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Abstract DRC-1339 was used in 1990 and 1991 to reverse gull (Laridae) domination at Ram Island in Mattapoisett, Massachusetts, a site historically important to the endangered roseate tern *(Sterna dougallii).* Reduction of the very dense gull population at Ram Island and reclamation of the island for nesting terms is seen as a challenge, especially considering the site's proximity to New Bedford, the largest commercial fishery on the Atlantic Seaboard. During 1990 and 1991, gull productivity at Ram Island was completely suppressed Eight hundred twenty-three and 172 gulls were recovered dead following treatments in 1990 and 1991. Females predominated nearly 2 to 1. Totals of 931 and 259 clutches of eggs were destroyed in 1990 and 1991. Results suggest overall efficiency of the toxicant may decline in successive years. Ultimate success in discouraging gulls from using the island may hinge on how quickly we are able to capitalize on dramatic early results by augmenting continued DRC-1339 use with additional measures.

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Rapid increases in herring gull *(Larus argentatus)* and great black-backed gull (L. *marinas)* populations and their potential adverse effects on other seabird populations became apparent in Maine by 1920 (Norton 1924). More recently, this problem has moved southward along the Atlantic Coast. During the 1930s, fewer than 100 pairs of these gulls were nesting in Massachusetts. However, by the mid-1980s, the population was estimated at nearly 50,000 pairs (Blodget 1988x).

The increasing gull population in Massachusetts has dramatically impacted common tern *(Sterna hirundo)* and roseate tern numbers. From a peak of 30,000 pairs in 1935 (Nisbet 1973), common terns declined to under 5,000 pairs in 1977-78 (B. Blodget, MasFish. and Wildl., unpubl. data). By 1989-90, numbers recovered to near 10,000 pairs (B. Blodget, Mass. Div. Fish. and Wildl., unpubl. data), but potential for further recovery is poor because gulls have excluded terns from most of the ideal predator-free nesting islands. Remaining sites (often close to or on the mainland) are more vulnerable to human disturbance and mainland-based predators.

Since a peak of 4,000-6,500 pairs was recorded in 1939-49, the roseate tern population in Massachusetts declined to an average of 1,672 pairs in 1984-90 (a decline of 58-74%). During the gull increase, roseate terns were supplanted at 7 sites in Massachusetts alone (Blodget 1990). The northeastern population of the roseate tern was designated as endangered by the United States Fish and Wildlife Service on 2 November 1987 (52 Federal Register 42064).

The Roseate Tern Recovery Team for the northeastern population determined that competition for space with nesting gulls is a major problem confronting the roseate tern and recommendedreclamation of certain key nesting islands through gull control as a top priority (United States Fish and Wildlife Service 1989). This paper details our efforts to reverse gull domination at Ram Island in Mattapoisett, Massachusetts, an island historically important to common and roseate terns, using 1339 gull toxicant 98% concentrate (DRC-1339).

DRC-1339 has been used in a limited number of sitespecific applications to reclaim and protect tern nesting stations in New England (Blodget 1988b, Nisbet 1989). In 1969-70, it was tested by the United States Fish and Wildlife Service and the Massachusetts Audubon Society at a number of islands in Massachusetts including Ram Island, Tern Island in Chatham, and Bird Island in Marion (Anonymous 1970). It was employed in a demonstration treatment at Matinicus Rock, Maine in 1971 (Anonymous 1971). In combination with other techniques, DRC-1339 was successfully used to reestablish a mixed-tern colony at Eastern Egg Rock, an island in Muscongus Bay, Maine in 1974-75 (Kress 1983). It was used at Monomoy Island in Chatham, Massachusetts in 1980 to **try to restore** portions of the island once occupied by terns (United States Fish and Wildlife Service 1986). In 1984-90 it was successfully used to restore and protect a mixed-tern colony at Petit Manan Island, Maine (Drennan et x1.1980, Andrews 1990x). Seal Island, Maine was treated in 1985-88 and Arctic terns (S. *paradisaea) were* subsequently reestablished in 1989 (Anonymous 1989).

