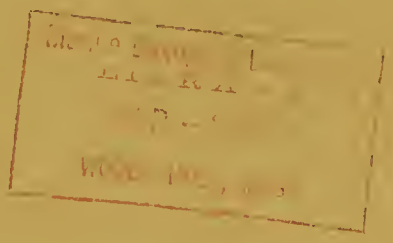
OBSERVATIONS OF THE EFFECT OF ACID-IRON WASTE DISPOSAL AT SEA ON ANIMAL POPULATIONS



SPECIAL SCIENTIFIC REPORT: FISHERIES No. 11

UNITED STATES DEPARTMENT OF THE INTERIOR
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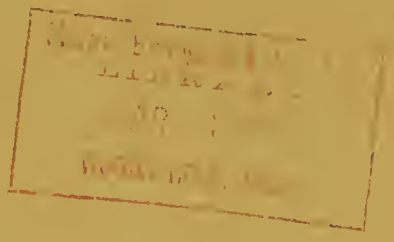

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Explanatory Note

The series embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for the official use of Federal, State or cooperating agencies and in processed form for economy and to avoid delay in publication.

Washington, D. C.
January 1950

United States Department of the Interior
Oscar L. Chapman, Secretary
Fish and Wildlife Service
Albert M. Day, Director

Special Scientific Report - Fisheries
No. 11

OBSERVATIONS OF THE EFFECT OF ACID-IRON WASTE DISPOSAL AT SEA ON ANIMAL POPULATIONS

By

Edgar L. Arnold, Jr. and William F. Royce
Fishery Research Biologists

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INTRODUCTION

This is the fourth report on a series of investigations conducted by the Woods Hole Oceanographic Institution in co-operation with the U. S. Fish and Wildlife Service and sponsored by the National Research Council. The three previous reports have been:

1. Preliminary report on the acid-iron waste disposal by Bostwick H. Ketchum and William L. Ford. Special processed report of the Woods Hole Oceanographic Institution.

2. A survey of the sports fishery of the Middle Atlantic Bight in 1948 by Raymond J. Buller and Harlan S. Spear. United States Department of the Interior, Fish and Wildlife Service, Special Scientific Report - Fisheries No. 7.

3. Drift bottle releases off New Jersey. A preliminary report on experiments begun in 1948 by John R. Webster and Raymond J. Buller. United States Department of the Interior, Fish and Wildlife Service, Special Scientific Report - Fisheries No. 10.

These studies have been concerned primarily with the effects of waste disposal operations at sea begun by the National Lead Company in April 1948. By disposing of a solution of sulphuric acid and ferrous sulphate at sea in quantities on the order of 3,000 tons each day, they have created many problems for study. At the same time in the Marine District of New Jersey and New York the growing conflict among the sports fisheries, public health, and the disposal of sewage, sewage effluents and industrial wastes has spot-lighted a similar situation which has led us to consider secondarily the general problem of waste disposal at sea.

THE POPULATIONS OF BOTTOM ANIMALS

Prior to the commencement of the disposal of acid-iron waste at sea, the claim was made that the operation would create a biological desert in the vicinity where it was dumped. This study was planned to determine the numbers of bottom animals before and after the commencement of disposal operations and thereby affirm or refute the claim. Early studies of the dispersal of the waste effluent behind the disposal barge showed that the waste was mixed with the upper 50 feet of water and buffered rapidly by the slightly alkaline sea water. The possibility, nevertheless, remained that a bubble of the acid would reach the bottom, and even though this might happen rarely it could have a serious effect on the animal populations.

A survey of the bottom using a special underwater camera appeared to be the most practical method of determining quantitatively the numbers of the larger animals living on the surface of the bottom. To obtain a sample of the small burrowing animals in the upper two to four inches of the bottom an orange peel dredge 9-1/4 inches in diameter was used.

A four-square-mile area in the Hudson Canyon region, eleven miles south (170° True) of Ambrose Lightship (fig. 1), was the area in which the acid solution disposal was to take place. For the survey, stations were laid out within this square at 0.4-mile intervals. As a control area which would help to distinguish changes in bottom life owing to seasonal variation from those caused by acid disposal, a similar square was laid out in a region known as the Mud Hole, just south of the lightship.

A coverage of these two areas was planned just before the start of the acid disposal operation in April 1948 and at intervals thereafter. The Balanus of the Woods Hole Oceanographic Institution made the first cruise from March 26 to April 2. On this cruise various difficulties were encountered, chiefly those concerned with the operation of the camera and the adverse weather conditions. Consequently, the desired number of bottom photographs could not be obtained in the time allotted, but enough were taken to give a good indication of the character of the bottom. Out of 52 lowerings, 22 black and white (fig. 2) and four color photographs were obtained in the Disposal Area; also four black and white and 3 color photographs were taken in the Mud Hole. At each station, also, samples were taken with the orange peel dredge.

