

Impacts of Beach Raking on Macro-Invertebrates of Phylum Arthropoda in the Wrack Lines

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Abstract

Beaches are raked to enhance recreation, removing important aspects of the ecosystem, such as macro-invertebrates in wrack lines. Macro-invertebrate populations, represented by the Phylum Arthropoda as an indicator species, were sampled on a raked and natural beach in Brigantine, NJ. The samples were sorted by a Berlese funnel and hand to determine impacts on the populations that exist in the surface of wrack on the backbeach/dune areas. Sampling was conducted on July 12, 2004 and July 21, 2004. Potential differences were found between raked and unraked sites on the raked beach which will require more sampling before conclusions can be made.

The Problem

Beach ecosystems are complex, with many biotic species and physical characteristics playing important roles in the habitat and food-web. However, many beaches are used for human recreation. Nature has been so degraded in many beach resort communities that residents and visitors view not only cultural litter but also natural beach litter, incipient vegetation, beach fauna, and even dunes as undesirable. A common environmentally damaging action is the elimination of natural beach litter (wrack) by mechanically cleaning it, creating a neat, clean beach that has recreational value but little natural resource value (Nordstrom et al. 2000; Colombini and Chelazzi 2003).

Beach Raking Tractor



Wrack = Food + Shelter + Stabilization

Wrack consists of both natural and cultural litter found on beaches (see table below) and is an important source of food, shelter, and stabilization for the dunes. Natural litter provides food and shelter for macro-invertebrates, which then provide food for higher trophic levels. Fruits and seeds provide a vital genetic link, a primary dispersal agent for plants, and a food source. Carrion (commonly jellyfish, bivalves, fishes and occasionally birds and other animals) provide a food source of special value for scavenging birds and mammals (Colombini and Chelazzi 2003). Cultural litter may provide shelter that is not provided by natural debris of unique shapes, chemical makeup or non-biodegradable materials that have different temperature, water-holding capability and longevity.

Problems with wrack removal

Natural Litter	Cultural Litter
Macrophytes (algae and seagrass)	Anthropogenic trash
Driftwood	Inorganic Products
Fruits	Beach Chairs
Seeds	Plastics (candy wrappers, straws, etc)
Vegetation	Cans
Carrion	Bottles

Removal of wrack from the beach eliminates both the habitat and the large quantities of invertebrates contained within it, with a resulting decrease in biodiversity (Colombini and Chelazzi 2003). When wrack is dumped at the base of the dunes, it stays within the beach system but it is placed

in a different subenvironment, and the process of raking physically disturbs surface fauna. **Purpose**
This study evaluates the impact that beach raking has on macro-invertebrates, with Phylum Arthropoda used as an indicator species. It is hypothesized that fewer arthropods would occur on the surface of wrack dumped on the backbeach/dune contact after raking occurs due to physical disturbance of fauna.

How Municipalities Clean Beaches

Municipality	Rake	Freq	When	Class
Ocean Co.				
Long Beach Twp	Yes	Daily	Sum	LF
Barnegat Lt Twp	No		Sum	NC
Harvey Cedars	Yes	Daily	Sum	LF
Ship Bottom	Yes	Daily	Sum	LF
Beach Haven	Yes	Daily	Sum	LF
Pt. Pleasant	No			Priv
Bay Head	No			Priv
Mantoloking	No			Priv
Brick	Yes	4 /wk	Sum	LF
Lavellete	Yes	Daily	Sum	LF
Seaside Hts	Yes	Daily	Sum	LF
Atlantic Co.				
Brigantine	Yes	Daily	Sum	DD
Atlantic City	Yes	Daily	Sum	LF
Ventnor	Yes	Daily	Sum	LF
Margate	Yes	Daily	Sum	LF
Longport	Yes	Daily	Sum	LF
Cape May Co.				
Ocean City	Yes	Daily	Sum	LF
Sea Isle City	Yes	Daily	Sum	LF
Avalon	Yes	Daily	Sum	LF & DD
Stone Harbor	Yes	Daily	Sum	LF & DD
Wildwood	Yes	Daily	Sum	LF
Wildwood Crest	Yes	Daily	Sum	LF
Cape May Point	No			HP
Upper Twp	No			HP
Monmouth Co.				
Spring Lake	Yes	Daily	Sum	LF
Sea Girt	Yes	5-6/wk	Sum	LF
Asbury Park	Yes	occasionally	Sum	LF
Avon by the Sea	Yes	Nightly	Sum	LF
Belmar	Yes	Daily	Sum	LF
Deal	Yes	Daily	Sum	LF
Union Beach	Yes	3 /wk	Sum	LF

Legend:
NC - Not Cleaned
HP - Hand Picked
DD - Dumped at Dunes
LF - Landfill
Priv - Beaches owned by private individuals that were not contacted because the sites were not considered for sampling.

Information about beach cleaning was collected during June 2004 through phone surveys to the listed municipalities.



