocean Protection Council unanimously adopted a new Resolution on Reducing and Preventing Marine Debris. The facts in the Resolution were earlier stated in the *Plastic Debris, Rivers to Sea* Plan of Action from the Plastic Debris Project,[2] based on Algalita Marine Research Foundation's data collected and archived during this project.

Legislation is vital for guaranteeing that these actions are carried out. AMRF supports AB 258, AB 820, and AB 904 because these bills will largely reduce the densest part of plastic marine debris, including pre-production plastic resin pellets and single-use plastic food packaging as well as increase public awareness of the importance of plastic safety through education. As found during the Plastic Debris Project, enforcement at the government level is needed to ensure that best management practices are followed, as there is little incentive for organizations to comply voluntarily.

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[1] <http://gov.ca.gov/index.php?/press-release/2724/>

[2] Gordon, Miriam, "Eliminating Land-based Discharges of Marine Debris in California: A Plan of Action from the Plastic Debris Project," (June 2006), California Coastal Commission, LARWQCB & SWRCB.

The remainder of this submission presents our position on the particular problems with plastic waste and its entry into marine life cycles so that the reader may better understand the critical need for the above bills, as well as the need for further work and regulation of this major detrimental anthropogenic effect on our marine environment.

THE PROBLEM WITH PLASTICS

Marine pollution represents one of the most significant environmental problems facing mankind.[3] Since 70% of the Earth's surface area is covered by an interconnected ocean, marine debris is a global issue. The ocean's vast surface area, which many people have never seen, except perhaps on a beach, may be part of the reason that people do not feel alarmed at how much of our trash has reached the center of the ocean.

The ocean has historically been viewed as a dumping ground. Unlike their experience with an overflowing trash bin at home, people cannot literally see the effects of the marine debris on the ocean, its marine life and the ecosystems involved. With more research and understanding of the world ocean and all its waterways, we have become intensely aware of how much the Earth needs the ocean, because all life is intricately linked to it.

The amount of marine debris is increasing in spite of global treaties such as MARPOL Annex V and the Marine Plastic Pollution Research Control Act to prevent pollution in international waters, and increasing efforts in developing countries to protect water quality. For example, the abundance of micro plastics in the Central North Pacific went up by a factor of 3 during the last decade[4] and off the coast of Japan by a factor of 10 every 2-3 years[5].

Plastics are the largest and most detrimental part of the marine debris problem. The majority of marine debris is comprised of plastic materials—60-80% overall and 90% of floating debris.[6] Plastic is a mix of monomers linked together to become polymers, to which additional chemicals can be added for suppleness, flame retardance, and other qualities. Because of their properties, plastics are essentially "forever": they do not biodegrade or dissolve into organic matter that can reenter the life cycle. Instead plastic photodegrades, which means it breaks up into smaller pieces when exposed to sunlight, and these smaller pieces persist in the marine environment for hundreds of years. No one knows the true length of time it will take for these plastic pieces to biodegrade, but researchers estimate that it could be several centuries. This is alarming, especially considering that 60 billion tons of plastic are being produced every year, and most of this for single use.

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[3] Tharpes, Yvonne, "International Environmental Law: Turning the Tide on Marine Pollution," 20 U. Miami Inter-Am. L.Rev. 579, 581.

[4] Charles Moore, Gwen Lattin, Ann Zellers, "Density of Plastic Particles found in zooplankton trawls from Coastal Waters of California to the North Pacific Central Gyre," in *Proceedings of the Plastic Debris Rivers to Sea* Conference, 2005 www.plasticdebris.org

[5] Ogi, H. 1990. Ingestion of plastic particles by sooty and short-tailed shearwaters in the North Pacific. pp. 635-652. *In*: R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris. April 2-7, 1989, Honolulu, Hawaii. US Dep. of Comm., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-154.

