COMPARISON OF COSTS FOR MOSQUITO CONTROL ON NEW JERSEY DISPOSAL SITES[1]

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ABSTRACT. The disposal of dredge material and associated mosquito production have continued to plague New Jersey Mosquito Control agencies for over half a century. The efficacy and costs of controlling mosquito populations associated with these sites are discussed. Both temporary and permanent methods of control are contrasted utilizing mosquito population data, treatment frequencies and long-term cost analysis of such projects. Methodologies for assessing economic feasibility of control programs are presented.

INTRODUCTION

The problems of mosquito production on dredge material disposal sites are not new to New Jersey. Historically, county mosquito control commissions have been combating mosquitoes associated with dredge spoil since the early 1930's (Brooks 1939) by employing both temporary and permanent control techniques (Jobbins 1951). A survey of these sites throughout the state was undertaken in 1976 for the purpose of locating and assessing their potential as mosquito breeding sites (Shisler 1977). In cooperation with county mosquito control commissions, 127 sites encompassing 16,000 acres were identified.

Initially, it should be stated that not all dredge material disposal sites resulted from channel maintenance of the Intercoastal Waterway and Delaware River. Rather, large expanses of dredge material were the direct result of dredging for the construction of roadbeds, industrial and residential areas. Mosquito production associated with the latter kind of site has had the greatest impact on humans due to the close proximity to both seasonal and permanent communities.

Mosquito species associated with these sites will vary according to the location and environmental conditions. For example, dredge disposal sites along the Intercoastal Waterway will likely produce substantial populations of *Aedes sollicitans* (Walker); while along the Delaware River, *Ae. cantator* (Coquillett), *Ae. vexans* (Meigen) and *Culex salinarius* Coquillett are dominant. The dredging of inland lakes produces still different mosquito problems. This interface of the various mosquito species breeding on dredge disposal sites and human populations requires the control of mosquitoes from both a nuisance and potential disease standpoint. As mentioned earlier, mosquito control agencies essentially have 2 general methods of control, temporary and permanent. The purpose of this treatise is to evaluate the efficacy and costs of both methodologies in the control of mosquitoes associated with maintenance dredging in a coastal ecosystem.

METHODS

An example of such an ecosystem is the Tuckerton Creek Dredge Disposal Areas located in Ocean County, New Jersey. The area originally consisted of 3 old dredged disposal sites that were placed on

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the salt marsh along the west side of Tuckerton Creek. One was a diked site that contained enough water to provide habitat for *Spartina alterniflora* and the other 2 were non-diked sites. The diked site (4.6 acres) had a continuous history as a mosquito source and had 100% of its area treated at least once a year since 1974 (Table 1). The conditions that caused the diked site to produce mosquitoes were its propensity to trap high tides and rains which created an ideal habitat for *Ae. sollicitans*. The non-diked site (51.3 acres) only required 32% of its area to be treated at least once in 1975, a year in which substantial populations of *Ae. sollicitans* were reported (Table 1).

The U.S. Fish and Wildlife Service has taken the position that dredged material can not be placed on existing salt marsh vegetation, and, as such, the diked site could not be utilized as a disposal site in the 1977 dredging of Tuckerton Creek (Huff 1977, personal communication). In essence, the non-diked sites were considered to be unproductive since the "sacred cow" of the estūary, *S. alterniflora*, was absent from the sites. These non-diked sites were an important habitat for migrating birds and supported large populations of edaphic algae and associated fauna.

The construction of the dikes and the pumping of dredged material into the sites occurred from April through May, 1977. During the 1977 mosquito season, these dredged disposal sites required a significantly increased larviciding of the area for mosquito control (Table 1). This increase in temporary control and its associated costs precipitated the development of a water management program for these sites. The mosquito breeding areas were located in habitats similar to those reported by Ezell (1978) which encompassed: 1) the borrow pit around the inside of the dike, 2) along the outside of the dike, and 3) areas impeded by an in-

Table 1. Larviciding treatment data for the Tuckerton Dredge Disposal Area and the mean light trap catch for female *Aedes sollicitans* in Ocean County, N.J. from 1974–1979.

Year	No. of treatments	Acreage treated: Old	New	Total	Light trap mean*
1974	1	4.6	8.3	12.9	2.69
		4.6	8.3	12.9	
1975	1		4.6	4.6	4.23
	2	2.3	3.7	12.0	
	3		6.4	19.2	
	4	2.3	1.8	16.4	
		4.6	16.5	52.2	
1976	2	4.6		9.2	1.82
		4.6		9.2	
1977	1		28.4	28.4	3.21
	2		22.9	45.8	
	3		4.3	12.9	
	4				
	5	4.6		23.0	
		4.6	55.6	110.1	
1978	4	4.6		18.4	3.72
		4.6		18.4	
1979	1		8.3	8.3	2.34
			8.3	8.3	

* Williams' mean

terruption of the normal drainage patterns of the marsh. An additional 10.1 acres adjacent to the old disposal areas required chemical treatment. As such, a total of 66.0 acres were larvicided at least once in 1977 (Table 1).

The water management plan developed for mosquito control in the areas consisted of a combination of Open Marsh Water Management (OMWM) (Ferrigno and Jobbins 1968) and the destruction of the dikes to allow dewatering of the sites. OMWM was utilized in the areas of the marsh where normal drainage patterns were interrupted. It consisted of the construction of 7 ponds with radial ditching to connect ponds to mosquito breeding depressions (Table 2). The combination of these 2 methods was considered the most applicable strategy because of the existing drainage patterns and because it permitted revitalization of migratory bird habitats that had been destroyed by the construction of the disposal sites. Other mosquito breeding areas were subjected to tidal ditching by reconditioning and the construction of new ditches which allowed the penetration of predaceous tidal fishes and associated organisms. The combination of both the tidal and standing water alterations increased both components of the salt marsh ecosystem while eliminating the mosquito breeding habitat.