Station procedure

At the start of each day's operations, the initial station was located as accurately as possible and a buoy set out as a reference point. Subsequent stations were made by dead reckonings, soundings, and frequent checking by Loran. Camera and bottom sampling lowerings were made, with the vessel dead in the water, or nearly so, to eliminate wire angle and prevent breakage of gear. At each station pertinent data were inscribed in the special underwater camera log. Bottom sample material was carefully washed over a fine-meshed screen and organisms found were preserved for later identification. As each roll of film was finished it was developed immediately, thus serving as a check on operation of gear and technique.

To supplement the initial attempt, a second cruise was made in May 1948, on the U. S. Fish and Wildlife Service's research vessel Albatross III. In examining the photographs and bottom samples from the earlier cruise it was found that a preponderance of the marine life inhabited muddy bottom.

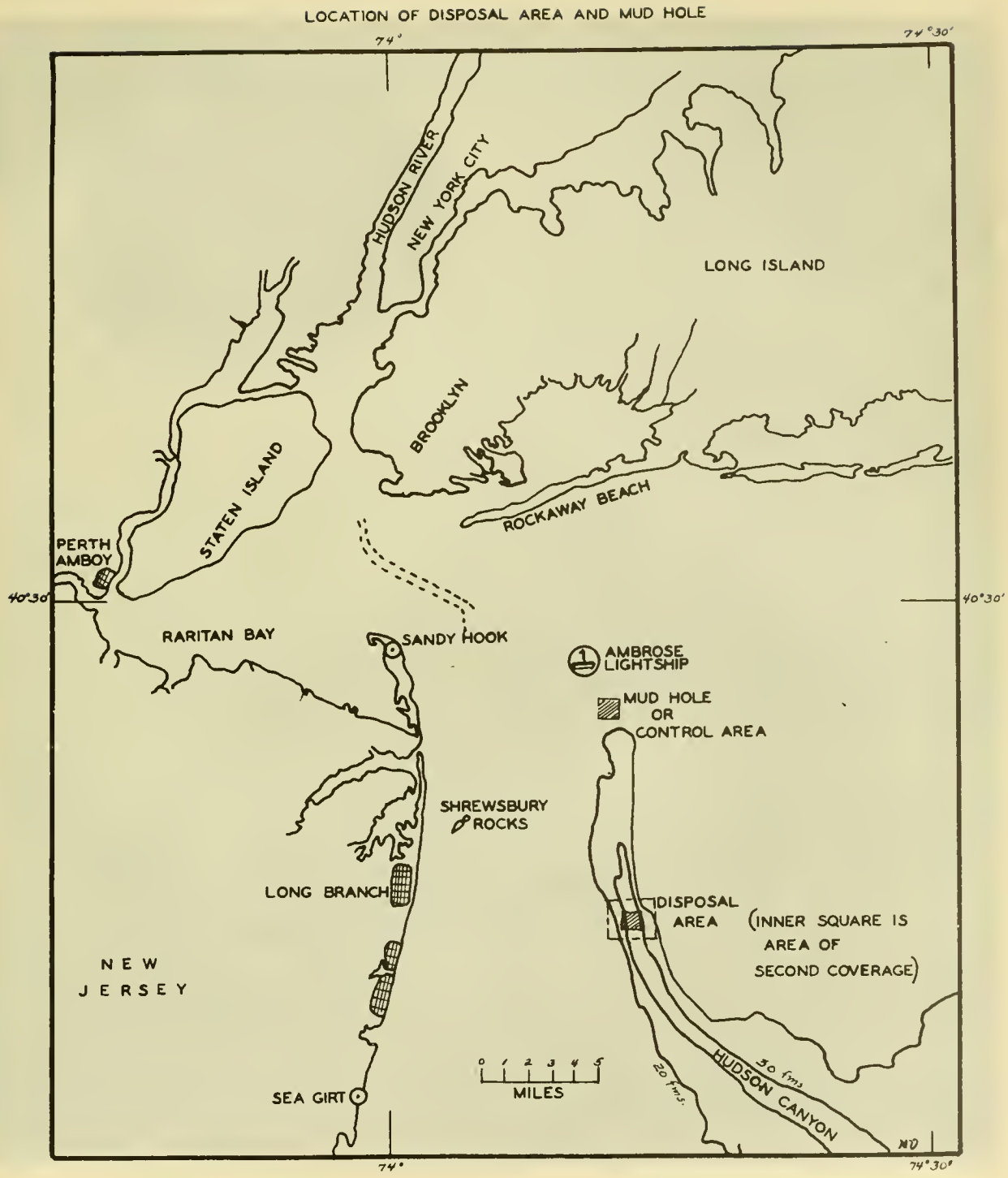

Figure 1. Chart of acid disposal area.

