THE EFFECTS OF WATERFOWL MANAGEMENT PRACTICES ON MOSQUITO ABUNDANCE AND DISTRIBUTION IN LOUISIANA COASTAL MARSHES[1]

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ABSTRACT. A 12-moth study was conducted to determine the effects of waterfowl management practices on mosquito production in Louisiana coastal marshes. An intermediate and brackish marsh impoundment, a marsh pump-out area, and a natural salt marsh area were studied.

The data obtained indicate that waterfowl management practices utilized in the intermediate and brackish marsh impoundments produce significantly (P<0.01) more mosquitoes than practices utilized in marsh pumpouts or natural salt marsh.

During the time that the impoundments were flooded the intermediate marsh impoundment produced significantly (P<0.01) larger numbers of mosquitoes than the brackish marsh impoundment. *Culex salinarius* preferred the intermediate marsh impoundment. *Anopheles bradleyi* preferred the brackish marsh impoundment. During the time that the impoundments were drained (May through September) *Aedes sollicitans* eggs were collected in significantly larger numbers (P<0.01) from the intermediate marsh impoundment.

INTRODUCTION

The Louisiana Coastal Region encompasses an area of 3.2 million hectares. The marshes and adjacent water bodies extend along the entire southern border of the state and vary in width from 24 to 80 km (Chabreck 1972). MacNamara (1952) reported that impounding greatly increased the wildlife usage of New Jersey marshland. Chabreck et al. (1974) stated that duck usage in fresh water impoundments averaged over 4 times the usage of other areas; however, during the fall season, duck usage of brackish water impoundments was almost 7 times greater than that in fresh water impoundments. Lowest duck usage was observed in the marsh pump-outs; areas that are drained all year and used as a nesting place for Canada geese (*Brnta canadensis* (L.)).

Provost (1973) reported that the breeding of salt marsh mosquitoes (*Aedes taeniorhynchus* (Wied.) and *Ae. sollicitans* (Walker)) was generally limited to the high (intermittent flood-drain) marsh areas. Studies in New Jersey and Delaware showed that by impounding intermittent flood-drain areas, salt marsh *Aedes* production was eliminated. However, a favorable habitat was created for certain *Culex, Anopheles,* and *Mansonia* species, with *Culex salinarius* Coquillett and *Anopheles bradleyi* King the principal species present (Chapman and Ferrigno 1956; Catts et al 1963). Clements and Rogers (1964) reported that salt marsh *Aedes* sp. could be controlled by flooding salt marshes year long, or only seasonally from March through August or early September in Florida. Rees and Anderson (1966) showed that in Utah permanent flooding during the mosquito season eliminated the production of *Aedes* but provided more permanent water required for the production of *Culex* and *Culiseta* mosquitoes. They also stated that permanent withdrawal of water eliminated mosquito production and created safe sites for nesting waterfowl.

This study shows the effects of waterfowl management techniques on mosquito production and compares mosquito production in brackish and intermediate marsh impoundments, a marsh

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pump-out, and a natural salt marsh during the flooded and drained periods.

MATERIALS AND METHODS

This 12-month study was conducted on the Rockefeller Wildlife Refuge, Cameron Parish, Louisiana, from September 10, 1975 through September 1, 1976. Four study sites were selected; a 400 ha intermediate marsh impoundment, a 600 ha brackish marsh impoundment, a 1400 ha natural salt marsh area and a 160 ha marsh pump-out. The intermediate marsh was described by Chabreck (1972) as marsh having less than 3 parts per thousand (ppt) saline water and a range of plant species intermediate between those in fresh and brackish marsh. The marsh pump-out consisted of a 160 ha area encompassed by levees to prevent surface water intrusion. The interior of the area was graded and ditched to direct surface water from rainfall to pumps that were used to move the water over the levees. Larval mosquito counts (for permanent water mosquitoes), and egg counts (for floodwater mosquitoes) were taken in each of the 4 sites surveyed. every 2 weeks throughout the study period.

