

DISCUSSION

Fisheries Management Session

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Discussion Panel: JAMES E. ALEXANDER, ALBERT C. JONES,
GEORGE B. GROSS, FRANK J. SILVA

Aquaculture and the Law

HARMON W. SHIELDS

Q. Frank J.
Silva:

Is it likely that the physical structure delineating the aquaculture lease line-boundaries will be considered a navigation hazard by the Corps of Engineers?

A. Harmon W. Shields:

I'm sure that there will be project proposals that will be hazardous to navigation, especially if they interfere with waterways such as the Intercoastal Waterway. Of course, such a proposal would be turned down. The industry must take great care in applying for leases in reference to navigable waters.

However, we have a very good working relationship with the Corps of Engineers, and I think any reasonable proposal might be accepted. Local problems, rather than navigation, will have to be most carefully considered by industry.

Q. George Gross:

Have any leases been issued? How much acreage will be involved in this program in the next several years?

A. Shields:

At the present time leases have been issued only on an experimental basis through our department and not under the new mariculture law. Now, however, we have an application for a lease of 2,500 acres in the vicinity of Botheration Bayou in West Bay near Panama City. This area constitutes something in the neighborhood of 2% of the bay area of Bay County. The Internal Improvement Fund staff and the staff of our department proposed in the beginning that leases should not exceed 5% of the sea bottom in any one county. Although our recommendation was not adopted, the idea of some similar limitation was favorably received. The formula will have to be made at some later date.

Q. Albert C. Jones:

What can you tell us about the discussions that went on between your department, the legislative branch of Florida, and industry representatives, before this law was passed? Mr. Jones, I don't think I could begin to relate all the discussions that we had with members of the Legislature or even our staff. Because the problems were numerous and complex, we had to carry on many conversations and negotiations while the Legislature was in session.

A. Shields:

In addition, we have had the very finest cooperation from state and national agencies including the Bureau of Commercial Fisheries.

We expect the problem with this colorful new industry to come from people at the local level. Because they traditionally fished the waters, they hate to give up any of what they assume to be their birth rights. I think maybe this is why Representative Chapman amended the bill to give the veto power to the County Commissioners who might be more aware of adverse effects on tourism or commercial fishing.

Q. James E. Alexander:

What water quality requirements is the State going to require in setting up a potential area for aquaculture?

A. Shields:

Although there is nothing in the bill or in the guidelines that speaks of water quality, aquaculture people say their own requirements for pure, clean water are very rigid. The interest that has been shown so far has been in waters that are relatively free of pollution.

- Alexander:
(Comment) The lack of water quality data in your bill disturbs me because other states which copy this new bill may also fail to include water quality guidelines.
- Shields:
(Comment) We are going to be looking for suitable aquaculture areas for which lease approval will not involve insurmountable political difficulties. However, the aquaculture industry is also seeking their own locations. They will be responsible for testing their own water quality.
- Dennis
O'Connor:
(Comment) Mr. Shields, we are indebted for your presentation of the many positive features of the Florida law on aquaculture and the Aquaculture Lease Guidelines adopted by the Trustees of the Internal Improvement Fund. I am in agreement with the general purpose of the legislation and with your correct emphasis on resolving the local problems as well as those of the wider community at state and federal levels. Florida is a forward-looking state in being the first to provide for the conduct of aquaculture in its public waters. However, a critical look at the law will show that it was drafted without careful considerations of the legal and business aspects of aquaculture.
- First, while the legislation requires that the interests of some users of the coastal region be taken into account and allows the interests of all users to be considered in making decisions to grant an aquaculture lease, the decision procedures are limited. General questions of coordination with federal jurisdiction over navigation, and the potential effect on international rights of navigation by aquaculture areas in the territorial sea are not dealt with. Not only interference with an officially established waterway, but any exclusive use of a water area which affects navigation may raise questions of federal and international law.
- Second, the standards to be applied in decisions on the granting of aquaculture leases are specified only in the most general and vague terms in the legislation. The balance of interests in the "effective development" of aquaculture on the one hand and the "traditional water activities" of navigation and fishing on the other can be noted, as can the balancing of interests in the area to be leased for efficient aquaculture and the conservation interests of the community. The standards which will be used in decisions to establish an aquaculture area and to accommodate the conflicting interests of other users of the coastal region should be spelled out in greater detail than "public interest," "reasonable area" and "conservation." Also, the question of pollution, both to protect the aquaculturist during his 10-year lease term from changes in the estuary, and to insure that means he uses to eliminate predatory species from his area will not lead to damage beyond the area, should be considered. There exists considerable uncertainty at present on the degree of impairment of navigation which will be authorized, the degree to which public fishing may

be curtailed, the allowable ecological consequences resulting from elimination of other species and other questions.

