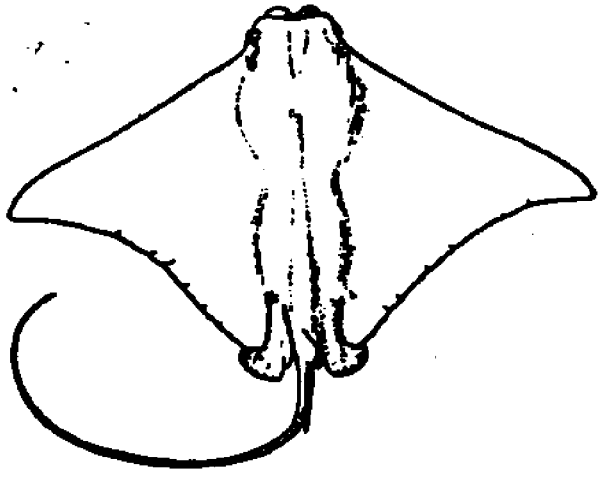
Utilization of North Carolina Skates and Rays



W.S. Otwell
T.C. Lanier

UTILIZATION OF NORTH CAROLINA SKATES AND RAYS

By

W. Steven Otwell[1] and Tyre C. Lanier

Department of Food Science
North Carolina State University
Raleigh, N. C. 27650

North Carolina Department of Natural Resources and Community Development

Division of Marine Fisheries

Morehead City, N. C. 28557

Special Scientific Report No. 31

December, 1978

This study was conducted in conjunction with the U. S. Department of Commerce, National Marine Fisheries Service under the Commercial Fisheries Research and Development Act, PL 88-309, Project 2-323-R and sponsored by the Office of Sea Grant, NOAA, U. S. Department of Commerce, under Grant No. 04-8-M01-66 and the North Carolina Department of Administration. The U. S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright that may appear hereon.

[1]Current Address: Food Science Department, University of Florida, Gainesville, FL

TABLE OF CONTENTS

INTRODUCTION

Utilization of skate and ray for human food is not a new concept. For many years skate (synonymous with rays as a marketing term) have been purchased by Western Europeans, Japanese, Chinese and certain South American countries. Present market trends in Europe attest to the demand for edible skate. The supply of traditional skate has decreased and the steady demand by European consumers has caused an increase in wholesale value (Otwell and Crow, 1977). At present there exists no intentional fishery for skate in the United States. The supply of skate and ray along the coast of the United States has been designated an underutilized marine resource (Rathjen, 1977).

The utilization of skate by the United States fishing industry is also not a new concept. In 1888 Collins (1887) advocated marketing of skate as an export item destined for existing European markets. Only recently has a major effort been conducted by governmental agencies to interest United States fish firms in international marketing of skate (McAvoy and Earl, 1977; Rathjen, 1977). Presently a small amount of United States skate, harvested as incidentals, are being exported through major seafood firms in New York (Daniels, 1978 personal communication). A very small domestic demand for skate is growing within local ethnic groups in major cities, i.e., New York, Washington, D. C. (Wash. Post, 1977).

Since skate and ray have historically been of minimal commercial value to the United States fishing industry, very little information is known of their biology, availability, abundance, processing requirements, edibility,

etc. Such information is essential to assure success of any new marketing venture, and to protect the existing skate supply. The intention of this study was to generate preliminary information pertinent to development of marketing of skate and ray in established foreign markets. The scope of this work was limited to skate and ray common to North Carolina, and emphasis was placed on utilization of the abundant and troublesome cownose ray, Rhinoptera bonasus. As will be explained later in this report, a long haul fishery for cownose ray is feasible only in North Carolina sounds, thus presenting a potential unique resource for the state.

SPECIFIC OBJECTIVES

1. Locate and characterize foreign markets for North Carolina skate and ray.
2. Determine product characteristics of North Carolina skate and ray as they apply to market demands.
3. Initiate development of a skate and ray fishery in North Carolina.

Objective I. Assessment of Foreign Markets

Previous research has indicated that potential markets for North Carolina skate and ray exist in Europe (Otwell and Crow, 1977). To further investigate the availability of these markets, recommendations suggested a telex machine was essential to communicate with European seafood firms which had expressed an interest in North Carolina skate. Due to circumstances beyond the control of the researchers, requested operational use of a telex machine was never secured during the six months duration of this project. All information concerning markets for skate in Europe was obtained through literature reviews, direct communication via letters and indirect communication through seafood brokers based in the United States.

