From the air, the rich salt marshes of Florida's Wakulla County.

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Jack and the dragline

One man's unwavering battle to save North Florida's marshes

story by WYATT BLASSINGAME
photography by ROBERT PERRON

THE BIG BEND OF NORTH FLORIDA has no exact geographic limits. It is a half-moon of coastline that reaches from somewhere north of Tarpon Springs to somewhere east of Port Saint Joe, a stretch of perhaps 300 miles. There are relatively few roads and few towns, all of them small, in this country of lush and lonely saltwater marshes threaded by winding creeks. Behind the marshes lies a narrow band of still heavily wooded, largely unpopulated land; in front is the Gulf of Mexico. Marine biologists say the marshes of the Big Bend produce and shelter more sealife than all the rest of Florida, including the Everglades.

These marshes may now be on their way to joining the passenger pigeon and the Carolina parakeet. Some have already been dredged-and-filled, seawalled, and condominiumed. The rest are threatened, although not without opposition. Currently the battle is centered around a comparatively small area almost directly south of Tallahassee, the state capital. Its outcome will surely affect the rest of the Big Bend, and all of Florida's remaining marshlands.

Newspapers have referred to the Battle of the Big Bend as a struggle between a lone conservationist David and a constantly growing army of developer Goliaths. In this metaphor the unlikely looking David is a chubby, self-educated, 29-year-old collector of marine specimens, Jack Rudloe.

Rudloe was born in Brooklyn, "around one corner from Prospect Park." No one else in his family had any particular interest in nature, but the park—the plants, the birds, everything in it—fascinated Jack from the time he could toddle. By the age of nine he had started a collection of turtles, carefully measuring their annual growth. When he was fourteen and the family was planning to move to Florida, Jack presented his turtles to the Staten Island zoo—then became indignant when "the stupid zoo keepers put my beautiful turtles in the same pen with the alligators, which promptly ate them."

In Florida Jack first attended high school in Carrabelle, a fishing village on the Big Bend. When his family moved to Tallahassee, he got a part-time job working for a biology professor at Florida State University, and after graduating he enrolled there to study biology.

"I had absolutely no money. I felt I was wasting my time. Apparently the university felt the same way." So at eighteen he was a dropout, with no job and no salable skill. But the professor he had worked for bought bullfrogs (he was studying the neuromuscular reactions of amphibians) and "Georgia thumper" grasshoppers, and Rudloe began to spend his days catching grasshoppers, his nights wading swamps in pursuit of frogs. Then another professor asked for two dozen pink shrimp, and it changed Rudloe's life.

He drove to Carrabelle and went out with one of the commercial shrimpers he had known there. "After that one night on the bay," he would write later, "I fell in love with the sea and with shrimping, and I never went back to the woods." He got a job shrimping. But it was not the commercial shrimp that fascinated him. It was the trash fish, the eels and rays, the hydroids and tunicates the nets dragged up and the shrimpers threw away.

Shrimpers work mostly at night, and Rudloe used his days going back to the university to ask professors what sea creatures they would buy for scientific study. He wrote to other universities and to research laboratories. He got orders he could not fill because he didn't know what the things were. He read every technical book on the subject he could find. He sent weird-looking specimens to Florida State, to Harvard, to Woods Hole, for identification. Almost in self-defense the Harvard biologists took an interest in

Jack Rudloe collects an angel wing from the tidal flats of Alligator Harbor.

their fanatical correspondent. They invited him to Cambridge and turned him loose in the library and laboratories. He lived with a brother, scrounged meals, and absorbed information. His language began to change: a bulldozer lobster became a *Scyllarides nodifer,* and a toadfish an *Opsanus tau.*

When the Woods Hole Oceanographic Institution planned an expedition to the Indian Ocean, Rudloe applied for a job as biological collector and got it. Afterward he went back to Florida and a broken-down trailer in the fishing village of Panacea. Once more he spent his nights on shrimp boats and his days digging in the tidal flats for tunicates, clams, mantis shrimp, and other creatures. He called himself the Gulf Specimen Company. In his spare time (maybe the weather was too rough for the shrimp boats, the tide too high to dig sea squirts on the flats, and he'd had some sleep the day before) he wrote a book about his work, THE SEA BRINGS FORTH. It got excellent reviews. His business was picking up, making a little money; he found several persons who wanted to invest money—and Rudloe spent every bit of it on small boats and land for homebuilt aquariums in which to keep his specimens alive.

