A PRELIMINARY REPORT OF THE EFFECTS OF THE T. S. I. PROGRAM ON THE WILDLIFE HABITAT IN THE OCALA NATIONAL FOREST

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INTRODUCTION

The purpose of this study is to help determine the effects of the T. S. I. (Timber Stand Improvement) program of the U. S. Forest Service in the Ocala National Forest upon the game habitat in this area. This study was suggested by the Florida Game and Fresh Water Fish Commission and Ranger John Olson of the U. S. Forest Service. By far the greatest amount of T. S. I. work to date has been conducted on longleaf pine habitat sites, and it was in these areas that most of the study was made.

The T. S. I. work conducted in the longleaf pine areas consisted of either girdling and poisoning (2, 4, 5-T) or cutting down and poisoning undesirable commercial species for the purpose of releasing longleaf pine seedlings. The undesirable trees were treated only if they were in competition with pine seedlings. Undesirable species were considered in competition with longleaf pine seedlings if in good sites they overtopped the seedlings, and if in poor sites, such as in scrub oak and deep sand, they were closer than their height to the desirable seedling. Most of the trees cut down or girdled were turkey oak (*Quercus laevis*), live oak (*Q. virginiana*), and upland willow oak (*Q. cinerea*). The T. S. I. crews were given instructions by the U. S. Forest Service to leave at least four mast producing oaks per acre untreated for game food trees and also to leave den trees.

STUDY METHOD USED

In order to measure any effects of this T. S. I. program upon the wildlife habitat, it is important to determine just how many potential acorn producing oaks had been destroyed, and how many had been left. Acorns are recognized as excellent food for deer, turkey, squirrel, and quail. In this case we are primarily interested in deer food as this is the only game species found in large numbers in the longleaf pine areas.

Lines were run on a compass bearing, on which at 150 foot intervals plots one chain square (1/10 acre) were intensively studied to determine the number of oak trees per acre (4" DBH or greater),* the number girdled, the number cut down, and the area in square feet covered by the oak crowns. On each line a total of ten plots, or one acre, was intensively studied. Twenty-five of these compass lines were run, making a total of 250 plots or an area of 25 acres studied. The sample areas were selected at random, but an effort was made to run some in heavy stands of oaks, some in thin stands, and some in moderately thick stands.

The majority of the T. S. I. work was done in March, April and May of 1955, although 30 plots were studied from an area T. S. I. treated in the Spring of 1953. This study was conducted in August of 1955 and April of 1956.

RESULTS OF STUDY

The grand totals for all the study areas showed an average of 2.82 oaks (4" DBH or greater) per plot or 28.2 oaks per acre. Of these 28.2 oaks, an average of 5.9 was girdled and 3.5 cut down. Adding the girdled and cut down oaks gives a total of 9.4 oaks per acre treated in the average T. S. I. area. Subtracting 9.4 from the average of 28.2 oaks per acre leaves 18.8 oaks untreated.

In order to get a better understanding of this problem, the study areas were divided into various units depending upon the number of oaks per acre. These units were areas with 1-10 oaks per acre, 10-20 oaks per acre, 20-30 oaks per

* The 4" DBH was selected since the turkey oak, which is the common oak in the longleaf pine area, seldom produces a mast crop when under 4" DBH.

acre, 37-50 oaks per acre, and 65-97 oaks per acre. Obviously there would be a greater effect upon the game habitat if 50 per cent of the oaks were destroyed in an area with only four oaks to the acre than if 50 per cent of the oaks were destroyed in an area with 50 to the acre.

1-10 Oaks Per Acre

Examination of the figures from these areas showed an average of 7.8 oaks per acre. Of these, 4.4 were girdled and 0.6 were cut down for a total of five trees per acre T. S. I. treated. Substracting the five treated trees from the average of 7.8 oaks per acre leaves 2.8 untreated trees per acre. Sixty-four per cent of all oaks were either cut down or girdled in this group. A total of 50 plots or 20 per cent of the plots studied fell into this group.

Many of the oaks were large, having at least a 10-12 inch DBH. This is important in this study, because large oak trees growing in fairly open country have large crowns and tend to produce heavier mast crops than smaller trees growing under more crowded conditions.