We discuss the effectiveness of DRC-1339 in eliminating gulls at Ram Island, a site characterized by an extremely dense gull population and situated in close proximity to New Bedford, home port for the largest commercial fishery on the Atlantic Seaboard.

STUDY AREA

Ram Island in Mattapoisett, Plymouth County, Massachusetts (41 ° 37'N and 70° 48' W) lies within Buzzards Bay, 0.8 km from the nearest mainland. It appears on the Sconticut Neck United States Geological Survey quadrangle and is identified as colonial waterbird colony number 352043 (Erwin and

Korschgen 1979, Andrews 19906). The 0.8-ha island was deeded as a wildlife sanctuary to the Commonwealth of Massachusetts in 1925 by the long-defunct Federation of New England Bird Clubs, and is now owned and operated as the Ram Island Wildlife Sanctuary by the Massachusetts Division of Fisheries and Wildlife. The island, rising to a maximum elevationof approximately 3.5 m,isnearly submerged in severe storms. Consequently, vegetation consists mainly of mixed gtasses.'T`ne cer~l~potVOOO~~he is~dis occupied by a tidal lagoon. The entire periphery of the island is broken rock jumble.

Common and roseate terns nested on Ram Island most years from 1921 through 1972. It had an estimated 2,500 pairs of roseate terns in 1947 (Nisbet 1980), and possibly at least that many common terns. Gulls began to overrun the island in the 1960s. DRC-1339 treatments on the island in 1969-70 temporarily reversed the trend (Anonymous 1970), allowing terns to hold on at the island's northwest corner through 1972. In the absence of continued control work, gulls consolidated their hold on the island. Aerial estimates of the gull population included 370 pairs in 1977 (Erwin and Korschgen 1979) and 590 pairs in 1984 (Andrews 19906). In the first year of our field work, we estimated 732 pairs (667 pairs of herring gulls and 65 pairs of great black-backed gulls).

About 1986, double-crested cormorants (Phalacrocorax auritus) established a small colony near the southeast corner of the island. About 100 pairs were estimated in 1989 and 225 pairs in 1990.

METHODS

Driven by a need to restore nesting sites for the roseate tern (LJ. S. Fish and Wildlife Service 1989), gull control activity using DRC-1339 (Environ. Prot. Agency Regul. No. 56228-17) was reinstituted in 1990-91. Work on the island commenced on 23 April and concluded on 25 June 1990. In 1991, work was initiated on 16 April and concluded on 24 June. Primary treatmentin 1990wasmadeon 15Mayprecededby2prebaitings on 8 and 10 May, and in 1991 on 14 May with a prebaiting on 13 May. Secondary treatments were made on 5 June 1990 and 4 June 1991 with a p 'retailing in each case on the preceding day. All field work was conducted between 0500-0900 hours.

Small, white-bread-and-margarine sandwiches were used as bait and prebait, except during prebaiting for the secondary treatment in 1991, when plain white-bread cubes were used. Nests with clutches as well as empty but well-formed nests were prebaited and treated. All baits were prepared off-island the day prior to use and carried to the island in plastic bags.

Gull carcasses were retrieved from Ram Island and several mainland sites on the second, third, and *fifth mornings* posttreatment. Age and sex data were collected fora large subsample and the carcasses were buried off-site.

Eggs were broken on 25 April in both years to synchronize nesting and prevent any possibility that very early clutches could hatch on or just before the primary treatment target date. On the dates of treatment, any untreated nests (due to insufficient baits) were broken-up. Finally, all clutches were brokenup on the third morning posttreatment to assure that no pairs that happened to survive would hatch chicks.

In lieu of a tertiary DRC-1339 treatment, clutches of immigrant of presistent pairs were destroyed on 25 dune 1990 and on various dates in 1991 through 24 June.

In 1991, from 13 May to 24 June, wooden tern decoys were set out in one section of the island considered prime tern nesting substrate.