In Panacea, Carrabelle, Apalachicola, the small towns along the northern rim of the Big Bend, the commercial fishermen regarded Rudloe with bemused affection. They were impressed with his energy and by the fact he could get money for junk like electric rays and cusk eels, which they considered damn nuisances. They laughed when he sat down to operate on a small fish, looking for parasites inside its mouth; but they were respectful of the fact he knew things they didn't about the very fish they'd been catching all their lives. And they were happy that he would buy some of the trash they had formerly thrown away.

BY EARLY 1970 THE BULLDOZERS and draglines had already had their way with much of the Florida coastline. But the lonely marshes of the Big Bend remained largely overlooked. Wakulla and Franklin counties, with close to one hundred miles of Gulf beaches and almost five hundred miles of waterfront including estuaries and marshes, had a total population of less than 14,000.

But there was the smell of fortunes to be made, and this rich aroma reached the nostrils of numerous developers. They descended upon the Big Bend, particularly the area closest to Tallahassee.

Rudloe observed the first of them with only mild interest. "I wasn't an ardent conservationist. At least I didn't think of myself in that way. I'd seen a dozen shrimp boats working the same area, and their hauls teemed with so much sealife it seemed totally inexhaustible. I didn't think anything could destroy it."

It did not take him long to learn otherwise. He visited Shell Point, intending to collect sea urchins in an area where they had always been plentiful. But bulldozers were working along the beach now, and draglines dug the marsh. Rudloe pulled his net a short distance offshore. When it came up, "The smell damn near knocked me out of the boat. There was not a live sea urchin, but there were over one hundred dead ones, rotten, their spines falling off and their viscera oozing out of their hulls. There was not a single living thing in the net, not a hermit crab or a grass shrimp. The place was a graveyard."

Scallops had always been plentiful in the grass flats off Live Oak Island. But draglines were cutting into nearby marshes, and the only scallops Rudloe could find were dead ones. Mashes Island was being turned into a network of roads and building lots. What remained of the marshes were almost lifeless except for the fiddler crabs. Then they too began to disappear.

By accident, Rudloe gave himself another dramatic lesson in what dredging can do to the benthic population of an area. In one of his aquariums he kept a number of deep-burrowing sea cucumbers, mollusks, and worms along with sunray clams, sea urchins, and eels. When an order came for a dozen sea cucumbers he dug his fingers into the sand and gravel bottom of the tank and kept groping until he fetched up the required number. By this time the aquarium was murky with silt. He assumed that flushing the tank with fresh seawater and the system's filter would take care of the problem. It didn't. In a few days the water in the tank was crystal clear; but the sea urchins and sunray clams were dead, the eels dying.

Rudloe looked at his decimated aquarium and thought of the draglines, the silt spreading over the bay shallows, drifting for miles with the tides. He remembered the smell of the rotten sea urchins in his net. "I was learning the hard way." But he was also writing to the American Littoral Society, studying all the scientific material he could find about the death as well as the life of marshland.

Alligator Harbor, a few miles southwest of Panacea, has long been regarded as one of the richest estuarine areas in the United States. Twenty universities have sent expeditions to study its marine life, and Rudloe calls it a "biological jewel." He was wading its tide flats one morning looking for *Diopatra,* the plumed worms, when on the far side of an inlet he saw the long, steel arm of a dragline lift against the sky. Below it a huge bucket swayed, tilted, and splashed its load of muck into the bay. The crane swung, and the bucket dipped down for another load.

"By this time," Rudloe says, "I had come to regard the marsh as a living thing. When the dragline tore into it, to me it was like tearing into living flesh. I could almost hear it scream." He forgot his *Diopatra* and headed back for the ancient trailer he still used as an office. In the next two hours he had fired off letters to the governor, the attorney general, the director of the Department of Natural Resources, the Department of Pollution Control, and to the U.S. Army Corps of Engineers.

The Battle of the Big Bend had begun.