The average oak crown covered 320.4 square feet. With 7.8 oaks per acre this gives a total of 2,499 square feet or 5.7 per cent of the area per acre utilized by oaks. It should be pointed out that the root system covers a larger area than the crown in the dry sand soil present in the area, and one oak may actually require a larger growing area than the diameter of the crown. After T. S. I. treatment 2.8 oaks were left, which utilized two per cent of the area. The T. S. I. treatment in this area reclaimed 1,602 square feet per acre or 3.7 per cent of the area. If the radius of the crown of an average longleaf pine growing in a moderately heavy stand is ten feet, the T. S. I. treatment in this area would allow growing space for approximately five more pine trees per acre. Considering that the growth cycle of the longleaf pine is 120 years and that the average mature tree would bring approximately 20 dollars, an increase of 100 dollars in saw timber would be produced. This amounts to 83 cents per acre per year increase in saw timber production due to the T. S. I. program. Undoubtedly some thinning for pulpwood would be carried out through the years, but the author doubts if this would increase the timber production income to above one dollar per acre per year in this type of area.

10-20 Oaks Per Acre

Results from the plots checked in these areas showed an average of 15.4 oaks per acre. Of the 15.4 oaks present, 5.8 were girdled and 1.6 were cut down for a total of 7.4 oaks per acre T. S. I. treated. Subtracting the 7.4 treated trees from the 15.4 oaks present leaves eight trees untreated per acre. Forty-eight per cent of all the oaks were either girdled or cut down in this 10-20 oaks per acre group. Fifty plots or 20 per cent of the total plots studied fell into this group.

Oaks utilized 10.7 per cent of the area per acre in this group. After T. S. I. treatment 5.5 per cent of the area was utilized by oaks. A total of 5.2 per cent of the area per acre was reclaimed by T. S. I. treatment.

20-30 Oaks Per Acre

An average of 25 oaks per acre was found in this group. Of the 25 oaks, 6.7 were girdled and 1.6 were cut down. An average of 8.3 oaks per acre was T. S. I. treated. Subtracting the 8.3 treated trees from the 25 oaks per acre leaves 16.7 untreated oaks per acre. A total of 33.3 per cent of all oaks was either girdled or cut down in this 20-30 oaks per acre group. Seventy plots or 28 per cent of the total plots studied fell into this group.

Oaks utilized 14.3 per cent of the area per acre before T. S. I. treatment and eight per cent after treatment. Six and three-tenths per cent of the area per acre was reclaimed by T. S. I. treatment.

It should be pointed out at this time that as the number of oaks per acre increases there is an increasing number of oaks smaller than 4" DBH growing in the stand. Although these oaks are not counted in this study, they do take considerable growing space. These smaller oaks are not included in the figures given for per cent of the area utilized by oaks in this report.

37-50 Oaks Per Acre

An average of 42 oaks per acre was found in this group. Of these, 6.6 were girdled and nine were cut down, giving an average of 15.6 oaks per acre T. S. I. treated, while 26.4 were left untreated. A total of 37.4 per cent of all oaks was T. S. I. treated in this 37-50 oaks per acre group. Sixty plots or 24 per cent of the total plots studied fell into this group.

A large increase in the number of trees cut down can be noted in this group. This is due to the fact that in the thicker oak stands the trees become more crowded and smaller. Cutting down is the usual T. S. I. treatment for oaks four to five inches DBH.

Oaks utilized 15.5 per cent of the area per acre before T. S. I. treatment and 8.3 per cent following treatment. Seven and two-tenths per cent of the area per acre was reclaimed by T. S. I. treatment.

65-97 Oaks Per Acre

Results from the plots checked in these areas showed an average of 81 trees per acre. Of these 81 oaks, 5.5 were girdled and 5.5 were cut down for a total of 11 oaks per acre treated, and 70 oaks untreated. A total of 13.6 per cent of all oaks was T. S. I. treated. Twenty plots or eight per cent of the total plots studied fell into this group. Very little T. S. I. work was done in these areas due to the dense stands of oaks present and the lack of pine reproduction within the area.

Oaks utilized 14.3 per cent of the area per acre before T. S. I. treatment and 16.4 per cent after treatment. Two and six-tenths per cent of the area per acre was reclaimed by T. S. I. treatment. The author would like to point out that the area utilized by oaks in this study denotes the area covered by the crown and does not necessarily include all the area utilized by oaks due to their extensive root system in the dry sandy soil present.

