to develop cattle pasture simply removes that much area from duck usage and the marsh condition no longer exists.

Snipe. Probably no game species benefits more by cattle grazing than does the wilson snipe. This species feeds on earthworms, insects, snails and occasionally seeds and prefers exposed moist soil with no overhead cover. In fact the largest concentrations of snipe are usually found on over-grazed marsh range.

Rails. Louisiana has several species of rails but none are affected by moderate cattle grazing. This species likes an "edge effect" and will do well where cattle have opened up dense stands of mature vegetation. The rail must have adequate escape cover but seldom are marshes so heavily over-grazed that such is not available.

Fur-bearing Animals. At one time the fur industry in Louisiana was a multi-million dollar industry; but, with the gradual disappearance of the muskrat its value has steadily declined. However, in areas which still have muskrat and suitable habitat, anything more than light to moderate grazing would be detrimental.

O'Neil (1949) reported that cattle grazing in muskrat *(Ondatra zibethicus)* marshes seriously handicapped the harvest. Cattle snapped traps, broke down cane markers and trampled rat runs, making it difficult to make sets. Also, cattle bedding down on muskrat houses and hooking the houses killed young muskrats and caused the old to move.

Landowners in certain areas supplement their income by trapping nutria *(Myocastor coypu).* Nutria are grazing the browsing animals and as such a certain amount of competition takes place between cattle and nutria. However, marsh ranges are seldom grazed to the extent that this would be noticeable. Also, most range management practices, other than permanent de-watering, will benefit this species as well as cattle.

ACKNOWLEDGEMENTS

The writer gratefully acknowledges the assistance of personnel of the Louisiana Wild Life and Fisheries Commission in setting up and conducting the study. Special credit is due biologists Clark Hoffpauir and Fred Webert.

LITERATURE CITED

Junca, Hugh A. 1962. A quantitative study of the nutrient content of food removed from the crops of wild mallards in Louisiana. Unpublished Master's Thesis, La. State Univ., Baton Rouge, 94 pp.

Nichols, Lewis G. 1959. Rockefeller Refuge levee study. Tech. Bull., La. Wild Life and Fisheries Comm., 17 pp.

O'Neil, Ted. 1949. The muskrat in the Louisiana Coastal Marshes. La. Wild Life and Fisheries Commission., New Orleans, 152 pp.

POTHOLE BLASTING IN MARYLAND WETLANDS[1]

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ABSTRACT

Approximately 90 potholes were blasted with ammonium nitrate and fuel oil mixtures on a fresh marsh and a saline marsh in the Chesapeake Bay area of Maryland. Work covered a 3-year period in fresh marshes and one growing season in saline marshes. Number of ANFO charges used per pothole ranged from 1-15 varying in gross amounts per pothole from 20-415 lbs. Detonation was by dynamite using either primacord, cap and fuse or electric caps. Depth of charge holes varied from 8-36 inches. Available data are presented on size and depth of potholes, sloughing of spoil, soil types and plant invasions.

[1] Presented at 22nd Annual Conference of Southeastern Game and Fish Commissioners, October 21-23, 1968, Baltimore, Maryland.

INTRODUCTION

Since the discovery of the first known explosive, gunpowder, man has used this force in an ever increasing number of ways. Gunpowder, and other blasting agents that were developed later, have been used by man to procure food, to protect himself against his enemies, in construction, in mining, and in many other ways. Now one of these blasting agents is being used to improve habitat for wildlife. This blasting agent is one that most wildlife management personnel know as ANFO or ammonium nitrate and fuel oil. When mixed at the rate of 100 lbs. of ammonium nitrate to one gallon of fuel oil and detonated by a small charge of dynamite, a powerful explosive force is released. Although ammonium nitrate was first tried as an ingredient in blasting compositions over a century ago, it has only been in the past several decades that it has become an important blasting agent (Bureau of Mines Staff, 1963). Recent investigations on procedures and results of blasting for wildlife purposes are shown in Appel (1963), Haley (1963), Mathisen et al (1964), Mathiak (1965), Miller and Stricker (1965), Gordon (1966) and Bandel et al (1967).

