THE CROSS-FLORIDA BARGE CANAL COUNTER-102 STATEMENT

CONTENTS

§11.01 INTRODUCTION
§11.10 SUMMARY OF COUNTER 102 FINDINGS
§11.20 SUMMARY OF COUNTER 102 RECOMMENDATIONS
§11.30 DESCRIPTION OF THE OKLAWAHA REGIONAL ECOSYSTEM
- §11.31 Introduction
- §11.32 Geology and Physiography
- §11.33 Hydrology
- §11.34 Bioclimate
- §11.35 Soils-Vegetation Complex
- §11.36 Vegetation
- §11.37 Terrestrial Wildlife
- §11.38 Native Aquatic Fauna
- §11.39 History of Man in the Oklawaha Valley

§11.40 HISTORY OF THE CROSS-FLORIDA CANAL
§11.50 EFFECTS OF THE CROSS-FLORIDA BARGE CANAL ON THE OKLAWAHA REGIONAL ECOSYSTEM
- §11.51 Introduction
- §11.52 Geology
- §11.53 Hydrology
- §11.54 Water Quality
- §11.55 Aquatic Plant Problems
- §11.56 Vegetation
- §11.57 Terrestrial Wildlife
- §11.58 Aquatic Animals
- §11.59 Man's Environment

§11.60 SYSTEMS ANALYSIS
§11.70 LAND-USE PLANNING FOR THE OKLAWAHA REGIONAL ECOSYSTEM
§11.80 ECONOMIC EVALUATION OF THE CROSS-FLORIDA BARGE CANAL PROJECT
§11.81 Barge Canal Design
§11.90 IN CONCLUSION

§11.01 Introduction

In 1969, the Florida Defenders of the Environment sought to stop further construction of the Cross-Florida Barge Canal on the general grounds that it would destroy the beautiful Oklawaha River, a river being considered for inclusion in the federally protected "Wild and Scenic Rivers System." Counsel advised the Florida Defenders of the Environment that extensive scientific evidence would have to be gathered before any attempt could be made to reverse a decision made many years previously and upon which many millions of dollars of public tax revenues had already been spent.

The preliminary information required before the effect of litigation could be evaluated included the following:

I. A General Description of the Area
   A. Physical
   B. Biological
II. The Cross-Florida Barge Canal Project
   A. Construction Plans
   B. Operating and Maintenance Plans
III. Effect of the Cross-Florida Barge Canal Project on the Area
   A. Physical
   B. Biological

This general information was assembled, on August 15, 1969, a detailed outline of the information necessary to support a legal challenge to the canal was developed by counsel and the scientists advisory committee of the Florida Defenders of the Environment.

I. Description of the Area
   A. Physical
      1. Location and description of underlying rock
      2. Location and description of soils

3. Location of ground water levels
4. Topography
5. Surface water
   a. Location
   b. Chemical composition
   c. Rate of flow
   d. Seasonal fluctuations
6. Temperature
7. Rainfall

B. Biological
1. Botany
   a. Distribution of area vegetation
   b. List of plants of the area
   c. Description of hydric hammock in river valley (in detail)
   d. Description of aquatic plants (in detail)
2. Zoology
   a. Distribution of fauna of the area
      (1) Terrestrial
      (2) Aquatic
   b. Faunal list for the area
   c. Detailed description of aquatic vertebrates
   d. Detailed description of aquatic invertebrates
   e. Detailed description of terrestrial vertebrates commonly found in or dependent on the Oklawaha River Valley

II. The Cross-Florida Barge Canal
A. Construction Plans
1. Exact location and dimension of project right-of-way and canal channel
2. Amount of material to be excavated for various sections of project
3. Method of digging material for canal channel in various sections
4. Deposition of material dug out of canal channel
5. Description of project constructions—dams—locks—bridges
6. Extent of land clearing for various sections—particularly reservoir

7. Method of clearing land for various sections
8. Water levels planned for each section of the project
9. Annotated list of project contractors
10. Cost of constructing various units of the canal project
11. Time schedule for construction of various sections of project
12. Details of all land acquisition for project

B. Operating and Maintenance Plans

1. How many lockages per day
2. How much water moves out with each lockage
3. Extent of water flow at each dam with no lockage, per day
4. Seasonal changes in water levels in each pool
5. Plans for pollution control—including emergency conditions
6. Plans for control of water weeds
   a. submerged
   b. floating
7. Flood control plans

III. Effect of the Cross-Florida Barge Canal Project on the Oklawaha Regional Ecological System

Each heading under this section should draw on information from

1. Corps of Engineers
2. Other government agencies and
3. Private expert testimony.

(Sometimes they may all agree, sometimes not.)

A. Physical Effects

1. Number of surface acres of water in each reservoir
2. Number of surface acres of water in each of the other canal sections
3. Depth of water in reservoirs—average and extremes
4. Depth of water in each section of canal channel
5. Detailed description of flow or movement of water in each section of the canal channel and reservoirs
6. Amount of water to be lost by evaporation from each section of the canal
7. Chemical composition of water in various sections of canal

8. Changes in underlying rocks
9. Changes in ground water levels
10. Changes in soils
11. Changes in surface water
12. Salt water intrusion
13. Effects on the Florida aquifer

B. Biological
   1. Effect on the hydric hammock of the Oklawaha River valley
   2. Effect on terrestrial animals in both project area and adjacent lands
   3. Biological description of reservoir after 5, 10, 25 and 50 years
      a. bottom flora and fauna
      b. submerged flora and fauna
      c. surface flora and fauna
      d. shoreline of reservoirs
   4. Effect on the Florida Regional Ecological System

With respect to the particular problem of water weeds, detailed data must be obtained on:

A. The Plants
   1. Detailed description of each species
   2. Life history of each species
   3. Description of optimum environment for each species
   4. Growth rate of each species

B. Effect of each of these plants in areas of optimum environment

C. Control of each species of plant
   1. Detailed description of each method of control
   2. Evaluation of effectiveness of each method of control
   3. The cost of each method of control
   4. The effect of each method of control on the Regional Ecological System.

Teams of scientists and concerned citizens conducted the investigation. Suit was filed on September 15, 1969, and by early 1970 the scientists of the Florida Defenders of the Environment had prepared what was destined to become the first "counter 102 statement"—a model for such statements today. President Nixon soon thereafter halted construction of the canal.

The allegations of the complaint set the stage for pleading the inadequacy of the Corps of Engineers considerations of the long term ecological effects of the Cross-Florida Barge Canal by comparison of the Engineers data and perhaps an environmental impact statement, (should one be filed) with the *Florida Defenders of the Environment* Counter 102 Statement which anticipated the eventual passage of the National Environmental Policy Act and the requirement for environmental impact statements on major federal projects.

UNITED STATES DISTRICT COURT
for the
DISTRICT OF COLUMBIA

ENVIRONMENTAL DEFENSE FUND,
Incorporated,

on behalf of all those entitled to the full benefit, use and enjoyment of the national natural resource that is the *Oklawaha Regional Ecosystem* without degradation resulting from the construction of the *Cross-Florida Barge Canal* by the Defendants,

Plaintiff,

v.

Corps of Engineers of the United States Army; Stanley S. Resor, Secretary of the Army; William F. Cassidy, Chief of Engineers, Corps of Engineers of the United States Army,

Defendants

The Plaintiff complaining of the Defendants by its attorneys, Yannacone & Yannacone, sets forth and alleges:

1. Jurisdiction

Jurisdiction of this Court is invoked under Title 28, USC, § 1331(a).

"The district courts shall have original jurisdiction of all civil actions wherein the matter in controversy exceeds the sum or value of $10,000, exclusive of interest and costs, and arises under the Constitution, laws, or treaties of the United States."

This action arises under Article VI, section 2 of the Constitution of the United States.

"This Constitution, and the Laws of the United States which shall be made in Pursuance thereof; and all Treaties made, or which shall be made, under the Authority of the United States, shall be the supreme Law of the Land; and the Judges in every state shall be bound thereby;

any Thing in the Constitution or Laws of any State to the Contrary notwithstanding."

and involves the declaration and interpretation of the rights of the Plaintiff retained under the Ninth Amendment of the Constitution of the United States.

"The enumeration in the Constitution of certain rights, shall not be construed to deny or disparage others retained by the people."

and protected under the *due process* clause of the Fifth Amendment of the Constitution of the United States.

"...nor shall any person...be deprived of life, liberty, or property, without due process of law...,"

and also requires the declaration of the rights of the Plaintiffs under the Treaty with Great Britain for the Protection of Migratory Birds concluded August 16, 1916, and the Treaty with the United Mexican States for the Protection of Migratory Birds and Game Mammals, concluded February 7, 1936.

The matter in controversy, exclusive of interest and costs, exceeds the value of Ten Thousand ($10,000) Dollars.

2. Jurisdiction

Jurisdiction of this court is invoked under Title 5, United States Code, § 702(a) and the federal statutes relevant to this proceeding are:

Title 33, United States Code, § 540

"Federal...improvements of rivers...and other waterways shall be under the jurisdiction of and shall be prosecuted by the Department of the Army under the direction of the Secretary of the Army and the supervision of the Chief of Engineers...which said...improvements shall include a due regard for wildlife conservation."

Title 16, United States Code, §§ 580m, 580n

"It is declared to be the policy of the United States to provide that reservoir areas of projects for flood control.....and other related purposes owned in fee and under the jurisdiction of the Secretary of Army and the Chief of Engineers shall be developed and maintained so as to encourage, promote, and assure fully, resources of readily available timber, through sustained yield programs, reforestation and accepted conservation practices, and to increase the value of such areas for conservation, recreation, and other beneficial uses: Provided, that such development and management shall be accomplished to the extent practicable and compatible with other uses of the project."

"In order to carry out the national policy declared in § 580m of this title, the Chief of Engineers, under the supervision of the Secretary of the Army,

shall provide for the protection and development of forest or other vegetative cover and the establishment and maintenance of other conservation measures on reservoir areas under his jurisdiction, so as to yield the maximum benefit and otherwise improve such areas..."

Title 16, United States Code, § 661 *et seq.*

"...Wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs..."

"...Whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States,...such department or agency first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular state wherein the impoundment, diversion, or other control facility is to be constructed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water-source development."

"...the project plan shall include such justifiable means and measures for wildlife purposes as the reporting agency finds should be adopted to obtain maximum overall project benefits."

"...whenever the waters of any stream or other body of water are impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage by any department or agency of the United States, adequate provision, consistent with the primary purposes of such impoundment, diversion or other control shall be made for the use thereof, together with any areas of land, water, or interest therein, acquired or administered by a Federal agency in connection therewith, for the conservation, maintenance and management of wildlife resources thereof, and its habitat thereon, including the development and improvement of wildlife resources."

The Water Pollution Act

Title 33, United States Code § 466(h)

"It is declared to be the intent of the Congress that any Federal department or agency having jurisdiction over any...installation, or other property shall...cooperate...in preventing or controlling water pollution."

Title 16, United States Code, § 460d
33 CFR § 209

The Migratory Bird Act
Title 16, United States Code, §§ 701 *et seq.*

3. Venue

The venue of this action is determined under Title 28, United States Code, § 1391(e).

4. Declaratory Judgment

This is a proceeding for a Declaratory Judgment under Title 28, United States Code, §§ 2201, 2202, declaring the rights and legal relations of the parties to the matter in controversy, [in particular]:

(a) That the *Oklawaha Regional Ecosystem* is a national natural resource treasure.

(b) The rights of the people of the United States and the State of Florida in and to the full benefit, use, and enjoyment of the economic, recreational, educational, social, cultural and historic values of the *Oklawaha Regional Ecosystem* without degradation resulting from the construction of the Cross-Florida Barge Canal by the Defendants.

(c) That the construction of the Cross-Florida Barge Canal violates the rights of the class represented by the Plantiff guaranteed under the Ninth Amendment of the Constitution of the United States and protected by the *due process* clause of the Fifth Amendment of the Constitution of the United States.

5. Class Action

The Plantiff, Environmental Defense Fund, Incorporated (EDF) is a non-profit, public-benefit membership corporation duly organized and existing under and by virtue of the laws of the State of New York. EDF is made up of scientists and other citizens dedicated to the protection of man's environment, and was established for the purpose of taking whatever legal action is necessary to protect the environment. EDF serves as the legal action arm of environmental scientists throughout the United States and seeks to establish, through appropriate litigation, a body of common law under which the general public can assert its constitutional right to a salubrious environment.

