THE MARINE PLASTIC DEBRIS PROBLEM OFF SOUTHERN AFRICA: TYPES OF DEBRIS, THEIR ENVIRONMENTAL EFFECTS, AND CONTROL MEASURES

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ABSTRACT

Plastic debris is a global marine pollutant which is inflicting ever-increasing environmental and financial costs. In the seas off southern Africa and the adjacent Southern Ocean, entanglement has been recorded for at least 5 species of marine mammals, 13 seabird species, 2 turtles, and 6 shark species. Plastic ingestion has been recorded from 7 marine mammal species, 36 seabird species, 2 marine turtle species, and 7 shark species. The incidence in invertebrate taxa is not known. At present, entanglement does not pose a threat to the survival of any populations off southern Africa, but the recent introduction of a driftnet fishery to the South Atlantic and Indian Oceans and the suffering frequently associated with entanglement are causes for concern. By contrast, ingestion of plastic particles may adversely affect almost the entire population of species that do not regurgitate indigestible objects, with large, accumulated plastic loads reducing feeding efficiency or obstructing the digestive tract. Off southern Africa, generalist, surface-feeding, pelagic taxa such as certain procellariiform seabirds (petrels and albatrosses) and juvenile marine turtles are at risk from plastic ingestion. The incidence of ingested plastic in some species exceeds 90% of the population. The major financial cost of marine plastic debris is the reduced aesthetic appeal of coastal areas, which adversely affects the tourist industry. In South Africa alone, approximately R10 million is spent annually on cleaning beaches, where plastic makes up more than 90% of all stranded debris.

To address the problem of marine debris requires knowledge of the sources of various pollutants. Beach surveys readily assess the most abundant types of plastic debris, and from these data their sources can be inferred. Disposable packaging accounts for more than half the large plastic objects on southern African beaches, with most of the remainder composed of fishing gear. Sheet plastic (bags and wrappings) is the most abundant single type of plastic. Among small particles, virgin industrial pellets and fragments of other products predominate.

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Using these findings to assign culpability and to elicit assistance, four approaches are being used to tackle the problem of marine plastic debris off southern Africa: education, product substitution, recycling, and legislation. As a short-term measure, specific types of artifacts responsible for most entanglements (e.g., hi-cone six-pack yokes, packing straps) and ingestion (e.g., virgin pellets, plastic bags) have been targeted for action. These approaches to control marine plastic pollution are discussed in relation to the highly diverse socioeconomic conditions prevailing in southern Africa.

INTRODUCTION

Much concern recently has been focused on the problems associated with anthropogenic marine debris, particularly as regards plastic (Shomura and Yoshida 1985; Laist 1987; Wolfe 1987). A variety of approaches has been adopted to tackle these problems, but have concentrated on maritime legislation (e.g., Bean 1987; Lentz 1987) and on awareness campaigns in developed, first world communities (e.g., Neilson 1985). Other than international maritime legislation, there have been few attempts to tackle the growth of marine debris arising from third-world communities. The southern African region comprises virtually the entire socioeconomic spectrum, and is to a large extent isolated from the world's major manufacturing centers. It is thus a useful area for examining the efficacy of various measures taken to limit persistent debris production. This paper reviews the occurrence of anthropogenic marine debris off southern Africa and in adjacent oceanic areas, and summarizes the known environmental effects of debris. The approaches used to identify the sources of marine debris and to control the amount of litter entering the sea are discussed.

THE SEAS OFF SOUTHERN AFRICA

Southern Africa has an unindented coastline, with few large bays or inlets (Fig. 1). Strong wave action is characteristic of much of the coast, with sandy beaches comprising almost 70% of the coastline. The continental shelf is narrow (<50 km wide) off the east coast, moderately broad (up to 150 km wide) off the west coast, and is most extensive off the south coast, where the Agulhas Bank extends more than 200 km offshore.

There are two main current systems. The cool (10°-16°C) Benguela Current flows north along the west coast, and is characterized by localized upwelling of cold, nutrient-rich bottom water when surface waters are advected offshore (Shannon 1985). The warm (22°-28°C) Agulhas Current flows south, close inshore along the east coast until it reaches the Agulhas Bank, where it moves offshore. South of the subcontinent, the Agulhas Current retroflects to flow eastward in oceanic waters to the north of the Subtropical Convergence (Lutjeharms 1981). However, large (500-km diameter) eddies formed at the retroflection zone frequently transport Agulhas Current water into the South Atlantic (Lutjeharms 1988; Lutjeharms and Valentine 1988). Elsewhere to the south of the subcontinent, the predominant surface flows are eastward, associated with the West Wind Drift (Lutjeharms et al. 1988).