The dredging in Alligator Harbor that galvanized Rudloe into action was relatively minor. An individual landowner had decided to build a small marina. To do this he needed a channel four feet deep and two hundred feet long, part of it across state-owned land. Apparently it didn't occur to him that anyone might object. He rented a dragline and put it to work.

Rudloe's letters brought fairly prompt action. The dredging was stopped—at least until a permit could be obtained. This required a survey and report by the Department of Natural Resources. The report filed was adverse: the proposed dredging would "seriously damage the biological values" of Alligator Harbor.

This, however, was not the final word. The ultimate state authority (a federal permit would also be required) lay

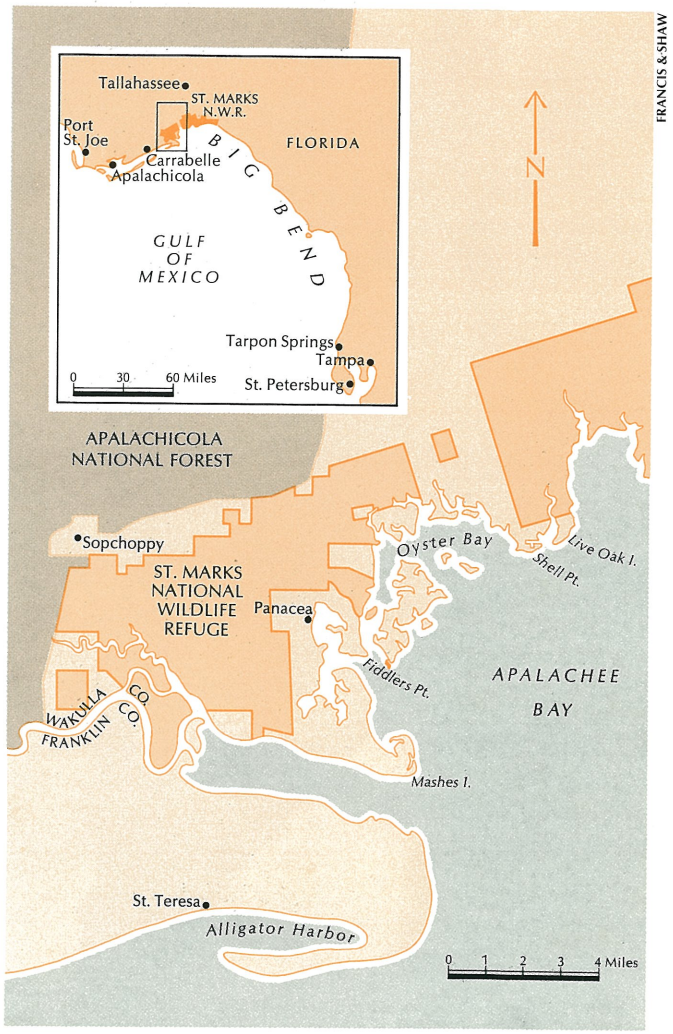
with the Internal Improvement Trust Fund. This is a board composed of the governor and his cabinet of six elected state officials—the secretary of state, attorney general, comptroller, treasurer, commissioner of education, and commissioner of agriculture—who are empowered to hold in trust all the public lands of the state. Despite the recommendation of their own Department of Natural Resources, the trustees approved the permit.

Rudloe was not unprepared. His typewriter was already red hot from producing letters to newspapers, articles for conservation magazines, brochures that he mailed to scientists and research laboratories all over the country. Fortunately for his business, he had found an assistant in a former commercial shrimper, Leon Crum. Crum, who had once sold Rudloe the trash fish his shrimp nets brought up, had become so intrigued with the creatures that he gave up shrimping to work with Gulf Specimen Company. He was soon speaking of *Prostheceraeus floridanus* (pink flatworms) and *Tucca impressus* (parasitic copepods) as knowingly as Rudloe himself. Leaving a good part of the actual collecting work to Crum, Rudloe began to lecture to students, to civic organizations, to anybody who would listen.