Potholes have been constructed with ANFO at two locations in Maryland since 1966. One area, a freshwater tidal marsh, was near the head of the Chesapeake Bay on Edgewood Arsenal. Primary vegetation is a dense growth of cattail *(Typha sp.)*. Phragmites *(Phragmites communis)* occurred at several locations. Normal flood tides covered the area to a depth of about six inches. The soil profile showed a mat of roots about 18" thick over four feet or more of soft muck containing a large amount of organic material. One pothole made in a small drainage area in the woods was constructed in soil with a shallow layer of roots and vegetative material overlaying silt and clay.

The second area was on State-owned saline marshes of the lower Chesapeake Bay area of Maryland. Marsh sites were mostly vegetated with saltmeadow cordgrass *(Spartina patens)*. The layer of roots and vegetative material was about 12" thick, followed by one to two feet of soft clay underlain by tight clay for three to five feet and then by sand. Some marsh sites had 18 inches of roots and vegetative material underlain by an undetermined depth of muck. Two potholes were blown to deepen natural ponds that had a soft bottom with no solid material for at least five to six feet. Four holes were also made in a stand of mature pine-oak forest growing in poorly drained othello silt loam.

Costs of blasting operations at Edgewood Arsenal were a contribution of the personnel and the U. S. Army at Edgewood Arsenal, Maryland.

Blasting of potholes by the Maryland Department of Game and Inland Fish is a *contribution of Federal-Aid-in-Fish and Wildlife Restoration under* Pittman-Robertson Project W-44.

METHODS AND MATERIALS

In the freshwater areas of upper Chesapeake Bay, three potholes were blasted in the spring of 1966 and 17 were made in the spring of 1968. Weights of individual ANFO charges used were 20, 25, and 50 lbs. Number of charges used per pothole ranged from two to eight. Total weight of ANFO used per pothole ranged from 80 to 160 lbs. About 2200 lbs. of ANFO was used for the 20 potholes. All charges were detonated with 60% dynamite, primacord, fuse and cap.

In the wetlands of the lower Chesapeake Bay, all blasting was done during the winter-spring of 1968. Total amount of ANFO per pothole ranged from one 20 lb. charge to fifteen 27 lb. charges. About five tons of ANFO were used in blasting 68 potholes. Most of the ANFO was detonated with 60% dynamite, primacord, fuse and cap. Both delayed and instant electric caps were used for about one-fourth the potholes. In one instance, a combination of primacord and electric caps was used.

Prepackaged ANFO was used in the freshwater marshes at Edgewood Arsenal. Ammonium nitrate used on the lower Chesapeake wetlands was uncoated, 33-1/3 percent nitrogen and prilled. Diesel fuel was used in place of fuel oil because it was on hand. The ammonium nitrate was mixed with diesel fuel in a cement mixer and packaged in 16" x 28", 6 mil plastic bags, each containing either 20 lbs. or 26-2/3 lbs. Bags were tightly secured to keep out moisture. Some were held about two months without affecting detonation.

When using primacord, fuse and cap, the primacord was tied around one or two sticks of dynamite which was then imbedded in the bagged ANFO. One end of the primacord extended out of the bag, which was wrapped tightly with plastic tape and buried upside down in the charge holes. The ends of the primacord were tied either to the next charge or to a trunk line connecting all charges. A three to five minute fuse with cap was taped to one end of the primacord to detonate the charges.

In using electric caps for detonation, the dynamite was still placed inside the bag, but the cap was inserted in the end of one stick. The mouth of the bag was then twisted and folded over with the lead wire extending out and the bag tied securely with strong cord. No failures occurred in making the charges waterproof with this method and it took less time to prepare than with plastic tape.

Charge holes were 8"-12" deep in fresh marsh sites. They were 24"-36" deep in brackish marsh sites. Most of the work done with electric caps was with the delayed action type. These are a must when disturbance to the local community is to be kept to a minimum.