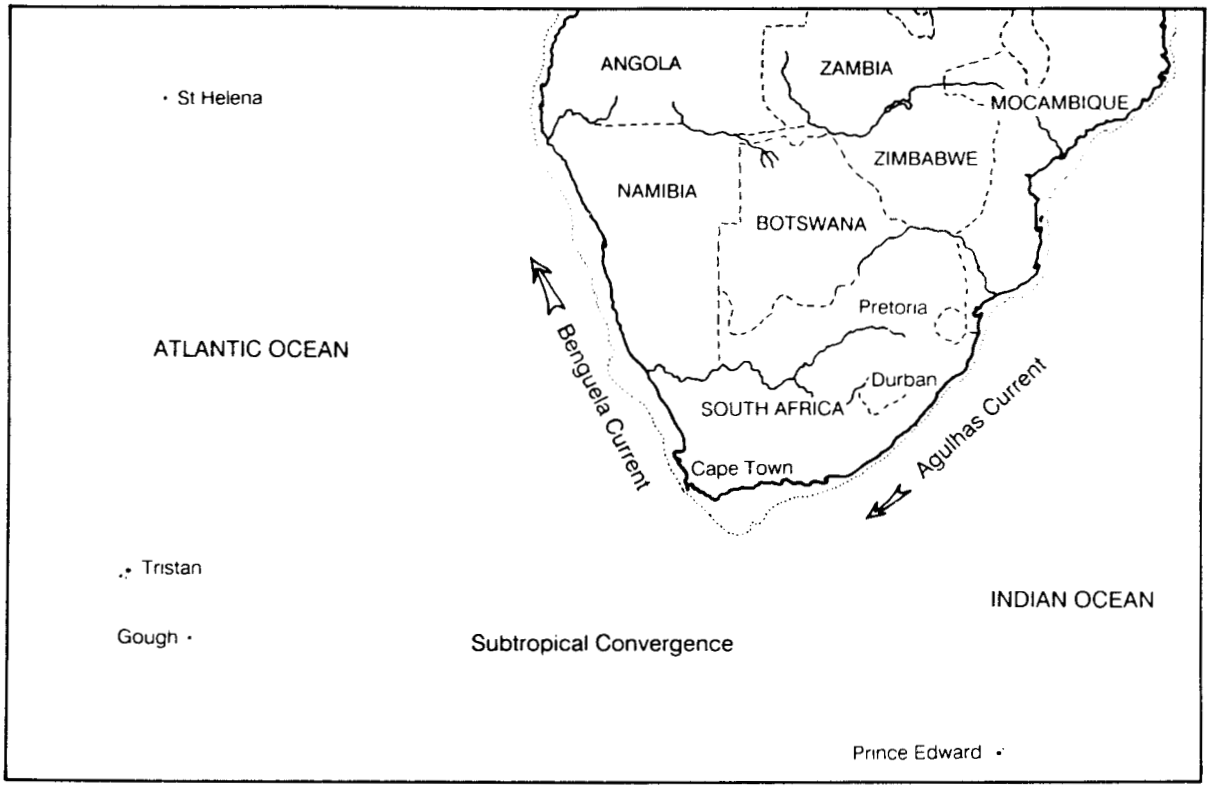

Figure 1.--The southern African region and adjacent oceans. The stippled line indicates the approximate edge of the continental shelf.

Most merchant ships in the area travel around southern Africa following the Cape sea route between Europe-North America and the Persian Gulf-Southeast Asia. This route runs close inshore along the south and east coasts of southern Africa, only moving offshore off the west coast. There is relatively little transoceanic merchant trade to either South America or Australia.

Commercial fisheries off southern Africa are concentrated on the broad continental shelves off the south and west coasts, where there are extensive demersal (bottom trawl) and pelagic (purse seine) fisheries (Crawford et al. 1987). There is a limited prawn fishery off the east coast, and a longline tuna fishery in oceanic waters. Gillnets were little used in the region until 1989, when oriental vessels started using driftnets more extensively in both the South Atlantic and South Indian Oceans (Ryan and Cooper in press).

THE DISTRIBUTION OF PLASTICS AND OTHER DEBRIS AT SEA

Little has been recorded of the distribution and abundance of plastic and other debris at sea off southern Africa. The abundance, distribution, and movements of tar balls at sea have been documented for two regions off the southern African coast, with a view towards identifying coastal areas

vulnerable to oil pollution (Shannon et al. 1983). The abundance of small plastic particles (<10 mm diameter) also has been estimated from surface neuston trawls. Morris (1980) reported densities ranging between 1,300 and 3,600 virgin industrial pellets km^{-2} in oceanic waters of the Cape Basin west of Cape Town.

The density of plastic debris in coastal waters off the southwestern Cape averaged 3,640 particles km^{-2}, derived from over 1,200 neuston trawls conducted at monthly intervals during 1977-78 (Ryan 1988a). Seasonal patterns of distribution and abundance were related to probable source areas and transport at sea. However, the highly clustered dispersion of particles, presumably due to fine-scale convergence zones, resulted in great variances in debris abundance estimates (range 0-445,000 particles km^{-2}), largely as a consequence of the relatively small sampling area (190 m^2 per trawl). Foamed plastics and fragments of manufactured articles were the most abundant types of particles, but virgin industrial pellets accounted for most of the mass (mean 42.4 g km^{-2}; Ryan 1988a). It appears that at least a significant proportion of the debris arises from local sources, with concentrations inshore and close to harbors (Ryan 1988a, cf. Morris 1980). However, there is also evidence that the Agulhas Current is an important debris vector (Ryan 1988a).