Once he started talking about the marshlands, he was a hard man to stop. Shaggy black hair aquiver, arms waving, his voice shaking with emotion, he spoke of the ecological importance of "the hatchery, the nursery of most sealife. Without the marshes, vast areas of the sea would be dead. They mean food and shelter for larval fishes, juvenile crabs, and shrimps, home to hordes of scuttling fiddler crabs, periwinkle snails, birds. The decaying blades of marsh grass, the waxy leaves of mangroves, provide an important nutrient source for plankton in the estuary. The production of an average acre of salt marsh is seven times that of an acre of the richest wheat field in the world. Marshes and mangrove swamps stabilize the shoreline with their network of roots. No matter how severe a hurricane, the living community of plants holds the beach soils in place." Rudloe would describe what happened in his own aquarium when the bottom was disturbed, and he was not above producing rotten sea urchins to illustrate the smell that draglines left behind.

Letters poured in to the state cabinet. The cabinet reversed itself on the Alligator Harbor permit and asked for new studies. When a hearing was held, Rudloe appeared to testify along with biologists from Florida State University and representatives of Conservation 70s, a lobbying coalition of legislators, state officials, and conservationists. Newspapers referred to them as the "Biology Bombers," and they bombed the Florida cabinet into a temporary agreement.

It was only a beginning. Every time Rudloe went on the bay or set foot on a tidal flat he had only to raise his eyes to see a dragline at work. At Shell Point, Live Oak Island, Oyster Bay, the developers were ripping up the marsh, burying the needlerush under tons of muck, spreading silt up and down the bay. "I counted ten drag-



lines at one time," he says.

And he reported them all, to every agency he could think of. "Some of them had no permits at all. Some had state permits but not federal. There was one hell of a lot of illegal dredging going on."

Apparently he was right, for one operation after another was shut down—at least temporarily. One after another promptly applied for new permits. But these required new studies, and the work hung suspended. Draglines and bulldozers, looking like prehistoric monsters, stood idle in the marshes.

This was the spring of 1972.

As the most vociferous and the most publicity conscious of the Biology Bombers, Rudloe had made himself exceedingly unpopular with wealthy developers as well as some chambers of commerce. Nor had he endeared himself to all of the state conservation agencies. In a speech before the Florida Wildlife Federation, Rudloe made the statement that the Department of Natural Resources had its priorities confused. He referred particularly to the Division of Marine Resources, saying its Marine Patrol would rather arrest an oysterman for having three undersized oysters than stop a developer from destroying five miles of bay bottom. Always one to turn a colorful phrase, Rudloe drew a picture of his own particular doomsday: a lone oysterman, hemmed in by concrete seawalls beyond which industries belch smoke into the air and pour poisons into the water,

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is dredging up the last half dozen, oil-soaked oysters, while Marine Patrolmen circle in boats, waiting to arrest him if the oysters are undersized.

Harmon Shields, director of the Division of Marine Resources, was in the audience and was not amused. Later he spoke to Rudloe in what two witnesses have referred to as "abusive terms, shaking his fist in Jack's face." According to these witnesses, Shields said that Rudloe's interest in conservation was motivated only by his own financial interest, and that his state permit for scientific collecting would not be renewed. Shields later claimed he had not threatened to withhold Rudloe's permit but merely to study carefully the work of Gulf Specimen Company.

Whatever was said, when Rudloe applied for a new permit he got no answer. He went to see Robert Ingle, who handles the permits under Shields. According to Rudloe, Ingle refused to issue the permit, claiming he had "slandered the department in public."

At this point Rudloe wrote to Governor Reuben Askew: "I wish to object to Mr. Shields' charges in front of witnesses that Gulf Specimen is a fraudulent operation used to cover up illegal practices. We currently service over one thousand schools, research laboratories, and hospitals with living marine organisms from Florida. Without our service such programs as research on the anatomy of the squid nerve axon in Canada or cancer research on sea squirts at the National Cancer Institute would be virtually impossible."

By now the issue had come to the attention of the press. When questioned by reporters, Randolph Hodges, executive director of the Department of Natural Resources, said Rudloe should appeal to the proper committee—to consist of Shields, Ingle, and another assistant. But after more "study," Rudloe's collecting permit was finally renewed.