The Environment Defense Fund, Incorporated, does not support private damage suits of any kind. Any legal action brought by EDF is founded on broad ecological grounds and asserts the fundamental constitutional right of all the people to a salubrious environment undiminished in quality by the actions of the Defendants complained of herein.

Policy for the Environmental Defense Fund, Incorporated, is set by a

Board of Trustees composed of scientists, citizens and counsel. EDF maintains a Scientists Advisory Committee which evaluates the scientific merits of any legal action contemplated, and EDF only takes legal action where its position has broad support within the scientific community.

No Trustee of the Environmental Defense Fund, Incorporated, including its legal counsel, receives any fees for services rendered as a trustee, although expenses related to corporate activities are reimbursed. EDF finances are handled by an independent Certified Public Accounting firm.*

This action is brought by the Environmental Defense Fund, Incorporated, on behalf of all those entitled to the full benefit, use and enjoyment of the particular natural resources herein described without diminution by the actions of the Defendant, as a class suit in accordance with the provisions of Rule 23 of the Federal Rules of Civil Procedure.

The members of this class are so numerous as to make it impracticable to bring them all before this Court. There are substantial questions of law and fact common to the class and common relief on behalf of all members of the class is sought.

The claims of the representatives being typical of the claims of the members of the class, and the defendants' actions having substantial effect upon all members of the class, thereby making appropriate final injunctive and corresponding declaratory relief with respect to the class as a whole, this action is a proper class action.

The members of the class are fairly and adequately represented by the Plaintiff and the Plaintiff has no interest adverse to that of any individual who might be entitled to the relief sought herein.

6. The Undisturbed Oklawaha Regional Ecosystem†

The Oklawaha is one of the principal rivers of Florida. It has its source in several large lakes of the central peninsula, including Lake Griffin, Lake Eustis, Lake Harris and Lake Dora. It flows northward for some sixty miles and enters the St. Johns River about eight miles below Lake George. The great flow of the water from Silver Springs joins the Oklawaha through Silver Springs Run and twenty miles further north, where the river bends abruptly eastward, it receives the overflow from Orange Lake through Orange Creek.

The Oklawaha is a sand-bottom river and its waters are clear, although stained tan by acids from the bark and leaves of the dense tree swamp

*These allegations concerning EDF, its organization and operations, were true until 15 October 1969. They are no longer accurate.

†Pleaded in this paragraph was a summary description of the Oklawaha prepared by Mrs. Marjorie Carr, one of the founders of the Florida Defenders of the Environment, and edited by counsel.

through which it meanders. Throughout its course the river twists and doubles back and forth in a well-defined, heavily forested valley so that its actual length is a third again as long as its valley.

The Oklawaha is navigable, and indeed for many years small steamboats, short enough to negotiate the many sharp turns, made weekly trips from Palatka on the St. Johns to Silver Springs. From earliest times the Oklawaha has served man as a pathway through the jungle fastness of its great tree swamp. The Indians of the time of William Bartram, Florida's first visiting naturalist, called the river Ockli-Waha—Great River—and it was for them an important highway and hunting ground. A hundred years ago, when most of Florida was wild, naturalists and hunters alike regarded a trip up the Oklawaha as an exciting and rewarding venture into wilderness. Today, when so many of the diverse original Florida landscapes are threatened with obliteration, the Oklahawa, in its lower reaches, remains as it was, a dark, beautiful stream, clear and free-flowing, and now as in past times, noted for its fine fishing. Channel catfish, chain pickerel, and many species of sunfish including redbreast, shellcrackers, and speckled perch abound and the river is famous for the exceptional size of its largemouth black bass.

The many kinds of wildlife that delighted the early outdoorsmen remain, with the exception of the Carolina Paroquet, the Ivory-billed Woodpecker and the Roseate Spoonbill. And perhaps if the great woodpecker is not really extinct, and if the spoonbills continue their slow come-back, travelers on the Oklawaha will one day round a bend and see once again the heart-stopping sight of these spectacular birds against the green back-drop of the river forest. In any case they surely will see the many kinds of herons, theLimpkins, gallinules and rails feeding at the river edge; Wood Ducks flying headlong through the bordering forest; snakes, turtles and alligators sunning themselves on downed tree trunks, and may get fleeting glimpses of deer, raccoons, otters, a wild cat or a black bear. By incredible good fortune, most of the wild things Bartram saw are still to be seen along the lower Oklawaha today.

The Oklawaha is an ancient Florida river, geologically speaking. In its long life span it has carved out a mile-wide valley, through which now it meanders leisurely. When the river runs high, as it does in the wet period of the climatic cycles, or in the annual rainy season, the water flows over its low banks and spreads out on the valley floor. During dry times the water recedes to within the river banks. The trees of the valley forest are adapted to these periodic floodings and recessions. They are for the most part deciduous, and include tupelo, water-locust, water-ash, swamp red bay, water oak, sweet gum, red maple, loblolly bay, Florida elm, water-hickory, cabbage palm and the magnificent bald cypress. On higher ground, along the edges of the valley, the typical hammock hardwoods

such as magnolia, blue beech, hop-hornbeam and laurel oak make up the forest.

This hydric hammock or tree swamp supports a much more abundant and varied fauna than the adjacent pine islands. Indeed, the Oklawaha Valley provides habitat for a majority of all the different kinds of terrestrial vertebrate animals resident in peninsular Florida. The strip of valley forest is wide and very long and its great area enhances its quality as a wilderness region. The wild turkey, for example, requires for its living area, a big piece of unbroken woods. This largest of North American birds serves as an indicator of true wilderness. The turkey flocks of the Oklawaha are among the finest in Florida.

The role of the valley forest in serving as a reservoir of wildlife for the adjacent lands is most evident when seen from an airplane. Flying north from the Silver Springs area the Oklawaha Valley appears as a broad, densely-forested belt that curves for more than forty miles around the northern third of the Ocala National Forest. To the west lie open pine lands, and the dry low forest of the Big Scrub spreads out to the east. Clearly, the valley forest serves as a safe highway and sanctuary for wildlife over an enormous area.

The area of roughly thirty-five square miles, designated here as the Oklawaha Wilderness Area, extends from the Silver Springs region eastward to Lake George. The area is bordered on the east by the St. Johns River and extends north nearly to Palatka. It includes the pine lands for some ten miles to the north and west of the Oklawaha River. This region offers an extraordinarily wide range of out-of-doors pleasures for mankind.

The Ocala National Forest, established many years ago, makes up the largest part of the area. Generations of Floridians have been coming here for the fine hunting in the Big Scrub and the river forest. It is particularly renowned for its deer, wild turkey, squirrel, bobwhite quail, waterfowl and black bear. Today, as Florida's population increases and its wilderness decreases, more and more people, with a variety of interests are coming into the Forest. Students, ranging from grade school to college, come here on field trips; winter visitors, groups of youngsters, Boy Scouts, Girl Scouts and families come for a day or a week, just for the pleasure of being in natural Florida woods.

The Youth Conservation Camp sponsored by the Florida Game and Fresh Water Fish Commission is located on Lake Eaton in the National Forest. This lovely little lake, only two miles from the Oklawaha, will be wholly drowned along with forty-five miles of the river, if the Cross-Florida Barge Canal construction continues as presently planned.

Five outstanding Florida springs are located in or very near this natural wilderness area: Silver Springs, Juniper Springs, Alexander Springs near

the St. Johns, Salt Springs, and Silver Glen where Jody played with his flutter mill in *The Yearling*. This is the country made to glow in the writings of Marjorie Kinnan Rawlings.

The lands adjacent to the river valley are abundantly supplied with lakes. In addition to many small lakes scattered through the forests, Lake Bryant is located a few miles southwest of Silver Springs, and Lake Kerr, near Salt Springs, is located in the center of the wilderness area. To the west and less than fifteen miles from the Oklawaha River are the great lakes, Lochloosa and Orange Lake, long famed to naturalist, hunter and fisherman for their abundant waterfowl and fish.

7. The Defendants

The Defendant, Corps of Engineers of the United States Army is a civil and military engineering and construction agency. As a civil construction agency, it is responsible for the design, construction, operation and in certain cases, maintenance of navigation and flood control projects.

The Defendant, Stanley S. Resor, is Secretary of the Army of the United States and in such capacity is, or should be, responsible for the activities of the Defendant, Corps of the Engineers of the United States Army.

The Defendant, William F. Cassidy, is the Chief of Engineers, Corps of Engineers of the United States Army. The Defendant William F. Cassidy is, or should be subject to the supervision and control of the Defendant, Stanley S. Resor.

The Defendants, jointly or severally, individually or in concert, by their several agents, servants and/or employees, have acted to commit the People of the United States through the Congress of the United States to expenditures far in excess of the amounts contemplated in initial appropriations for projects subject to the jurisdiction and control of the Defendants.

The Defendants, jointly or severally, individually or in concert, by their several agents, servants and/or employees, have consistently failed to fully determine the actual cost to the American People of their several projects, in particular, the Cross-Florida Barge Canal.

8. Defendants' Actions

Defendants have consistently failed to report to the U.S. Congress and to the people of the United States the numerous, well-founded objections of scientists, specialists and informed, dedicated, experienced citizens received during the years the project was studied and authorized. These objections were received as testimony at hearings and meetings attended by high officials of the defendant.

The defendants have misrepresented cost and benefit data by underestimating costs and overestimating benefits.

The costs of maintenance of the Cross-Florida Barge Canal have been grossly underestimated. The defendants have repeatedly failed to heed a large body of evidence readily available to them which would have permitted calculation of maintenance costs with greater accuracy. Rather, they have recklessly persisted in reporting to the Congress and the people of the United States projected costs which were underestimated.

Defendants have failed to evaluate the present and future impact of aquatic vegetation largely of foreign origin that is thriving and will continue to thrive as a result of the defendants' challenged project. This uncontrollable aquatic vegetation creates economic, biological, flood control and navigational problems of increasingly massive proportions for which there is no permanent and satisfactory solution in any significant aquatic area of Florida. This is true in spite of the continuing efforts of local, state and federal agencies responsible for aquatic weed control.

Since the time of authorization of the project, the number of species of known nuisance water weeds infesting ecosystems such as the proposed barge canal has increased greatly. Furthermore, this barge canal would provide an effective means of distribution for additional species, infecting one part of the state from another.

Defendants knew or should have known with the exercise of due care that:

> Clearing sections of river swamp forest for reservoirs by crushing the forest would only contribute to eutrophication and create snags adversely affecting recreational and navigational values and benefits expected therefrom.
>
> Forest survival would be minimized in the reservoir areas due to higher, stabilized levels of water.
>
> The lower Oklawaha River from Rodman Dam to the St. Johns River will suffer serious, permanent and irreparable damage as a result of the upstream activities of the defendants.
>
> Upstream developments of parts of the Oklawaha River that are out of the Cross-Florida Barge Canal project area would cause pollution, eutrophication and siltation in the Cross-Florida Barge Canal and its reservoirs.
>
> The reservoirs of the Cross-Florida Barge Canal will retain nutrients and cycle them in such a manner as to be incompatible with maintaining the economic, cultural, recreational, historic and transportation values of that national natural resource treasure, the Oklawaha Regional Ecosystem.

Migratory fish important to the sports fishery and to the tourist attraction at Silver Springs will be effectively denied access to the Oklawaha River by the canal structures.

The defendants have been less than candid in reporting to the Congress and the people of the United States concerning the geology of the Cross-Florida Barge Canal project area.

The Defendant's proposal to vary the surface water elevations in the Cross-Florida Barge Canal will drastically affect the ground water levels in the Oklawaha Regional Ecosystem. Defendant's stated plan is to use hydraulic dredges to dig segments of the canal that will traverse the Rodman and Eureka pools. Such action can cause serious, permanent and irreparable damage to the Oklawaha Regional Ecosystem, and there is no evidence that the Defendants have even seriously considered the effects of this action, much less evaluated the dollar value of the damage.