Adult mosquitoes were collected with CDC light traps baited with dry ice as described by Newhouse et al (1966), one trap per study site. On 2-week intervals throughout the 12-month study, the traps at each study site were operated simultaneously from 1 hr before sunset to at least 1 hr after sunrise. The collection bag was then removed from each light trap and placed in an ice chest containing dry ice. The mosquitoes were kept on dry ice. transported to the laboratory at Louisiana State University and stored at −5°C until they could be counted and identified to species. All mosquitoes obtained in a light trap collection bag with less than approximately 1,500 adults were identified and counted. When more than 1,500 mosquitoes were collected in a light trap, a proportionate sample of the catch was identified and counted. The proportionate sample was determined on the basis of a percentage of the total volume for a given collection.

When the intermediate and brackish water marsh impoundments were flooded (October through April), 100 dips (one dip every 10m) were taken over a 1,000m semi-circle through each study site. Each sample dip was poured into a mosquito accumulator which was made by cutting out the bottom and cutting three 2.5 x 3.8 cm openings near the handle of a 3.785 liter Mazola® oil bottle. The openings were covered with 32 mesh plastic screen. The top was covered with 0.64 cm hardware cloth to prevent any large plant debris from falling into the accumulator. The bottle cap was removed and replaced with the transfer apparatus from a World Health Organization adult susceptibility kit holding tube and a 100 ml specimen vial was attached to the WHO holding tube. The openings in the plastic bottle were cut in order to remove all but 50 ml of the water collected by dipping. When the transfer tube was moved to the open position the water and the mosquito larvae contained in the accumulator passed into the 100 ml vial which contained 50 ml of 95% alcohol. The vial was then removed, sealed, labelled, and a new vial placed on the accumulator. Thus, each vial contained the mosquito larvae resulting from 100 dips from each study site. The vials were then transported to the laboratory and stored until the larvae could be identified and counted.

After the impoundments were drained (May through September), soil samples were collected to determine the presence of floodwater mosquito eggs. Soil samples were taken from the intermediate and brackish marsh impoundments, natural salt marsh and marsh pump-out using a modification of techniques described by Meek and Olson (1976). The soil samples consisted of 15 x 15 x 2.5 cm samples cut in groups of 5, collected at random from 4 different areas within each study site for a total of 20 samples per study site per collection date. Samples were collected on 8 collection dates (2-week intervals May through September). Thus, 160 soil samples were collected at random from each of the 4 study sites (640 samples taken and processed to determine the number of floodwater mosquito eggs). Each soil sample was placed in an individual plastic bag and labelled as to location and date of sampling. The soil samples were transported to the laboratory and processed for the presence of floodwater mosquitoes using the egg separating device described by Horsfall (1956) and Meek (1975). The eggs collected from each soil sample were counted and identified to species.

The data obtained from the study to determine the effects of waterfowl management practices on mosquito production were statistically analyzed as a randomized block design with the number of collection dates as the replication source.

RESULTS AND DISCUSSION

Larvae were collected from each of the study sites, and results are shown in Figures 1 and 2, Table 1. *Cx. salinarius* was the dominant mosquito species collected in the intermediate marsh impoundment with a population density that ranged from 0.5 larvae/dip in early December to 5.0 larvae/dip in late April just prior to drainage of the impoundment. The density of the mosquito population increased with time, with the larger numbers being collected during the latter part of the study when the water temperature had increased to 18°C and above. *An. bradleyi* larvae were also present during the flooded period but in smaller numbers that ranged from 0.0 in December to 0.29 larvae/dip in early May. The number of larvae per dip decreased as the water temperature decreased. The critical temperature was around 16°C. *Culiseta inornata* (Williston) was collected from late February through early April, with a range of 0.1 to 0.4 larvae/dip/collection date. Again, water temperature seemed to affect larval density, but this species seemed to prefer cooler water.

In the brackish impoundment during the flooded period, *Cx. salinarius* was the dominant species, ranging from 0.3 larvae/dip in November to 5.4 larvae/dip in early April. *An. bradleyi* was present during the entire 7 months that the impoundments were flooded, ranging from 0.07 larvae/dip in January to 0.6 larvae/dip in early April. The mosquito populations in the brackish impoundment followed the same trends that were observed in the intermediate marsh impoundment, in that the larval density increased with time. However, water temperature never decreased enough to eliminate *An. bradleyi*.