The Guidelines offer some considerable clarification of the above-mentioned standards. They provide that aquaculture use shall have no appreciable detrimental effect on any existing industry, and that it shall have no permanent effect on the wildlife or the ecology of the leased lands and surrounding areas. The wildlife and ecology of the leased lands must be able to be materially restored within one year of the termination of the lease. The Guidelines do not, however, add any useful specifications on the level of ecological consequences permitted during the lease, nor do they offer clarification on questions of accommodation of conflicting uses.

A particularly important question concerns the specific area leased for aquaculture. The Guidelines provide that "only that amount of the bay bottoms in any county will be leased which shall be considered reasonable and fair as determined by the Board." The ecological facts, of course, should be presented in the survey submitted by the Department of Natural Resources. However, the weight to be given these considerations and the standards for determining when the general public may be asked to forfeit common interests are not prescribed. It is known that some parts of bays and other estuaries are highly productive biologically, and may even be critical for the entire ecology of the area, while other portions may be sacrificed without any major detriment to the public interest. The 2% of the bay area which would be within the prospective lease area near Panama City is, in the view of many scientists, the most productive part of West Bay. We can anticipate that future applications for aquaculture leases will also be competitive with the public interest for the most highly productive estuarine areas. Since any restitution to the public as required by the Guidelines must be in the form of a substitute which is different from nature, it is desirable to have the standards on this critical issue spelled out in somewhat greater detail than in the legislation and Guidelines as they stand at present.

Third, some structural features of the law need attention. As the legislation and Guidelines now stand, the bidding process is illusory. Riparian rights which are substantially affected by an aquaculture area are entitled to compensation under our laws. The legislation is silent on this matter, but the Guidelines require the written consent of the riparian owners in all cases. In effect, this means that only the riparian owner or his designee can bid. A feasible alternative would be for the state to acquire either the riparian land or the consent of the riparian owner (through agreement or eminent domain) and then put the aquaculture area and riparian consent up for bids as a package. If the

legislation is not revised in this direction, then the pretense of a bidding process may as well be dropped from the legislation, Guidelines and practice.

Fourth, the provision for royalties to be fixed in the future, after the productivity of the enterprise has been established, is authorized by the legislation and is required by the Guidelines. Change in the law is necessary if we don't want to deter business investment in aquaculture in Florida.

Finally, there are reports that some fishermen in the area of Panama City are so disturbed that spawning and nursery grounds will be affected that they are thinking of taking out weapons and engaging in violence. I believe this problem was alluded to earlier. But it is useful to be more explicit. If there is any purpose for law in the coastal region, it is at least to preserve minimum public order. While one set of issues may involve enforcement costs and whether the Department of Natural Resources or local law enforcement authorities should be engaged in protecting the aquaculture users' activities and property, I would like to address the broader consideration of whether different procedures might reduce the danger of the conflicts which are materializing. The provision in the legislation that if objections are filed to the granting of a lease, a hearing shall be held in the county where the lease will be is a constructive one. Perhaps we should go further and specify that fishing interests and the general public, as well as riparian land owners, are to be given a right to file objections. In effect, the law allows for this at present without stating so explicitly. The history of our legal institution has been that by providing a day in court for persons who believe their interests are affected and applying standards representing the common interests of all users in the community, the emotion and bitterness of private persons is usually dissipated during the impersonal argument of issues before an impartial tribunal. One or two decisions in full public hearing under such conditions should dissipate the fears and anger of nearly all citizens and obtain general public support for experimental and commercial aquaculture. The procedures and conduct of these hearings should be designed so as to include the airing and argument of all objections.

Recently a Master of Laws thesis was successfully defended at the University of Miami in our Ocean Law Program by Mr. Thomas Kane. He advanced the conclusions that the state has the power to prescribe for the conduct of aquaculture and that the accommodation of conflicts with other users of the coastal region can be successfully accomplished within our legal system. I agree with his conclusions and so do most of us in the Ocean Law Program. However, some changes in the legislation appear desirable if we want Florida to maintain its lead in this new type of use of the coastal region. We all agree that judicial overruling of

decisions to grant leases under the present aquaculture law would damage prospects for this new coastal zone use which our state seeks to be the first to support.