Defendants have created a noxious system which, regardless of the degree of treatment using methods now known or likely to be devised by the time the Cross-Florida Barge Canal is complete, will only result in replacement of one or more species of noxious water weeds by one or more species even more difficult to control and of at least equal hazard to navigation, flood control, or recreation.

The Defendants have shown a callous disregard for suggestions by citizens and other governmental agencies that, if followed, would have minimized the damaging effects of the Cross-Florida Barge Canal on the Oklawaha Regional Ecosystem.

Defendants have failed to determine the real value of the existing Oklawaha Regional Ecosystem in spite of the declared policies of both state and federal governments to protect significant areas of unique and unspoiled native wilderness, and the Defendants' actions will diminish the resource value and multiple use potential of the Ocala National Forest.

WHEREFORE, the Plaintiff on behalf of all the people of the United States entitled to the full benefit, use and enjoyment of the national natural resource that is the *Oklawaha Regional Ecosystem* demands judgment of the Defendants:

DECLARING

That the *Oklawaha Regional Ecosystem* is a national natural resource treasure.

DECLARING

The rights of the people of the United States and State of Florida in and to the full benefit, use, and enjoyment of the economic, recreational, educa-

tional, social, cultural and historic values of the *Oklawaha Regional Ecosystem* without degradation resulting from the construction of the Cross-Florida Barge Canal by Defendants.

DECLARING

That the construction of the Cross-Florida Barge Canal violates the rights of the class represented by the Plaintiff retained under the Ninth Amendment of the Constitution of the United States and protected by the *due process* clause of the Fifth Amendment of the Constitution of the United States.

RESTRAINING

the Defendants from continuing the construction of the Cross-Florida Barge Canal, pending the final hearing and determination of this action.

RESTRAINING

the Defendants from continuing the construction of the Cross-Florida Barge Canal, pending the full determination of the total social cost and real social benefits of the proposed Cross-Florida Barge Canal.

TOGETHER

with such other and further relief as to this Court shall deem just and proper under the circumstances.

Patchogue, New York
September 15, 1969

YANNACONE AND YANNACONE
Attorneys for Plaintiffs

§ 11.10 Summary of Gunter 102 Findings

The Cross-Florida Barge Canal under construction by the United States Army Corps of Engineers has been studied from the viewpoints of geology, hydrology, ecology, economics, land-use planning, anthropology and environmental quality. The results of these studies are presented in this report. The following is a summary of the principal findings and resulting recommendations.

GEOLOGY

1. The presence of solution holes and fracture zones near project

structures makes it likely that there will be problems of porosity and leakage, and that pollution of, and hydrologic changes in, the aquifer will occur.

2. The location of the canal locks and the dams on or very near the Oklawaha River fracture zones introduces the risk of earthquake damage to these facilities. The history of Florida earthquakes is not reassuring in this respect.

3. Mineral resources in the vicinity of the barge canal are meager, being mostly bulk materials for local use. Therefore, it is unlikely that construction of the canal would result in greater utilization of these resources.

HYDROLOGY

1. Water supplies in drought periods may be inadequate for canal operation without extensive additional pumping facilities.

2. Because the summit pool connects freely with the ground water of the *Floridan* Aquifer any pollution of that pool will contaminate the aquifer and flow to natural discharge points.

3. Some pollution of the summit pool and the *Floridan* Aquifer is inevitable because of nearby residential or industrial development, leakage from barges, and turbidity resulting from construction.

4. Major pollution from accidental spills of oil, herbicides or toxic materials is predictable during the long run of barge operation. These pollutants in the Aquifer may damage water supplies of communities nearby and impair the unique recreational qualities of Silver Springs and of whatever sports fishing the canal impoundments might afford.

5. Oklawaha River water which will be back-pumped to the summit pool may accelerate solution of limestone in the summit reach because of its different chemical characteristics.

6. Excessive and possibly uncontrollable leakage of water from the summit pool to the lower pools is a distinct possibility.

7. There is little doubt that the canal would produce an overall decline in the quality of surface water in the system.

8. Flood control benefits claimed for the canal project appear highly dubious.

ECOLOGY

1. Most of the Oklawaha Regional Ecosystem is still unimpaired and it is the only large wild area remaining that supports the full spectrum of plant and animal life native to north-central Florida. Destruction of this unique natural region by the proposed canal is unjustified and hopelessly uneconomic in terms of long-run social needs.

2. Experience in Florida has proved conclusively that shallow bodies of impounded water (such as the Rodman and Eureka Pools) trap nutrients and hence are subject to rapid overenrichment and invasion by masses of water weeds which are difficult and costly to control. Crushing forests into the bottom, as was done in the Rodman Pool, merely speeds and compounds enrichment processes. These processes will quickly reduce, and ultimately destroy, most recreational and fisheries values of the impoundments.

LAND-USE PLANNING

1. Controversy about the proposed barge canal emphasizes the need for long range regional land-use planning. No such planning has yet been done in this region and no agency now exists to do it. To introduce major environmental changes (such as the Barge Canal) in the absence of an overall land-use plan is utter folly.

ECONOMICS

1. The discount rate used in calculating the cost-benefit ratio of the canal is unrealistic. If realistic interest rates were applied, the supposed benefits of the canal would no longer exceed the cost.

2. In calculating the benefits of the canal, both the amount of traffic which it was assumed that the canal would carry and the freight savings per ton mile appear to be unjustifiably inflated.

3. Little evidence exists to support the view that the canal will actually bring the enhancement of land values shown as one of its benefits.

4. Results in completed sections of the project suggest impairment rather than enhancement of potential recreational values in

the region affected by construction of the canal. There is little evidence to support Corps of Engineers figures on recreational benefits claimed for the proposed canal.

5. If the canal did compete effectively with other forms of transportation, the resulting losses incurred by these transport agencies would necessarily be passed on to the public in higher rates. These represent an additional cost of the canal not considered in computing the cost-benefit ratio.

6. Successful operation of the canal depends to a considerable degree upon the completion of the Intracoastal Waterway from St. Marks southward along the northwest coast of Florida. The need for, and cost of, this "missing link" waterway is not considered in calculating the costs of the proposed canal.

7. In view of these and other facts reported in the economic section of this report, we believe that in spite of the amount already invested, an impartial economic restudy of the project would result in its rejection as unsound, on a purely economic basis, without any consideration of the environmental values to be lost.

EXISTING CONDITIONS

1. The sections of the canal system already completed have seriously disrupted portions of the natural ecosystems of the lower Oklawaha River and the Withlacoochee River. The river courses and flow have been modified. Natural forests in the flood plains and vicinity have been destroyed over extensive areas. A debris-choked reservoir, heavily invaded by exotic water weeds, has been created in the Rodman Pool area of the Oklawaha system in particular. Fisheries values have been impaired. The wild quality of the environment in these areas has been drastically reduced. Nevertheless, much of the Oklawaha River and its valley still remain unimpaired.

2. With cessation of further construction and expenditure of funds to remove downed timber and other debris from the areas affected, and with proper pollution control measures in the watershed, it is expected that with time even in the damaged areas the natural environments would recover, the wild quality of the area could be regained, and the ability of the region to supply high quality outdoor recreation would be restored.

The three locks already built are of a size being criticized as antiquated in other barge canals which the Cross-Florida Barge Canal is supposed to complement. To replace these locks with larger units in order to accommodate large, unbroken tows of barges would probably prove uneconomic. This barge canal will be too shallow for the newer trans-Gulf barges and for super-vessels carrying numbers of smaller barges.

§ 11.20 Summary of Counter 102 Recommendations

1. We [The *Florida Defenders of the Environment*] recommend that further expediture of Federal funds for the construction of the Cross-Florida Barge Canal be halted and that no further state funds be expended toward completion of the canal.

2. We recommend that the authorization extended by Congress in 1942 for the construction of the Cross-Florida Barge Canal be rescinded.

3. We recommend that the lands along the canal right-of-way in the vicinity of the Oklawaha River to which the Federal government or the state of Florida now hold title be deeded or leased to the United States Forest Service or other appropriate agency for recreation and other appropriate multiple-use management. We further recommend that a portion of the area suited to such purpose be designated a Scenic River and be included in any Wild and Scenic Rivers System.

4. We recommend that the Rodman reservoir be drained immediately, and that the Oklawaha River be returned to its natural free-flowing condition from Silver River to the St. Johns River.

5. We recommend that the hydric hammock and adjacent forest communities destroyed and flooded when the Rodman Pool was created be carefully tended back to their original composition, organization and zonation. This restoration will proceed rapidly in the Florida climate and will be well advanced in ten to twenty years.

6. We recommend that a regional environmental planning council, established in accordance with existing Florida statutes, consider

the needs of conservation, environmental protection, recreation, and development throughout the Oklawaha Regional Ecosystem.

7. In accordance with plans to be developed by the planning council, we recommend that the Corps be authorized to construct in the completed western portion of the project those features required to make the existing canal and other water bodies more useful to the residents of the region and of the nation.

8. We further recommend that in future projects, benefit-cost analyses be conducted by an impartial agency not involved with project construction, and that full consideration be given to ecology and environmental values in the planning and evaluation of such projects.

9. To avoid difficulties in future projects, we recommend that all authorized public works be started within five years of their time of authorization, and if not completed within ten years of their original authorization date, that a full restudy be accomplished. Failure to comply with these conditions should result in termination of project authorization.

10. We recommend that official public hearings be held in a location conveniently close to any proposed public works project within a year previous to authorization and within a year previous to initial funding in order to evaluate all evidence and to decide whether initiation or continuation are in the public interest. This is necessary in view of the rapid environmental, economic and social changes currently being experienced in the United States.

§ 11.30 Description of the Oklawaha Regional Ecosystem

§ 11.31 INTRODUCTION: THE OKLAWAHA RIVER. The Oklawaha is one of the principal rivers of Florida. It has its source in a chain of lakes—Griffin, Eustis, Harris, and Dora—in the central peninsular highlands and flows northward and then eastward for some 70 miles, entering the St. Johns River about eight miles below Lake George. The Oklawaha is a sand-bottom stream with clear water stained tan by acids from the bark and leaves of the trees of the broad swamp-forest through which it flows. The river owes much of its character to Silver Springs, which joins it a short way along its course and is responsible for much of the flow of the river

the core borings and profiles of the Corps of Engineers, and the cursory mineral investigations of private industry.

* * *

Structure controls the pattern of distribution of the outcropping formations and the pattern of drainage.

* * *

Structure and Stratigraphy. The strata underlying the area are the *Ocala Limestone*, The *Hawthorne Formation* (probably several units of various origins), the *Citronelle Formation* and the near-recent peats, mucks and marls.

The Ocala Limestone underlies all of the area but it is exposed or very near the surface only in the large area south of Orange Lake and west of Fort McCoy Fire Tower and Silver Springs. This limestone, a portion of the Floridan Aquifer, lies near the surface in the large area southeast of the Oklawaha River in the area of Lynne. Here the top of the limestone is highly irregular in places, it is overlain by 100 feet or more of Hawthorne phosphatic clays, limestones and dolomites with most of the surficial materials being sands and gravels of the Citronelle Formation. A comparable area of limestone terrain with an irregular surficial cover is found in the vicinity of Orange Springs. The isolated out-crops of Ocala Limestone along the east bank of the Oklawaha River north of Eureka are of special interest. These small, isolated outcrops cannot be shown on the map but they are of great significance in determining the amount of structural displacement along the Eureka fracture zone.

The Ocala Limestone is a highly porous, bioclastic limestone of late Eocene age. Most of the porosity of the Ocala Limestone is secondary due to solution caverns that have developed along joint and fault plains. Though the Ocala Limestone is used in large amounts in North Florida as road-base materials it is too unlithified to compete where other materials are available for crushed stone. The 1,002,472 short tons mined in Marion County in 1967 had a value of only $1,894,889.00. Small amounts were processed as agricultural lime. At Dunnellon the phosphatic replacement of the Ocala Limestone has been mined. No "hardrock phosphate" was mined in 1967 and the 500,000 short tons of soft rock phosphate mined was worth only $263,000.00. This is a relict industry made

obsolete because the patchy, unpredictable occurrence of the phosphatic ore cannot support the large, mechanized operations essential for successful modern mining.