The combined means (Table 1) for all species indicate that the intermediate marsh impoundment was the preferred breeding habitat followed by the brackish impoundment. No significant difference ($P>0.05$) for any of the study areas was obtained for *Ae. sollicitans* larvae. They were collected only during the initial flooding of the impoundments.

Significantly ($P<0.01$) more *Cx. salinarius* were collected in the intermediate marsh impoundment than in the brackish impoundment. *Cs. inornata* was collected only in the intermediate marsh impoundment. *An. bradleyi* larvae were collected in significantly ($P<0.01$) larger numbers in the brackish impoundment than in the intermediate marsh impoundment.

Ae. sollicitans was the only species of floodwater mosquito identified that utilized the marsh impoundments as ovipositional sites. The mean number of

Table 1. The mean numbers of mosquito larvae collected/dip/collection date while the impoundments were flooded, October, 1975, through April, 1976.

	IMPOUNDMENT	
Species	Intermediate	Brackish
Ae. sollicitans	0.35	0.19
Cx. salinarius	2.58[a]	1.70[b]
An. bradleyi	0.11[b]	0.20[a]
Cs. inornata	0.09[a]	0.00
Total	0.78[a]	0.53[b]

a, b—Those mean numbers not having the same letter were significant at $P<0.01$.

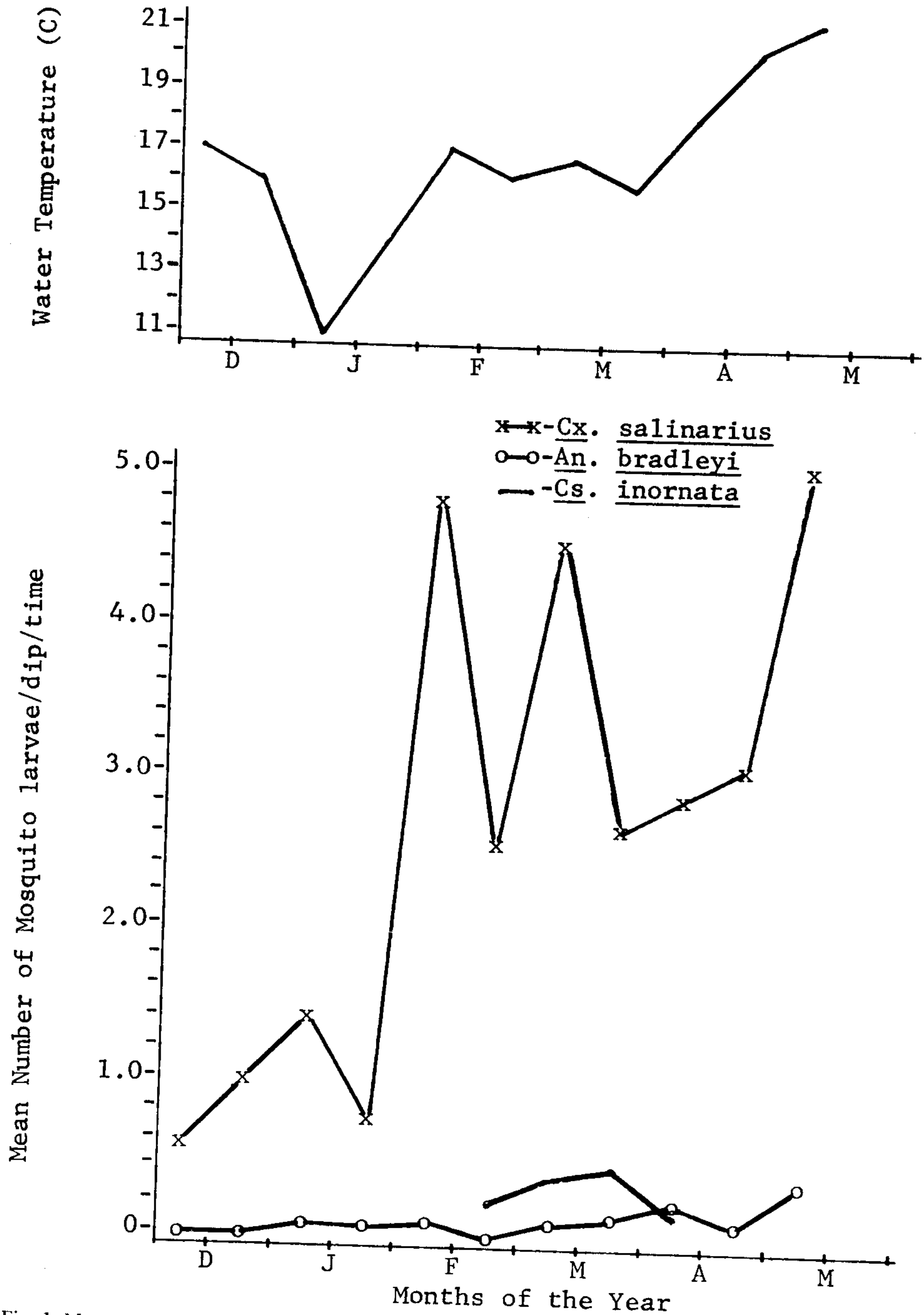

Fig. 1. Mean number of mosquito larvae collected/dip/collection date from the intermediate water impoundment during the flooded period, December 3, 1975, through May 3, 1976.