It cannot be emphasized too strongly that regardless of how much knowledge is acquired before this work is undertaken, test shots must be made to determine the best formula for that particular area.

RESULTS

A total of 88 potholes, 68 in saltwater marsh and 20 in freshwater marsh, were blasted with ANFO. The size of potholes using different arrangements, amounts of ANFO, and numbers of charges per pothole, are presented in Tables 1 and 2. The efficiency of the ANFO used is also presented using square feet of water surface created and cubic yards of material removed as a guide.

DISCUSSION

In using ANFO for making potholes, an effort was made to determine the effectiveness of various patterns for the charges that will create a pothole of adequate size and make efficient use of the ANFO. In the freshwater marsh it appears as though a square pattern with charges at the corners, 8 feet apart and one charge in the center gave the most satisfactory results when either 20 or 25 pound charges were used. This combination of pattern and charge size gave a pothole 4-5 feet deep and 30-35 feet in diameter. Efficiency of the ANFO was also at its best with this combination. Water surface created was 5.7 and 8.3 square feet per pound of ANFO with the 25 and 20 pound charges, respectively. Material removed was also at its highest, 1.4 cubic feet and 0.9 cubic feet per pound of ANFO, respectively.

In the saltwater marsh several attempts were made to make potholes with 10-foot spacing using a square, a square with one charge in the center and also a triangle. None of these made a pothole with a clean and reasonably flat bottom. Eight foot spacing was used in either a square or straight line to give the best results.

On one occasion an attempt was made to detonate the ANFO by propogation. It was found that it can be done by placing a stick of dynamite every 12 to 15 inches between the charges. Also, two sticks of dynamite must be used per charge. These two sticks must be placed in line with the axis of the pond and if placed inside the bag, they should be next to the plastic, one on each side of the charge. If placed outside, they should be taped or tied firmly to the bag and also in line with the axis of the pond.

The potholes blasted in this study have not been constructed long enough to make any accurate prediction on their longevity. Sloughing-in has been noted on the 3 year old potholes constructed in the freshwater marsh. The potholes should be about 5 to 6 feet deep when made so that after some filling they are still four to five feet deep. At this depth it is believed that they contain enough water to preserve fish and plant life. It is felt that potholes blasted in firm soil, typical of most of those in the saltwater marsh, will last considerably longer than those blasted in soil which is mostly organic as was found in the freshwater marsh.

Consideration of the concussion from a blast is necessary since considerable damage may be done to neighboring property owners. Although concussion is dependent upon several variables, the primary cause, total amount detonated at one time, can be very easily regulated. Complaints were received from personnel up to two miles from the blast site when a total of approximately 200 pounds of ANFO was detonated. Four hundred and fifteen pounds of ANFO was detonated in the saltwater marsh using four delayed electric caps to set off a series of fifteen charges. Very little disturbance was created by this blast. The delayed time between each group of charges should be about 50 to 100 MS (milli-seconds). This distributes the shock wave over a longer period of time and results in less disturbance to nearby inhabited areas. It should be noted that when using delays they must be detonated in ascending sequence with all the delays of one number next to each other. They can be connected either in series or parallel. One hundred to 125 pounds of ANFO appears to be the limit for a single blast without causing disturbances to neighboring property owners beyond one mile from the blast site.

A number of the potholes made in the saline marshes were checked in the summer of 1968 for vegetation, wildlife-use and depth. Four ponds in one area were checked, and sago pondweed *(Potamogeton pectinatus)* was found in one, saltmeadow cordgrass and saltgrass *(Distichlis spicata)* and saltmarsh bulrush *(Scirpus robustus)* were found growing in the shallow portions of all four. Fish were also observed in all four ponds. One black duck was flushed from the largest pond and droppings and feathers were observed in all others. There was muskrat usage as evidenced by droppings and cuttings of giant cordgrass *(Spartina cynosuroides)*. The level of water was almost a foot below the surface of the marsh with 3.5 to 4 feet of water in the ponds during the period of observation.