The squabble over the permit may or may not have stemmed solely from Rudloe's criticism of the Marine Patrol. Certainly there were other pressures upon the politicians. Draglines and bulldozers, costing thousands of dollars a month, were still idle in the marshes. And still more developers were eyeing the Big Bend. There was talk around Panacea that Palm Shores Development Corporation was planning to spend $52,000,000 developing Fiddlers Point, a lonely stretch of salt marsh rimmed by shallow baywater. A real estate agent whose roadside signs announced that he was SELLING FLORIDA'S LAST FRONTIER predicted that Wakulla County (1970 population 6,308) would soon have a city of more than 50,000 persons.

Rudloe was digging for tunicates in Alligator Harbor when a friend came splashing toward him shouting, "They're dredging at Fiddlers Point." Without changing his clothes, Rudloe drove to Tallahassee to see Joel Kuperberg, executive director of the Internal Improvement Trust Fund. Kuperberg sent a field inspector, who reported that the work being done at Fiddlers Point was not in violation of any state laws. Two days later, however, a second inspector visited the site with Rudloe trotting beside him. They found a bulldozer pushing sand into the mouth of a creek to close it off. This was a clear violation of law. On order, the bulldozer stopped in its tracks.

Its engine is still silent.

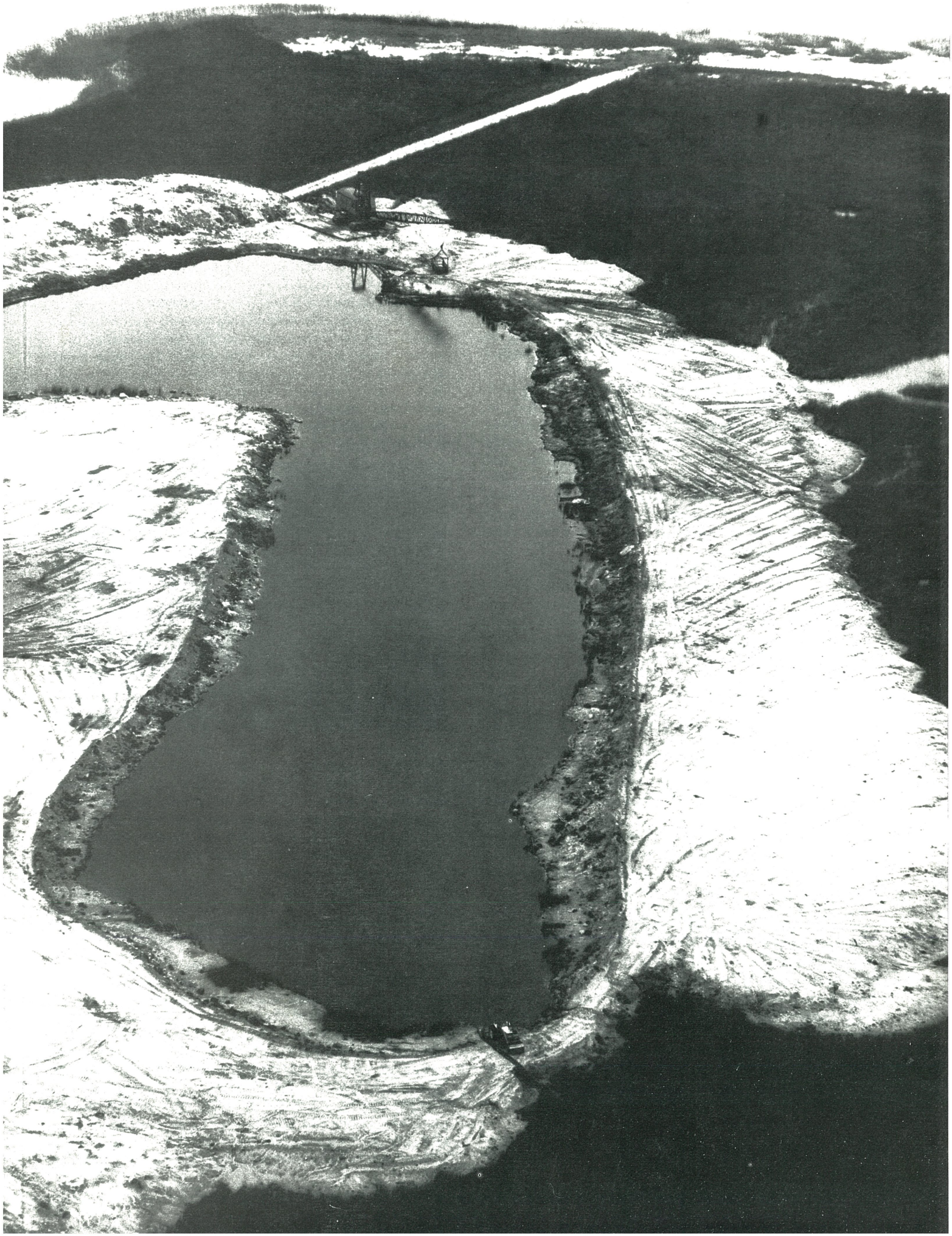
This was too too much for the Wakulla County Chamber of Commerce; it met and resolved: "Our native seafood fishermen through many years of practical experience derived from taking fish, oysters, and crabs from local waters have found that our aquatic life is more often benefited by dredging canals than harmed." Then, taking dead aim at Rudloe: "Wheareas the seafood industry in Wakulla County provides employment for many people who are more entitled to consideration than one lone specimen company which has lately arrived and owns only a few feet of tidal lands and employs only three or four people, and whose qualifications as a marine expert are wholly unproven," the chamber enthusiastically endorsed the Fiddlers Point project.