A small number of neuston trawls (39) in oceanic waters south of southern Africa in the Agulhas retroflection area collected only two plastic particles, both fragments of manufactured articles (P. G. Ryan unpubl. data). This gives a density estimate for the area of only 50 particles km^{-2}, similar to the density in the Southern Ocean south of New Zealand (Gregory et al. 1984).

Ryan (1988a) found that the density of large (>100 mm diameter) objects counted from a low-flying plane was an order of magnitude greater 10 km from the shore (19.6 objects km^{-2}) than 50 km offshore (1.6 km^{-2}) in the area between Cape Town and Saldanha Bay, where the merchant shipping lane runs close inshore. This offshore gradient is likely to be less marked farther north off the west coast where the continental shelf is broader (hence fishing grounds more extensive) and the shipping lane runs farther offshore. In oceanic waters south of the subcontinent, in the region of the Agulhas retroflection, ship-based counts provided density estimates of between 0.04 and 0.09 large objects km^{-2} (P. G. Ryan unpubl. data).

These data refer only to floating debris. Virtually nothing is known about debris on the seabed off southern Africa. Debris comprised of materials denser than seawater presumably does not disperse far from source areas. Such items occasionally are caught in bottom trawls off the west coast (B. Rose pers. commun.; pers. observ.). Floating debris can also sink if it supports sufficient sessile organisms or entangles enough animals to increase the density above that of seawater. Such objects have a much greater dispersal capability than do plastics that are denser than seawater.

IMPACTS OF MARINE DEBRIS

Marine debris has both environmental impacts and financial costs. The major financial burden results from the reduced aesthetic appeal of polluted marine systems. Beaches are important for the >R2,000 million per annum tourist industry in southern Africa, and their appeal is reduced when they are littered with stranded debris. In South Africa alone some R10 million is spent annually on cleaning litter off beaches.

Apart from the accumulation of unsightly debris, the main environmental impact associated with marine debris is animal mortality through entanglement in and ingestion of debris. In addition, it has been suggested that anthropogenic debris is having some ecological effect by increasing the amount of available substratum onto which sessile organisms can settle (Carpenter and Smith 1972; Winston 1982), and it is possible that debris has increased the rate of propagule dispersal to islands (Ryan 1987b). However, the significance of the latter two impacts has not been determined.

Entanglement off Southern Africa

Entanglement involves animals becoming enmeshed in objects that impede movement, causing drowning, starvation, or reduced fitness, or restrict growth, cutting deep wounds into growing animals. This typically involves fairly large pieces of debris, and the apparent suffering associated with entanglement engenders considerable public concern.

Representatives of five marine vertebrate classes are known to have become entangled in debris off southern Africa (Table 1); there are no data for invertebrate groups. Most records are from coastal waters (where there are most observers), but a few entangled seals and birds have been found at subantarctic islands. Overall, the incidence of entanglement is fairly low, with only one species, the great white shark, *Carcharodon carcharias*, having more than 1% of individuals examined entangled in debris. There may be some cause for concern along the south coast, where 14% of stranded birds are entangled in debris ($n = 97$), with 28% of the vulnerable jackass penguin, *Spheniscus demersus*, entangled ($n = 32$, P. G. Ryan unpubl. data).

However, interpretation of the incidence of entanglement is complicated by different sampling techniques. For example, recoveries of banded crested terns, *Sterna bergii*, in southern Africa indicate that 14.2% ($n = 267$) of birds are captured after being entangled in debris, whereas only 2.2% ($n = 46$) of stranded birds were found entangled ($\chi^2 = 5.23$, $P < 0.05$; FitzPatrick Institute unpubl. data). And yet it is to be expected that the proportion of entanglement among stranded animals is higher than that among the general population, although the exact relationship is unclear. Also, it is not possible to infer the consequences of a given level of entanglement on population trends. Northern fur seal, *Callorhinus ursinus*, numbers have been decreasing apparently at least partly as a result of a 0.4% frequency of entanglement (Fowler 1987). A similar entanglement frequency has been recorded at some Cape fur seal,

Table 1.--A summary of the known incidence of entanglement of marine animals in plastic objects and other debris off southern Africa, excluding the by-catch of nontarget species during fishing operations (including shark exclusion nets). Based on Shaughnessy (1980), Balazs (1985), and (unpubl. data) from G. Avery, P. B. Best, N. Rice, G. J. B. Ross, and the Natal Sharks Board.

Taxon	Type of debris	Frequency of occurrence
Cetaceans	Ropes, nets	Three plus species, apparently infrequent.
Seals	Ropes, nets, line 92% Packing straps 6% O-rings 2% Wire <1%	Cape fur seals 0.12%, but 0.6% in one colony. Two records at subantarctic islands.
Birds	Nets, rope, line 89% Plastic bags 11%, Six-pack yokes	Thirteen species, 0.6% of stranded animals but up to 14% locally.
Turtles	Rope	Two species.
Fish	All packing straps	Six species of sharks, 0.2% of shark-net catch, incidence ranges 0-1.4%.