In another saline area, about 12 ponds were checked and conditions were similar to the ones above, except that no evidence of ducks or muskrats were seen. Wigeongrass *(Ruppia maritima)* was found in one pond and the same plants were found in the shallow portions as in the aforementioned ponds. Potholes made in the woods remained almost full of water, not dropping more than a foot below the ground level as of August 1, 1968. Deer trails led to at least two of the ponds and there were numerous raccoon tracks.

There has been no emergent vegetation found growing in any of the potholes in the freshwater marsh. A check during June, 1968, of the potholes blasted in the freshwater marsh in 1966, revealed considerable smartweed *(Polygonum sp.)* walter's millet *(Echinocloa walteri)* and spikerushes *(Eleocharis spp.)* growing on the spoil around the edge of the pothole. Japanese millet, seeded during April, 1968 on the spoil of the pothole blasted in the mixed hardwood forest, has grown profusely and produced seed. It is apparent that, given time, native vegetation beneficial to waterfowl will become established at blasted potholes.

The cost for detonating one ton of ANFO at the two different locations is shown below. There was less than $24.00 difference between the two locations.

	Saline Areas	*Freshwater Areas*
Material		
(less lead wire and blasting machine)	$160.00	$231.29
Labor	$300.00	$205.00
Total	$460.00	$436.29

The amount of earth moved averaged approximately 1,530 cubic yards per ton of ANFO. The cost per cubic yard was approximately 30 cents which compares very favorably with a dragline, which costs a minimum of 50 cents per cubic yard.

The problem of where to use this new tool to benefit wildlife is not difficult but the patterns and size may have many variations. Perhaps one of the best patterns for waterfowl, especially from the hunter's standpoint, is to have the potholes in groups of from five to fifteen of various sizes within a radius of 200 feet. Another similar group would then be placed about 500 to 1,000 feet away. Another method would be the saturation method of covering the whole area with ponds of various sizes. Regardless of size or pattern, the ducks seem to appreciate them, since ducks have been seen in these potholes or in the vicinity of them, less than one week after they were constructed.

TABLE NO. 1

Summary of Potholes Blasted with ANFO
in Freshwater Tidal Marsh

		ANFO Charges				*Results*		*Habitat and Comments*
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. per lb. of ANFO*	*Cu. Yds. per lb. of ANFO*	
2	4	20	X 6' X 6' X X	1'-2'	20' x 25'	4.9	0.3	Cattails, high center, shallow
1	3	50	X 8' X 8' X	6'	10' x 30'	2.0	0.4	Mixed Hardwood Forest
1	8	20	X X X 8' X 8' X X X X	2'	32' x 38'	7.6	0.5	Cattails, too shallow
2	2	50	X 6' X	6'	12' x 20'	2.4	0.5	Cattails, too shallow
2	2	50	X 6' X	6'	10' x 25'	2.5	0.6	Cattails, too shallow
1	3	50	X 8' X X	6'	25'	3.3	0.7	Cattails, too shallow

TABLE NO. 1 (continued)

Summary of Potholes Blasted with ANFO
in Freshwater Tidal Marsh

ANFO Charges						*Results*		*Habitat and Comments*
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. per lb. of ANFO*	*Cu. Yds. per lb. of ANFO*	
1	4	20	X X 8' X 8' X	3'-4'	24'	5.6	0.7	Cattails, too shallow
3	5	20	X 8' X X 8' X X	2'-3'	30' x 35'	8.3	0.8	Cattails, too shallow
1	6	25	X X 6' X X X 6' X	3'-4'	36' x 30'	7.2	0.9	Cattails
3	5	25	X X X 8' X 8' X	4'-5'	30'	5.7	0.9	Cattails, Clean Center
3	5	20	X X X 8' X 8' X	4'-5'	30' x 35'	8.3	1.4	Cattails, Clean Center