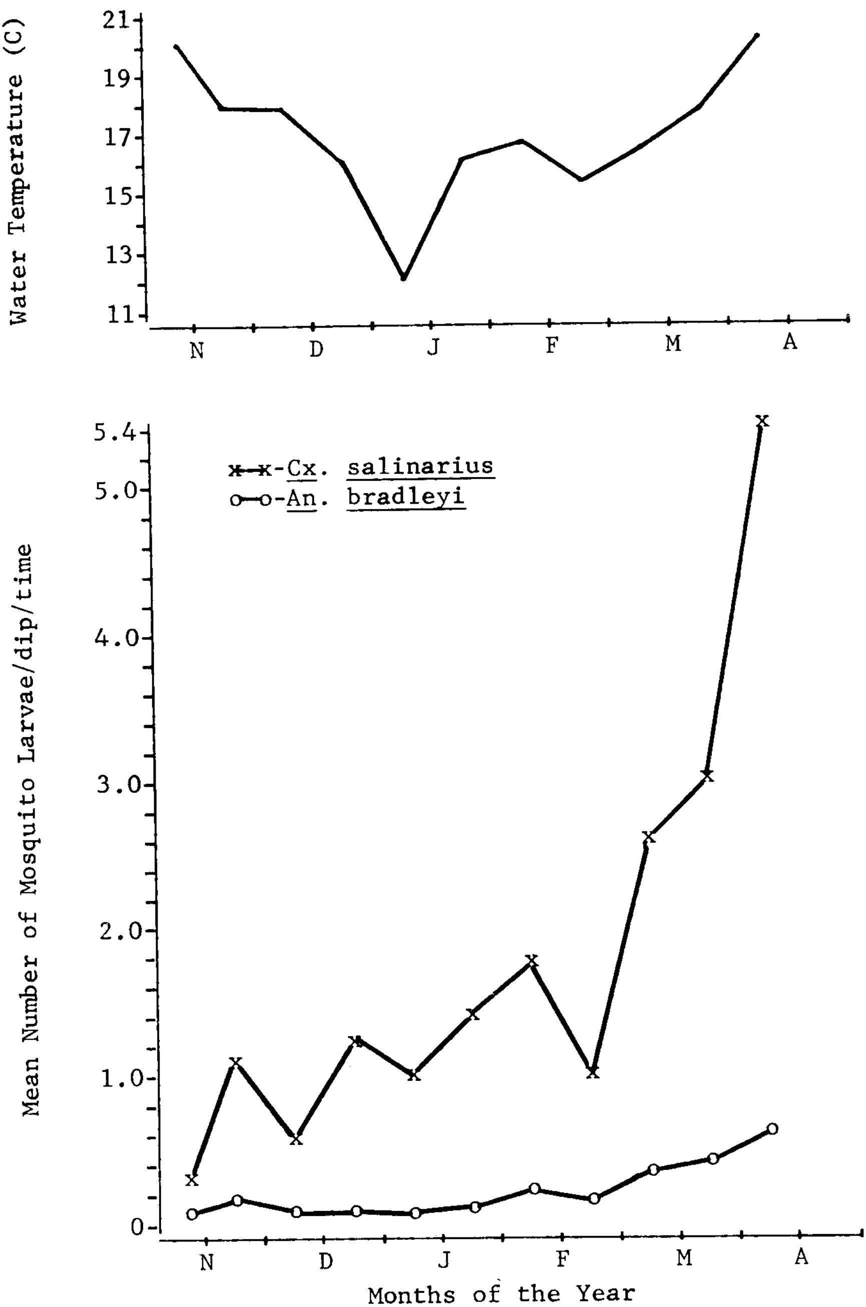

Fig. 2. Mean number of mosquito larvae collected/dip/collection date from the brackish marsh impoundment during the flooded period, November 7, 1975, through April 5, 1976.

Ae. sollicitans eggs collected per 15 x 15 x 2.5 cm soil sample per collection date is shown in Table 2. Eggs were collected in significantly higher numbers ($P<0.01$) from the intermediate marsh impoundment than in the brackish impoundment. Averages of 2.15 and 3.83 eggs/soil sample were collected from the marsh pump-out and natural salt marsh study sites, respectively.

did not oviposit in those areas. This agreed with Meek (1975) who reported that the moisture content of the soil was one of the determining factors in oviposition preference by *Ps. columbiae* in riceland habitats.

The data obtained from this study indicate that the waterfowl management practices utilized in the intermediate and brackish marsh impoundments of Louisiana cause the production of massive mosquito

Table 2. The mean numbers of *Aedes sollicitans* (Walker) eggs/15 x 15 x 2.5 cm soil sample/collection date while the impoundments were drained, May to September, 1976.

Date	Impoundment: Intermediate	Impoundment: Brackish	Natural Salt Marsh	Marsh Pump-Out
5/26	—	2.80	—	1.55
6/08	5.70	5.50	3.95	2.55
6/21	8.00	7.50	4.90	2.23
7/05	8.56	8.90	7.70	2.70
7/20	10.75	8.30	4.10	1.65
8/04	10.55	10.60	2.30	2.50
8/18	11.05	8.50	1.60	2.00
9/01	18.45	5.10	2.25	2.10
Total	10.43[a]	7.15[b]	3.83[c]	2.15[d]

a, b, c, d—Those mean numbers not having the same letter were significant at $P < 0.01$.

Again, the permanently drained state of the marsh pump-out would account for the lack of significant numbers of eggs. This agreed with the work done by Rees and Anderson (1966) in Utah. In addition, the continuous flushing action in the natural salt marsh area caused a high moisture content in the soil and *Ae. sollicitans*