I understand that revision of the legislation is presently being contemplated by some private groups and wonder if you would comment on whether the Department of Natural Resources is expressing views for legislative change.

Also, are any other areas besides the Panama City area being designated as prospective lease areas?

A. Shields:

Apparently, you have put in quite a bit of study on the aquaculture bill and the Guidelines. We have many conflicting opinions about what has been done and what is to be done in the future. Florida took a major step in being the first to present an aquaculture bill, but it is not perfect, and modifications are necessary. Your suggestions would be highly honored by the Department of Natural Resources, the Internal Improvement Fund and the Board of Trustees, the bodies that will determine changes in the bill. Our department will be directly involved only on questions of marine science and technology. In addition, we are the policing agency for the bill, and will be charged with public order. Although we have a limited force—120 men trying to police 8,000 miles of coastline—the sheriff of each county involved will also have police power.

Other than some small one or two acre leases for experimental purposes, I don't know of any leases other than the ones we already have on file now.

I might bring you up to date on the West Bay application. It has been advertised, and the biological study has been made. It has been recorded, objections have been raised, and a hearing will be held in Dade County soon. At the hearing we will offer scientific and technical assistance.

Q. Arthur
Lyons:

There are two associations that represent the commercial fishing industry in Florida: Southeastern Fisheries Association, and Organization of Florida Fishermen. Have they been contacted about the aquaculture bill? If so, what have been their reactions to it?

Secondly, you mentioned that the maximum amount of water bottom that would be allotted to any program in any one county would be 5%. Is there any proposed limitation on the number of leases that would be allowed in each county?

A. Shields:

In answer to the first question, we held meetings on aquaculture in different areas of the state, and have had representatives of both trade organizations there. There are some differences of opinion between the Department of Natural Resources and the trade associations, but we are alike in our concern about natural resources and the people's rights. Although we don't agree on everything, our relations with them are good.

- In answer to your other question, there is no numerical limitation on the number of leases in each county.
- Q. Lyons: Are the two commercial fishing organizations endorsing aquaculture legislation?
- A. Shields: One organization would not endorse it, and the other would probably endorse it, but I would rather let these organizations speak for themselves.
- Q. J. Zieman: I would like to return to the question of water quality. You said that it is up to the lessee to determine if the water is suitable for his requirements, but if a man commits himself to a 10-year lease and puts substantial investment into this land, what protection is the state going to offer him against water pollution in that period, particularly in view of the rapid growth rate of Florida?
- A. Shields: Scientific and industrial people as well as the public and the Legislature are now more pollution-conscious than they have ever been before. Although increased population growth will mean new pollution, I believe that we are moving towards cleaning it up. However, I can't answer whether the state has the responsibility to guarantee lessees that they will have clean water. At present, industry determines what water bottom they want to lease. Although we have been asked to begin a search for suitable areas, choosing sites has not been our responsibility.

***The Relationship of the Pink Shrimp Emigrating from
Everglades National Park to Commercial Catches
on the Tortugas Grounds***

BERNARD J. YOKEL

- Dr. Smith:
(Comment) Bernard Yokel spoke on the relationship of the pink shrimp emigrations from Everglades National Park to commercial catches on the Tortugas grounds. It seems that quite a number of the papers this morning have dealt with potentially conflicting demands on environment. Here we have a case where the shrimp caught in the off-shore fishing grounds go through part of their life cycle in the bayous and the shallow waters of mangrove areas along the coast. This area in turn is dependent upon the control of the fresh water flow and this, in turn, depends on changes in the environment.
- Q. Silva: Do you expect any problems concerning the productive capacity of the Everglades to arise from the possible changes in the water quality or water quantity coming into the Everglades as a result of the construction of the proposed international jetport?
- A. B. J. Yokel: Productivity in the estuary is dependent, certainly, upon good fresh water entering this system. However, until we know the extent of development around the proposed jetport and how it is going to affect flow patterns, your ques-