TABLE NO. 2

Summary of Potholes Blasted with ANFO
in Saline Tidal Marsh

	ANFO Charges					Results		Habitat and Comments
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. Per Lb. of ANFO*	*Cu. Yards Per Lb. of ANFO*	
1	1	20	X	4′	15′	6.4	0.9	S. Paten, Exp. Shot
1	6	20	X X 10′ X 10′ X X X	3.5′	20′ X 30′	5.0	0.6	Too Shallow
1	10	20	X X X 10′ X X X 10′ X X 10′ X X	6.5′	20′ X 40′	4.0	0.5	S. Patens, Too Shallow
1	11	20	X X X X X X X 10′ X X 10′ X 10′ X	4.0′	20′ X 43′	3.9	0.6	S. Patens, Bottom Not Clean
1	14	20	X X X 10′ X X X X 10′ X X X X X 10′ X X	4.0′	20′ X 43′	3.9	0.4	S. Patens, Bottom Not Clean
1	10	20	X X 10′ X X X 10′ X X X X X	4.0′	20′ X 30′	3.0	0.4	S. Patens, Bottom Not Clean

TABLE NO. 2 (continued)

Summary of Potholes Blasted with ANFO
in Saline Tidal Marsh

		ANFO Charges				*Results*		*Habitat and Comments*
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. Per Lb. of ANFO*	*Cu. Yards Per Lb. of ANFO*	
2	11	20	X X X 8' X X X X 8' X X 8' X X	5.0'	20' X 36'	3.3	0.6	Good
2	14	20	X X X X X X X X X 8' X X X X 8' X	5.0'	20' X 42'	3.0	0.6	Very Good But Not Efficient
1	3	26-2/3	X 10' X 10' X	6.5'	20'	3.9	0.9	S. Paten Marsh, Center Not Clean
4	3	26-2/3	X 8' X 8' X	7.0'	21'	4.0	1.0	S. Paten Marsh, Good
12	4	26-2/3	X 8' X 8' X X	6.5'	24'	4.2	1.0	S. Paten Marsh, Good
23	4	26-2/3	X 8' X 8' X 8' X	6.5'	15' X 37'	5.2	1.2	S. Paten Marsh, Good

TABLE NO. 2 (continued)

Summary of Potholes Blasted with ANFO
in Saline Tidal Marsh

	ANFO Charges					Results		Habitat and Comments
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. Per Lb. of ANFO*	*Cu. Yards Per Lb. of ANFO*	
1	7	26-2/3	8′ Spacing Irregular Line	6.5′	14′ X 73′	5.4	1.2	S. Patens Marsh, Very Good
1	9	26-2/3	8′ Spacing X X X X / X X X X X	6.0′	15′ X 90′	5.6	1.2	Two Fuses Set At Same Time - Not Practical
1	3	26-2/3	8′ 8′ XxxxxXxxxxX	7.5′	15′ X 20′	3.8	1.0	By Propagation, Only Center Charge Detonated
1	2	26-2/3	8′ XxxxxX	6.0′	14′ X 16′	4.2	0.9	Both Charges Detonated
1	4	26-2/3	8′ X xxxx X xxxx X xxxx X	7.0′	18′ X 30′	5.1	1.3	S. Patens Marsh, All Charges on One Fuse And All Detonated
1	8	26-2/3	No. 1 Fuse/No. 2 Fuse XXXX/XXXX	6.5′	18′ X 65′	5.5	1.3	S. Patens Marsh, Two Fuses, Works But Not Practical

TABLE NO. 2 (continued)

Summary of Potholes Blasted with ANFO in Saline Tidal Marsh

ANFO Charges						*Results*		*Habitat and Comments*
No. of Ponds	*No. of Charges*	*Size of Charges in lbs.*	*Pattern*	*Depth*	*Size*	*Sq. Ft. Per. Lb. of ANFO*	*Cu. Yards Per. Lb. of ANFO*	
1	4	26-2/3	8′ X X X X 75MS 200MS 250MS 400MS	5.0′	12′ X 32′	3.6	0.7	S. Patens Marsh, First Test With Delayed Fuse, Good
2	12	26-2/3	Same As Above But 3 Charges For Each Delay	6.0′	14′ X 100′	4.4	1.0	S. Patens Marsh, Delays Work Very Good
4	6	26-2/3	X X X X 9′ X 9′ X	7.0′	14′ X 30′	2.6	0.7	Mature Forest, Very Good
2	9	26-2/3	Irregular Line	6.0′	14′ X 75′	4.3	1.0	S. Patens Marsh, Three Delays Used
1	15	26-2/3	Irregular Line	6.0′	14′ X 125′	4.3	1.0	S. Patens Marsh, Three Delays Used, Very Good
2	7	26-2/3	Irregular Line	5.0′	15′ X 55′	4.3	0.8	S. Patens, Soft Marsh at Edge of Natural Pond