The official Wakulla County Commission went two steps further. It sent a resolution to the Department of Natural Resources saying that if the state stopped the development of Fiddlers Point, the state should be held responsible for any possible taxes the county would lose. Next the commission struck at the heart of the matter. The department was asked to "void or revoke any license or permit it may have issued to Gulf Specimen Company, or Jack Rudloe of Panacea, allowing him or them to take specimens and marine life from the Gulf waters, bays, and marshes of Wakulla County."

That was it, with no mention whatsoever of a reason. But Bob Kornegay, whose development at Oyster Bay had been stopped for lack of proper permits, was more explicit. He wrote to the governor: "I hereby fully agree with the county commissioners as it is high time that the citizens and property owners of Wakulla and Franklin counties be permitted to develop their property for the well-being of these counties and their citizens.

"This man, Jack Rudloe of Gulf Specimen Company, with his meddling in other people's business has cost property owners untold thousands of dollars, and has cost me personally around $50,000."

The big guns were coming into action. E. C. Allen, a multimillionaire whose Paradise Village had been one of the first developments near Panacea, and who was also having his own permit problems because of Rudloe's "meddling," wrote to the governor backing the county commission's request. Howard Williams, a Tallahassee attorney representing the Palm Shores development at Fiddlers Point, asked to appear before the trustees of the Internal Improvement Trust Fund. He said he would present evidence that Rudloe was "unfit" to hold a scientific collector's permit. "The law authorizes taking only for scientific and educational purposes," Williams said. He did



A stalled dragline and damage already done at Shell Point.

not deny that Gulf Specimen sold to scientific and educational institutions; the charge seemed to be that he sold for a profit.

These forces were difficult for politicians to ignore. The trustees arranged for an informal hearing that would determine whether there should be a formal hearing of charges against Gulf Specimen Company.

In Wakulla and Franklin counties, where seafood is the only important industry, feelings became intense and often bitter. Quite obviously the things at stake would affect the lives of a large part of the population. But how? Every commercial fisherman knew that mullet, trout, and redfish sometimes congregate in canals and large catches can be made. There were many who agreed with the chamber of commerce's statement that "our aquatic life is more often benefited by the dredging of canals than harmed." James Taylor, president of the Wakulla County chamber and chairman of the county commission, told a reporter: "Just about every fisherman in this area knows that canals help fishing. And as for the marshes—there are thirty-five miles of waterfront in this county. Twenty-two of those are government refuge. The thirteen miles left that either are or could be developed won't hurt anything."

Not everyone concurred. The Panacea Chamber of Commerce, directly opposed to the county chamber, passed a resolution in favor of Rudloe. Burl Vaughn, president of the Panacea chamber, said: "Fishing is our main industry, and we don't have any unemployment now. But if these developments take place, out-of-towners will make the money. And if the marshes are destroyed, our fishing, our shrimping, and our oystering are destroyed forever."