The number of T. S. I. treated oaks in this group was smaller than in the 37-50 oaks per acre group. As the oak stands become thicker, it is harder for the longleaf pine seedlings to get a start. In heavy oak stands there is little or no longleaf pine reproduction.

Table I

Area Per Acre Utilized by Oak Crowns

Group (Oaks Per Acre)	*Before T. S. I. Treatment*		*After T. S. I. Treatment*	
	Sq. Ft. Covered	*% Acre*	*Sq. Ft. Covered*	*% Acre*
1-10	2,499	5.7	897	2.0
10-20	4,645	10.7	2,412	5.5
20-30	6,255	14.3	3,507	8.0
37-50	6,745	15.5	3,621	8.3
65-97	8,262	19.0	7,140	16.4

Table II

Summary of T. S. I. Program in Longleaf Island Habitat Type in the Ocala National Forest

Oaks Per Acre	*Avg. No. Oaks Per Acre*	*Avg. No. Oaks T. S. I. Treated Per Acre*	*Avg. No. Oaks Left Untreated*	*% Oaks T. S. I. Treated*	*No. Plots Studied*
1-10	7.8	5.0	2.8	64.0	50
10-20	15.4	7.4	8.0	48.0	50
20-30	25.0	8.3	16.7	33.3	70
37-50	42.0	15.6	26.4	37.4	60
65-97	81.0	11.0	70.0	13.6	20
Total	28.2	9.4	18.8	33.3	250

Figure 1. Number of Treated Oaks Per Acre on Areas Treated for T.S.I.

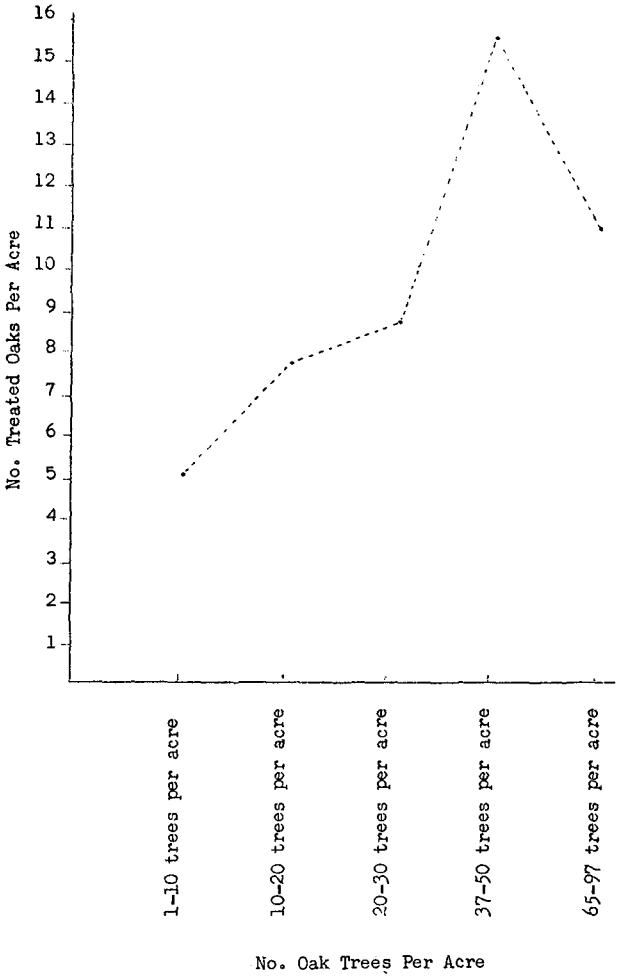


Figure 2. Number of Untreated Oaks Per Acre Left on Areas Treated for T.S.I.