- tion is impossible to answer. Certainly, the potential for upsetting or adding pollution to this system is there, but we don't yet know how large an area would be affected.
- Q. Gross: Has the work you have been doing on the pink shrimp in the Everglades area indicated any need for recommendations for change in fishing regulations of the state?
- A. Yokel: I think not. I believe the landings in the fishery have sustained themselves reasonably well. There is no evidence of depletion. You see fluctuations in the catch, but these are to be expected in any population of animals. At this point, I think, there is no justification for more stringent regulations on the fishery.
- Q. Gross: Are you saying this work indicates no need to change from the present restrictions on shrimp fishing?
- A. Yokel: Yes, I would say so.
- Q. Jones: You showed the absence of correlation between the index of emigrants going out of the Little Shark River channel to the catch on the Tortugas, and also to catches on the Sanibel grounds. Would you comment on the alternate hypothesis that, since the Little Shark River channel is a major channel in the major area of egress, perhaps the shrimp migrating out of that area are going to off-shore areas north of the Tortugas grounds and might represent an off-shore shrimp resource which is not being fished at the present time?
- A. Yokel: Your assumption is that Little Shark River is a major channel. This is not the case, actually. There are several channels that are larger, both in width and depth, and transport more water. You are correct, however, that the Little Shark River certainly is one of the most important ones there. Are you suggesting, Dr. Jones, that the shrimp are turning up in the Sanibel fishery?
- Q. Jones: I don't know. Did you examine or look for a correlation with the Sanibel catch?
- A. Yokel: I did, and it was inconclusive because the Sanibel data was incomplete, especially for the smaller sized shrimp. I would say from the work of Costello and Allen, however, that the likelihood that these animals are ending up in the Sanibel area is small. Their work showed that animals released in the Shark River area were recaptured in the Tortugas fishery. Only when they released animals north of Shark River, in the area of Everglades City, did they begin to find a few recoveries on the Sanibel grounds. The split in recovery was about 50% between Sanibel and Tortugas when the release was made from Everglades City.
- Q. Alexander: Has your approach to catch prediction reached a point where industry, or perhaps the conservation department could use it to predict the future of the crop?
- A. Yokel: I wanted to make a strong point here that the amount of variation precludes making an estimate with great precision. This work will show large changes, but it is not

precise enough to detect small changes on a month-to-month basis.

When you average data over a 12-month period, some of the variations average out, correlations then become much more precise. But this method has no real use for the fishery since the fishing is already accomplished by the time the data is in. You need a measure on a month-to-month basis. Based on the Buttonwood catches, we can predict that the catches of small shrimp on the fishing ground are going to increase, increase considerably, remain about the same or decrease. Because there is a qualitative relationship, we can anticipate when recruitment will begin and reach a peak.

Shrimp Mortality Rates Derived from Fishery Statistics

RICHARD J. BERRY

- Q. Gross: During your talk you mentioned the size of 30 count per pound in one case, and 70 count per pound in another case, as the optimum size for harvesting Penaeid shrimp under certain conditions. Were these size recommendations based on the economic value of the shrimp or on biological considerations?
- A. Richard Berry: The 30 count size would generally apply to either the economic or the biological viewpoint. Actually, I don't think that you can state a count size with exactness. What you are talking about is a range that you should harvest. In general, for the greatest economic yield, shrimp should be harvested at a larger size than is recommended from a biological standpoint. It isn't possible to regulate the Tortugas fishery with any precision, so it seems sufficient to talk in a general range.
- Q. Jones: You made the statement that as a result of an earlier study, you had found that fishermen operate so that they level their earnings opportunity. If they level their earnings opportunity, then I don't see how this leads to the assumption of uniform distribution because of the price difference among different sizes of shrimp. Could you clarify this?
- A. Berry: Your point is quite correct. The technique that I am using is admittedly a gross one. The fact that they do operate in a manner that levels earnings opportunity suggests to me that they also tend to level catch rates. Because of the nature of the technique and the data involved, we cannot speak in terms of exact leveling.
- Q. Alexander: Are there any methods by which we can more accurately determine natural mortality? The subtraction method seems rather gross.
- A. Berry: It is gross. To my knowledge, there aren't other methods for determining natural mortality with precision. I think very detailed studies might enable you to arrive at an estimate of the effect of predators. But there are also the effects

of diseases and environmental conditions; and it is very difficult, if not impossible, to get a reliable figure that will reflect all of these variables.