Market Size

The muscular pectoral fins or 'wings' with skin-on or off are the main marketable portion of skate. A total in excess of 30 million pounds of skate wings were marketed in England, France and Belgium in 1973 (Table 1). An estimate of 50 million pounds of wings is considered conservative for the entire market size for skate wings in Europe. No estimates of the quantities sold in other foreign markets is available.

The percent of skate purchased from external sources in 1973 indicates that European firms are willing to import wings (Table 1). Volume of potential imports will depend on the amount of European domestic harvest, quality of imported wings and institutional barriers to trade. All skate importing countries levy import duties, apply turnover taxes and require health inspections of foreign seafoods. Although the specific information concerning these barriers is variable, United States seafood firms should be

made aware of their existence prior to entering into contracts for marketing skate.

Species Marketed

A list of skate species with commercial value in Europe (Table 2) is in agreement with species requested in initial letter surveys and supplements the marketed species list compiled in preliminary reports (Table 3; Otwell and Crow, 1977). Raja batis, the common and/or flapper skate is considered the most desirable skate in Europe. Rays (Dasyatis pastinacea, the common stingray; D. centroura, the rough tail stingray; myliobatis aquila, the eagle ray, and Mobula mobular the devil ray) possess no economic importance in Europe primarily due to their relatively infrequent occurrence (Wheeler, 1969).

Exchange of Skate Samples

Letter correspondence was continued with 12 European seafood firms which had expressed an interest in North Carolina skate during initial market surveys in Fall, 1977. These letters attempted to initiate an exchange of products so that North Carolina seafood firms could become acquainted with quality demands, product forms and packaging methods desired; and foreign firms could examine samples of typical skate and ray harvested from North Carolina waters (Figure 1). The first reply to our February 17, 1978 letter did not arrive until April 15, 1978. Letter correspondence required at least 56 days turn-around time. To date six replies (50% return) have been received. The foreign replies continue to express an interest in cooperating in an exchange of samples. Unfortunately, without operational use of a telex machine, the planned exchange was near

impossible during the six month project term. The enthusiasm of one foreign firm for a product exchange was most evident as he sent cables requesting "please send your telex number - we will send samples."

To circumvent communication problems and avoid excessive transportation costs, a French seafood firm suggested purchasing frozen skate wings from a Canadian firm which presently markets an acceptable frozen skate wing in France. One 25 pound box of frozen skate wings was purchased from Bonavista Cold Storage, Inc. in St. Johns, Newfoundland. The samples arrived May 1978. The species purchased was labelled Raja batis. Each individual skate wing had been individually blast frozen, then loosely packaged in a cardboard fish box lined with plastic. No particular care had been taken in packaging to assure a quality product. Although later tests confirmed the Canadian samples were of excellent quality, their method of packaging should not be exemplified by North Carolina firms attempting to ship skate to Europe.

Letters from European seafood firms were skeptical of the ability and desire of the United States fishing industry to supply a quality product. The preferred method of processing is IQF (individually quick frozen) or blast frozen in shatter pack. Shatter packing implies individual wings can be separated from a package simply by dropping the pack on a solid surface which loosens attachment of adjacent frozen wings. The specified size and color of wings varied per country (Table 3).

Attempts to allow foreign firms to examine North Carolina skate and ray were made through international seafood brokers based in the United States. Unfortunately these brokers have their established clientele and could not work directly with European firms which had replied to our

letter surveys. All brokers contacted were interested in our project and agreed that marketing of North Carolina skate was most feasible under the existing market conditions in Europe. Brokers warned that new marketing ventures in Europe would have to consider third country competition.

Samples of clearnose skate, Raja eglanteria were harvested from piers in Morehead City, N. C. and prepared for shipment to Holland and Germany through an eel broker, George Robberecht of Montross, Virginia. These wings were frozen individually with skin-on, then wrapped as pairs in plastic bags. Frozen wings were shipped in dry ice in May of 1978. No report of the results of this trial shipment have been received other than a request by Mr. Robberecht for more samples, which were unavailable at the time of the request. This could indicate, however, that some interest had been expressed in the clearnose skate samples.