Materials assigned to the Hawthorne Formation are diverse...I have subdivided the green clays, sands and phosphatic sands into two mappable units. The lower unit consists of consolidated gray to green clays and sandy clays with some lenses of limestone and dolomite. It is believed that this unit is largely Lower Miocene in age whereas the overlying green clays and sands, sometimes with considerable shell, are younger, probably Pliocene to Pleistocene in age. These clays have retained their plasticity. It is recognized that both types of materials occur within areas mapped as one or the other. It is important, however, to distinguish the fact that the older, more consolidated materials outcrop primarily along the southern scarp of the Okefenokee Highlands in the area of Hawthorne and Gainesville and in the residual hills in the area of McIntosh, Fairfield and Emathla northwest of Ocala. In fact, Ocala proper is built upon an outlying hill underlain by the older clays.

The younger plastic clays and sands are restricted in their general occurrence to lower areas. Orange Lake, Paynes Prairie and Lochloosa are underlain by a thin blanket of these materials. They reach their maximum development in the large flat area that extends from Silver Springs north nearly to Orange Springs, west of the Oklawaha River. Exploration for the route of the Cross-Florida Barge Canal in about 1934 clearly demonstrated the nature of these materials in the graben-like structure at Sharpes Ferry. Private mineral exploration shows that a considerable thickness of these sands and clays occurs between Fort McCoy and Eureka.

In other areas the materials of the Hawthorne Formation yield the most valuable mineral resources in our State. Fuller's earth clays are mined near Quincy in Leon County and some pebble phosphate is mined from the "Hawthorne" near Bartow in Polk County and near White Springs in Columbia County. In the area covered by this report fuller's earth is mined at Emathla. Pebble phosphate is not known to occur in sufficient quantities for economic exploitation in Marion County.

The coarse sands and gravels with lenses of clay that underlie the high hills forming the axis of peninsular Florida, i.e., the Lake Wales and Mount Dora Ridges, have been correlated with and

assigned to the Citronelle Formation. The State Survey has recently termed these deposits the Fort Preston Formation. In this report, however, I have used the older term, Citronelle Formation, because the original correlation is probably correct. Recent evidence indicates the high level sands and gravels of the Coastal Plain and those of peninsular Florida are Upper Miocene in age.

The main body of the Citronelle Formation is restricted to the high sand hills in the Ocala National Forest and comparable hills to the north in the area of Johnson, Interlachen and Grandin. Minor amounts of kaolinitic clays are being mined in the vicinity of Edgar and Johnson in southwestern Putnam County. At Interlachen and Grandin some sands and gravel from this Formation have been concentrated for marketing.

Possibly the most interesting geological materials in southeastern Alachua County and northeastern Marion County are the peats, fresh water marls and mucks of the Oklawaha Valley and the Mud Lake and Orange Lake basins. The colloidal algal gels of Mud Lake are becoming world renowned, not only for their scientific significance and uniqueness, but also for the record of geological events recorded by pollen grains in these organic sediments. Mud Lake is the only known place in the southeastern United States in which such a superb record has been discovered.

I am in a preliminary stage of studying the stratigraphy of the fossiliferous muck and marl sequence in the Silver Run-Oklawaha River Valley. Evidence to date has revealed an unconformable sequence of deposits that record the history of the river and spring back to 17,000 years ago as dated by the ^{14}C method. There is a sequence of marl beds that dates 16,500 to 17,000 years Before Present, 11,000 to 12,500 years B.P., 6,000 to 7,000 years B.P. and 4,000 years and younger.

Physiographic Divisions of the Oklawaha Regional Ecosystem. Limestone underlies all of the area, but in some places it is covered by clay deposits that impede downward movement of water. In other areas it is overlain by sands and gravels or a heterogenous combination of earth materials. Since solution features dominate much of the topography of north-central peninsular Florida it is proper that descriptions start with the Limestone Plain.

Limestone Plain. The Limestone Plain is extensive in the northwestern portion of peninsular Florida and it lies west of the Fort McCoy Fire Tower and Silver Springs. It is an area of beautiful rolling hills with elevations generally from 80 to 130 feet above mean sea level. Some hills reach altitudes of 170 feet or more. The higher hills, such as the hill upon which the city of Ocala is located, are commonly capped with remnants of Hawthorne Formation. The Limestone Plain is distinctive because of the excellent drainage provided by the underlying porous, cavernous Ocala Limestone. There are no surface streams in the Limestone Plain. In general, the water table lies 30 to 40 feet below the surface of the ground. This region is an area of extensive agricultural activity, especially pasture land.

Fairfield Hills. The high hills southwest of Orange Lake, in which there are extensive remnants of Hawthorne clays, have been named the Fairfield Hills. The tops of some of these hills are 170 feet above sea level. This is a fertile area of hardwood hammocks.

Okefenokee Highlands. The high area to the north of the area of Gainesville and Hawthorne is the eroded southern edge of the Okefenokee Terrace, a distinctive topographic feature that extends northward into Georgia. This high, poorly drained flatland is underlain by a thick sequence of impervious clays and the surface water is perched. The elevation of the land is 120 to 170 feet above sea level. The natural vegetation is wet pine-palmetto flatwoods.

Mount Dora and Interlachen-Grandin Ridges. The eastern portion of the area mapped is also a highlands, but it is quite distinctive because of the high porosity and permeability of the underlying sands and gravels of the Citronelle Formation. These sand hills are extremely well drained and nearly all of the excess water has direct access to the underlying aquifer, the Ocala Limestone. Turkey oak and scrub pine are the characteristic vegetation. The sand hills of the Mount Dora Ridge are erosional relicts. Some hills reach considerable heights: for example some of the hlls northwest of Interlachen are 189 feet above sea level. This portion north of the Oklawaha in Putnam County I have designated as the Grandin-Interlachen Ridge, but is is certainly a continuation of the same topographic entity as the Mount Dora Ridge.

Prairie-Lake Lowlands. Large prairies and lakes in solution basins are unique to Florida. They are best developed and known in the area of southern Alachua County. The hills and flatwoods between provide a great diversity of landscapes and habitats. The general elevation of the lakes and prairies is about 60 feet above sea level. The level of the prairies is that of the water table. Areas between the lakes are generally less than 90 feet above mean sea level.

The difference between the Prairie-Lake Lowlands, with large prairies and lakes in solution basins, and the Lake-Sandhill Lowlands to the east in the vicinity of Orange Springs, results from differences in the materials overlying the Ocala Limestone. In both areas the surficial deposits are, for the most part, relatively thin, but there is an aquiclude of clays in the Prairie-Lake Lowlands as opposed to direct flow of water downward to the aquifer via sinkholes as in Paynes Prairie and Orange Lake.

Lake-Sandhill Lowlands. The solution hole lakes, mostly small and round, in the low hills in the area of Orange Springs and in the similar area south of the Oklawaha east of Sharpes Ferry in the vicinity of Lynne, represent comparable geological conditions. In both cases the top of the Ocala Limestone is highly irregular and is blanketed by a variable thickness of superimposed materials of older Hawthorne Formation and coarse surface sands of the Citronelle Formation. These lakes are relatively clear with clean sand bottoms. This contrasts with the swamp water and the peat and sapropel deposits found in the large prairies and lakes to the west. Mud Lake is an exceptional lake whose high degree of eutrophication remains unexplained.

The areas of the small lakes and low sand hills are generally less than 90 feet above sea level. Distinctive features of this terrain are the overburden of sands and clays and the fact that the water table is above the top of the Ocala Limestone. Vegetatively, these are the most diverse areas in North Florida. Much of the area is swamp. The lower, poorly drained land is flatwoods and the hills may support hardwood hammocks or turkey oaks.

Oklawaha Lowlands. The extensive wet flatwoods in the area of Burbank and Fort McCoy west of the Oklawaha River at Eureka is underlain by a clay deposit, though there is some diversity. In the

immediate vicinity of Fort McCoy there are low sand hills with lakes, but this is a small isolated portion surrounded by more poorly drained land. The lowlands are less than 90 feet above sea level and slopes are nonexistent or very gentle. This distinctive area also extends southward from Sharpes Ferry in the graben-like structure in which the upper portion of the Oklawaha occurs. The Oklawaha Lowlands are predominantly wet flatwoods. The northern portion has a typical pine and palmetto wet flatwood association but the southern portion has large numbers of cabbage palms, indicating that soils in the southern portion are alkaline. Abundant shells have been reported in the sands and clays in this area. The beautiful river swamp bordering the meandering course of the Oklawaha River should be separated from the Oklawaha Lowlands as a topographic unit because it is the only one of its kind in the world.

River Swamp. The low forested flood-plain of the Oklawaha River, the Dead River and Silver Run is one of the most beautiful continuous swamps in the world and it is readily accessible in its natural condition by boat and the few roads that penetrate it. Rivers with flood plains and flood plain swamps are common. It is the nature of the materials underlying this flood plain that makes the Oklawaha different. Because of the past hydraulic history of Silver Spring and the Oklawaha River, referred to above in the stratigraphic discussion. freshwater marls have in past ages accumulated to form the major portions of the flood plain. What other river has a nonclastic flood plain?

Silver Springs Sand Hills. The discontinuous sand hills that extend northeast from Silver Springs between the Limestone Plain and the Oklawaha Lowlands is the northernmost expression of the Lake Wales Ridge. However in this area the sands overlying the limestone are relatively thin and irregular in distribution. The xeric sand hills are significant topographic and ecological entities upon which turkey oak dominates.

§ 11.33 HYDROLOGY (BY MARTIN MIFFLIN*).

Free communication between surface water and the ground water of the Floridan aquifer is the dominant characteristic of regional

*Associate Professor of Geology, University of Florida.

just about equal to rainfall in the region. Thus, the broad, shallow bodies of surface water with small catchment basins that are typical of the limestone solution terrain have a rather delicate water balance—sometimes rising, sometimes going essentially dry.

Okefenokee Highlands. This physiographic division is characterized by rather flat topography underlain by Hawthorne sediments. Drainage tends to be poor, giving rise to swampy flatlands. The basic difference between this division and the Fairfield Hills division is that the relatively intact Hawthorne sediments have protected the underlying limestones from extensive solution. The water table is generally very shallow and little recharge to the underlying Ocala Limestone occurs. There is also some evidence that the Ocala Limestone may be less permeable in this region because of the limited amount of secondary solution.

Lake-Sandhill Lowlands, Mount Dora and Interlachen Grandin Ridges. These physiographic divisions are constituted by depressions containing ponds, lakes and well drained divided areas. They differ from areas underlain by important amounts of Hawthorne sediments in their more permeable soil and well developed solution topography. The lake levels reflect the water table and the terrain acts as an important recharge basin to the Floridan Aquifer. The basic hydrological difference between these areas and the previously described Limestone Plain is the relative position of the zone of saturation with respect to the rolling land surface. Here the saturated zone commonly intersects the land surface, whereas the Limestone Plain has far less saturation at or near land surface. Solution topography prevails throughout most of these physiographic divisions; the relative difference in position of the water table with respect to landsurface probably constitutes the basic hydrogeologic difference between the two divisions.

Adjacent to the lake-dotted lowlands are higher sandhill ridges composed of sand and gravels of the Citronelle Formation. These areas are very well drained due to the permeable nature of the sand sediments overlying the Limestone. They probably represent rather effective recharge areas for gound water.

Ground-Water Flow Systems. ...Silver Springs, Rainbow Springs,

the Withlacoochee River, and the Oklawaha River are the principal hydrologic features where ground-water occurring in the summit section area ultimately dicharges.... Three ground water flow systems occur in the area. Low ground-water gradients...and the large flows in areas of discharge indicate the extremely permeable nature of the Ocala Limestone in this area. Much of the runoff from rainfall first passes into the ground-water systems, then into the surface-water drainages.

§ 11.34 BIOCLIMATE (BY ARIEL LUGO*).

The bioclimate of the Oklawaha Regional Ecosystem may be characterized as mild but exhibiting significant extremes in all climatological parameters. There is a mild winter dry season, with few days below freezing, and a summer wet season. Organic production is bimodal, having peaks in the spring and fall, productivity is limited in the winter by cool temperatures and in the summer by moisture stress and high temperatures. All climatic parameters are presented in a series of six figures and one table.