RESULTS

1990

The large initial gull population that was established on Ram Island during the first two weeks of May 1990 was difficult to estimate accurately. On 8 May, 432 nests were prebaited and 495 pairs of gulls estimated. Two days later we prebaited 590 nests. On 15 May we treated 661 nests, tan out of baits, and destroyed 71 additional nests (a total of 732 nests). We estimated 667 pairs of herring gulls and 65 pairs of great black-backed gulls. The gulls were extremely bold and bait consumption was excellent.

In preparation for the secondary treatment, 462 nests were prebaited on 4 June. On the following day we treated 563 nests, once again ran short of bait, and broke up an additional 20 nests for a total of 583 nests. We estimated 563 pairs of herring gulls and 20 pairs of great black-backed gulls. During the secondary application, the gulls were noticeably less bold. As we distributed baits, the gulls evacuated the entire island and circled high overhead. However, as the gulls resettled, bait consumption was excellent.

Following the primary treatment, we recovered 527 gulls (Table 1). Most (79%) were found dead at or near their nests, and the remainder were recovered on the mainland in saltmarsh loafing areas near the mouth of the Mattapoisett River (Table 2). After the secondary treatment, 296 gulls were picked up. A smaller proportion (52%) of the gulls were picked up on the island, with the balance from the same mainland loafing areas (Table 3). Between the 2 treatments, 823 gulls (776 herring gulls and 47 great black-backed gulls) were recovered. A total of 931 clutches of eggs was destroyed.

1991

During 1991 we found overall numbers much reduced and more manageable. In the primary treatment cycle, 301 nests were prebaited and 303 treated. In the secondary treatment cycle, 295 nests were prebaited and 296 treated. The boldness thatcharacterized the behavior of gulls on our first visits in 1990 was not seen again. Gulls evacuated the island upon our arrival,

circled high overhead or landed offshore, and never landed anywhere on the island while we were present. Bait consumption, though slower, remained excellent.

Table 1. Total numbers of herring gulls (IEGU) and great black-backed gulls (GBBG) recovered following primary and secondary applications of DRC-1339 gull toxicant at Ram Island, Mattapoisett, Mass. in 1990 and 1991.

	HEGU		GBBG		Total	
Treatment	1990	1991	1990	1991	1990	1991
Primary	489	55	38	38	52793	
Secondary	?$Z	72	-2	--1	-226	79
Total	776	127	47	45	823	172

Table 2. Times and locations of gulls recovered following primary applications of DRC-1339 gull toxicant at Ram Island, Mattapoisett, Mass. in 1990 and 1991.

			recovered			
Time	On Island		Off Island		T	
postbai6ng	19901991		1990	1991	TORMW	
48 hours	318	37	67	9	387	46
72 hours	76	17	31	12	107	29
120 hours	21	_§	*JD*	*12*	*M*	*1A*
Total	417	60	110	33	527	93

Table 3. Times and locations of gulls recovered following secondary applications of DRC-1339 gull toxicant at Ram Island, Mattapoisett, Mass. in 1990 and 1991.

	Numbers of gulls recovered					
Time	Island		Off Island		Total	
postbaiting	1990	1991	1990	1991	TM	199
48 hours	107	64	77	3	184	67
72 hours	34	2	25	3	59	5
120 hours	_U	6	4Q Total	154	72 142	7
					296	79

A total of 172 gulls wasrecovered following the 2 treatments, 93 following the primary treatment, and 79 after the secondary treatment (Table 1). In the aggregate, 77% were recovered on the island. Classified by species, 127 (74%) were herring gulls and 45 (26%) were great black-backed gulls. Herring gulls comprised 59% of the birds recovered after the primary treatment, and 91 % after the secondary treatment. Two hundred fifty-nine clutches of eggs were destroyed.

Of the 995 gulls recovered during both years, a sample of 591 adults was sexed. Females predominated almost 2:1, and this imbalance was notably pronounced in the great blackbacked gull (Table 4).

Table 4. Aggregate sex data for adult herring gulls (I-IEGU) and great black-backed gulls (GBBG) recovered after DRC-1339 gull toxicant applications atRam Island, Mattapoisett, Mass. in 1990 and 1991.

