PRAIRIE CRAYFISH: A HAZARD IN DIRECT SEEDING

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The prairie crayfish has been a suspected cause of seed and seedling losses on poorly drained sites where southern pines have been direct seeded. Crayfish burrows are often numerous on these sites, and clipping of newly germinated pines is similar to agricultural crop damage by crayfish.

A series of studies was started near Alexandria, La., in 1963 to determine if crayfish eat pine seeds and seedlings. Results indicate that they seldom feed on either, but that washing of seeds into burrows is a major problem.

Several similar species of prairie crayfish *(Cambarus)* are intermingled on upland pine sites in Louisiana [1]; no attempt is made to distinguish among them in this article. All are grayishwhite. Adults average about 2-1/2 inches long, smaller than the commercial species used in many food delicacies (fig. 1). Almost their entire life (probably not longer than 2 years) is spent in underground burrows extending below the water table (fig. 2). According to Johnson (1948), the crustaceous shell extracts oxygen from water similarly to fish gills, and if it is dry for more than a few minutes the crayfish will suffocate. Consequently, above-ground activity takes place at night during or after a rain when vegetation is wet. The principal food of these crayfish appears to be vegetable matter, either alive or dead (Hamner 1953)[2].

Populations

Crayfish populations are often dense on sites with a high water table. Davison (1947)[2] states that more than 40,000 surface openings per acre have been counted in Mississippi, and that 5,000 to 10,000 are common. In the studies described here, the range was from 2,800 to 4,600 holes per acre; an average of three openings converged into a single main burrow. By counting crayfish in excavated burrows, we estimated adult populations at 500 to 1,000 per acre.

Methods and Results

Study 1.-The objective of this study, carried out in the laboratory, was to determine whether crayfish would eat seeds, seedlings, or both. Five 5-gallon cans were partially filled with soil and covered with native grass sod. Water was added to within 3 inches of the sod surface. One adult and two young crayfish were put in each of the four cans, and three young were put in the other. Repellent-treated longleaf pine *(Pinus palustris* Mill.) seeds (Derr 1963) and newly germinated longleaf seedlings were made available to the crayfish continuously.

In 75 days, only eight seeds and five seedlings were eaten; five seedlings were damaged. Two adults and four young died in cans where treated seeds were taken; one adult and three young died without taking seeds. Since the unnatural environment very likely affected feeding habits, the rest of the tests were done in the field.

Study 2.-The objective of the second study was to examine feeding habits in a natural environment. The study involved 25 active field burrows, each with a single surface opening. Vegetation within a foot of each hole was removed, and the entrance was enclosed in a fine-mesh wire cage measuring about 10 inches in diameter. The cage excluded all seed and seedling predators except small insects. Five of the 25 enclosures were assigned to each of the following treatments: (1) 25 untreated longleaf pine seeds; (2) 25 untreated slash pine (P. *elliottii* Engelm.) seeds; (3) 25 repellent-treated slash seeds; (4) 25 treated

1 Personal communication, from Cecil LaCaze, Crayfish Biologist, Louisiana Wild Life and Fisheries Commission, 1970.

2 Hamner (1935) and Davison (1947) report on only one *species, Cambarus hagenianus.*

Figure 1.—Adult female prairie crayfish with three young.

and 25 untreated slash seeds; and (5) five newly germinated slash seedlings. The enclosures were checked twice weekly for 2 months.

Average losses per burrow were:

Treatment	*Number of seeds*	*Percent lost*
Untreated longleaf seeds	25	75.2
Untreated slash seeds	25	47.2
Treated slash seeds	25	41.6
Treated and untreated slash seeds	50	48.4
Slash seedlings	5	64.0

Seed losses averaged 18.8 per burrow for untreated longleaf and 11.8 for untreated slash. Treated slash pine losses were slightly lower than untreated slash when the two were provided separately. Approximately the same ratio was observed where treated and untreated seeds were mixed within the same enclosure. Since high water tables prevented excavation of the burrows, it was impossible to tell whether seeds were eaten by crayfish, carried into their burrows, or floated into the entrance holes during storms. Water movement was suspected as the main cause of loss, however. Few burrows had mud chimneys such as crayfish often build; most had a slight depression at the opening. Longleaf is more susceptible to flotation than slash pine, and longleaf losses were 28 percentage points higher than slash under identical conditions.

Sixteen seedlings were damaged or destroyed One crayfish was observed feeding on a single

Figure 2.—Two separate burrows extending about 30 inches below ground.

seedling for several days before starting to eat anothet one. Results of the study showed crayfish would feed on seedlings-and possibly on seed when other foods were *not* available. Further study was needed to appraise crayfish damage when natural foods were present.

Study 3.-Native vegetation was left in place around 60 surface openings to provide a choice of foods. The objective of this study was to measure losses caused by washing of seeds into the holes. Twenty burrows were poisoned with about 5 cc of creosote emulsion to kill the occupants. Forty slash pine seeds, 20 treated and 20 untreated, were placed around each of the 60 burrows and covered with wire cages as in study 2. Periodic observations -were made for 11 weeks, twice weekly during the germinating period and once a week thereafter.