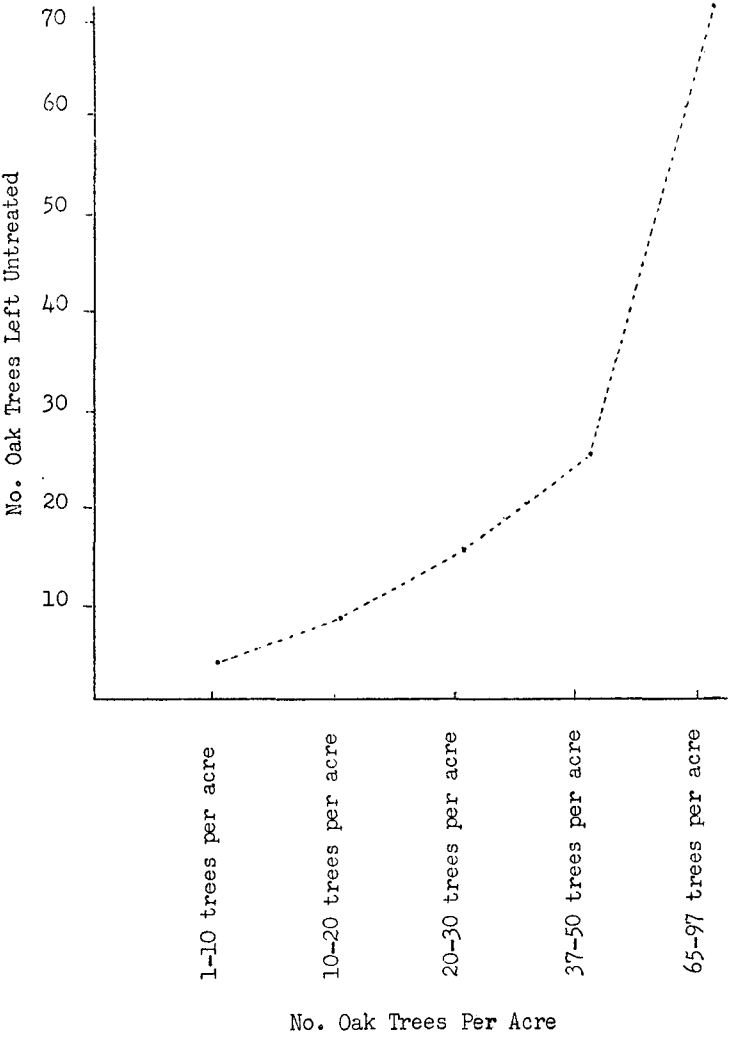
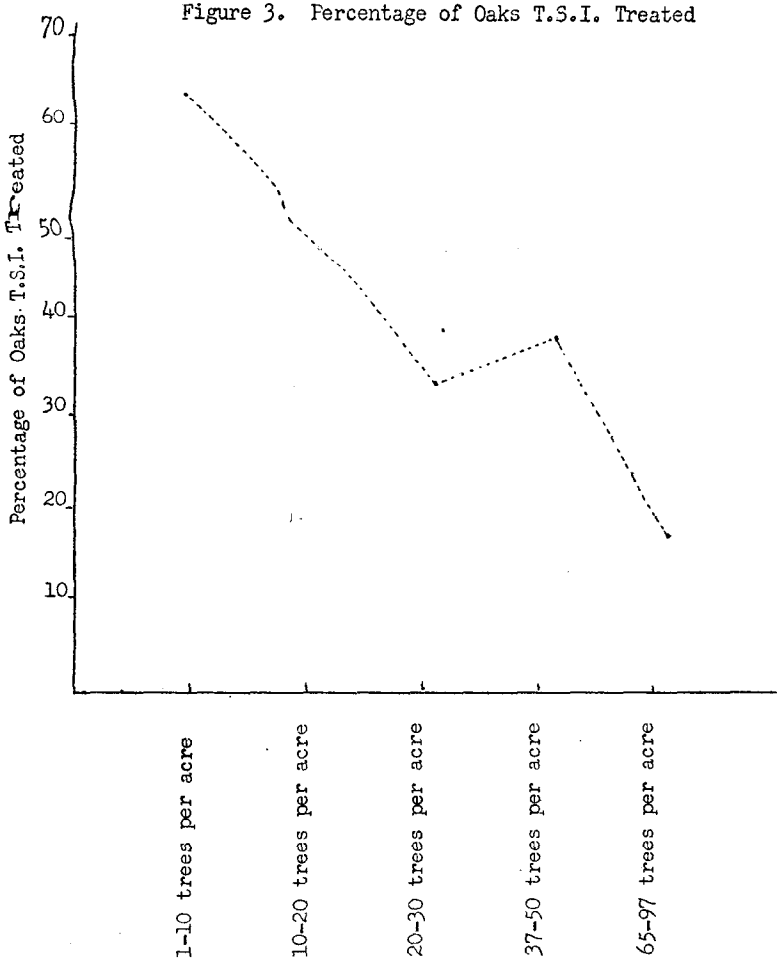