Species	Male (%)	Female (%)	Total (%)
HEGU	186 (36)	335 (64)	521(100)
GBBG	6 (9)	64 (91)	
Total	192 (32)	399 (68)	591(100)

Common and roseate terns from the nearby colony at Bird Island, Marion (9.7 km to the north) feed regularly in the waters surrounding Ram Island. Many of these birds surely noted the tern decoys. During our visits in June 1991, we occasionally observed single terns flying over and circling the decoys. On 1 occasion, a bird flew in lower and lower circles and eventually landed with the decoys. We found no evidence of tern nesting in 1991. A small number of nesting gulls persisted near and among the decoys, and we suspect these pairs of gulls (which returned to their territories within minutes of our departure) probably discouraged any prospecting terns from initiating nesting.

DISCUSSION

During 1990 and 1991, gull productivity at Ram Island was completely suppressed. A total of 995 gulls was recovered, of which 903 (91%) were herring gulls and 92 (9%) were great black-backed gulls. In 1991, we recovered 79% fewer gulls than in the first year (172 versus 823). This apparent decline in numbers taken, however, may cast an overly optimistic light on our progress in reducing the island's gull population. In yearto-year primary treatment comparisons, we actually treated only 41 % fewer nests (732 versus 303). Similarly for secondary treatments, we treated only 52% fewer nests (563 versus 296).

Theoretically, by baiting nests with DRC-1339, at least 1 member of every pair is killed. In actual practice, not every pair is broken, presumably because aggressive individuals garner more than their share of the bait, stealing from neighbors' nests. Thus we baited 1.39 nests for every gull recovered in the primary 1990 treatment. In our 3 successive treatments, nests treated for every gull recovered dead increased to 1.90, 3.25, and 3.74 respectively, suggesting declining efficiency. We believe our recovery of dead gulls was consistent and highly efficient and thus could not have accounted for this variation. We speculate the decline might have been due to a number of factors, including more scrupulous baiting of marginal nests, a greater number of duplicate nests built by first-time nesters, and possibly bait shyness in a growing number of wary individuals.

In both years the percentage of great black-backed gulls recovered in the secondary treatments was notably lower than in the primary treatments (Table 1), because black-backs tend to nest slightly earlier. The total number of black-backs recovered was almost unchanged year-to-year (47 versus 45) compared with recovery of herring gulls (776 versus 127). This may have been explained by the fact that in our sexed sample of great black-backed gulls *(n = 70*) and herring gulls *(n = 521*), only 9% of the black-backs were male, compared with 36% in the herring gulls. Male gulls, being the territory holders, merely remate. This markedly skewed sex ratio among black-backs recovered may also explain why Kress (1983) found that blackbacks failed to show a significant decline until the fourth summer after control work began at Eastern Egg Rock, Maine.

Another oddity in our data is the trend reversal seen between years in the numbers of herring gulls taken in the primary and secondary treatments. In 1990, 41% fewer (489 versus 287) were taken in the secondary treatment, while in 1991, 31% more were recovered (55 versus 72) (Table 1). We have no explanation for this except that it may be due to more first-time nesters (which tend to nest later) joining the colony.

MANAGEMENT IMPLICATIONS

It is clear that DRC-1339 is very effective for reducing gull populations in strategic, site-specific applications. It appears thateven in the shadow of the New Bedford commercial fishery and the huge food resources associated with it, DRC-1339 successfully reduced the gull population on Ram Island.

Restoration of terns, however, does not always follow automatically. The rapid reoccupation of the Petit Marian tern colony in Maine within 3 weeks of gull removal with DRC1339 (Andrews 1990) seems more an exception than the rule. More often, reclamation of nesting islands and successful restoration of ferneries requires continual effort spread over an unbroken period of at least 4 years (Anonymous 1970).

DRC-1339 has reversed gull domination at Ram Island. We hope that continued DRC-1339 applications and egg breaking, augmented by selected shooting, increased human presence on the island, and the use of decoys and other social attractants, will lead to eventual reoccupation of the island by terns.

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