The dewatering of the disposal sites became a problem due to the nonconsolidation of the dredge material in one site and completion of work had to be postponed until the fall of 1979. The only larviciding treatment to the area occurred in the site that was not altered (Table 1) and was located around the inside of the dike. This breeding area developed as a result of the excavation of marsh for construction of the dike and the consolidation of dredge material in the dredge site which Ezell (1978) classified as the borrow pit swale. Dewatering of the sites consisted of breaking a series of holes in dikes in various locations where the water had accumulated in the borrow pit swale and the connection of these interior low areas using a rotary ditcher. Another mosquito breeding location created by dike construction was in the marsh area adjacent to the outside of the dike. This area seems to sink because of the weight of the dike and accumulated water, thereby creating ideal mosquito breeding habitat. In this case, the problem was corrected by the construction of a ditch approximately 20 feet from the dike. These mosquito breeding problems associated with the dike construction could, in most cases, be eliminated in the future by the utilization of marsh from the outside of the dike. This would eliminate the borrow pit swale inside the dike thereby allowing drainage of the water that accumulates adjacent to the dike on the outside.

Costs associated with the project were compared to determine the relative economical feasibility by employing permanent control vs. the continuation of existing temporary control measures. The Army Corps of Engineers contracted with the county mosquito commission for $7,200 to do permanent control on the dredge disposal sites and the adjacent marsh. The work completed in the per-

Table 2. Actual permanent control work completed by the amphibious rotary ditcher and the Case backhoe-dozer on the Tuckerton Creek Dredge Disposal Area in Ocean County, New Jersey.

				Ditching			
		Pond		New		Reconditioned	
	Hours	No.	Yd³	Ft	Yd³	Ft	Yd³
Amphibious rotary	100.5	7	1,255	17,739	5,889	2,760	614
Case backhoe-dozer	12.0			50	11		

manent control plan is shown in Table 2, and totalled 66.0 acres. Two pieces of equipment were utilized, an amphibious rotary ditcher (Quality Marsh Equipment Co., Thibodaux, LA) and a modified wide track Case Backhoe-Dozer (Carey Equipment Co., Seaford, DE).

In determining the costs associated with temporary control the following parameters were determined or estimated:

1. Cost for larviciding: The utilization of larviciding records is critical in documenting the cost since the exact areas are identified and number of treatments are recorded (Gooley and Lesser 1976). Costs for larviciding an acre of marsh varies from year to year (Shisler 1979) and in this example a figure of $10.00/A was utilized (Hansen 1979).

2. Mosquito breeding potential of the area: Mosquito breeding in an area will vary from year to year because of environmental conditions (Ezell, 1978), primarily climatic or tidal conditions in coastal areas (Downing 1978, Shisler 1978). Another important factor with mosquito breeding associated with dredge material sites is the age of the site (Ezell 1978). The 110.1 acres treated in 1977 (Table 1) would be a low estimate of the average annual acreage treated if the site was allowed to go through the stages that Ezell (1978) described. The dredge material sites would be classified as DM-3 by Ezell's classification (Ezell 1978) and maximum mosquito breeding is reached in DM-4 and DM-5. An examination of Table 1 shows that when mosquito light trap yearly means (n = 5,500) reach or exceed 3.00 *Ae. sollicitans* per trap night, the old dredge material site required a minimum of 4 treatments per year.

3. Inflation: The effects of inflation have to be considered in the cost of temporary control over a long period of time. Today we are facing double digit inflation which will undoubtedly affect the cost of pesticides and their application. An estimate of 10% is reasonable with today's economic situation.

4. Effective time span of permanent control projects will vary from project to project. In habitats similar to those considered in this work, OMWM projects around the state have remained functional for 10–20 years (Hansen 1979, Shisler 1979). For the purpose of this exercise, a time span of 10 years will be utilized.

RESULTS

The comparison of temporary and permanent control methods on an economic basis is done (in this example) over a period of 10 years. The cost of temporary control for this period is done by multiplying 110.1 acres (annual average treatment) by $10.00/acre (cost of treating one acre in 1979) by 15.94 (inflation factor of 10% for 10 years, Grant and Ireson 1970). This yields an accumulative cost of $17,693.40 for temporary control over a 10-year period. Dividing this figure by the contracted cost of $7,200.00 for permanent control, yields a cost ratio of 2.46. Costs for temporary control were projected to be 2.46 times greater than those incurred for permanent control measures. Therefore, this project was economically feasible for permanent control and the cost of the project will be recovered in approximately 5 years by the elimination of larviciding costs.

CONCLUSION

While the primary consideration of any such project is the control of mosquitoes, both environmental impact and economics play important roles in the decision making process. Considering the example offered in this discussion, either temporary or permanent control measures could be said to offer equivalent results. Secondly, the impact of OMWM on the productivity of the salt marsh ecosystem has been shown to be beneficial in the movement of organic carbon (Shisler and Jobbins 1977a), vegetational productivity (Shisler et al. 1975, Shisler and Jobbins 1977b, Shisler 1979) invertebrates

(Shisler and Jobbins 1977b, Lesser et al. 1976) fish (Able et al. 1979, Talbot et al. 1980) and birds (Burger et al. 1977, 1978). Consequently, the remaining factor, cost, will likely receive even greater consideration in future mosquito control projects. The need, then, for an efficacious, environmentally sound and cost effective method of controlling mosquitoes associated with dredge material disposal sites can be met with the utilization of permanent control procedures.

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