Figure 3. Percentage of Oaks T.S.I. Treated



ACORN PRODUCING PATTERN OF OAKS IN LONGLEAF PINE AREA

Fortunately for the game the various oak species produce their acorns during different months of the year. Acorns first become available during the month of September and may be used as late as February or March the following year. Thus it is possible to have acorns available as food for a six month period.

The live oak is the first to drop its acorns which are very important as they provide a valuable food just prior to the rutting season when deer need to be in good condition. Following the live oak, the upland willow drops its acorns. The last species to drop its acorns is the turkey oak. These acorns are very valuable as they provide food through the winter months when other food may be scarce. Deer are quite fond of the turkey oak acorns, preferring them to the other acorns present in the area.

Only the three large major oak species have been discussed here; a few minor species present will not be included. Of the three oaks discussed, the live oak and the turkey oak are more valuable as a game food tree than the upland willow oak.

T. S. I. PROGRAM IN HARDWOOD SWAMP AREA

Besides the T. S. I. program carried on in the longleaf pine habitat, a small amount of T. S. I. work was done in a hardwood swamp area. For the purpose of this paper the river hammock type has been included under the term of hardwood swamp area. At the time of this writing only a very small acreage had been treated. The T. S. I. program followed logging operations in the area.

The purpose of this T. S. I. program was to release valuable hardwood species by cutting down and poisoning and by girdling and poisoning the the less desirable species of hardwoods. The desirability of the hardwood species in this program depended upon its value as a marketable tree. Magnolia (*Magnolia* spp.), gum (*Liquidambar styraciflus*), maple (*Acer* spp.), and to a lesser extent hickory (*Carya* spp.) were considered desirable species while live oak (*Quercus virginiana*), laurel oak (*Q. laurifolia*), and water oak (*Q. nigra*) were the species most commonly treated as undesirable. Other species were also taken into consideration, but in this area the above mentioned trees are by far the most common trees present.

Although the T. S. I. area to be studied was small, the same study procedures were used in this area as already described for the longleaf pine area. Ten plots were intensively studied within the river swamp, ten in the transition zone between the river swamp and the river hammock, and ten in the hammock.

For the purpose of this paper the river swamp is considered to be those areas that are usually inundated from the river. The overstory consists primarily of sweetgum, cypress, oaks, and maple. The transition zone is the area where the land is higher and seldom has any standing water. The overstory is primarily of oaks, magnolia, and sweetgum. The hammock is comparatively high and dry with an overstory of oaks and magnolia with scattered hickory and sweetgum.

Within the river swamp a total of 14 oaks (4" DBH or greater) per acre was recorded. Of these, 13 had been girdled causing 93 per cent destruction of the oaks within this area. Sweetgum was the most common desirable hardwood species with which the oaks were in conflict. Many of the live oaks in this area were huge, having a 24-inch DBH or greater.

In the transition zone a total of 66 oaks per acre was recorded. Sixty-three of these had been girdled, making a 95 per cent destruction of the oaks. Magnolia was the most common desirable hardwood with which the oaks were in conflict. As was the case in the river swamp many large live oaks were present.

In the hammock area a total of 77 oaks per acre was recorded. Thirty-eight of these had been girdled and four cut down for a 54.5 per cent destruction of the oaks in this area. Magnolia was the hardwood with which the oaks were in conflict.

In the hardwood swamp areas oak mast is not only important to deer but also very important to squirrels and turkeys. The oak mast is especially important to turkeys and squirrels during the long hunting season when they seldom venture out of the river swamp and must depend upon the available food in these areas.

The author noted that the logging operations in this area had torn down and knocked over many of the understory shrubs causing a heavy sprout growth. There was evidence of heavy deer browsing on this sprout growth.