Arctocephalus pusillus, colonies (Shaughnessy 1980), and yet this species' population is increasing by 3.7% per year (David 1987).

The types of objects causing entanglement off southern Africa vary among taxa (Table 1). However, most items are either fishing gear (rope, netting, and fishing line) or disposable packaging (primarily plastic packing straps and plastic bags). Only one item was not made of plastic; a single seal was found with a piece of wire caught around its neck (Shaughnessy 1980).

These data on entanglement ignore the incidental catch of animals during commercial fishing operations. Some birds and mammals are caught in demersal trawls (e.g., Ryan and Moloney 1987) and by the longline fishery (e.g., Ryan and Rose 1988), but for at least these taxa the fishery by-catch is relatively small (cf. Tull et al. 1972; Piatt and Nettleship 1987), due largely to the limited use of gillnets. The impact of the recent expansion of oriental driftnet fisheries in oceanic waters of the South Atlantic and South Indian Oceans needs urgent investigation. The killing of seabirds for food by fishermen is an ongoing problem (Cooper 1977; Ryan and Rose 1988).

Table 2.--A summary of the known incidence of marine animals ingesting plastic objects and other debris off southern Africa. Based on Hughes (1973), Ryan (1987a), and unpubl. data from P. B. Best, J. H. M. David, G. J. B. Ross, and the Natal Sharks Board.

Taxon	Type of debris	Frequency of occurrence
Cetaceans	Plastic bags 8 Plastic bottles 1 Packing strap 1	Seven species, 3.0% of stranded animals.
Seals	--	No records.
Birds	Virgin plastic pellets 56% Plastic user fragments 43% Wood, tar balls, paint, glass, and aluminium foil 1%	Thirty-six species, incidence ranges 0-92% with 10 species >50% and 4 species >80%.
Turtles	Plastic bags 75% Virgin plastic pellets 25% Glass 1 piece	Two species, 11.1% of stranded animals.
Fish	Plastic bags 82% Plastic bottles 12% Nets and line 6%	Seven species of shark, 0.3% of shark-net catch, incidence ranges 0-6%.

Debris Ingestion off Southern Africa

The effects of debris ingestion are seldom as dramatic as those of entanglement, but ingested debris can cause death or debilitation by obstructing the digestive tract (e.g., Balazs 1985; Fry et al. 1987) or reducing meal size and the urge to eat (e.g., Ryan 1988b). Ingested plastic may also be a source of toxic chemicals (e.g., Ryan et al. 1988).

Ingestion of marine debris has been recorded for four vertebrate classes off southern Africa (Table 2); there are no data for invertebrate groups. Debris ingestion is much more prevalent than is entanglement, affecting over 90% of individuals of blue petrels, *Halobaena caerulea*, and great shearwaters, *Puffinus gravis*, breeding at oceanic islands (Ryan 1987a). The incidence of debris ingestion among southern African seabirds is among the highest in the world, largely due to the predominance of generalist, surface-feeding procellariiform seabirds (petrels, storm-petrels, shearwaters, and albatrosses) that do not frequently regurgitate indigestible objects and thus accumulate ingested plastic (Ryan 1987a, 1988c). The present incidence of debris ingestion by turtles may be greater than the 11% indicated in Table 2, because there are no observations subsequent to 1973. Debris ingestion by birds has increased since the late 1970's off southern Africa (Ryan 1988c).

Ingestion of debris off southern Africa by large proportions of populations of birds and turtles in particular is cause for concern. Almost all debris ingested is plastic that floats in seawater (Table 2). The few nonfloating debris items found in animals apparently are eaten ashore (e.g., gulls at refuse dumps, giant petrels at their breeding islands). Although the types of objects ingested are influenced by an animal's size (e.g., Ryan 1987a), two types of plastic objects make up the majority of ingested debris: virgin industrial pellets and plastic bags (Table 2). Reducing the abundance of these items at sea is the only long-term solution to the problem of debris ingestion.

TACKLING THE MARINE DEBRIS PROBLEM

Marine debris is extremely heterogeneous in terms of both the size and composition of artifacts and the wide range of their sources. This diversity makes the control of marine debris problematic. Examining the various impacts of marine debris highlights the types of debris responsible for most environmental problems. Off southern Africa these are discarded fishing gear, various types of plastic packaging (notably bags and packing straps), and small plastic particles (chiefly virgin industrial pellets). These types of debris warrant most attention, but the implementation of effective measures to reduce the amount of debris entering the sea requires knowledge of the sources of marine debris. It is evident that the general source of discarded fishing gear is the various fishing industries, providing a ready target for action. However, the sources of packaging and, to a lesser extent, industrial pellets are highly diffuse, complicating the assessment of culpability.