populations by providing breeding sites for several mosquito species.

Relatively large numbers of adult female mosquitoes were collected from the study sites using the CDC light traps baited with dry ice (Table 3). *Psorophora columbiae* (Dyar and Knab), and *Coquillettidia perturbans* (Walker) were collected in

Table 3. Mean numbers of adult mosquitoes collected/trap/collection date during the study period of September 10, 1975, through September 1, 1976, on the Rockefeller Wildlife Refuge, Cameron Parish, Louisiana.

Species	Impoundment: Intermediate	Impoundment: Brackish	Marsh pump-out	Natural salt-marsh	Overall species mean
Ae. sollicitans	1382.0	1006.0	850.0	1246.6	1153.4
Cx. salinarius	3043.0	2693.0	1925.0	2318.0	2543.4
An. crucians complex	101.0	151.0	80.0	59.0	94.0
Overall site mean	1508.6	1283.3	951.6	1207.8	

a, b, c, d—Those mean numbers not having the same letter were significant at $P<0.01$.

the light traps; however, immature stages of these species were not collected from any of the study sites. During late June and early July, female *Ae. sollicitans* averaged 9,500/trap/collection date and over the entire time that the impoundments were drained averaged 1,153.4/trap/collection date. When the impoundments were flooded, female *Cx. salinarius* averaged 2,543/trap-collection date and *An. crucians* complex averaged 94/trap/collection date.

The intermediate and brackish marsh impoundments, which had been manipulated to increase waterfowl usage of the marsh, produced significantly ($P<0.01$) more mosquitoes than the natural salt marsh or the marsh pump-out. These data indicate the need for cooperative planning between Wildlife, Fisheries and Mosquito Control Agencies in Louisiana.

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