[6] J.G.B. Derraik, "The pollution of the marine environment by plastic debris: a review" *Marine Pollution Bulletin* 44 (2002):843; Gregory, M.R., Ryan, P.G. "Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives" in Coe, J.M. Rogers, D.B. (Eds.), *Marine Debris- Sources, Impacts and Solutions*, (1997) Springer-Verlag, New York, pp. 49-66

Pre-production plastic pellets (commonly known as nurdles or mermaid tears), are lentil-sized pellets, light enough to be swept up into the air and small enough to easily spill out of shipping containers when loading and unloading. When improperly stored these nurdles wash into waterways. Most of the pellets enter the waterways through storm water runoff into sewers and other drainage from pellet industries. A sizeable source of coastal pollution comes from these nurdles as well as plastic powders and production scrap. A survey done by S.L. Moore, et al., estimated that "approximately 106 million items, weighing 12 metric tons, occur in Orange County beaches… The three categories of plastics (pre-production plastic pellets, foamed plastics, and hard plastics) accounted for 99% of the total abundance and 51% of the total weight."[7] Another study estimates that nurdles now make up roughly 10% of plastic debris in the ocean. Recent research illustrates that plastic debris in smaller sizes is becoming more prevalent in the ocean, due partially to photodegraded pieces of plastic that are breaking down but not going away.

HOW PLASTICS MOVE

The North Pacific Central Gyre is a convergence zone with high atmospheric pressure, thus having weak currents and winds. With little current moving the water, marine debris that has been circulating in the oceans gets caught in these gyres (six in all). Algalita Marine Research Foundation has performed multiple studies in the North Pacific Central Gyre and has found that six times by weight more plastic particles than zooplankton exist in this location.[8] Hence the common nickname for this region is the "Eastern Garbage Patch", as the gyre traps and holds the trash unwittingly discarded by humans.

Plastics have been found throughout the ocean water column. Some plastic is buoyant (it floats), some neutrally buoyant, while other plastic is heavier and sinks. The plastic particles that float will circulate through the ocean currents, often traveling great distances as can be seen from the variety of debris on various coast lines. Uninhabited islands have some of the worst marine debris problems (as in the case of Kure Atoll), just from the currents along their borders washing up debris from inhabited places.

Some of this floating plastic may end up in the food chain because many marine organisms are known to ingest plastics they mistake for food. 40% of the premature deaths of innocent Albatross chicks in Midway Atoll are from plastics in the regurgitated food the parents provide their young.[9] Even zooplankton and marine invertebrates are known to ingest small plastic fragments of marine debris.[10] Nurdles are readily confused for fish eggs by mammals that consume them. Another problem related to marine organisms is entanglement, with mammals getting caught in various marine debris. Cases of harm to marine mammals range from the classic examples of fish being caught by a 6-pack soda ringlet to a baby turtle getting a plastic ring stuck around its shell - as he or she grows the shell deforms to a bow shape. Plastic debris affects at least 267 species worldwide, including 86% of all sea turtle species, 44% of all seabird species, and 43% of all marine mammal species.[11] Some wildlife harmed by plastic is threatened

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[7] Moore, S. L., D. Gregorio, M. Carreon, S.B. Weisberg, & M.K. Leecaster, "Composition and Distribution of Beach Debris in Orange County, California." *Marine Pollution Bulletin* 42.3 (2001): 241-245.

[8] C.J. Moore et al., (2001) "A Comparison of Plastic and Plankton in the Pacific Central Gyre," Marine Pollution Bulletin 42: 297-1300.

[9] Kenneth R. Weiss, "Plague of Plastic Chokes the Seas," (2 Aug 2006) *LA Times*.

[10] Richard C. Thompson, "Lost at Sea: Where is all the Plastic?" *SCIENCE Magazine*, 838, (May 7, 2004): 304.

[11] Laist, D.W. (1997) "Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of

or endangered species under California or federal law.

THE TOXICITY ISSUE

Plastics may be releasing pollutants because of their original additive components. Additives like, Nonylphenols, PBDEs, Phthalates, and Bisphenol A (BPA), are added to plastic during production to catalyze monomers into polymers and give it different properties like flexibility, durability and UV resistance. Some of these chemicals are considered hormone-disrupters. These chemicals have the potential to be released from plastics and enter the marine environment. Additives even contaminate the foods they are designed to protect. As an example, BPA has been linked with cancer and "mimics the activity of the endocrine disrupting chemicals. …Significant human exposure to BPA has been documented, and a number of small epidemiological studies have reported a relationship between blood levels of BPA and abnormalities such as miscarriage, ovarian disease, and obesity in humans. These studies were all conducted after similar findings had been reported in animals."[12] New research also demonstrates that plastics absorb, transport, and desorb hydrophobic pollutants. Nonylphenols, PCBs, DDT and DDE are three of the hydrophobic pollutants that are carried or absorbed by plastic particles and released by plastic debris.