Samples of cownose ray, Rhinoptera bonasus were harvested from Core Sound and prepared for shipment to Blackpool, England via Barbary Coast Seafoods, international seafood brokers, based in Burlingame, California. Four boxes of frozen ray wings were prepared in the same manner as used for clearnose skate. This shipment was made in May 1978 so as to coincide with the Annual Seafood Exhibition in Blackpool. From England the samples were distributed to Paris, France; Goteburg, Sweden; Hamburg, Germany and Italy. Initial responses of some foreign firms (England, Sweden, Germany) were disappointing. They were unfamiliar with the large amount of blood in the muscle tissue. Samples sent to Paris had spoiled prior to arrival. Inexperience of the brokerage firm in marketing of skate is a partial cause for the initial product rejections. The brokers introduced the product as skate, when in fact it was a ray. Foreign firms anticipated pure white flesh commonly associated with most European skate. Cownose

ray is not harvested in European waters. To introduce a new product with the connotation of an old familiar product was misleading. All foreign impressions of cownose ray have not been received. Red and/or pink flesh in skate and ray is not uncommon (Table 3). With proper promoting, markets receptive to cownose ray may be located.

Summary of Results for Objective I

Market trends in Europe are conducive for increased importation of skate. Demand for skate exceeds the traditional supplies and European seafood firms continue to express interest in purchasing quality skate from the United States. Certain species marketed in Europe frequent the North Carolina coast; however, the local availability of the species is limited compared to that of the cownose ray. Skate samples typically marketed in Europe were purchased from Canada for evaluation of product characteristics. Clearnose skate and cownose ray samples from North Carolina were shipped to various foreign firms for their evaluation of frozen wings. Impressions on the clearnose skate have not yet been received. Impressions of the cownose ray were initially disappointing; however, misleading promotion of the product by brokers unfamiliar with skate marketing did not prepare foreign buyers for the red appearance of the cownose muscle tissue. Despite this, red meat in rays is not an uncommon marketing attribute. Additional test shipments and marketing efforts are needed to accurately assess the potential market for cownose ray from North Carolina in foreign countries.

Objective II. Description of Product Characteristics

Skates and rays are basically nothing more than flattened sharks. Their 'skeletons' are primarily composed of the same cartilaginous substance

typically found in all true sharks. This flexible, gristly skeleton is reason for phylogenetic distinction of all Elasmobranchs from fishes with calcified skeletons, bony fish, Osteichthyes. The flattened structures of skates and rays resembles 'wings' attached to the main body trunk. 'Wing' shapes vary from semi-circular to triangular, and 'wing' spans range from less than 12 inches for some deep water skates to 22 feet or more for some giant Manta rays. The 'wings' are composed of a central thin layer of cartilage which is sandwiched between two thick layers of muscle tissue. A tough 'skin' covering the muscle tissues can be smooth or rough depending on the patchiness of thorn-like projections more typically found on skates; and body coloration varies from brown to gray or black, with or without dark stripes and/or spots.

Skate vs. Ray

Laymen generally differentiate skates from rays by the length of the 'nose' and spines on the 'tail'. Skates are generally long nosed and harmless, with the exception of small spines on the upper 'wing' surface. Rays are generally not long nosed and have a venomous stinger located on the dorsal surface of their 'tail' which is their most fearsome defense. Experts differentiate these fish by their mode of birth. Skates are oviparous, producing leathery egg capsules that develop and hatch outside the maternal body. Rays are all believed to be ovoviviparous, bearing forth their young alive after they have hatched from eggs within the mother. Rays are more widely distributed than skates. Skates are usually limited to waters with near ocean salinity; while, rays are found living over great depths of the ocean, along the shelves of all continents, and in some completely

fresh water environments. Some rays prefer to migrate into the fresher water reaches of rivers in search of foods and warmer water temperatures. Food habits of most skates and rays are similar, ranging from crabs and shrimp to clams, oysters and scallops. As a result of these food habits, skates and rays have been labelled as nusiance fish, especially in North America due to the consumption of valuable oysters in the Chesapeake Bay of Virginia, and scallops in the North Carolina sounds.