The fact that two-thirds of Wakulla County is owned by the federal government (part in the Apalachicola National Forest, part in the Saint Marks National Wildlife Refuge) gnaws at the would-be developers. "If I had my way," James Taylor says, "I'd take that government land and give it to the people. I mean, I'd let the people buy and develop it. Then we could collect taxes on the whole thing instead of one-third."

"It's impossible," E. C. Allen said, "for a developer to get a fair hearing before politicians when the place is crowded with environmentalists." He thought about that a moment and changed his statement. "Maybe not impossible, but there's only a slim chance. Yet what we want to do is really a benefit to the majority of people. I'll bet you a thousand dollars to ten that not ten people saw part of that marsh in ten years. You couldn't get to it. But now they come from all over to fish and enjoy the place."

Bob Kornegay is particularly bitter. "I've worked all my life. I was plowing when I wasn't tall enough to reach the handles and had to hold the crossbar. Now I've got every cent I own, every cent I could borrow, in this land." He waved at a dragline standing idle. "That's costing me a thousand dollars a month. They say I'm killing the fiddler crabs. Look yonder. There's millions of 'em. I don't want to destroy the fishing. I want to live right here the rest of my life, because I like to fish. They say I'm destroying the marshes. The government's got thousands of acres of marsh, millions of acres; they don't need to bother with my few hundred."

Kornegay has circulated a petition that "has hundreds of names" asking for the revocation of Rudloe's collector's permit. "But I don't want to put him out of business," Kornegay said. "I just want him to stop meddling in mine. But I'll tell you one thing. I don't want to get in trouble with the law for murder, but if I ever catch Jack Rudloe on my land, that may happen."

SO MATTERS STOOD in mid-October when the preliminary hearing on Rudloe's "fitness" for a scientific permit was held. Conservation groups sent witnesses to testify in his behalf. Strangely, the only person to appear against him was a lawyer for E. C. Allen. His evidence, he said, had no bearing on Rudloe's qualifications or his methods as a scientific collector. "But he has appointed himself a private attorney general to see the laws are upheld, and he has, under the auspices of his permit, reported to public agencies information that, to be kind, was extremely inaccurate."

This was scarcely proof of "unfitness" to hold a permit for scientific collecting. It was, however, convincing evidence of why the charges had been made. A spokesman for the Sierra Club told the hearing examiner that it was obvious some developers were attempting to intimidate anyone who might report illegal dredge-and-fill operations. Even so, the examiner gave complainants ten days in which to file written and more specific charges.

The days passed, with no charges.

The governor and cabinet then denied the complaint. And for icing they officially commended Rudloe for his "watchdog tactics along the Big Bend coastline."

So the particular battle ended, but the war is far from over. Even now state and federal agencies have requests for dredging and filling mile upon mile of the Big Bend. And from conservationists' point of view the outlook is gloomy. State law permits the filling of land above the median high-tide line. Such permits are hedged with numerous and complicated provisions that will make development slower and more expensive—but do not prohibit it. The median high-tide line is currently set at approximately 1.4 feet above sea level—it varies slightly from place to place. Along the table-flat coast, an inch may mean a half mile or more of salt marsh, much of it actually flooded by any strong spring tide.

"If the marshes are to be saved, the fish, the shrimp, the oysters, the source of most of the Gulf Coast's sealife, then we must have new laws," Rudloe says. "Perhaps a new definition of the median high-tide line, determined by species of plants rather than fractions of an inch. Georgia defines its estuarine areas as 'all tidally influenced waters, marshes, and marshlands lying within a tide-elevation range of 5.6 feet above mean tide level and below.' We must have something of the sort in Florida—or the marshes are doomed."

Officials of the state conservation agencies agree with him. Most of them are staffed by young, sincere men truly anxious to preserve the environment. But the laws come from an older legislature. Standing beside a temporarily abandoned dragline at Fiddlers Point, Rudloe said, "It's a matter of time. Young people growing up now are acutely aware of the need for conservation. If we can save these marshes for ten years, then the new voters will take care of the future. But if we lose them now, they are lost forever." ■

Buoyed by air carried beneath its wing covers, a half-inch-long diving beetle clings to an aquatic plant. When suitable prey ventures close—a dragonfly nymph, a tadpole, perhaps a small fish—this accomplished swimmer will dash off in pursuit, propelled by powerful oarlike thrusts of its hind legs. Long fringing hairs stick out from the legs to form paddles on the power stroke, but lie flat during the recovery.