Floating plastic particles also transport marine organisms that attach themselves to debris and migrate, serving as a vector for exotic species dispersal.[13] The arrival of these invasive species has vast consequences, including an estimated loss of global marine species diversity by 58% if this biotic mixing continues. The invasive species can be detrimental to littoral, intertidal and shoreline ecosystems because it dominates over the native species.[14] For example, plastic washed ashore on the Florida coast brought with it two bryozoan species, the *Membranipora tuberculata* and the *Electra tenella*, that are increasingly prevalent as dominant predators and continue to drift to the coast from the Caribbean.[15]

THE NEED FOR BMP's

Rationale for Land-Based Approach: Do NO more harm-STOP putting plastic in the ocean and our waterways: In view of the facts discussed above, the best way to begin addressing the problem is to concentrate on more efficient and less wasteful manufacture, usage, and disposal of plastic materials. Land-based debris is the most significant part of the marine debris problem; estimates indicate that 80% of marine plastic comes from land-based sources.[16] This switch of litter away from shipping- and fishing-related debris shows that the latter is no longer the key

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species with entanglement and ingestion records," in Coe, J.M.. Rogers D.B., (eds.) in Marine Debris—Sources, Impacts and Solutions. New York: Springer-Verlag; J.G.B. Derraik at 844.

[12] Vom Saal, F. S., W.V. Welshons, & S. Parmigiani "Leaching of Bisphenol A From Polycarbonate Plastic Disrupts Development via Epigenetic Mechanisms." Prepared for the Erice International Seminars on Planetary Emergencies, Erice, Italy. 19-26 August 2006.

[13] California Ocean Protection Council, "Resolution of the California Protection Council on Reducing and Preventing Marine Debris," (8 Feb 2007): 1-4. <http://resources.ca.gov/copc/02-08-07_meeting/Adopted_Marine_Debris_Res_0207.pdf>

[14] J.G.B. Derraik at 847.

[15] Winston, J.E., et al, "Encrusters, epibionts, and other biota associated with pelagic plastics: a review of biogeographical, environmental, and conservation issues," (1997) Coe, J.M.. Rogers D.B., (eds.) in Marine Debris—Sources, Impacts and Solutions. New York: Springer-Verlag; & J.G.B. Derraik at 847.

[16] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Public and Constituent Affairs, "Turning to the Sea: America's Ocean Future" (1999): 56. See also, UNEP, United Nations Environment Programme (1995) "Global Programme of Action for the Protection of the Marine Environment from Land-based Activities." Note by the secretariat. UNEP (OCA) /LBA/IG.2/7

problem area that it has been in the past.[17] Consumer products, particularly plastic materials, end up in the marine environment and can become widely dispersed.[18] Most of these products are carried by runoff from urban areas through the storm drains, man-built outfalls directly from sewage treatment plants, and waterways to the ocean, and from there are carried off by currents.

Some programs to clean up the larger pieces of marine debris, such as the drift nets, are effective, such as the National Oceanic and Atmospheric Administration ghost net removal program off the coasts of Hawaiian Islands. Programs for ocean cleaning are still in the planning stages. However, *the vast majority of debris cannot be removed due to its small size and abundance*. By focusing efforts on urban areas, we focus on the most significant sources and conveyances of debris.[19] Since there is no viable way to clean up the small plastic particles once they reach waterways, especially the ocean, the best way to begin mitigating the marine debris problem is to *stop the flow of debris to the marine environment.*

By enforcing a zero discharge policy from facilities handling pre-production plastics and all plastics facilities, we will begin to curb the tide on the increases of plastics in the ocean. Improving local solid waste management is another key element in addressing this problem: introducing measures first to reduce the generation of wastes at sources, then to properly manage wastes once generated. As an outcome of its Plastic Debris Project work and rather than "re-inventing the wheel" AMRF recommended use of Operation Clean Sweeps' (OCS) waste prevention protocols, set up by the American Chemistry Society and the Society of Plastics Industry. AMRF provided companies with the OCS manual and advised them on specific best management practices (BMPs) to help them to clean up their facilities. The OCS program was introduced a few years before the grant was set, and once AMRF's project began, it was blatantly obvious that most companies were not following the OCS. Even after spending time with them and offering this advice, most companies did not initiate any of the BMPs suggested nor did they sign the OCS pledge. These facts clearly show how little participation and concern for the pollution problem is evidenced within the plastic industry to curb plastic pellet loss and that voluntary programs to implement BMPs are not satisfactory in dealing with the problem. This lack of concern is attributable to the fact there are no consequences for failure to comply with the BMPs.