LITERATURE CITED

Appel, J. C. 1963. Cratering charge pothole development. Progress report No. 1, Parker River NWR, USFWS. Unpubl. report.

Bandel, D., D. A. Brown, and K. O. Horner, 1967. Pothole blasting as a wildlife management practice. Am. Soc. Agron. Ann. Meeting, November 5-10, 1967, Wash. D. C. 5 pp.

Bureau of Mines Staff. 1963. Safety recommendations for sensitized nitrate blasting agents. Bur. of Mines Infor. Circular 8179.

Gordon, J. F. 1966. Medicine for a marsh. Ont. Fish and Wildl. Rev. 5(4):11-16.

Haley, Ted D. 1963. Ammonium Nitrate - Fuel Oil Mixtures. Blasting Applications for Rocks, Ponds, Ditching, Stumps. Gulf Oil Corporation. Unpubl. report.

Mathiak, H. A. 1965. Pothole blasting for wildlife. Publ. 352. Wisconsin Conservation Dept., Madison. 31 pp.

Mathisen, J., J. Byelich and R. Radtke. 1964. The use of ammonium nitrate for marsh blasting. Trans. N. Amer. Wildl. Conf. 29:143-150.

Miller, R. J. and V. Stricker. 1965. Wetland development by blasting. USDA Soil Cons. Serv., Wisc. Tech. Note Biol. No. 4. 8 pp.

PLANNING THE MANAGEMENT OF MARYLAND WETLANDS

by Roy G. Metzgar[1] and David A. Wharton[2]

Purpose

The purpose of this paper is two-fold. First, it is intended to acquaint you with recent activities in Maryland concerning wetlands management. Second, there seems to be a lack of published information on the subject of resource planning for fish, wildlife, waterfowl, and especially wetlands management. Notable exceptions are (California, 1966), (Delisle, 1966), and (Stokes, *et al*, 1967). With regard to the lack of published information, we are not suggesting or claiming to fill the void (if one does exist), but intend merely to discuss our recent experiences with the planning process and wetlands.

To achieve the purposes just stated, this paper discusses previous study activity on Maryland wetlands. Then consideration is given to planning guidelines that we believe are essential to a wetlands study and formulating an eventual management plan. Next, discussion elaborates on procedures developed to incorporate the guidelines in the current study in Maryland. A general overview summary of the current study's results to date concludes this presentation.

Background

Recent concern about the preservation and proper management of all wetlands in Maryland resulted in the passage of House Joint Resolution No. 2 (HJR 2) by the 1967 Maryland Legislature. This Resolution requested "that the State Planning Department, in cooperation with the Board of Natural Resources and the Department of Economic Development, prepare a detailed long-term plan for the optimum use of all Maryland wetlands, such plan to be based so far as is possible upon the results of economic, biologic, hydrologic, and recreational research previously completed or underway in Maryland and in other states or nations having comparable wetland types and functions" (Maryland, 1967).

Wetlands are defined by HJR 2 as those "areas on which standing water, seasonal or permanent, has a depth of six feet or less and where the wet soil retains sufficient moisture to support aquatic or semi-aquatic plant life." Thus, wetlands is a collective term for areas of varied ecology more widely known as swamps, sloughs, marshes, bogs, and mud flats.

Prior to passage of HJR 2 in 1967, a number of studies of an inventorial nature had been conducted on Maryland wetlands. These studies include: *Maryland Marshes*

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