The average number of seeds missing per enclosure was:

Burrow treatment	Treated	Untreated	Total
		Number Missing	
Poisoned	2.1	5.7	7.8
Unpoisoned	3.2	5.8	9.0

Burrow treatment with creosote is lethal to crayfish (Lyle 1937). It must be assumed then that the missing seeds (19.5 percent) washed into the treated burrows. If washing caused equal losses in unpoisoned burrows, crayfish probably destroyed the difference, or 1.2 seeds per burrow. The large difference between treated and untreated seeds that disappeared into poisoned burrows could not be explained and laboratory tests failed to reveal a statistically significant difference (0.05 level) in flotation qualities between the two types of seeds.

Fifteen seedlings were damaged or destroyed, and all were under two cages covering live burrows. However, three nests of small black ants, probably *Monomorium minimum* (Buckley) were near one cage and two nests were near the other. They were observed on one occasion feeding on a seedling; they have also been observed damaging seedlings in other local studies.

Study 4.-This was the first of two studies made in successive years to determine the effect of crayfish on initial seedling stocking. Five pairs of 0.1-acre plots were established at each of two locations. Each plot was surrounded by a 33-foot isolation strip. Crayfish were killed on one plot of each pair by creosote emulsion poured into every hole; they were left undisturbed on the other. Plots were sown in February 1966 with 10,000 sound, repellent-treated slash pine seeds per acre. Seedling counts were made several months later. To exclude the possibility of crayfish from untreated areas influencing results on treated plots, counts were made on the central 0.025 acre of the 0.1-acre plots.

One of the study areas had a total of 2,832 surface holes per acre. An average of 2.95 entrances converged into each burrow; there were 960 burrows per acre. Excavation of a small sample of the burrows showed that 55 percent were occupied by one adult and zero to two young crayfish. The population was estimated at 528 adults and 576 young per acre. Burrow excavation and population estimates on the other area, which had 4,586 entrances per acre, were prevented by a high water table.

Initial seedling stocking on one area averaged 3,290 seedlings per acre on treated plots and 3,530 on the checks. The difference was not statistically significant at the 0.05 level. On the other area, plots with an undisturbed crayfish population also had the highest tree count-2,890 vs. 2,220 seedlings per acre. The difference between treatments in total seed and seedling losses on both areas was less than 3 percentage points.

Observations made during warm, rainy nights in late April (when crayfish are apt to emerge from their burrows to forage) disclosed only six crayfish on the surface in four searches of 2% hours each; two were eating dead grass and three crawled over seedlings without feeding on them.

Study 5.-In this study, 10 contiguous pairs of plots were established-five for longleaf and five for slash pine. Crayfish were eradicated on one plot of each pair.. Seeds of both species were treated with repellents and sown at the rate of 15,000 per acre. Longleaf was sown in November 1967, and slash in March 1968. The crayfish population was not estimated, but entrance holes averaged 4,600 per acre.

Initial stocking of longleaf, measured soon after germination was completed, averaged 3,300 and 3,180 seedlings per acre on treated and untreated plots. Slash pine seedling stocking averaged 6,800 per acre on plots free of crayfish and 7,250 on the checks. Differences were not statistically significant at the 0.05 level for either species.

Discussion and Conclusions

Results of these studies showed that crayfish will eat a few pine seedlings-and possibly some seeds-when normal - foods are scarce. But in three of four field installations, initial seedling stocking was slightly higher on plots with 500 to 1,000 crayfish per acre than on plots where crayfish were eliminated. Therefore, it is clear that direct damage by crayfish is not a major barrier to seedling establishment.

Much more serious than depredations, however, were losses for which crayfish were indirectly responsible. Apparently, during a rain many seeds float into crayfish burrows where holes are numerous. Seed movement up to 6 feet during intense rains has been measured by the author [3].

About 20 percent of the seeds under cages in study 3 disappeared into burrows where the crayfish had been killed. In the first seedling establishment study, seed disappearance on one area averaged 16 percent on treated plots and 14 percent on controls. The other area was more susceptible to water movement and standing water; 22 percent of the seeds disappeared on treated plotss and 25 percent on controls. In the second study, disappearance of slash pine seed averaged 26 percent on treated plots and 23 on controls, while 42 and 45 percent of the longleaf seeds were missing op treated and untreated plots. Longleaf seeds are more ' buoyant than slash pine seeds, and thus more likely to be moved by water. These ' indirect crayfish-caused losses could be important in years of heavy rainfall during the germination period.

How, then, does the forest manager combat these losses when direct seeding an area with numerous crayfish holes? One solution is to bed the site', which will destroy the surface openings. The approximate 3-month time lapse for bed settling and seed germination will not be long enough for the relatively inactive crayfish to reopen many burrows to the surface. And seeds will not move as easily on the rough beds as they do on the relatively smooth unprepared soil. Bedding cannot be economically justified solely to prevent seed loss in crayfish holes, but studies have demonstrated a positive growth response of pines to bedding on poorly drained sites where crayfish are abundant. The combined effect may be worth considering.

Another solution is strict adherence to recommended sowing rates, which are high enough to allow for some uncontrollable seed losses. Some foresters, having gained considerable directseeding experience, have lowered establishment costs by reducing the recommended sowing rates. Reduced rates should not be applied where crayfish burrows `are numerous until several years of experience have been gained in seeding such areas.

[3]Unpublished studies.

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