



Plastic Ingestion By Planktivorous Fishes in the North Pacific Central Gyre

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Introduction:

A significant amount of marine debris, both large and small, has accumulated in the North Pacific Central Gyre (NPCG). The effects of marine debris on larger marine organisms have been documented through reported cases of entanglement and ingestion, however, little is known about the effects of this debris on lower trophic level marine organisms in this area. As a step in understanding this relationship, the present study is the first of its kind to document ingestion and quantify the amount of plastic found in the gut of common planktivorous fish in the NPCG. In 1999, Algalita Marine Research Foundation (AMRF) discovered that in the NPCG neuston plastics averaged over 300,000 pieces per km² (Moore *et al.* 2001). In 2008, an AMRF neuston trawl survey of the same area found a dramatic increase in the number of particles per km² to 752,110 (unpublished data). This increase in particles per km² may affect the ability of fish to distinguish between plastic and their natural food sources.



Results and Discussion:

February 2008 – Gyre Voyage

Total Fish = 670 (46% immature)

35% had plastic in the stomachs



6 Species:	Count	% with Ingested Plastic
<i>Astronesthes indopacifica</i> <i>Indo-Pacific snaggletooth</i>	6	16
<i>Cololabis saira</i> <i>Pacific saury</i>	51	16
<i>Hygophum reinhardtii</i> <i>Reinhardt's lanternfish</i>	43	23
<i>Loweina interrupta</i> <i>Lanternfish</i>	26	8
<i>Myctophum auro lanternatum</i> <i>Golden lanternfish</i>	460	37
<i>Symbolophorus californiensis</i> <i>Big fin lanternfish</i>	74	56

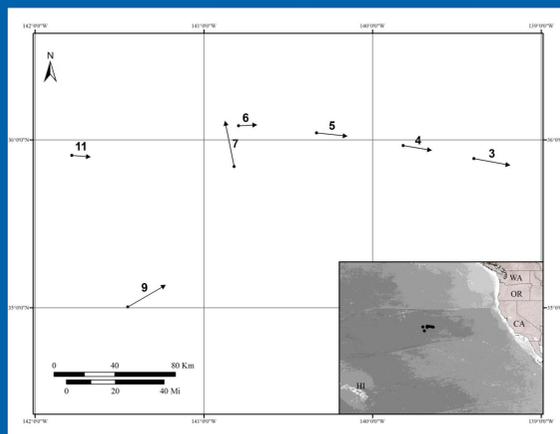
A total of 670 fish were processed, representing five mesopelagic and one epipelagic species, which included *Symbolophorus californiensis*, *Myctophum auro lanternatum*, *Loweina interrupta* and *Hygophum reinhardtii* (Family Myctophidae), and *Astronesthes indopacifica* (Family Stomiidae). The epipelagic species was *Cololabis saira* (Family Scomberesocidae). Approximately 35% of the fish examined had plastic pieces in their guts. A total of 1,375 pieces of plastic, ranging from 1 to 83 pieces per fish and averaging 2.1 pieces (± 5.78) per fish, were collected from fish guts. Quantitatively, the average number of plastic pieces ingested increased as the size of the fish increased. Qualitatively, ingested plastic consisted primarily of fragments (94%), film (3%), fishing line (2%), and finally rope, Styrofoam and rubber (all <1% total). These plastics represented a wide variety of colors, with white, clear, and blue (87% total) being most prevalent. Similar percentages were observed in the analysis of non-ingested plastics obtained from the 11 neuston trawls.

In spite of evidence that more than one-third of the fish examined had ingested small plastic pieces, it is not possible to fully understand the effects of ingestion until it can be determined to what extent the fish are able to pass this plastic through the gut, and whether some plastic remains in the gut for the life span of the fish.

Manta Trawl



7 Trawl sites with fish – 6 night trawls and 1 day trawl



Methodology:

Eleven neuston samples were obtained by manta trawl from February 11 to 14, 2008. Fish, plankton, and anthropogenic debris were sorted and processed. Each fish stomach was removed and the contents were sorted into natural (plankton) and non-natural (plastic) food source groups. Plastic pulled from each fish stomach was categorized by size, color and type (fragment, line, foam, pellet and film)

Percent of plastic pieces by color.

Ingested Plastic		Neuston Trawl Plastic	
Color	Percent	Color	Percent
White	58.2	White	53.0
Clear	16.7	Clear	21.0
Blue/Green	17.2	Blue/Green	15.0
Gray	0.9	Gray	7.0
Black	3.6	Black	3.6
Brown/Tan	0.4	Brown/Tan	1.0
Yellow	1.0	Yellow	1.0
Orange/Pink/Red	2.2	Orange/Pink/Red	1.0

Mean count and mass of plastic retrieved from gut of fish by species.

Species	Abundance		Weight (mg)	
	Mean	Standard Deviation	Mean	Standard Deviation
<i>Astronesthes indopacifica</i>	1.0	-	0.03	-
<i>Cololabis saira</i>	3.2	3.05	1.97	2.245
<i>Hygophum reinhardtii</i>	1.3	0.71	1.82	1.830
<i>Loweina interrupta</i>	1.0	-	0.64	-
<i>Myctophum auro lanternatum</i>	6.0	8.99	4.66	7.385
<i>Symbolophorus californiensis</i>	7.2	8.39	5.21	7.847
Overall	2.1	5.78	1.57	4.755

Conclusions:

This study examines the ingestion of plastic by lower trophic level fish and confirms the ingestion of plastic debris by planktivorous fishes in the NPCG.

Further study is needed to understand the impacts of plastic debris on the general health and life cycle of these fish, to investigate the potential for pollutant transfer to higher trophic levels, and to explore possible actions to protect the quality of aquatic life.

Percent of plastic pieces by Type (form).

Type (Form) of Plastic Ingested	Percent
Fragment	93
Film	3
Line	2
Foam	< 1
Rubber	< 1
Pellets	0

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Myctophid record holder
Stomach contained 83 plastic particles



Large plastic particle impacted in fish, it had to be broken to be removed