Using Beach Surveys to Identify Debris Sources

Beach surveys offer the simplest and most practical way to assess the relative abundance of various types of marine debris and to identify their probable sources (e.g., Merrell 1980; Vauk and Schrey 1987). However, one problem with stranded debris surveys is controlling for the selective removal of debris by beachcombers (see Ryan 1987b). Surveys at uninhabited islands avoid this problem. Figure 2 shows the numerical dominance of plastic articles and the much faster growth in amount of plastic debris compared with other debris types at Inaccessible Island in the Tristan group, central South Atlantic Ocean. Most of the debris identifiable as to country of origin derives from South America, and the proportion has been increasing: 32% in 1984, 36% in 1987, and 48% in 1988. Given the limited merchant trade across the South Atlantic, it is likely that much of the plastic debris reaching Inaccessible Island has drifted more than 3,000 km from South America (Ryan and Watkins 1988).

This contrasts with the situation on southern African beaches, where most identifiable debris derives from local sources. A survey of stranded debris at 50 sandy beaches between Cape Town and the Transkei was undertaken during June 1984. All large (>20 mm) articles within representative 50-m stretches of beach were collected (P. G. Ryan unpubl. data). Plastic made up more than 90% of stranded debris, and was recorded at all beaches sampled. Disposable packaging (e.g., bags, bottles; Fig. 3) comprised more

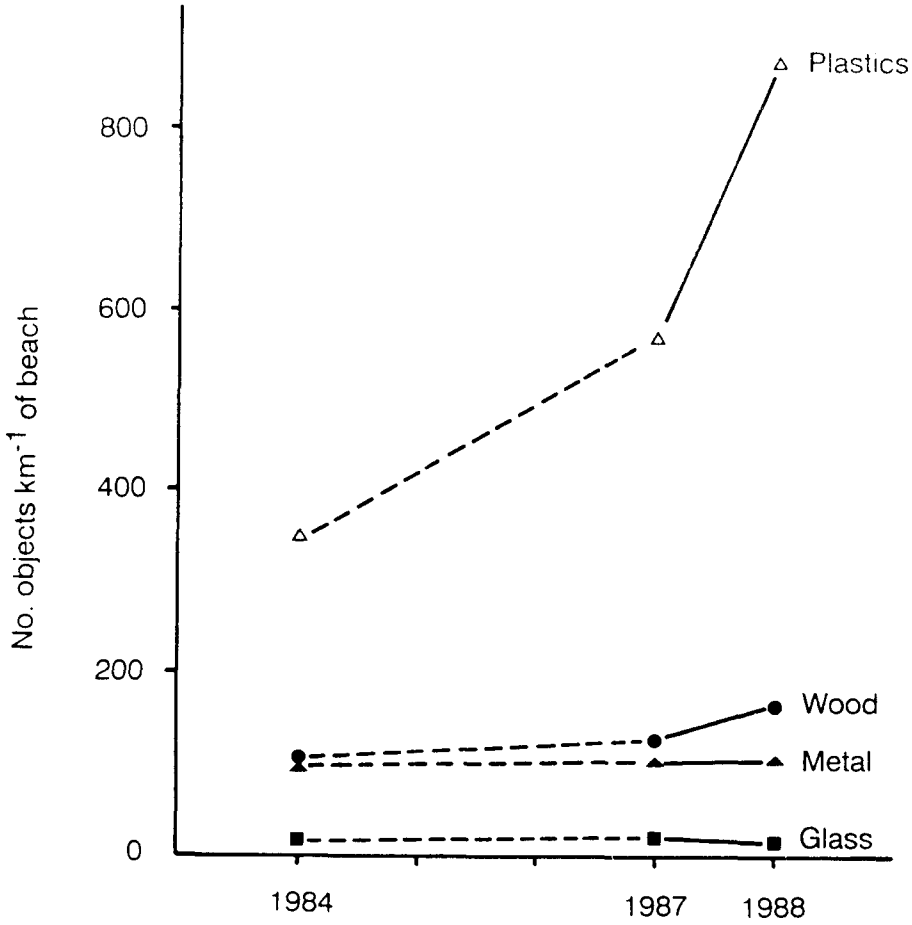

Figure 2.--The densities of various types of stranded debris at uninhabited Inaccessible Island during 1984 (Ryan 1987a), 1987 (Ryan and Watkins 1988), and 1988 (P. G. Ryan unpubl. data). Dashed lines between 1984 and 1987 indicate the lack of samples during this period.

than half of all plastic articles (57%), with fishing gear (netting, ropes, monofilament line, floats, traps, and fish boxes) making up most of the remainder (31%; Fig. 3). Almost half of the packaging was sheet plastic (bags and wrappings constituting 47% of packaging; Fig. 3), whereas polypropylene rope made up most of the fishing gear (85%).