TABLE III

SUMMARY OF T. S. I. PROGRAM IN HARDWOOD SWAMP AREA

Area	*Avg. No. Oaks Per Acre*	*Avg. T. S. I. Treated*	*% Oaks Destroyed*
River Swamp	14	13	93.0
Transition Zone	66	63	95.0
Hammock	77	42	54.0

T. S. I. AREA FOR RELEASE OF SAND PINE SEEDLINGS

A small area was T. S. I. treated for the release of sand pine seedlings. The same steps were taken as described when the longleaf pine seedlings were released. This area had originally been in longleaf pine as evidenced by a few remaining longleaf pine and also by adult sand pine with cones that were apparently opening and reseeding the surrounding territory. Sand pine cones usually do not open in the sand pine habitat type without fire, but will open in the longleaf pine areas. A heavy stand of turkey oak had formed an overstory over the sand pine seedlings.

In this small area the author did not set up any plots for intensive study, but did cover the area on foot. Heavy sand pine reproduction in the area resulted in an almost 100 per cent T. S. I. treatment of the oaks.

T. S. I. AREA FOR RELEASING AND PLANTING SLASH PINE

A small amount of work has been done in the Seminole Ranger District to increase the acreage of slash pine through a T. S. I. program. This program consists of clearing a narrow strip around ponds either with a brush cutter or by girdling and poisoning. Slash pine is then planted in these treated areas.

No study plots were set up in this area, but the areas treated were carefully examined. In those areas where the brush cutter was used, the oaks and palmettos were not killed but severely cut back. In those areas where the larger oaks were present they were girdled and poisoned. Almost 100 per cent of the oaks that were poisoned were killed in these small areas.

CONCLUSION

A careful appraisal of the results of this study indicates that the T. S. I. program to date in the Ocala National Forest has hurt the wildlife habitat in certain areas but has possibly helped in others. Whether this program helps or hurts the wildlife habitat depends primarily upon whether it is conducted in a heavy oak stand or in a thin stand, and whether there is a good or poor reproduction of desirable commercial species.

The over-all picture of the T. S. I. program in the longleaf pine areas showed an average of 18.8 trees untreated per acre which is probably enough oaks per acre for game food needs. It should be pointed out, however, that where only two or three oaks were left per acre, the number is insufficient to provide enough mast for game needs in these areas. The project leader believes that it is to the advantage of the deer herd if a suitable number of oaks can be left for each and every acre instead of concentrating the oaks in local areas.

In those areas where a heavy stand of oaks is present, 50 oaks to the acre or better, the T. S. I. program may help game food production in two ways. The T. S. I. treatment will break up the overstory which in turn should increase the ground plant growth, increasing the amount of available deer browse. Secondly, by opening up the overstory the competition between oaks is reduced and in the long run more acorns may be produced.

In those areas where 1-10 oaks per acre were found the T. S. I. program definitely hurt the wildlife habitat. In these areas only 2.8 oaks per acre were left untreated and in most cases the oaks in these areas were large with good crowns which produce a better crop of acorns that some of the more crowded oaks.

In those areas where 10-20 oaks per acre were found the overall wildlife habitat was injured, but not as severely as in the 1-10 oaks per acre group. In those areas with 20-50 oaks per acre the T. S. I. program probably neither helped nor hindered to any great degree.

In the hardwood swamp area where a small T. S. I. program was conducted the author believes the game habitat was temporarily improved for deer, but seriously injured for squirrels and turkeys. The help this program may give deer is through the opening of some of the heavy overstory allowing more browse species underneath, though at the same time deer will suffer from the loss of mast. The very heavy kill of oaks in the river swamp and the transition zone cannot help seriously decreasing the available mast for turkeys and squirrels.

In the area where the T. S. I. program was used to release sand pine seedlings the game food production was greatly decreased. Not only is almost all of the turkey oak mast crop gone, but as the sand pine seedlings mature they will choke out many of the browse species present. Sand pines have the facility of growing in such thick stands they completely dominate other plant species in that area.

Whether the T. S. I. treatment for slash pine release and planting helped or hurt the wildlife habitat depends upon the type of treatment used and the areas in which the work was conducted. As deer are the only game species present in any quantity in these areas, the term wildlife habitat is synonymous with deer habitat in the following discussion. In those areas where the scrub oaks and palmettos were brush cut back from the edges of ponds, the wildlife habitat was probably helped, as this treatment induces vigorous sprout growth throughout the area treated. The amount of mast lost in these areas would probably have little effect upon the game populations.