- Q. — In determining a more accurate mortality rate, could you apply your technique to a sampling system on incoming small juvenile shrimp, determine a population curve and various sizes? Resample them later while they are still on the nursery ground to determine whether or not some type of mortality rate exists in an undisturbed population? This would even be before fishing had occurred.
- A. Berry: I think you have hit on the flaw in my previous statement. I think this is possible, if you could get good samplings of the size composition at various stages.
- Q. Lyle St. Amant: Some of the states and BCF have detailed data for shrimp in some estuaries. These data are probably available for analysis. In Barataria Bay, Louisiana, for example, we have pretty fair data over the past 5 or 6 years that might be analyzed with respect to mortality rates. Is there any correlation between the mortality rates which have been measured rather accurately in artificial ponds and those which we might expect in a shallow nursery ground?
- A. Berry: There would not be a close relation between artificial conditions and those found in nature, primarily, because of the absence of predators in an artificial situation.
- Q. St. Amant: Couldn't you assume that the mortality rate in nature would always be greater than in a controlled pond?
- A. Berry: You certainly could.
- Q. St. Amant: If we could establish a base rate of mortality in ponds among very young juveniles of perhaps 100 to 120 days of age, wouldn't this establish a base line representing the minimum mortality you might expect? We would then expect a greater mortality in nature.
- A. Berry: Definitely, I agree.
- Q. David Wallace: You said that there was no way of establishing a management program for this fishery. Is this because of legal problems or because of the inadequacy of biological and economical data available for use as basis for a management program?
- A. Berry: I hope I didn't say that management was impossible. The state is managing it to a certain extent. From a theoretical standpoint, an ideal management program could be established. However, actual conditions on the Tortugas makes managing very difficult because recruitment, as Bernie Yokel showed, occurs throughout the year. When the young shrimp move on to the grounds, they move not only on to the shoreward edge of the grounds, but they flood over the entire grounds. This means that it is very difficult to regulate the size of harvestable shrimp by closing areas or limiting seasons. If mesh regulations were used, fishermen would have to use a very exact mesh in order to select over

a small range. In short, there are very difficult problems needing resolution before effective management can take place.

Q. Wallace: However, other forms of management might be implemented for this fishery. For example, a limitation of the total gear could be imposed.

A. Berry: I think there is evidence that there would be major benefits from limiting gear in this fishery. However, I would hate to argue what can be done politically.

Current Status of Biological Investigations of Florida's Mackerel Fisheries

DALE S. BEAUMARIAGE

Q. Silva: Have you done any work to determine levels of DDT or other chlorinated hydrocarbons in the Florida mackerel fishery? If so, have such levels been high enough to create concern about the future populations?

A. Dale S. Beaumariage: We haven't made any such chemical analyses; these studies have been limited to biological work.

Q. Gross: I would like to ask a two-part question concerning the substantial stocks of mackerel in Mexico's Gulf Coast waters. Are these the same stocks as the stocks of Florida mackerel? Secondly, is there any prospect of future cooperative biological studies of these stocks with Mexico?

A. Beaumariage: I have only looked at that from a speculative point of view, and think that there is possibly another stock in Mexico perhaps extending into Texas.

In answer to the second part of the question, I think it would be beneficial if such cooperative programs did exist. I understand, for example, that Mexico has proposed a tagging program on the Spanish mackerel and kingfish. However, I'm not in a position to say whether or not such cooperative efforts are being planned.

Silva:
(Comment) In the U.S. Fisheries Agreement of January 1, 1968, there is a provision for cooperation between the U.S. and Mexico on investigations of stocks of fish and shellfish of common interest. Studies on mackerel could be included in this agreement. Another meeting will take place in March 1970 in which this could be proposed.

Q. Jones: You mentioned that larval or small juveniles have been collected in two locations: off Cape Canaveral and off Destin, Florida. Are these the only places in which you made collections, or do they represent the specific spawning locations and areas of larval distribution?

A. Beaumariage: These were the only places that we were able to make collections during the program. An associate will be publishing the descriptions of the larval stages and this will include the larva distribution data. I explain this merely to emphasize that our observations on maturity in the adult have been backed up by larval collections.