The climatic data for the Oklawaha Regional Ecosystem (consisting of absolute values and trends in the various parameters) show that the climate is mild, with high temperatures in the summer, a few days below freezing, and a period of relatively high rainfall during the months of June to September. Although conditions seem to be quite mesic, the vegetation of the area exhibits many xerophytic adaptations. In other words, morphological characteristics of plants in these communities reveal environmental stress not evident when one examines the gross climatological data.

To understand the effects of climatic conditions on organisms, one must understand the effect of a combination of factors instead of a single factor effect. Both ecosystems and their component organisms show adaptions to climate through regulation of vital biological processes such as photosynthesis, respiration, behavioral mechanisms (orientation of exposed surfaces, etc.), periodicity (timing of flowering or reproduction), etc. Man exhibits similar adaptations to climate as shown in the seasonablity, for instance, of his dress and food habits.

*Assistant Professor of Ecology, University of Florida.

Ecosystems and organisms integrate the sum total of environmental and climatic stimuli and their metabolic and structural characteristics reflect the results of this biological integration. In the Oklawaha Regional Ecosystem the growing season, or period when the production of organic matter is highest, shows a bimodal pattern with periods of active growth during spring and early fall. During the summer rainy season, when moisture is abundant and temperatures are high, the system operates at a lower rate of production with regards to photosynthetic rates but rates are higher than those observed during the winter. This is a manifestation of biological response to a combination of climatic factors. During the winter the climate of the area is characterized by the cold fronts passing southward through the area. Temperatures are low, and skies are overcast. These fronts present rainy conditions of long duration, but bring less total precipitation than rains during the summer season. During the winter the relative humidity is at its seasonal lowest and results in an increased fire hazard. Winter fires release nutrients tied up in the vegetation which are available to the spring flush of vegetative growth.

During the summer rainy season the showers are short in duration and are preceded by high winds, characteristic of thunderstorms. There is also a greater variation in temperature even though the seasonal averages are significantly higher. Both relative humidity and evaporation are higher at this time of the year. Thus, the vegetation is submitted to a period of environmental instability with respect to climate. There are frequent changes in available moisture, temperature, and saturation deficit (evaporating power of the air). These fluctuations are unfavorable to constant high photosynthetic rates and result in a lower production during this portion of the summer season (July—September) as compared to production during spring and early fall. Following the summer rains, when river discharge is high and rivers frequently overflow their flood plains, the nutrient load is distributed and deposited in flood plains. Due to the fertilizing effect of summer inundation, favorable moisture conditions, and the high input of solar energy, photosynthetic rates again increase and a second peak of production is attained.

Figure 6 indicated graphically the following data:

(a) and (b) Climate diagrams for two stations in the Oklawaha Regional Ecosystem (Gainesville and Ocala). A lower curve repre-

senting the monthly average temperature (°C), and an upper curve representing rainfall (mm), with an indication of the rainy season (notice change in scale). Monthly averages were based on records from 1948–1968. 10°C = 50°F; 20 mm = 0.78 inches.

(c) Discharge of the Oklawaha River (cubic feet per second) at three different stations. The dotted line represents rainfall in Ocala (notice change in rainfall scale). Discharge increases downstream (Orange Lake) and lags rainfall by one month.

(d) Average evaporation from a standard weather bureau evaporation pan in Lake City and Lisbon, Florida. Monthly averages are for a 10 year period.

(e) Wind movement (miles) in two stations: Lake City and Lisbon, Florida. Monthly averages are based on 10-year records.

(f) Percent sunshine in Jacsonville. Monthly averages are based on 20 years (1948–1968).

Table 1 summarized the climate of the Oklawaha Regional Ecosystem. The Mean Yearly Averages, based on more than 50 years of data, were tabulated for seven stations in seven counties and included the precise location of each station, giving the following: latitude, longitude, elevation and the climatological parameters, temperature, rainfall, evaporation, number of days with T 90°F, number of days with T 32°F, mean daily minimum T, mean daily maximum T, and the lowest and highest temperatures. The sources for all climate data were *Climatography of the U.S. No. 86-6, Climatic Summary of the U.S. (Florida),* and *Atlas of American Agriculture.*

§ 11.35 Soils-Vegetation Complex (By Samuel C. Snedaker*).

The vegetation of the Oklawaha Regional Ecosystem is adapted to diverse extremes in the water balance. Soil textural characterisics and variations in the water table can be correlated with the major vegetation types and are of greater importance than fertility. The extremes are represented in forest vegetation by the frequently inundated hydrophytic hardwoods and the upland forest types occurring on deep, excessively-drained sands above the influence of the water table.

The diversity in types of vegetation encountered within the Ok-

*Research Associate, Aquatic Sciences, University of Florida.

lawaha Regional Ecosystem is strongly associated with the diversity in soils, particularly with regard to their role in the annual water balances. To a large extent, the water balance is a function of soil texture, that is its moisture holding properties, and depth to the water table. Depth of the water table is a function of elevation and topography. Because rainfall is essentially uniform over the Oklawaha Regional Ecosystem, but unevenly distributed throughout the year, the availability of water during the dry season is the strongest controlling factor in the distribution of the various types of vegetation. This phenomenon is accentuated by the fact that most of the soils are derived from unconsolidated silicious sands of Pleistocene marine origins.

The overwhelming majority of the upland soils are *regosols* with an excessively to well-drained sandy surface layer over 40 inches in thickness. They are for the most part strongly acid and very low in fertility. Depth of the water table is usually in excess of 60 inches. The most extensive vegetation types (xerophytic and mesophytic hardwoods, sand-pine scrub and longleaf pine—turkey oak sandhills) occur on these soils and exhibit functional adaptations to fires resulting from the fire frequency during the recurring, severe dry seasons. The mesophytic hardwoods, however, because of a more favorable moisture balance, are seldom destroyed by fire, and thus, are considered a more evident product of succession. The more luxuriant mesophytic hardwood forests are able to exist on these deep sands primarily because the soil-moisture holding properties (and fertility) have improved with time and the continued incorporation of organic material.

The flatwoods vegetation type occurs in low level areas with sandy, strongly-acid soils and a relatively high water table. A dominant feature of these *podzolic* soils is the presence of an organic-stained pan at two to six feet below the surface resulting from the high, fluctuating water table. These soils become inundated during periods of prolonged rainfall as rapid runoff is precluded by the flat, level topography. The generally favorable water balance and the periods of inundation restrict the dominant vegetation species to four pines, arranged in order of increasing moisture tolerance: longleaf, slash, loblolly and pond.

The other major vegetation types, hydrophytic hardwoods, marshes and prairies, and aquatic, are adapted to low wet areas

which may be inundated during a greater portion of the year. Humic Gleys and organic soils (peats and mucks) are common in these areas and may occur together in layers. The hydrophytic hardwoods occur along rivers, creeks, streams and in the swamps. The marshes occur in low areas interspersed among the other vegetation types. Both the hydrophytic hardwoods and marshes are found on peats and mucks from two to ten feet in thickness. Occasionally the organic soils may be interlaced with layers of clay and marl. Marshes, not maintained by an existing body of water, may result from a high water table or drainage into and retention of water by a subsurface clay lens in low areas. The prairies, however, occur on low sandy soils over a highly fluctuating water table. Usually found adjacent to marshes and lakes, they frequently go dry during prolonged dry periods. Aquatic vegetation, devoid of trees, occurs as submerged and emergent communities in all shallow waters. The soil substrate, perpetually submerged, is made up of marls, clays and organic soils, usually in alternating layers.

Intensive soil surveys have been made in the Oklawaha Regional Ecosystem by various federal, state and private agencies. Data from these published surveys together with extensive field observations enable a cursory correlation of soil series and vegetation to be made.

§ 11.36 VEGETATION (BY ARIEL LUGO* AND ARCHIE CARR†)

The framework of the Oklawaha Regional Ecosystem is a mosaic of diverse plant communities ranging from dry sand hill vegetation to the superb wet-forest landscape of the river floodplain. The vast unbroken spread of the river-forest community is the most conspicuous vegetational feature of the area. In a region in which natural environments are fast disappearing, the existence of such a reservoir of ecological stability should be counted an incomparable asset.

The Oklawaha Regional Ecosystem is made up of a strikingly varied array of vegetation types, a broad ecologic spectrum from lowland swamps to the very dry communities on the deep-sand hills that flank the river valley. Still relatively unruined by human

*Assistant Professor of Ecology, University of Florida.
†Graduate Research Professor of Biology, University of Florida.

exploitation, this region is a treasure-house of distinctive kinds of animals and plants, and of unique examples of ecologic organization. Its value lies not merely in the richness of its fauna and flora, however, but also in the great size of the area that has escaped complete disruption. The Oklawaha Valley is almost the only part of mid-peninsular Florida in which large tracts of ecologically varied terrain spread uninterruptedly and meet in natural ecotones, affording asylum for rare or distinctive species, and providing the scope required by animals that need to cover broad territory in foraging, or to move from one kind of habitat to another as the seasons change. Perhaps most important of all, the Oklawaha Regional Ecosystem is an investment in the ecologic future of man, a big expanse of uncommitted, undisrupted, biological landscape, left as a buffer against human ecological error. In a region that is fast becoming fit habitat only for man, and perhaps is not long destined to remain even that, such an asset is one to be treasured.

The framework and base industry of the ecosystem is the vegetation. The chief vegetation types, most of which are easily recognizeable by anybody, are listed and briefly described herein.

§ 11.36.10 Coniferous Forest

Flatwoods. Flatwoods are coniferous forests on level, imperfectly drained ground. They are dominated by one of three distinct pine species—slash, long-leaf, or pond pine. Associated with the pines are various understory species, among which saw palmetto, wire grass, or gallberrry usually predominate. All three types of flatwoods occur in the Oklawaha area. These communities have for decades been heavily exploited for lumber, turpentine, and pulpwood, and under present management practices have been reforested to ensure high production of pulpwood and timber.

Cypress Domes. These are unique swamp-forest communities composed mainly of pond cypress, with or without admixture of black gum, red maple, and other species. Such vegetation usually occurs within, or alternating with, the slash pine flatwoods. The cypress stands often occupy circular depressions over clay lenses, and in silhouette they are often symmetrically convex—thus the name "dome." Soil characteristics, such as nutrient content, acidity, amount of organic matter, and clay content, vary in relation to the

distance from the center of the dome, and account for the decrease in height of the trees toward the edges.

Long-Leaf Pine—Turkey Oak Sandhills. This community type, which like the flatwoods has been strongly modified by timbering, is widespread in the Oklawaha region. It occurs on sand ridges of white to yellowish sands. The vegetation is adapted to drought, and the animals of the community are predominantly burrowers. Fires are common here, and in its original state the long-leaf pine hill forest was a fire climax association. A problem under active investigation by ecologists is why long-leaf pine—turkey oak vegetation should be found occupying one sand hill while adjacent ridges may support scrub—a community type described below. Before the original pine was cleared off of the sand hills, it was said to have been possible to drive a wagon straight across the central ridge section of Florida through the open, park-like stands of long-leaf pines.

Sand Pine Scrub. This unique community type, found only in Florida, composes the greater part of the Ocala National Forest, where it is known as the "Big Scrub." The whole northern boundary of this area is formed by the Oklawaha River. Scrub occurs on sand ridges of acid, excessively well drained, and usually nearly white, sands. The dominant plant is scrub pine, with small oaks in the lower story. Fire plays an important role in the development of this community. When fire occurs, the mature pines are killed, but the heat causes the tight-scaled cones to open and the seed to spread and germinate. Subsequent fast growth of seedlings prevents other species from becoming established, and results in the development of the even-aged scrub-pine stands that can be seen as one travels through the forest. Deer are common in this vegetation type. Because it is also the habitat of numerous endemic animals and plants, the scrub is ecologically one of the most interesting communities in Florida. Besides its own distinctive flora and fauna, the scrub is set with small, completely isolated areas of ecologically different landscape, such as the giant-tree bayhead described below, and a number of "pine-islands" such as Pat's Island and Hughes' Island—isolated patches of typical long-leaf pine terrain completely surrounded by scrub. The southernmost stands of white cedar in the United States are similarly isolated in small swamps in the scrub.