A regulatory system must be set up to ensure proper compliance with the BMPs and to properly enforce the release of these plastics into the marine environment. The regulation needs to encompass production, transportation, and storage of materials while setting up a fee system when rules are breached. Best Management Practices were proven successful for some of the companies who did actually comply with the voluntary BMPs AMRF recommended to them. A recommendation that was key in many facilities having minimal to no pellet loss was the presence of shop vacuums to clean up any spills immediately after they occurred. This cleanup can also benefit the company: some of them recycled these pellets back into their production, saving them money.

PLASTIC RECYCLING ISSUE

[17] Richard Thompson, Charles Moore, et al., "New Directions in Plastic Debris," *SCIENCE Magazine*, 310, (Nov 18, 2005): 1117.

[18] J.G.B. Derraik at 842-852.

[19] Gordon, Miriam, "Eliminating Land-based Discharges of Marine Debris in California: A Plan of Action from the Plastic Debris Project," (June 2006), California Coastal Commission, LARWQCB & SWRCB: 3.

Only 3-5% of plastic is currently recycled. There are seven different types of plastics in general use, all of which have numbers with the recycling triangle symbol. However, of those seven, only two can actually be recycled. Plastics with the number 1 triangle that makes up water and soda bottles, and the number 2 triangle that is used for milk jugs, are the only plastics that can be recycled at this time. Also, recycling plastic is different from recycling other products like glass and aluminum that can be made back into the products they were before. Recycled plastics cannot be used for food again because plastic melts at low temperatures, so chemicals and residue of past contents remain in the plastic. The plastics' molecular composition changes, its quality degrades, and the range of its usefulness shrinks.[20] Plastics cannot be melted at higher temperatures because this process releases toxins into the air. So recycled plastic must be downgraded and enter items that will not normally come into contact with food products. A milk jug can not be recycled into a new milk jug unless a new layer of virgin plastic is put on the inside of the jug to protect the milk from the chemicals absorbed by the recycled plastic. Virgin-plastic is cheaper to use than recycled plastic, so most manufacturers opt for the virgin material. Most of this recycled plastic becomes clothing or carpet that goes to the landfill once its second use is finished. Some of the lower quality plastic that has been 'recycled' is actually shipped to Asia, where it goes into landfills.[21]

THE NEED FOR EDUCATIONAL AWARENESS

Much of the marine debris arises from conscious acts of littering or dumping by individuals' human behavior. Each person throws away approximately 185 pounds of plastic per year. The natural tendency when littering is to be rid of one's garbage as fast as possible. Once a product is purchased, then consumed, the left over bi-product becomes garbage that a person naturally seeks to rid himself or herself of as quickly as possible. If there are no garbage or recycling bins nearby, the average person will drop it after a short period of time. Plastics' lightweight makes it prone to flying away even if it does land in a proper trash receptacle. Providing easy access collection receptacles, thus not requiring people to make a special trip is a cost-effective way to mitigate natural tendencies.

Communication is essential. Since human behavior is the major cause of marine debris, it is important to educate the public about the problems, so that the average person does not just drop their trash, but waits to find a garbage bin or preferably a recycling container to throw away unwanted product. The message needs to be clear and delivered in an effective way to reach the target audience.

COSTS

The presence of debris along shorelines can lead to serious economic problems for regions that are dependent on tourism. California has a $46 billion ocean tourism industry, and the trashed beaches are having a detrimental effect. The cost of removing the polluted debris reaches millions of dollars every year. Managing solid waste has high costs for both collecting it and its ultimate recycling and disposal. Reducing the wastes generated in the first place is the most cost effective means to address the issue, as less waste reduces both the costs of managing it and the chances for debris being released.[22]

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[20] Stallone, Steve, "Plastic Seduction," *San Francisco Bay Guardian* (15 Dec 1993).

[21] Stallone, Steve, "Plastic Seduction," *San Francisco Bay Guardian* (15 Dec 1993).

[22] Gordon, Miriam, "Eliminating Land-based Discharges of Marine Debris in California: A Plan of Action from the Plastic Debris Project," (June 2006), California Coastal Commission, LARWQCB & SWRCB: 57.