- Q. Alexander: Is the mackerel fishery in need of management? If this is so, should there be a uniform regulation up and down the coast?
- A. Beaumariage: There are variations of opinion on whether the fishery needs management now. Hopefully we are gathering the type of biological data which will be useful in proper management. Some of the things involved are the range of the stocks, the population size, their growth rates and survival. We hope that proper management will be the end result of our research.
- Q. Alexander: Do you think it is feasible to establish a uniform regulatory system up and down the coast?
- A. Beaumariage: That would have to be left to those people in the Department of Natural Resources who do have jurisdiction there. In fact, such a regulatory system would have to be settled between states as well.
- Q. Richard T. Whiteleather: Have you included food habit studies for either the kingfish or the Spanish mackerel in your work?
- A. Beaumariage: We analyzed stomach contents whenever possible. Working as we were during the wintertime with the large landings of the commercial fishery, two things made an examination of each and every stomach difficult. The catches often were gutted before we could get to them at the dock, or the fish had been out of the water long enough that digestion had taken place to the point that much food was unrecognizable. In the spring fishing, when we were working closely with sports catches, which are quite fresh, we saw that there were various types of bait fishes in the stomachs. These vary from bluefish to shrimp. We aren't ignoring this facet of the work, but it has yet to be interpreted.
- Q. Whiteleather: I raised this question because some people, particularly on the west coast of Florida, are considering some commercial development of this resource. It is apt to be quite important that we know how the Spanish mackerel and kingfish feed. Considering the additional interest of sportsmen in these two species, I was hopeful that your study would answer this. You may have a lead. Could BCF ask you to accelerate your work a little bit?
- A. Beaumariage: Yes, you could. Now that our extensive sampling is over, we will add to feeding data. One way to accomplish this is to get aboard the boats more frequently.

The Gulf Menhaden and Our Changing Estuaries

JOHN W. REINTJES

- Q. Silva: You mentioned that it had been estimated that we were destroying about 1% of the estuaries each year. What kind of destruction is involved? Degradation of water quality? Physical alteration?

- A. John W. Reintjes: This estimate refers to elimination only, that is, filling for other purposes or channel effects. This does not include pollution, deterioration or loss of water quality, but only the physical changes that come about with filling, channeling and diking. In places like Tampa Bay, for example, more than 1% of the area has been destroyed. The estimate may have arisen from some of the proposals and projects in Texas water resources usage.
- Q. Silva: Then in terms of acreage this land is lost?
- A. Reintjes: That's right, not a change in quality but the actual elimination of an estuarine area by having it taken out of use by filling or draining.
- Q. Gross: Is there any estimate of the survival rate of menhaden after the young leave the estuaries and return to the Gulf?
- A. Reintjes: No. The problems are similar to those brought up earlier in connection with shrimp. Estimating natural mortality is extremely difficult. It is generally agreed that the largest mortality occurs in the larval phase during the transition from yolk nourishment to actual eating. Therefore, the principal mortality probably occurs before they enter the estuary. Then, in the estuary when they are young, predation from bluefish, mackerel and redfish is very heavy. During that first winter there is probably quite a bit of predation by most of the medium-sized carnivores, but after they reach yearling size, we believe that predation is reduced since only the larger carnivores would be able to take them.
- Jones:
(Comment) You brought out very, very well the dependence of menhaden on the estuaries. It seems to me that in the last few years conservationists and fishing groups alone have been unable to stem the physical changes in the loss of estuaries. A third group, however, could be recruited from those people with an interest in aquaculture. These groups together demanding high water quality might be a potent influence for better estuarine management.
- Reintjes:
(Comment) Such cooperation will help. The industrial changes in the estuaries along the Atlantic and the Gulf Coast are probably the principal threats. Domestic sewage could, conceivably, help some areas by increasing planktonic production, but industrial pollution could be disastrous.
- Smith:
(Comment) In my own estimation the greatest danger to the fisheries comes from real estate operators. It seems that the only permanent solution is zoning for the whole coastal area. In the areas which are already heavily populated, let them cram more high-rise apartments there. In those places that have not been fully developed simply institute a state-wide zoning restriction limiting the population and restricting the building of high-rise apartments.
- Q. Alexander: What specific parameters will be involved in your ecological study?