Figure 2. Bottom photograph of disposal area.

Accordingly, one mile square encompassing this type of bottom was chosen within the Disposal Area. The area in the Mud Hole, too, was similarly reduced to this dimension. Then a series of photographic and bottom sampling stations were laid out at one-sixth mile intervals, but only nine pictures resulted from this operation because of the failure of the camera to function properly.

To determine the number and kind of animals and vegetative growth visible for each unit area a comprehensive study was made of enlargements of satisfactory bottom exposures from both cruises. The area covered by each photograph was calculated by taking under-water tank pictures of a framework marked off at 6-inch intervals, using focal distances and lens apertures adopted for the investigations. From these observations it was found that 246 square feet of bottom were covered in the Disposal Area, of which 154 square feet were of the muddy portion; and 40 square feet were covered in the Mud Hole. The combined results of the two cruises are summarized in table 1.

The bottom samples were utilized by counting and identifying the animals contained in them. Table 2 shows the results of 37 samples taken in the Disposal Area (29 in muddy-type bottom) and 8 samples in the Mud Hole.

A second underwater photographic and bottom sampling survey of the same 1-mile-squares in the Disposal Area and Mud Hole took place November 1 and 2 during cruise 12 of the Albatross III. On this cruise, station procedure was changed slightly. It was decided that the best method under existing conditions, instead of running from one station to another, was to drift slowly across the area, lowering and raising the camera and bottom sampler as rapidly as possible. Then when the vessel reached the opposite boundary, it steamed back to the windward boundary several hundred yards to the southward of the first station, with the process being repeated as many times as necessary.

During this particular cruise the taking of bottom photographs was greatly facilitated by using a better camera (Robot), plus an improved routine of operations: 72 negatives and 25 bottom samples were obtained in less than two days despite adverse weather conditions. Thirty-five negatives and thirteen samples were obtained from the Disposal Area and 37 negatives and 12 samples from the Mud Hole. Enlargements were made from the negatives, the area covered was calculated, and bottom samples were examined as in the earlier study. The summarization of these results are shown in tables 3 and 4.

Discussion

These two photographic surveys (tables 1 and 3) show a marked decrease in the numbers of marine organisms visible on the bottom between the spring of 1948 and November 1948. There were 27 animals per-one-hundred-

Table 1.--Numbers of animals visible in bottom photographs taken in March and May 1948

Locality	Asteroidea (starfish)	Echinoidea (sea-urchins)	Malacostraca (crabs)	Porifera (sponges)	Animal trails	Animal burrows	Vegetation	Area covered
Disposal Area								
Muddy bottom	37	-	2	-	6	21	2%	154 sq. ft.
Sand and gravel bottom	-	2	-	-	4	4	-	92 sq. ft.
Total	37	2	2	-	10	25	-	246 sq. ft.
Mud Hole	1	6	-	1	-	15	4%	40 sq. ft.
Total	38	8	2	1	10	40	-	286 sq. ft.

Table 2.--Numbers of animals present in bottom samples taken in March and May 1948

Locality	Pelecypoda (clams quahogs)	Polychaeta (marine worms)	Paleonemertea (marine flat-worm	Gammaridae (Amphipods)	Cuoumaridae (sea cucumber)	Echinoideae (sea urchin)	Muricidae (drills)	Naticidae (drills)	Malacostraca (crabs)	Number of samples
Disposal Area										
Muddy	66	262	2	9	113	3	--	1	1	29
Other	6	39	---	8	---	1	1	--	--	8
Total	72	301	2	17	113	4	1	1	1	37
Mud Hole	12	26	---	--	---	---	--	--	--	8
Sum total	84	327	2	17	113	4	1	1	1	45

Table 3.--Numbers of animals visible in photographs taken in November 1948

Locality	Asteroidea (star fish)	Echinoidea (sea-urchins)	Malacostraca (crabs)	Porifera (sponges)	Cucumariidae (sea cucumbers)	Animal trails	Animal burrows	Vegetation	Area Covered (sq.ft.)
Disposal Area	34	--	--	--	1	--	14	-------	281
Mud Hole	1	1	--	--	--	1	--	Very sparse	296
Total	35	1	--	--	1	1	14	-------	577

Table 4.--Numbers of animals present in bottom samples taken in November 1948

Locality	Pelecypoda (clams, quahogs)	Polychaeta (marine worms)	Paleonemertea (marine flat-worms)	Gammaridae (Amphipods)	Cucumaridae (sea cucumber)	Echinoidrae (sea-urchin)	Muricidae (drills)	Natioidae (drills)	Malacostrace (crabs)	Nematode (parasitic worm)	No. of Samples
Disposal Area	12	331	--	168	37	--	--	--	--	--	13
Mud Hole	126	46	4	---	1	--	--	--	--	1	12
Total	138	377	4	168	38	--	--	--	--	1	25

square-feet in the Disposal Area in the spring and 12 in November. The Mud Hole had animals 20/per-one-hundred-square-feet in the spring while only 2 were visible in the 296 square feet covered in November.