Where the larger live oaks were killed by girdling and poisoning the effect undoubtedly was unfavorable. This treatment will increase the ground cover to a small degree but will drastically curtail the mast production in the areas treated.

SUGGESTED RECOMMENDATIONS

These recommendations are intended only as a guide until further research work points out better steps to take in coordinating wildlife habitat needs with the T. S. I. program. They are made with the objective of trying to coordinate the needs of both wildlife and timber programs.

Considerable time has been spent, not only by the author, but by other Florida Game and Fresh Water Fish Commission personnel and the U. S. Forest Service officials in the writing of these recommendations. Efforts are being made by U. S. Forest Service officials to adopt these regulations into the T. S. I. program of the Florida National Forests.

A. *Longleaf, Slash and Other Pine Types*

1. No timber stand improvement will be done in areas containing less than ten oaks per acre.
2. In areas containing more than ten oaks per acre, a minimum of five well formed game food producing trees (oaks preferred) will be left in each area. If possible, trees will be well distributed over the area. Trees with ten-inch DBH or greater will be selected when available.
3. In addition, four den trees per ten acres and all occupied den trees will be left.

B. *Bottomland Harwood Type*

1. A minimum of five well formed game food producing trees (oaks preferred) will be left in each acre. If possible, trees will be well distributed over the area. Trees with ten-inch DBH or greater will be selected when available.
2. In addition, four den trees per ten acres and all occupied den trees will be left.

C. *Live Oak Hammock Type*

1. No stand improvement work will be scheduled in areas containing less than two acres.

D. *Sand Pine Type (Ocala National Forest)*

1. Sand pine encroaching in the longleaf type will be eliminated, except in areas stocked with 500 or more sand pine trees per acre and which average 36 inches or more in height.
2. Control of encroaching sand pine in the longleaf type will be accomplished by prescribed burning or by removal of merchantable trees in timber sales.

E. *Most Desirable and Desirable Trees for Wildlife Management*

Most Desirable Hardwoods	*Desirable Hardwoods*
Turkey Oak	Hickory
Live Oak	Tupelo Gum
Water Oak	Magnolia
Laurel Oak	Beech
Overcup Oak	Maple
Cow Oak	Basswood
Post Oak	Sycamore
Blue Jack Oak	Elm
Black Gum	Ash
Black Cherry	
Other Preferred Tree and Shrub Species	
Iron Wood	Myrtle
Holly	Gooseberry
Dogwood	Sparkleberry
Persimmon	Wild Grapes
Youpon	Virginia Willow

TECHNICAL FISH SESSION

PRO-NOXFISH *

A New Synergized Rotenone Formulation for Fish Control

By ROBERT W. PRICE and DOUGLAS R. CALSETTA

The subject of this report concerns the management of fish populations in our inland lakes and rivers. The condition frequently arises wherein undesirable species will outgrow and overcrowd more desirable types of game fish. In some instances carp will overgrow and seriously damage a waterfowl feeding area by consuming pondweed and other aquatic plants. Also, they so muddy the waters that sunshine cannot penetrate to stimulate growth of new plants.

It has become common practice to treat selected waters for the complete removal of the fish population, then subsequently to restock with game fish. A satisfactory toxicant for the purpose must possess certain attributes among which we can list:

1. High toxicity to fish, low toxicity to mammals.
2. Rapid detoxification without the use of chemicals.
3. Low cost.
4. Readily dispersible.
5. Convenient and safe to use.

Rotenone has been found to be the most desirable toxin for this purpose. It is a chemical which is found in a number of plants belonging to the family *Leguminosae,* especially species of the genera *Derris, Lonchocarpus,* and *Tephrosia.* Lonchocarpus is indigenous to the Amazon Valley and the roots of the plant, commonly known as cubé, are the major source of rotenone for this country.

Although rotenone has been widely used, certain problems arise. Originally applied as a powder (milled cubé root) containing 5% rotenone, operators found it to be irritating to the nose and throat and there were difficulties with dispersion.

Our development of a liquid emulsifiable concentrate was met with enthusiasm. This product could be diluted readily with water at the point of use, and sprayed by hand or by power rigs from boats or even by plane. Reports were received

* Trademark of S. B. Penick & Company. Patents pending.