The relative proportions of packaging and fishing gear among stranded plastic debris varied with distance from human settlements. Beaches in urban areas had a much greater proportion of packaging than either rural or island beaches (Fig. 4). This indicates that dumping of garbage from ships is not the only source of debris; urban areas in coastal South Africa also contribute significantly to marine debris loads (although selective removal of fishery-related products by beachcombers may contribute to the

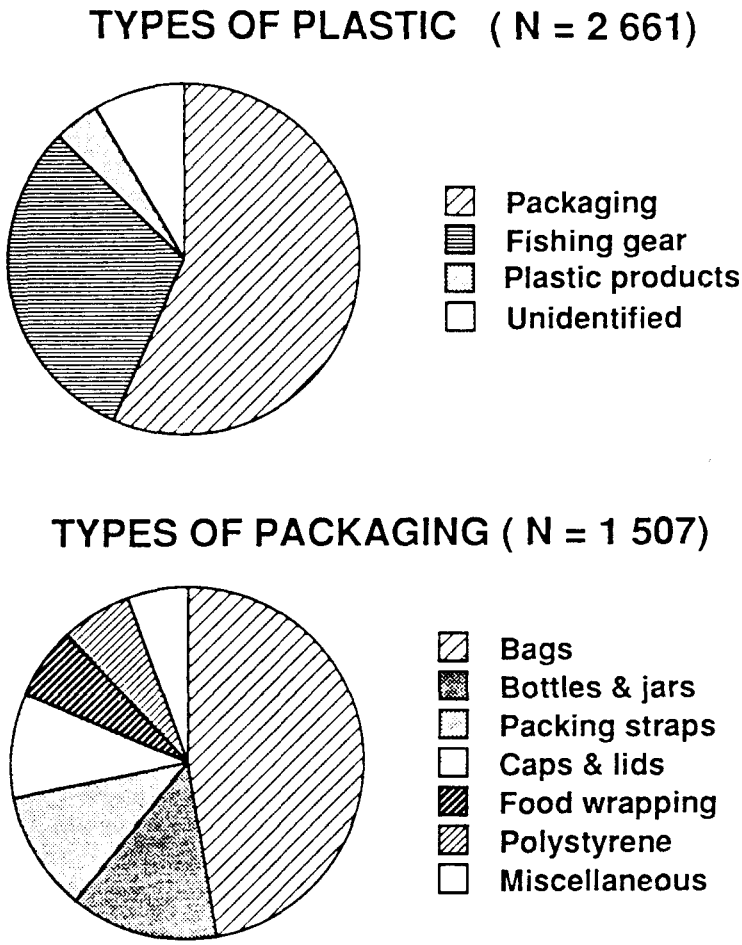

Figure 3.--The proportions (by number) of various functional groups of plastic articles found stranded on 50 South African beaches during June 1984.

differences). This is evident to anyone examining storm-water outlets draining urban areas, and concurs with current thinking that land-based sources may be more important contributors of debris to the marine environment than are vessels (Bean 1987, but see Pruter 1987; Wirka 1988). The mean density of packaging at urban beaches in South Africa (0.66 articles m^{-1} of beach) was greater than that at rural beaches (0.53 m^{-1}), although variances were great.

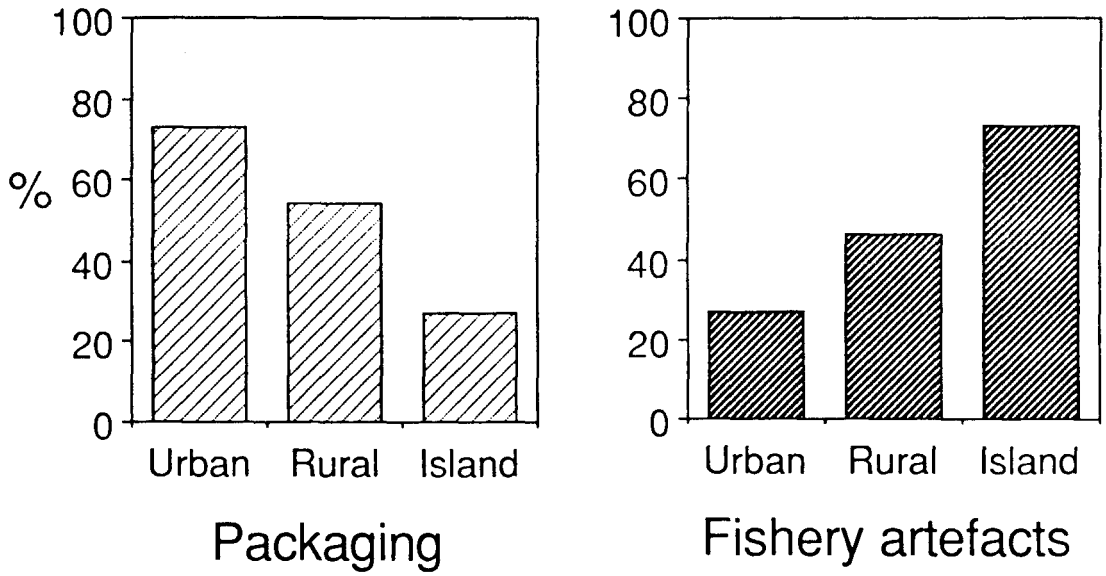

Figure 4.--The relative proportions (by number) of packaging and fishing gear stranded at urban (n = 26) and rural (n = 24) beaches in South Africa, compared with the situation at oceanic islands.