Sampling Methods

Samples were taken on July 12, 2004 and July 21, 2004 in Brigantine, NJ. Brigantine was a prime site based on the proximity of raked beaches and unraked natural beaches at the Edward B. Forsythe Wildlife Refuge (FWR). On July 12, three replicate samples were taken at locations 1, 2, and 3 (daily wrack dumped at base of dune), and 5 (naturally deposited wrack in natural area) (see below). On July 21, replicate samples were taken at locations 1, 2, 3 (deposit dumped nine days previously), 4 (past dumped raked wrack), 5, and 6 (older wrack in natural area). Samples 1, 2, and 5 were at different locations from July 12 because the previous removal of litter from the sites would confound repeated samples. Wrack was collected using a shovel and plastic bags for storage and taken to the lab to be sorted by Berlese funnels and hand. Litter weight and biomass were taken of all samples. The macro-invertebrates in the Phylum Arthropoda were preserved in 95% ethanol and identified to the taxonomic level of Order.

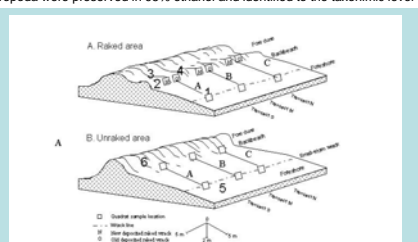
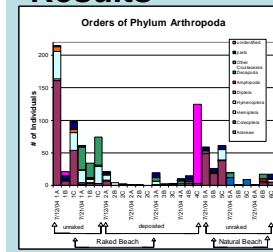


Figure 1. Sampling locations.
(A) Sampling at the raked site will include 1) the naturally deposited wrack, 2) the same day deposited raked wrack, 3) the next day deposited raked wrack from sample 2, 4) the deposited raked wrack from the past raked sample 2.
(B) Sampling at the unraked site will include 5) the naturally deposited wrack equivalent to sample 1, 6) the naturally deposited wrack equivalent to sample 2.

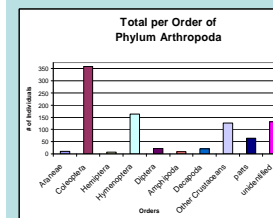
Phylum	SubPhylum	Class	Order	Description
Arthropoda	Chelicerata	Arachnida	Araneae	Spiders
		Insecta	Coleoptera	Beetles
			Hemiptera	True bugs
			Diptera	True flies
			Hymenoptera	ants, wasps, bees, and related insects
			Decapoda	shrimps, lobsters, crabs
			Amphipoda	amphipods
			Others	

(Weiss 1999)

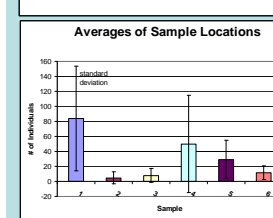
Results



Left Top: The highest abundance occurred in the unraked location (1) on the raked beach site on July 12, 2004 and was dominated by the order Coleoptera (beetles). The lowest abundance occurred in the freshly dumped wrack at the base of the dune (2) and both wrack lines on the natural beach (5 and 6) on July 21. Lower abundance may have occurred on July 21 because of a difference in the wrack that was deposited on the different days. The large number of unidentified species on the past deposited wrack resulted from unidentified larvae which is an indication of colonization of older dumped sites.



Left Middle: Coleoptera was the dominant order with 359 individuals. Araneae (spiders), Hemiptera (true bugs) and Amphipoda (amphipods) had the lowest abundance.



Left Bottom: The most individuals were in the unraked location (1) on the raked beach site because the undisturbed wrack is the prime environment for arthropods and the fewest were in the daily dumped raked wrack on the raked beach because of the disruption of surface wrack during the dumping.

Statistical Analysis

A One-Way ANOVA revealed significant differences between the six locations ($F=2.7895$). Individual pooled 2-sample T-Tests were performed on the locations. On the raked beach, the invertebrate abundance from the naturally deposited wrack (1) was significantly higher than on the wrack dumped at the base of the dune (2) ($p=0.10$), mildly higher than on the deposit dumped 9 days previously (3) ($p=0.057$) and was not significantly higher than the past deposited site (4) ($p=254$). On the natural beach, there was no significant increase in abundance between the naturally deposited wrack on the foreshore site (5) and the foredune (6) ($p=.146$).

Samples of the naturally deposited wrack on the foreshore of the raked beach (1) and the natural beach (5) were not significantly different in invertebrate abundance ($p=.103$). Samples from the foredune sites on both the raked and natural beaches (2, 3, 4 and 6) were not significantly different from each other in pooled 2-sample T-Tests (all $p > .10$).

Discussion

The significant decrease in invertebrate abundance from the naturally deposited wrack (1) and the wrack dumped at the base of the dune (2) sites on the raked beach supports the hypothesis that raking does decrease the amount of invertebrates on the surface of wrack deposited on the backbeach/dune contact after raking occurs due to physical disturbance of fauna. The lack of significant difference between the invertebrate abundance on naturally deposited wrack on the foreshore of the raked (1) and natural beach (5) suggests that there could be a cumulative effect of raking but the p value is close to the critical value. The lack of significant difference between locations (5 and 6) on the natural beach imply that differences between locations 1 and 2 may be caused by the mechanical effects of raking and not by location on the beach profile.

Conclusions

Though the samples support the hypothesis, more samples are needed before conclusions can be drawn due to the great variability in replicates taken on the same day and on different days. Further research and extensive statistical analysis are future plans for this project.

References

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Beach Raking Picture from: <http://www.frankston.vic.gov.au>

NJ Counties Map from the New Jersey Geographic Information Network, NJDEP

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