§ 11.36.20 Hardwood Forests

Hardwood forests in Central Florida are known as *hammocks* if composed of predominantly broad-leaved evergreen trees and not subject to periodic flooding. Wet forests that are seasonally flooded and composed mostly of evergreen species are known as *bayheads*, and are called *swamps* if seasonally flooded and dominated by deciduous species. These are usually limited to areas around the headwaters of acid streams. The bayheads of the Oklawaha region are unique in the relatively immense size that some of the trees in them attain, especially the loblolly bays. The world's record loblolly, for breast-high diameter, occurs in a bayhead a short distance east of the Oklawaha River.

The main Oklawaha Valley hardwood forest country can be subdivided into three broad community types that reflect relative amounts of moisture in the soil.

Xerophytic Hardwood Forest. This is dry hammock in which live oak is usually the dominant species of tree. The prevalence of evergreens allows this community type to survive on dry, nutrient-poor soils, because photosynthesis may proceed throughout the year, whenever conditions are favorable. This vegetation may replace the sand hill communities in dry areas when fire is kept out. Other successional relations of the association are very complex, however, and not yet thoroughly understood.

Mesophytic Hardwoods. This community is best expressed on calcareous soils. Florally, it constitutes the most diverse vegetation type of the region. Magnolia, hickory, dogwood, laurel oak, blue beech, and hop-hornbeam are prevalent, with a rich assortment of other trees, and of vines, shrubs, and epiphites. Mesophytic hammocks on non-calcareous soils are somewhat less diverse in composition.

Hydric Hammock and Swamp Forest. The greatest ecologic continuity in the Oklawaha Valley is provided by the vast expanse of contiguous or integrating lowland woods, the low hammock and swamp forest communities. Where the ground is not regularly flooded, the bottomland trees are mostly swamp red bay, water-oak, loblolly bay, Florida elm, sweet gum and cabbage palm. In more frequently flooded sections of the valley, hammock is replaced by swamp in which the vegetation is a variably mixed association of

water-tupelo, water-ash, water-locust, red maple and water-hickory. Some of this terrain once supported rich stands of bald cypress, and relict giants, spared by the saw because they were hollow or otherwise unsuitable as timber, can be seen from an airplane, towering above the hardwood canopy. One has only to fly over the remaining great expanse of this bottomland forest, and to note the contrast with the irreversably disrupted, settled-up region just outside the area, to sense the immense value of such tracts of continuous and ecologically stable country in a fast-growing region like peninsular Florida.

§ 11.36.30 Marshes and Prairies

These are wet, herbaceous communities in which trees are absent or are represented only by low scattered stands of willow or buttonbush. In North-Central Florida, a prairie is simply a marsh that is periodically or sporadically diverse in composition. It includes grasses, of which maindencane is the most prevalent, sedges, rushes, pickerel weed, arrowhead, *Decadon*, cat-tails and various other species. These communities occur in old lake basins throughout the region, and over large areas of the headwaters and lowermost reaches of the Oklawaha River they replace the valley forest vegetation.

§ 11.36.40 Aquatic Vegetation

The aquatic vegetation of the Oklawaha Regional Ecosystem varies markedly with water quality, with rate of flow, if any, and with the degree and rate of fluctuation of the water level. The species represented are highly diverse, and include a wide variety of phytoplankton and a long list of submerged, floating and emergent vascular plants.

In streams, and in deep still water low in nutrients, microscopic algae are the most important plant group. In the shaded waters of the Oklawaha River diatoms, green algae, and flagellated algae are common whereas submerged flowering plants are nowhere abundant. With reduction of oxygen concentration, blue-green algae and sulfur bacteria predominate. In clear waters, such as Silver Springs, light penetration is adequate for the development of extensive beds of submerged aquatic plants such as *Myriophyllum, Ceratophyllum, Vallisneria, Potamogeton,* and *Sagittaria.* The alga *Chara* is often

associated with these. The degree of prevalence of one of these species or the other depends mainly on the chemical character of the water.

In the littoral zones of lakes and in rivers and spring runs where waterflow is reduced, floating vegetation may shade out plankton and submerged plants. Important floating plants in the Oklawaha region are *Salvinia*, various duck weeds, water-lettuce, spatterdock, water lilies and the introduced water hyacinth. Emergent marsh plants, and plants partially adapted to terrestrial conditions are also found around the edges of most bodies of water in the region, wherever some fluctuation in water level occurs. The vegetation here is essentially that of the marshes and prairies described above.

§ 11.36.50 Agricultural Systems

Agricultural systems represent a prominent vegetation type on the edges of the Oklawaha Regional Ecosystem, particularly in areas where human population is clustered. The citrus groves represent the largest agricultural landscape in the area. Most of these are in Marion County. Citrus groves are common along the ridges where long-leaf pine-turkey oak communities once occurred. This region is at the northernmost limit of the citrus climate, and the groves have to be heated to survive the cold spells.

§ 11.37 Terrestrial Wildlife (By James N. Layne*)

The terrestrial wildlife of the Oklawaha Regional Ecosystem is outstanding in its abundance, variety, and scientific interest. This is due in large part to the inclusion of large blocks of several major habitat types in a natural, integrated state.

The land-dwelling wildlife of the undisturbed Oklawaha regional ecosystem is notable for its abundance, diversity, and unusual scientific interest. Of the several thousand species and varieties of animal life in this region, only the vertebrates, including amphibians, reptiles, birds, and mammals, are dealt with here. This is partly because the facts of the ecology and distribution of these animals are better known compared to other groups and partly because the vertebrates are often the more conspicuous kinds of animals in a region and include many species of esthetic appeal and direct economic value. In addition, vertebrates often play key

*Director of Research, Archbold Biological Station, Lake Placid, Florida.

roles in their respective ecosystems and thus serve as valuable "indicator" species for monitoring environmental change.

Exclusive of fishes, over 300 species of vertebrates are believed to inhabit the general area encompassed by this study. Space does not permit even superficial coverage of each species, and consequently the emphasis in the following paragraphs is on the general patterns of ecological distribution of the major groups with mention of certain species of particular significance because of their scientific or esthetic interest or importance as game or furbearers.

The vertebrate fauna of the Oklawaha region is clearly outstanding in its abundance and variety and includes many of the species that make Florida one of the biologically richest and most unique regions on earth. Particularly characteristic members of the hydric hammock association, of which perhaps no better example exists anywhere than along the Oklawaha River, are the Common Tree Frog, River-swamp Frog, Green Frog, Green Tree Frog, Alligator, Cotton Mouse, Gray Squirrel, Raccoon, Barred Owl, Pileated Woodpecker, Prothonotary Warbler, and Red-bellied Woodpecker. Of these, the Common Tree Frog, Riverswamp Frog, and Prothonotary Warbler are probably the species most closely associated with this habitat type. In addition to the species noted above, a great many more depend upon the hydric hardwoods to varying extent for food, homesites, escape cover, and other needs.

The bountiful wildlife of the region reflects its geologic history, geographic setting, and vegetative diversity. The region includes all of the major natural ecosystems characteristic of this part of Florida. In addition, each of these ecosystems is represented by areas of considerable size, a fact of great importance since reduction in the size of major ecosystems results in their eventual degradation. All of the major environmental types included within the Oklawaha region are being severely modified,or destroyed in other parts of the state at an ever increasing rate.

Another aspect of the Oklawaha area that contributes to its exceptional ecological importance is that the various habitats it includes exist in their natural integrated state rather than as isolated fragments which is often the case elsewhere. Thus, the evolutionary and successional history of these associations and their faunas can be better understood. In addition, the transition zones or "edge" between adjacent habitats in this mosaic contribute to further diversity.

By virtue of its large expanse and vegetational variety, the region presently serves as a very important refuge for the larger, wider ranging wildlife species, which typically require a broader range of conditions to satisfy their life requirements than smaller forms. Thus, a mixture of flatwoods, swamps, scrub, sandhills, marshes, prairies, ponds, and other habitats such as found in the Oklawaha region provide optimum conditions for Turkey, Deer, Bear, and Panther, as well as Opossum, Raccoon, Bobcat, Gray Fox, and various kinds of birds of prey. Large colonial nesting birds such as herons and ibises frequently shift their rookeries and thus also require large areas of land containing adequate potential nesting and foraging places.

Finally the Oklawaha region represents a magnificent natural "laboratory" for gaining further insight into the process of evolution and principles that govern the geographic distribution of living organisms. Many nothern species of plants and animals reach the southern limits of their range in or near this region, and some of the endemic species of peninsular Florida are found no farther north. The region is also a major transition zone between races, or subspecies, of numerous species. The patterns of variation between populations of some of these species reflect insular conditions that existed in past geological time when sea levels were higher than at present. Each of these phenomena is of vital interest to students of evolution and biogeography. Further understanding of such problems is not only of theoretical interest, as it also contributes to man's ability to manage his own ecology and evolution.

§ 11.37.10 Amphibians.

Thirty-three species of amphibians; including 13 salamanders and 20 frogs, may be expected in the Oklawaha region. Three additional species—two salamanders and one frog—may also occur. Three of the amphibian species occurring in the Oklawaha area are restricted to Florida or extend only a short distance outside of the state. These include the Striped Newt; the Dwarf Siren, which has a long evolutionary history within the state; and the Florida gopher frog, so-called because it inhabits the deep, humid burrows of the Gopher Turtle in the arid longleaf pine—turkey oak and sandpine scrub associations. This association between a member of a group of frogs normally found around water and a large dry land tortoise is an

Fig. 19 Equations for a single compartment are derived and their simulation with an analog computer is illustrated.

of the projected shallow reservoirs. It is true that reservoirs have more water surface than do wild rivers, but the critically important issue is the relative *quality* of recreational opportunity offered by the natural river and its adjacent valley forest compared with reservoirs in a region already richly endowed with natural lakes. Protective guidelines against pollution and encroachments are now being drafted by the Corps of Engineers, but it is unlikely that these will result in effective preventative or corrective measures in the long run.

Although construction of the Barge Canal is now 29% complete, no alternative proposal for land use was ever presented to local citizens for their consideration. However, preliminary investigations indicate that much greater economic benefits would accrue directly to local communities if the Oklawaha Regional Ecosystem were intelligently developed as a wilderness/conservation/recreation

area. It is not generally realized that the majority of the transportation benefits are predicted for areas beyond Florida, and yet state and local interests must share the consequences and legal responsibilities of environmental degradation.

If the thorough kind of planning that should have preceded this construction should now take place, three basic actions would be forthcoming.

1. Construction would be halted.
2. A regional environmental planning council, established in accordance with existing Florida statutes would be formed to draw up a master plan based on the needs of conservation, environmental protection, recreation, and development throughout the Oklawaha Regional Ecosystem.
3. An agency, perhaps patterned after such multi-county special-purpose governmental agencies as the Central and South Florida Flood Control District or the Southwest Florida Water Management District, would be created and given the authority to execute the land-use plan recommended by the Oklawaha regional environmental planning council.

It is essential to realize that there is now a unique opportunity to plan the future use of a significantly large ecosystem in peninsular Florida. The Cross-Florida Barge Canal controversy has exposed the lack of any valid plan for the wise use of a unique wilderness area in a section of the nation in which such original assets are rapidly being lost.

§ 11.80 Economic Evaluation of the Cross-Florida Barge Canal Project (By Paul E. Roberts, Jr.*)

The Cross-Florida Barge Canal project is a classic example of a long standing national disgrace—pork-barrel legislation. In the six years since construction began, the project has become a textbook example of what Robert G. Sherril, in his article "Corps of Engineers: The Pork-barrel Soldiers," describes as "the oldest established permanent floating boondoggle in American politics."

*Assistant Professor of Economics, University of Florida.

This Florida project is one of many water-resource projects, scattered throughout the nation, in which the taxpayers' natural and economic resources are recklessly wasted.

For decades economists have criticized the Alice-in-Wonderland economics of the most notorious of these public works projects, and political scientists have described the system that perpetuates the undemocratic process of "pork barrel" politics—but to no avail.

Today, however, there are signs that the public's mounting concern over the degradation of the environment, coupled with its growing impatience with federal programs that spend taxpayers money on programs that benefit only a few vested interests, will evoke corrective legislation by the United States Congress.