Virgin industrial pellets and fragments of plastic articles also are widespread and abundant on southern African beaches, with exceptional densities of up to 43,350 particles per meter of beach (88% industrial pellets, P. G. Ryan unpubl. data). Determining the origin of these items is more difficult than determining the origin of larger articles. However, at least some industrial pellets derive from local sources, where poor handling practices result in spillages, with transport to the sea in waste-water (pers. observ.).

Measures to Control Marine Debris in Southern Africa

The diverse nature of marine debris requires a multilevel approach to mitigating the problem. Four basic control tools are available: education, product substitution, recycling, and legislation. However, not all of these approaches are appropriate to tackle the different facets of the marine debris problem.

Ship-Based Sources

Ships are responsible for fishing gear (with the exception of mono-filament line and other wastes from shore-based anglers) and a proportion of general refuse (packaging and other operational wastes). This source of debris has received more attention than have land-based sources (e.g., Dixon and Dixon 1981; Horsman 1982; Low et al. 1985; Pruter 1987), and is the subject of several international conventions (e.g., Lentz 1987). South Africa has agreed in principal to sign Annex V of the International

Convention for the Prevention of Pollution from Ships (MARPOL), which came into force at the end of 1988 and prohibits the dumping of all plastic products at sea. This will be a major advance, and South Africa's ratification of Annex V warrants expediting. Priority should also be given to Namibia, which became independent in 1989, acceding to MARPOL.

However, there are problems associated with enforcing Annex V of MARPOL (e.g., Bean 1987) which necessitate that its implementation in South Africa be coupled with an intensive education campaign aimed at all mariners. A representation to this effect has been made to the South African committee working on incorporating Annex V into national legislation (Dolphin Action and Protection Group 1989). In the interim, favorable responses have been received from several merchant lines and the South African Navy in response to requests to reduce the amount of debris dumped at sea (Dolphin Action and Protection Group 1988a, 1988b, 1989).

One problem area not covered by Annex V of MARPOL is the accidental loss of fishing gear at sea. There is no simple solution to this problem. The dumping at sea of damaged nets and other persistent debris by fishing vessels has officially been outlawed in South Africa since 1986 (Dolphin Action and Protection Group 1988a). However, captains of commercial fishing vessels currently are paid bonuses based on the cleanliness of vessels returning to port. This is perceived by the industry as being responsible for considerable dumping at sea, an action that could be avoided by linking bonuses to the amount of persistent debris returned to shore.

Land-Based Sources

There are two main types of marine debris derived from land-based sources: virgin industrial pellets and the diverse array of manufactured articles, principally disposable objects such as packaging and convenience items (Bean 1987). The loss of industrial pellets into the environment is limited to the plastics industry, which in southern Africa is a fairly small target for control measures. There is only one polymer producer in southern Africa (linked to the oil-from-coal plant at Secunda in the Transvaal), and almost all converters (manufacturers that convert industrial plastics into user products) are based in South Africa (Fig. 5). The industry has been apprised of the problem and is sympathetic. The recent large increases in the price of virgin pellets apparently have resulted in improved handling practices leading to reduced losses, but this needs verifying, and, if necessary, supporting with punitive legislation against accidental spillages.

A more intractable problem is that of general refuse being washed or blown into the sea. This type of debris derives from such a variety of sources that there is no simple target for control measures (Pruter 1987). Ultimately, the only solution is to educate the public to dispose of refuse correctly. There are ongoing antilittering campaigns in most southern African states, but these are proving insufficient to the task. The problem is complicated by the difficulty of communicating to a broad cultural and economic spectrum simultaneously. South Africa has the potentially disastrous combination of a burgeoning third-world population shopping in first-world supermarkets for products wrapped in first-world packaging,