Hidden world of a pond

photography by E. R. DEGGINGER / text by NED BARNARD

ONE SUMMER DAY, when I was a boy of nine, I brought home a few small tadpoles, a handful of waterweed, and some pond mud in an old gallon pickle jar. That evening I placed the jar on the windowsill at the foot of my bed so that I could watch my new pets before falling asleep. Later that night I awoke to find the jar silhouetted against a brilliant moon. On an impulse, I got up and put my flashlight to the side of the jar. In its beam I could see a myriad of tiny creatures darting and tumbling through the water. Sweeping the light over the weeds, I discovered a strange green bug devouring one of my tadpoles. I remember wondering why I hadn't noticed any of these marvelous things in the daylight. It was almost as if the moon had performed some alchemy, transmuting my pickle jar into an enchanted underwater jungle.

I can't say that I have ever really capitalized on this revelation. I didn't become a limnologist, or an entomologist, or a biologist of any kind. But I did become a pond explorer by avocation. To this day I experience a thrill when I dip a pail into a pond. There is really no telling what will turn up. One who peers into pond water must be prepared for the unexpected.

For aquatic creatures a freshwater pond is an evanescent island surrounded by a hostile terrestrial world. Whether formed by glaciers, beavers, or men, it is destined to be strangled by its own fertility as it fills up with plant and animal debris. But a pond in its brief maturity is a wonder to behold. Nowhere else on Earth, except perhaps in salt marshes and on coral reefs, are living things so concentrated. Nowhere else is the struggle for existence carried on with such intensity.

All life in the pond depends directly or indirectly upon the green magic of photosynthesis—the ability of plants to manufacture sugar molecules out of air, sunlight, and water. In the pond world as in the sea, the least conspicuous plants are the most important. The microscopic one-celled drifting plants of the plankton feed most of the smaller animals of the pond—crustaceans, insects, tadpoles, snails, worms, rotifers. These in turn feed most of the bigger animals—fish, larger insects, turtles, frogs, salamanders. Only a relatively few pond animals, such as ducks and muskrats, eat the larger plants or eat the animals that eat these plants.

Every pond community is unique. No two have precisely the same combination of plants and animals. Aside from microorganisms, the only living things that one can be certain of finding in any unpolluted new pond are aquatic insects. Unlike most other freshwater creatures, they can fly from one pond, lake, or swamp to another. Attracted by the glint of sunlight or moonlight on water, they quickly colonize a new pond and begin feeding on its plants and on each other.

Their ancestors invaded freshwater from land millions of years ago, and all aquatic insects are still air-breathers during at least a portion of their life cycles. An adult diving beetle must come to the surface periodically to take on a fresh supply of air. It merely sticks the tip of its abdomen above the water for the briefest instant and then submerges again. Oxygen enters the beetle's tissues through a row of small holes beneath the wings called spiracles. The diving beetle larva is also an air-breather, but it has its spiracles located at the end of its abdomen, which is tipped by two stout hairs. To take in air it simply hangs in an upside-down position with these hairs spread against the surface film. The larvae of mosquitoes, gnats, and many flies breathe in a similar fashion through siphons or through tubes formed by hairs. Water boatmen and some other insects carry air in a thick, downy coating of fine hairs on their undersides. The hairs grow so close together that the water film cannot penetrate the spaces between them.

Some insects are completely aquatic in their larval stages and thus have no need to make hazardous trips to the surface for air. The damselfly nymph has three leaflike gills on the tip of its abdomen and can absorb dissolved oxygen directly from the water. The larger dragonfly nymph has gills in the hind part of the digestive tract and "breathes" by pumping water in and out of its rectum. The phantom midge larvae and some other smaller insects absorb dissolved air directly through their body surfaces.

The larger aquatic insects such as the dragonflies and diving beetles, and some of the smaller ones such as the mosquitoes, have been the subjects of a great deal of scientific study. Yet there are enormous gaps in our knowledge of many relatively familiar creatures. Very few aquatic species have been closely observed throughout their entire life cycles. And a great many haven't even been named and described. ■