And it will take Congressional action to correct the miserable aberration of the boondoggle. Sherrill described the Corps-Congress relationship succinctly: "The boondoggle routine is perfectly balanced. The Corps justifies the projects and Congress appropriates the money. On one hand the Corps gets bigger and more influential —two conditions dearly prized by generals—and on the other hand public-works money is doled out to civilian contractors "back home" with Congress getting credit for spreading the happiness."

In all fairness it must be noted that the Corps of Engineers has, from time to time, recommended improvements in the economic guidelines that govern the evaluation of and economic justification for its projects, only to have the proposals nullified by the Congress.

In these days, when great emphasis is placed on fiscal responsibility and the Congress has willingly cut federal spending on many domestic programs it is disconcerting to find Congress refusing to cut the appropriations for the enormous "pork-barrel" programs. The reason for this anomalous behavior may be found in the massive lobbying mechanism that supports the boondoggles.

In "Dam Outrage: The Story of the Engineers," Elizabeth B. Drew has clearly described how the coalition of Corps, Congress and vested interests operate. In discussing the organized and undisguised pork-barrel lobbying groups she says:

> "The nationwide coalition of interested groups keeps momentum behind the public works program and gives the barge industry...the strength to continue to win federal largesse."

Some of these "interested groups" are:

> "the Mississippi Valley Association, the Tennessee-Tombigbee Association, the Arkansas Basin Development Association, and so on. The Florida Waterways Association, for example, boosters of the controversial Cross-Florida Barge Canal, has among its directors a realtor, representatives of a consulting engineering company, chambers of commerce, port authorities, newspapers, and a construction company. The associations meet and entertain and lobby. The Lower Mississippi Valley Association is noted for its days-long barge parties. Some twenty- to thirty-odd people from an association descend on Washington from time to time to testify and to see the right people in Congress and the Executive Branch."

The most powerful lobbying group is, of course, the National Rivers and Harbors Congress,

> "an unusual lobbying organization made up of politicians and private interests who support federal water projects. The chairman emeritus of the Rivers and Harbors Congress is Senator John McClellan. Among its directors are Senators Allen Ellender of Louisiana (chairman of the Public Works Appropriations Subcommittee) and Ralph Yarborough of Texas, and Congressman Hale Boggs of Louisiana and Robert Sikes of Florida."

Water resource projects normally follow a well defined series of steps from instigation of the project by "local interests," through Congressional authorization for the Corps to study the project, conduct public hearings, and compute the benefit-to-cost ratio of the project, to Congressional authorization of the project and finally Congressional appropriations of funds for construction. In his recent book, *The Diligent Destroyers*, George Laycock has taken "a critical look at industries and agencies that are permanently defacing the American landscape." His many carefully documented case histories indicate how easily the public interest may be subverted in this process. He points out, the "public hearings" where only "interested parties" were notified; the deathlessness of project authorization—some authorized Corps projects are more than 20 years old, just waiting for an "interested" group and a favorable

benefit-to-cost ratio to become active nightmares; the restudy gambit whereby the Corps recalculates over and over again until the all-important benefit-to-cost ratio of 1-to-1 is reached. The Cross-Florida Barge Canal is just one of the many projects the defects of which are revealed by Laycock's detailed analysis.

The ratio of benefit-to-cost of a project has come to be the foundation of every Corps project. The theoretical reason for its importance rests on the reasonable assumption that an expenditure of public funds is acceptable only if the benefits to the public equal, or exceed, the cost to the public when calculated for the projected life of the project. Theoretically, a benefit-to-cost analysis is an objective method of evaluating a project. In actuality a wide variety of subjective value-judgments enter into any benefit-to-cost analysis. Highly arbitrary choices as to what constitutes primary benefits and/or collateral benefits are made. Dollar values are assigned to both the assumed benefits and the estimated costs. It cannot be overemphasized that the final number emerging from a benefit-to-cost analysis has within it a multitude of subjective value judgments.

The Cross-Florida Barge Canal project, when authorized in 1942, had a benefit-to-cost ratio of only 0.18 to 1.0. In 1958, after the inclusion of the collateral benefits, flood control and land enhancement, the ratio rose to 1.01 to 1.0. Today, after the addition of recreation benefits the ratio is listed as 1.4 to 1.0. The past economic restudies have all been made by the Corps or by agencies selected by the Corps. It is high time that an economic analysis of the Cross-Florida Barge Canal project be carried out by an unbiased group of economists, specialists in the fields of economic theory, transportation economics, and environmental or resource economics.

Economists associated with the Florida Defenders of the Environment are investigating the economic justification of the project from several different angles. Some of their preliminary findings are reported below.

§ 11.80.10 Total Costs have been Underestimated

The Corps' report for Fiscal Year 1971 shows estimated fixed contractor and land costs to be $185,200,000. To this amount approximately $20,000,000 should be added to account for interest

charges on capital costs during the period of construction. Total estimated costs, therefore, are now estimated to be $205,200,000. The $20,000,000 interest charge does not appear as a separate item in any of the Corps' reports although it is included in their calculations for annual charges. To calculate the interest charge on the capital costs, the Corps uses a rate of interest of 3.795 per cent. This rate is less than one per cent more than the present discount rate of 2.875 per cent used to discount benefits. It is unrealistic for the Corps to assume that interest rates for construction loans are this low. The Corps itself has recently increased land enhancement benefits by increasing the interest rate from six per cent to eight per cent because land values have gone up. Is it not reasonable to assume that increased land values would be accompanied by increased construction costs? If the Corps had calculated the interest charge on capital costs during construction at a rate of eight per cent, the total project costs would be much higher—and a great deal more realistic.

§ 11.80.11 The Discount Rate of 2.875% is Unrealistically Low

In an essay, "A Water Development Program for America's Future," U. S. Senator Stephen M. Young clearly describes the rationale for discounting the projected benefits of a project as follows.

> "As for the estimated benefits, they will be realized by society only in the future. For this reason, Federal practice 'discounts' these benefits to a lower-level present value. Obviously, the higher the rate of 'interest' assumed, the higher will be the estimated yearly 'cost' and the lower the present value of future benefits."

Then, a value judgment must be made as to what discount rate to use. The Water Resources Council of the Executive Branch of the federal government establishes guidelines as to the discount rate to be used at a given time. The present rate, established in 1968, is 4.625 per cent, and is based on the average yield of long-term U.S. government securities during the preceding year. It is interesting to note that the rate of interest used by the Army Corps of Engineers in this project from 1962 to 1965 was 2.625 per cent. This rate was

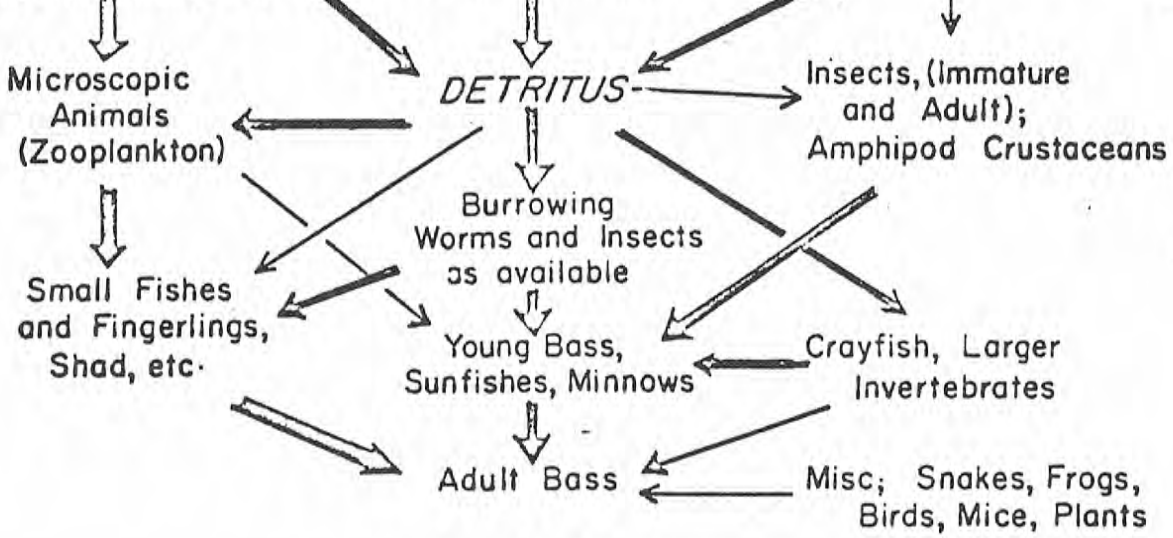
established in this region as elsewhere in the state. These include the Armadillo, Black Rat, House Mouse, and the Jaguarondi. A semi-wild group of Rhesus and Squirrel Monkeys occurs in the forests in the Silver Springs area. The Øyote and Nutria have also been reported from the region, but it is doubtful if established populations exist. The Red Fox may also have been introduced or spread into the area.

One of the unique species in the region is the Florida or Gopher Mouse, which is narrowly restricted to the dry, sandy longleaf pine - turkey oak and sandpine scrub habitats. This mouse, which occurs only in certain parts of Florida and thus has one of the most limited ranges of any North American mammal, often lives in the burrows of the Gopher Turtle. It appears to have its closest relatives in southern Mexico and Central America, which makes the problem of its occurrence in Florida an interesting one. The Round-tailed Muskrat is another mammal found in the Oklawaha region that is almost entirely restricted to Florida, being recorded outside the state only in the Okefenokee Swamp of southeastern Georgia.

Among the important game species of the region are Gray and Fox Squirrels, Black Bear, and White-tailed Deer. Both Cottontail and Marsh Rabbits are also abundant, and substantial numbers of Wild Hogs occur. The general Ocala forest region supports one of the best deer herds in the state and is a popular hunting area. The central Florida region also is one of the two areas of the state with a relatively large bear population. Other species pursued for sport or fur, including the Opossum, Gray Fox and Raccoon are also abundant.

The region also constitutes an important potential reserve for the Florida panther, which has been placed on the Endangered North American Species list. According to experienced observers in the region, sightings of panthers have increased in recent years, which may be indicative of a build-up of the population of this splendid cat in the Oklawaha region. The extensive wilderness, cover diversity, and abundance of deer and other game in this area provide ideal conditions for the panther.

The Oklawaha region, particularly the hydric hardwoods association, also serves as an important refuge for another rare species in the state, the Florida Long-tailed Weasel.



GENERALIZED FOOD WEB of FLORIDA LARGE-MOUTH BASS in UNDISTURBED OKLAWAHA

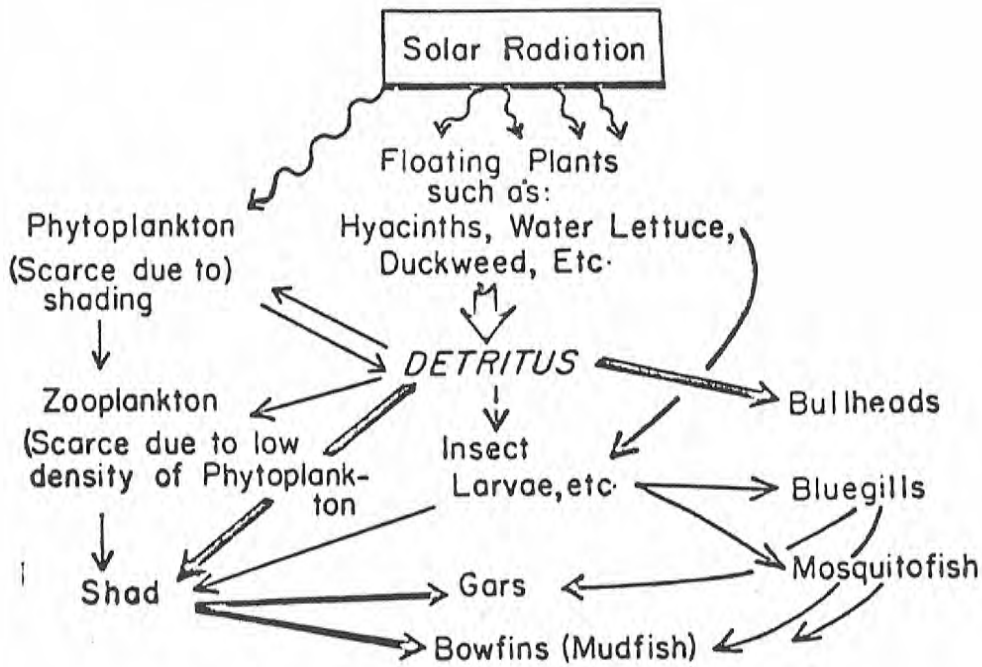
§ 11.38 Native Aquatic Fauna (By George K. Reid*)

The Oklawaha River is extremely rich in numbers of kinds of fish. At least 110 species are recorded, compared to 78 in the Escambia River. The diversity of fishes and invertebrates indicates the stability of the ecosystem and serves as a measure of the quality of the environment.