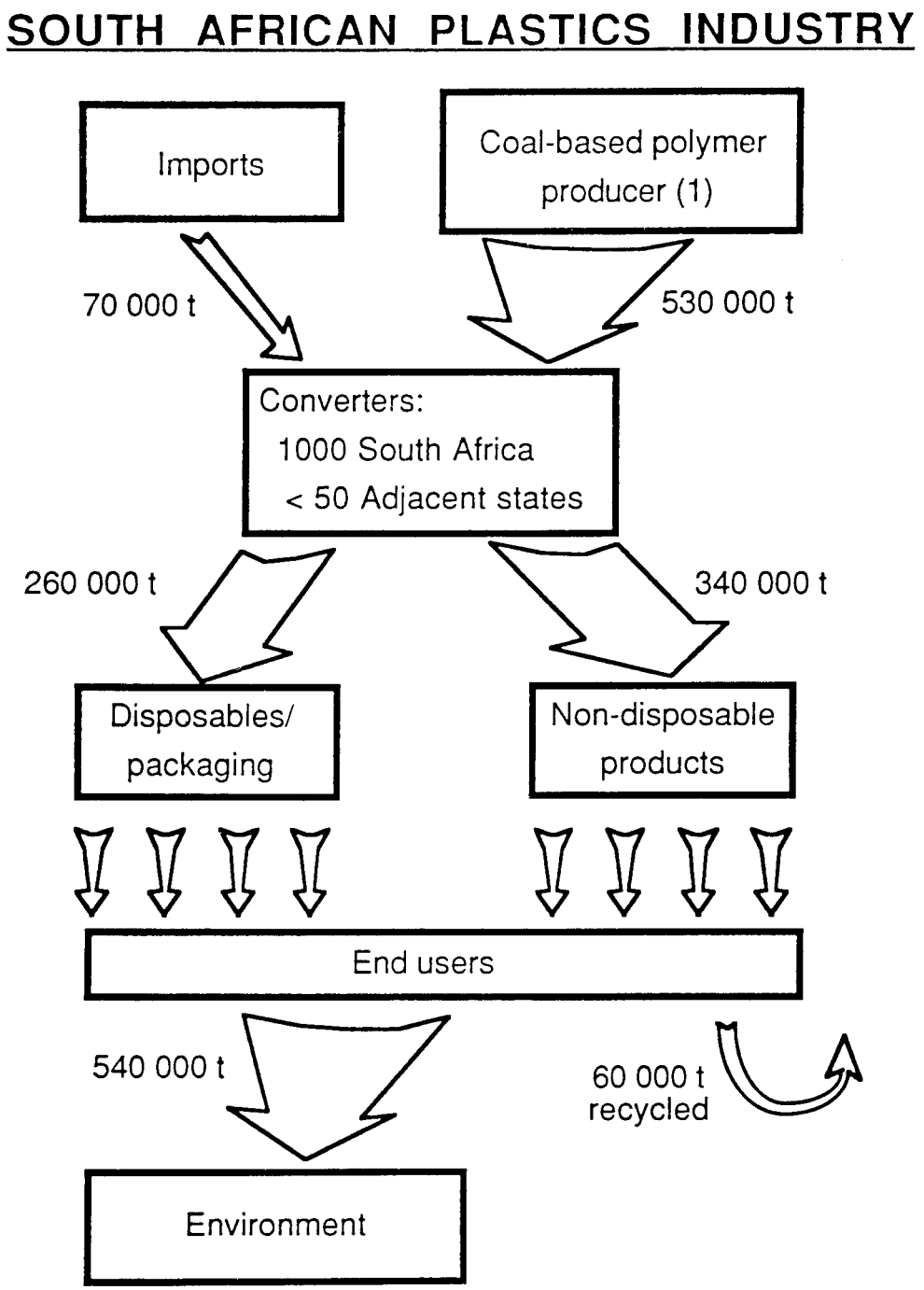

Figure 5.--The status of the South African plastics industry during 1988, showing the magnitude (metric tons) of flows between producers, users, and the environment (derived from data from the Plastics Federation of South Africa).

mostly plastic. Some 20% of South Africans live adjacent to urban areas in informal settlements where adequate waste disposal facilities are lacking. The same problem occurs in neighboring states such as Botswana and Namibia as a result of the large number of products imported from South Africa.

To counter these problems, attempts are being made to reduce the amount of plastic used in disposable applications (260,000 tonnes in South Africa in 1988, Fig. 5). This "source-reduction" approach (Wirka 1988) can be successful, judging by the small amount of litter found in Zimbabwe, where strict currency exchange regulations limit the use of plastics and almost all containers are returnable on a deposit basis. However, there is considerable industry resistance to such changes, despite support for a reduction in superfluous and environmentally damaging packaging by consumer bodies. Concerted public pressure is needed to stem the growth of plastics in disposable applications (Wirka 1988). At present, product substitution is preferred to the use of degradable plastics, which have attendant problems (e.g., Taylor 1979; Wirka 1988).

Almost 10% of South Africa's annual plastic production was recycled during 1988 (including factory scrap; Fig. 5), a greater proportion than that recycled in the United States (1%; Wirka 1988). One mixed-plastics recycling plant producing a wood substitute has recently been established in Cape Town, and there are several primary recycling operations throughout South Africa. However, there is much scope for further recycling, and incentives to return used plastics for recycling are likely to prove successful in limiting littering. There are problems associated with recycling plastics in southern Africa. The relatively small volume of material and the widely scattered markets render many recycling operations uneconomic. Also, in most areas of southern Africa, solid waste disposal using landfill sites remains by far the cheapest disposal technique, although groundwater contamination by leachates from landfills is a potential problem.

Legislation in South Africa is starting to address the problem of inadequate waste disposal. The recently promulgated Environmental Conservation Bill provides for heavy fines and, in some cases, jail sentences for littering and other disposal contraventions. However, it is hoped that voluntary meaures taken by the business sector will obviate the need for further legislation. Awareness campaigns focusing public concern have had considerable success in promoting the use of more environmentally friendly products and practices (e.g., the phasing out of six-pack yokes and shrink-wrapped packaging for bricks, and the printing of warning labels on a variety of disposable plastic products; Dolphin Action and Protection Group 1989), but many problems remain to be solved. It is only through the whole-hearted support of the entire community that the marine debris problem can be diminished.

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