- A. Reintjes: We need to determine the quantity of estuarine area that is needed, and how many herbivorous animals can actually be carried per acre. We must learn the food production in an estuary in terms of the number of grams of carbon fixed each year.
- About six or seven billion individuals are caught by the fishery. If we estimate fishing mortality or natural mortality, we get estimated populations of 40 or 50 billion menhaden that have to exist in Gulf Coast estuaries to produce a maximum sustained yield or a crop of about a billion pounds. Fifty billion juvenile menhaden must live in estuaries and thrive and grow in competition with others. There are approximately 5 million acres of estuaries of varying carrying capacities and varying productive levels. This means an average of 10,000 menhaden per acre. We must learn more about the carrying capacity of estuaries and what quality of environment the fish require, since we are dealing with a limited resource that must replenish itself.
- Q. Alexander: Will you be investigating specific pollutants which affect the plankton and in so doing affect the food chain of the menhaden?
- A. Reintjes: Our first studies will be conducted in the Pensacola-Gulf Breeze area where there is a pesticide laboratory. One of the initial studies will be the determination of pesticide levels in the area. Our first concern, however, is to learn the normal ecology rather than the unbalanced conditions of the estuary. If we can establish the normal conditions, we will learn at the same time what is abnormal.
- Q. Culbertson: You reported that in 1969 the Gulf had its greatest menhaden production. You also commented that the Atlantic Coast had its lowest production in modern times. Do you have enough information to contrast the factors that may be responsible for these results?
- A. Reintjes: We are dealing with two rather distinctive animals. The Gulf menhaden has a very high reproduction rate which yields a 2-year crop. The Atlantic catch, even though it reached 1.5 billion pounds a decade ago, was based on 5-, 6- and 7-year classes. Much of that catch was obtained from a reservoir of older fish rather than the annual production. Because the fishing was unrestrained and kept expanding, this limited reservoir began to dwindle. Fish populations are not infinite. Perhaps the failure of two or three year-classes in a row, coupled with heavy fishing, and the loss of some of the estuarine areas, all contributed to a deterioration in total stock size.
- It is almost impossible to answer your question simply because we are dealing with two different animals with two different reproductive potentials.

- Culbertson:
(Comment) My thought was that perhaps you required considerably larger amounts of funds to be able to answer these questions adequately.
- Reintjes:
(Comment) Certainly any ocean work is extremely costly, and this is one area that we know very little about.
- Q. St. Amant: How many areas did you study in the Louisiana estuary?
- A. Reintjes: We divided the coastal region so that each sampling site consisted of an equal area. In Louisiana there are at least four sites—Lake Pontchartrain, Atchafalaya, Vermilion and Cameron, I believe.
- Q. St. Amant: BCF statistics report an annual menhaden catch in Louisiana of 0.6 to 1.0 billion pounds. Since you report a 1.2 billion pound catch for the entire Gulf it would appear that 50 to 80% of this catch originates in the estuaries of Louisiana. Is this then correct that the bulk of the Gulf catch of menhaden is generated from the 5 million acres of Louisiana marsh?
- A. Reintjes: We don't know where they are generated. We don't know which estuaries are really producing the fish that are caught in the coastal waters. It is true that the bulk of the catch comes from the coastal waters of Louisiana, but the juveniles may be produced from the estuaries of Galveston or Mobile Bay. This year, in fact, both Galveston and Mobile Bay produced a rather exceptional population of juveniles. Perhaps the landings in Louisiana were actually generated in other estuarine areas. But there is doubt that Louisiana has a large share of the estuarine areas. Next year we will tag the juveniles before they leave the estuaries, and then recover them after they are landed at the menhaden plants. This will give some idea of which estuary areas are contributing to the commercial catch.
- Q. St. Amant: We must have a tremendous generating plant in the Louisiana estuaries even in the face of terrific industrial activity, because we are producing annually 1 billion pounds of menhaden, some 40 billion individuals. In addition, we are producing 60 million pounds of shrimp from this same estuarine system as well as 5 to 10 million pounds of oyster meat, which is competitive for the same food. Certainly this would be an area that would demand a great deal of study by the Bureau of Commercial Fisheries and by the state.
- A. Reintjes: I certainly agree. Because we can't study all of the estuaries, we have to start some place. Selecting an estuary in an area that is known to be productive or that is known to be endangered is an excellent idea.
- Whiteleather:
(Comment) There is another factor besides pollution that should be considered when talking about estuaries. The manipulation of the fresh water flow into these estuaries is critical. There are a number of exceptionally large projects being planned at the present time. For example, there are proposals to transport water from the Mississippi River over into Texas,

thus greatly reducing the amount that flows into the large estuarine area in the lower coast of Louisiana. There has been containment of fresh water run-off by dikes in the State of Florida resulting in salt water intrusion. There has been irregular water supply in the Everglades. The proliferation of this kind of manipulation of fresh water is something that people that are interested in menhaden or other estuarine fishes will have to keep alert to. I think that we should take every opportunity to evaluate these projects.