Cities of California are responding to this issue. In January 2005, San Francisco passed a mandate that charged consumers 17 cents per plastic or paper bag used at the grocery store. This was the first proposal of its kind in the United States. However in early 2006, the San Francisco Department of Environment and eight supermarket operators came to an agreement that the supermarkets would reduce the use of bags by 10 million by the end of 2006 to replace the 17-cent mandate.[23] This also failed since the passage of AB 2449 prohibits the regulation of traditional plastic shopping bags for six years. In response, the city mandated the use of biodegradable plastic bags by a 10-1 vote, making it illegal for supermarkets to use non-recyclable plastic bags.[24]

CONCLUSION

AMRF strongly supports the passage of AB 258, AB 820, and AB 904 and sees them as just the beginning, with many possibilities including furthering the education and research necessary to make the public aware of the issues that plastic poses - not only for our oceans but to human life as well.

With the acceptance that plastic marine debris is a legislative issue, we can begin to raise public awareness. It is vital that we continue to support research to further understand the effects of plastics on the environment, animals, and humans, thus improving future legislation. It is important that legislation specific to plastic waste be passed, because as of now legislation is limited to bulk waste management and does not address the special problems posed by photodegradation, in the absence of biodegradation, of plastics and its attendant toxicity for life on earth.

Respectfully Submitted,

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APPENDIX A

Ocean Research Priorities Plan
Recommendations for Improving Ecosystem Health

THE ISSUE

Plastics are the largest part of the marine debris problem: 90% of floating marine debris is comprised of plastic materials, 60-80% overall.[25] Any solutions the

[23] <http://www.findarticles.com/p/articles/mi_m0EUY/is_4_11/ai_n13828920>

[24] Glionna, John. "Paper or Plastic? San Francisco Decides." *Los Angeles Times* 28 Mar 2007: B1, B7.

[25] J.G.B. Derraik, "The pollution of the marine environment by plastic debris: a review" *Marine Pollution Bulletin* 44 (2002): 843; Gregory, M.R., Ryan, P.G. "Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives" in Coe, J.M. Rogers, D.B. (Eds.), *Marine Debris- Sources, Impacts and Solutions*, (1997) Springer-

committee makes must address the issue of plastic materials. Due to photo-degradation, the smaller bits of plastic are persisting in the ocean. These plastic pieces sorb pollutants up to a million times their level in ambient seawater.[26] Many species ingest the plastic or become entangled in it. The committee must provide more research in these areas. We must acknowledge also that plastics affect all global watersheds.

Land-based debris (litter) is the principal marine debris problem; nearly 80% comes from land-based sources.[27] Most small debris cannot be removed and with no viable way to remove it from the ocean, we must focus our efforts on small debris, preventing it from entering the watersheds.

SOLUTIONS

1. Research should identify geographic "hot spots" for production of litter and marine debris.
2. We must dedicate funds to existing research to better characterize trash in urban runoff.
3. Investigate the impacts on marine ecosystems of (a) photo-degraded plastics, (b) plastic additives as hormone disrupters, (c) rafting of marine species on plastics, and (d) pollutants sorbed to plastic.
4. The plan must include anti-litter education for beach visitors, cigarette smokers, boaters, motorists, pedestrians, commercial establishments, and the general public.
5. The plan must regulate the quantity of product and packaging waste generated by companies.
6. Increase enforcement of anti-litter laws as a deterrent to the most litter-prone segments of the population.
7. Develop a fee system to raise money for implementing solutions, including advanced disposal fees, litter enforcement fees, and increased garbage tipping fees.
8. Impose fees for excessive amount of single use and disposable products that consumers discard.

Captain Charles Moore, Captain of the Alguita Oceanographic Research Vessel and Founder of Algalita Marine Research Foundation.

Verlag, New York, pp. 49-66

[26] Mato, Yukie, Tomohilo Isobe, Hideshige Takada, et al, "Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment," in *Environmental Science & Technology* 35 (2001): 318-324.

[27] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Public and Constituent Affairs, "Turning to the Sea: America's Ocean Future" (1999): 56. See also, UNEP, United Nations Environment Programme (1995) "Global Programme of Action for the Protection of the Marine Environment from Land-based Activities." Note by the secretariat. UNEP (OCA) /LBA/IG.2/7