It is impossible to understand the complete role in, and total effect of a single species upon, the ecosystem of which it is a part. This is because its presence to some degree, however slight, however indirectly, affects all other species in that ecosystem. The complex relationships and interchange that occur are suggested by the diagrams in Figure 9. The most usual channel by which this interaction is expressed is the feeding of one species upon another. The existence of game species of fish, for example, depends upon the presence of various obscure species which are unknown to the public or collectively called minnows. Eons of time have established a natural balance of the many species occurring in natural ecosystems and this equilibrium depends, to some degree, upon the continued existence of all the species present. This balance is called ecological stability.

*Professor of Biology, Florida Presbyterian College.

In certain areas the ecological stability of an ecosystem is a direct function of its species diversity, the number of kinds of organisms in it. This is because there are numerous potential species available for food for any given organism whose existence, consequently, does not hinge upon the continued existence of a single food source. When one species of minnow becomes locally rare or extinct, predator species such as bass can utilize other species. Systems with few species are more unstable and the effect of the depletion or extinction of a species of forage minnow will cause a population crash of the bass feeding on it, and of the bass's predators, unless alternative food sources are available. In other words, small non-commercial fish and crustaceans are vital to the continued existence of the larger commercial fish which prey on them. Thus, an interest in the welfare of these little-known species is more than an intellectual whim; it is also a sign of concern for the people who utilize the game species. Above all, local extinctions, which simplify these food-webs and decrease the stability of the ecosystem, set the stage for ecological disasters which detract from the quality of the environment and from man's enjoyment of it. An ecosystem's usefulness to man depends directly upon the species diversity, and thus stability, of that ecosystem.



§ 11.38.10 The Native Fish Fauna

Studies of the fish populations of streams, lakes and ponds in the Oklawaha drainage show this river to have an exceptionally diverse fauna. Approximately 110 species of fishes are known from this drainage system, as compared with 70 species recorded in various portions of the Savannah River, Georgia, and 78 species of fresh and brackish species in the Escambia River of Alabama and West Florida.

This great array of species in the Oklawaha can be attributed, in part, to the antiquity of the stream and to the wide variety of bottom sediment types, which range from clean sand to muck materials. Each bottom type supports its own fauna of small vertebrate and invertebrate organisms and these serve as prey species for larger animals, including those of importance to man. Scattered patches of water lilies in the shallow zones and numerous sloughs, or backwaters, adjoining the river proper provide nesting and aggregation sites for many species of fish.

Some of the species of fishes and other animals that occur in the Oklawaha River are rare, and some* exist as disjunct colonies, isolated by hundreds of miles from the nearest population of the species. Serious consideration should be given to preserving the habitats of these rare river-dwelling species, to prevent their extinction.

No complete discussion of all 110 fishes of the Oklawaha drainage will be attempted, nor is such a prerequisite to an understanding of the importance of their continued existence in maintaining stability in this aquatic ecosystem. Groupings of these species according to their diet gives an idea of their place in the food-web, the complexity of which is another indication of its degree of ecological stability.

Many of the species are herbivorous. They feed on vegetation and thus represent one of the ecosystem's direct links between plant and animal kingdoms, transferring energy between the two. About a dozen species of herbivorous shad and herring-like fish (Family *Clupeidae*) occur in the Oklawaha drainage.

Other species are omnivorous, feeding on both animals and

*Two minnows, *Notropis cummingsi* and *Notropis welaka*, one darter, *Etheostoma olmstedi*, and one catfish, *Ictalurus platycephalis*.

plants. Three small live-bearing species (Family *Poeciliidae*) feed on tiny plants and animals (plankton) at the water's surface and the numerous species of true minnows (Family *Cyprinidae*) feed on plankton at intermediate depths. The live-bearing species prefer the slow moving back-waters and shallow zones while the minnows typically inhabit flowing waters above sandy or gravelly bottoms.

Numerous darters (*Percidae*) and Gobies (*Gobiidae*) feed on similar foods on the bottom, in moving water. They remain more or less stationary in the stream and snap at small organisms being carried by the current. Still other species are carnivorous, preying upon smaller fishes, and on other vertebrate and invertebrate animals. Their existence depends upon the herbivorous and omnivorous species mentioned above. Some so-called trash fish such as bowfin (*Amiidae*) and Gars (*Lepisosteidae*) are carnivorous, as are such highly-prized game species as pickerel (Family *Esocidae*), numerous sunfish, largemouth bass, warmouth, shellcracker, crappie, redbreast, etc. of the Family *Centrarchidae* and 7 species of catfish (*Ictaluridae*). Like the omnivorous live-bearers, the pickerel and gars inhabit mostly quiet waters and lakes in the Oklawaha drainage. Like the omnivorous gobies and darters, the catfish and bowfin are bottom dwellers in moving or static waters. The numerous sunfish feed largely at intermediate depths in both standing and flowing water.

§ 11.38.20 Invertebrate Fauna

The invertebrate fauna, including the plankton, of the Oklawaha is poorly known. Literature research and a small amount of direct investigation of bottom organisms reveal, however, that the Oklawaha is well-endowed with invertebrate life, particularly insects, crustacea, and worms. This might confidently have been predicted from the rich fish fauna that the environment supports.

A conservative estimate, based on published monographs and personal studies, is that 12-15 taxonomic orders of aquatic insects are present as immatures or adults or both in the Oklawaha drainage. The most prevalent groups are the mayflies (*Ephemeroptera*), midges and mosquitoes (*Diptera*), true bugs (*Hemiptera*), dragonflies and damselflies (*Odonata*) and beetles (*Coleoptera*). Approximately 100–125 insect species occur in the Oklawaha; only 58 are known from the Savannah River.

More than a dozen species of macro-crustaceans such as scuds, amphipods, shrimp, and crayfish occur in various habitats in the river, all heavily preyed upon by small species of fish and by the young of large species.

Most fish species in the Oklawaha drainage depend directly or indirectly upon the invertebrates present there. Only herbivorous fish are able to utilize as their food source the plants which, through utilization of sunlight, produce organic biomass upon which *all* animal life depends. All omnivorous and carnivorous fishes, including game species, feed upon herbivorous fish and invertebrates or upon other carnivorous species that are directly supported by herbivores and invertebrates. The invertebrates, thus, are essential links in food chains that lead through the smaller carnivorous fish to the large game species that prey upon them.

§ 11.39 HISTORY OF MAN IN THE OKLAWAHA VALLEY (BY GORDON E. BIGLOW*). The first inhabitants of the Oklawaha basin were Indians, whose name for the river was *Ockli-Waha*—the great river. Their tenure goes far back into prehistory. The earliest known Indian remains along the river are those of the Archaic Phase, a group who lived by hunting, fishing and foraging. Dating to at least 1500 B.C., these remains represent small camps of Indians scattered along the river, living in large part on freshwater shellfish, deer, turkey, and a broad range of nuts, berries, and edible roots. The fact that no large, deep middens have been found suggests that these may be temporary camps of groups who normally lived in the St. Johns Basin. The camps seem to have been sporadically occupied until about 500 B.C. when a gradual replacement began.

The new people still represented a hunting, collecting economy and may have learned the cultivation of some plants. During this phase, the Oklawaha seems to have been a frontier between the St. Johns and the Florida Gulf Coast peoples. Pottery from Oklawaha sites was made by techniques common to the St. Johns area, but was decorated with designs common to the Weeden Island Phase of the Gulf Coast culture. This blending of ceramic styles suggests an actual merging of cultural traditions. Small camp sites, scattered

*Professor of English, University of Florida.

along the river were still the major occupational feature, and no large sites are known within the immediate river valley. The high bluffs along the eastern bank of the river, however, do contain scattered burial mounds suggesting a more permanent population.

The Ft. Walton, fully agricultural, peoples who penetrated Florida after 1200 A.D. do not seem to have visited the Oklawaha in any numbers. Nor did the early Seminoles who infiltrated Florida after 1720 find the valley attractive. The Treaty of Moultree Creek in 1823 confined the Seminoles to a reservation largely west and south of the Oklawaha, whose major control point was Ft. King, located a few miles west of river near the present site of Ocala. Recent surveys have failed to disclose any evidence of Seminole towns along the river. On May 9, 1832, Seminole chiefs signed the Treaty of Payne's Landing on the bank of the Oklawaha between Ft. McCoy and Orange Springs. This treaty, obliging the Seminoles to give up their Florida lands and emigrate to Oklahoma, was one of the principal causes of the Second Seminole War, which began with the killing of the U.S. Indian Agent Wiley Thompson (on December 28, 1835) at Ft. King. When it was over the Seminoles had entirely vacated the area, moving either to Oklahoma or to inaccessible portions of the Everglades. On the whole there seems to have been little permanent Indian settlement in the Oklawaha basin.

The story is much the same for the white man: the main stream of white settlement flowed around the Oklawaha area for a hundred years. As early as 1830, the land west of the river had been pioneered by white settlers who lived chiefly from cattle herds and subsistence farming. And Southern slave-holding planter civilization had penetrated the St. Johns Basin as far south as the Zephaniah Kingsley plantation on an island at the north end of Lake George. But the Oklawaha valley itself and the Big Scrub east of the river were not settled until the 1870's and then only sparsley—a few families at Lake Kerr, and a few more along the main watercourse. As late as the 1920's, only six white families, and no Negroes at all, lived in the scrub, so that it remained quite literally a frontier area where one could make a living with an axe and gun, until well into the present century.

The history of the region during and after the Civil War is full of color. During much of the war, Federal forces blockaded the St. Johns River to prevent shipping, occupying the banks as far south

as Palatka, but they never troubled the Oklawaha, only a few miles away. The result was that the river acted as a major link in a wartime blockade-running enterprise. Goods came ashore from Atlantic schooners at Mosquito Inlet near New Smyrna, were freighted by wagon to the St. Johns, shipped up the St. Johns and the Oklawaha to Orange Springs, where they were taken by wagon to the railhead at Waldo on the Fernandina and Cedar Keys Railroad. All this was made possible by a little dumpy steamer especially designed for the Oklawaha River by Hubbard L. Hart who had come from Vermont to Palatka before the war. This unique boat was propelled by a boxed sternwheel, set so far inboard in a stern cleft as to be nearly invisible from abeam. The special design was required by the narrowness and the innumerable hairpin turns of the river as it flowed through dense cypress jungle. Shortly after the war, this same Mr. Hart was comissioned by the U.S. Government to clear the river channel of obstructions. Some idea of the difficulty of the project can be gathered from the fact that in one fifteen-mile stretch he took 300 trees from the banks and raised 175 logs from the bottom.

Hart Line steamers provided access to the region for tourists from about 1868 until the early 1920's. The favorite cruise started at Palatka and followed the winding course of the Oklawaha up to Silver Springs and return, though some passengers went on up to Lake Harris in central Florida. Part of the trip involved an awe-inspiring voyage at night with the jungle lighted fantastically by fatwood fires burning in iron baskets slung out from the forecastle. The exotic beauty of the cruise through the jungle called forth extravagant praise from a number of famous people, including General U.S. Grant, Harriet Beecher Stowe, William Cullen Bryant, and Lafcadio Hearn. The voyage moved Sidney Lanier to call the Oklawaha "the sweetest water-lane in the world...a lane which is as if God had turned into water and trees, the recollection of some meditative stroll through the lonely seclusions of his own soul." Less lyric are the matter-of-fact accounts of the habitual and wanton slaughter by gunfire of alligators and birds from the deck of the steamer as it moved through the paradisal jungle.

In literature, the Oklawaha region has been treated most fully and lovingly by Marjorie Kinnan Rawlings who saw the beauty of the region with clear eyes and the unique lives of the cracker inhabi-