However, the total numbers of bottom animals caught with the dredge increased during the period (tables 2 and 4). A comparison of the total shows that 2.4 times as many organisms per sample were taken in the second coverage in the Disposal Area and 3.1 times as many in the Mud Hole. These increases were not consistent in the several groups of animals. Worms and amphipods increased in the Disposal Area while clams and sea cucumbers decreased. In the Mud Hole clams and worms increased while the other forms were caught in too few numbers.

These changes cannot be clearly associated with the commencement of the acid disposal. Obviously they could be seasonal fluctuations or vagaries of sampling. However, the significant fact which applies to the problem of acid disposal is that there was no eradication of the bottom animals directly beneath the area where the acid was dumped for 7 months.

In the Disposal Area and its control, the Mud Hole--and especially in the latter--a comparison of the two photographic surveys (tables 1 and 3) shows a marked decrease in marine organisms visible on the bottom. There are approximately 27 animals visible per-100-square-feet of area in the Disposal Area in the first coverage compared to 12 animals per-100-square-feet of area in the second. Twenty animals are visible per-100-square-feet area in the first coverage of the Mud Hole, compared to only two animals for the entire 296 square feet covered in the second.

Similar comparison of tables 2 and 4 shows both increase and decrease in sub-surface bottom organisms when considered by species. However, when the number of organisms per sample are compared, it will be seen that there were 2.4 times as many organisms taken in the Disposal Area and 3.1 times as many in the Mud Hole during the second coverage.

While no definite conclusions regarding change in abundance can be made at this time due to the relative paucity of data, and the confusion of changes which could be caused by either season or acid, it is clear that even directly beneath the area where the dumping of acid solution has been going on for 7 months, there has been no eradication of bottom organisms. Seasonal variation might be the explanation for the fluctuation in abundance shown by the above data. Also, it is evident that very extensive studies of this nature will be necessary to detect if any changes are caused by acid disposal at sea.

Table 5.--Number of fish caught with otter trawl net in acid disposal area

Species	May 20, 1948		November 4, 1948
	Tow 1	Tow 2	Tow 1
1. Haddock	...	...	1/ 140
2. Whiting	1	2	283
3. Hake, red	2	4	21
4. Hake, white	4	1	1
5. Blackback	...	4	2
6. Four spotted flounder	...	...	2
7. Mackerel	...	1	...
8. Butterfish	6	4	5
9. Sea herring	...	28	...
10. Alewives	...	48	...
11. Shad	...	...	2
12. Weakfish	...	...	3
13. Sea bass	...	9	...
14. Cunner	10	17	...
15. Scup	...	...	6
16. Sea robin	1	...	...
17. Filefish	...	...	1
18. Long horn scupin	...	...	3
19. Goosefish	2	...	3
20. Lobster	...	...	1
21. Squid	...	...	68
Totals	26	118	472

1/ All of the haddock were young of the year ranging from 4 to 7 inches in length.

FISH IN THE AREA

A phase of the investigation concerned itself with the capture of fish from the acid Disposal Area. This phase was prompted by the question: what effect does the waste sulphate liquor disposal have on the nearby fisheries? To this end, on May 20 and again on November 4, 1948, the Albatross III was used.

The Albatross III towed a large-sized otter trawl (No. 1-1/2 Iceland model) having a head rope 78 feet long, equipped with rollers on the foot rope, and rigged with 30-foot cables between net and doors. In May, the net was used as purchased with 4-inch stretched mesh in the back parts. In the November tow, the top belly and cod end were lined with 1-1/2 inch mesh. The net was operated in a routine manner for each tow. Setting the net near one corner of the area designated, it was towed for one-half-hour diagonally toward the opposite corner.

The species of fish which were captured are itemized in table 5 and include two species of invertebrates. The catch, it is to be noted, included many of the demersal as well as some pelagic species common to the New York-New Jersey Bight.

Because of the difference in mesh used and the varying migrations of the fish between May and November, a critical comparison of the numbers of fish taken on the two occasions means little. In the immediate area where acid had been dumped daily for some 7 months, however, it is apparent that fish in considerable variety and numbers were to be found.