The cownose ray is an especially costly nuisance to scallop fishermen. Cownose rays have a notorious reputation for uprooting eel grasses in search of oysters and scallops. Consumption of these mollusks in combination with the alteration of their environment results in immediate losses for the fishermen and tends to diminish future stocks. Sea Grant-supported research in Virginia (Smith and Merriner, 1978) has estimated losses resulting from cownose predatory damage to be as much as $33,000 for one oyster fisherman and $100,000 for one clam fisherman within one season. Virginia oyster growers felt their yearly losses were sufficient to allow an investment of up to $200 per acre of planted bottom to protect their interest.

While the cownose ray is a costly predator to many coastal areas, its fishery by long-haul techniques, which is necessary for harvest in large quantities, is unique to the sounds of North Carolina. Large schools of cownose ray several thousand feet wide enter the sounds in early spring and fall, at which time harvest by long-haul becomes feasible due to the shallow water of the sounds. Upon reaching Virginia waters, the schools dissipate, later reforming for the southern migration in the fall.

Commercially, skate and ray are considered one and the same. This practice can lead to costly misunderstandings about product identification. Prospective dealers interested in marketing skate should become familiar with the particular species names. Common names vary depending on country and regional preferences. Knowledge of the scientific name is the best assurance that a skate product is properly identified. Established dealers of skate in Europe specify species names (Table 2 and 3) and require such labelling of shipments.

For example, recently a foreign dealer requested a shipment of smooth skate. A United States processor thought his cownose rays appeared "smooth" and packaged a contracted volume for shipment. On arrival the foreign dealer was confused and turned down the entire shipment. Both men were at fault. Smooth skate could have been one of possibly three distinct species. The smooth appearance of the skin on cownosed rays, however, did not warrant identification of this species as smooth skate. If scientific names had been specified, this costly mistake could have been avoided.

Marketable Yield

Samples of skate and ray were slaughtered to evaluate the percent marketable yield per species. Slaughtering is a simple process of cutting the wings from the skate such that a minimum amount of main body, cartilage supporting the visceral cavity and gills is included in the cut. Wings from the cownose ray were covered with a green-to-brownish smooth skin (Figure 2). Skate wings were covered with a light-brownish skin which contained patches of 'thorny' projections. Muscle tissue from the ray was red due to the presence of blood and a large number of red muscle fibers. Skate wings contain pure white muscle. The average wing yield with skin-on

ranged from 42% for the larger cownose rays to 35-36% for the clearnose skate (Table 4). The Canadian skate wings had been 'trimmed' (Figure 3). Trimming of the wing edges, which contain very little meat, is a preferred practice expected by most foreign dealers.

Chemical Composition

Analysis of the basic chemical composition of skate and ray yielded similar results for both species (Table 5). Muscle tissue from skate and ray wings is high in protein (~ 15.4-21%) and low in fat (0.8-1.4%). The accuracy of the indirect protein determinations was influenced by intrinsic variation in the content of non-protein nitrogen constituents as reflected by differences in nitrogen content, and influenced by extraneous moisture due to blast freezing used on Canadian skate. The urea content (0.4-1.2%) is lower than that commonly reported for most sharks (Gordievskaya, 1971; Morris and Stouffer, 1975). The Canadian skate, Raja batis, contained the lowest amount of urea (.4%). The smaller clearnose skate, Raja eglanteria contained the largest amount of urea (1.1-1.2%)

There was minimal effect of frozen storage on the chemical composition of all skate analyzed. During frozen storage for one month at -29°C,cownose ray and clearnose skate wings, wrapped as pairs in plastic bags, may have dehydrated slightly, but the basic composition of the muscle tissue did not significantly change. Stability of the urea concentration and absence of ammonia-like aromas after thaw suggests that frozen storage at -29°C helps prevent spoilage typically associated with most elasmobranchs. A high urea concentration in elasmobranchs is the major reason for spoilage due to its decomposition during storage and the accompanying release of ammonia

and ammonia-like aromas and flavors (Simidu and Oisi, 1951; Suyama et al., 1951; Gordievskaya, 1971).

Taste Panel Evaluations

A trained profile panel was used to assess the textural and flavor attributes of cownose ray and the Canadian skate. A preliminary taste session was conducted to acquaint the panelists with the product and to formulate ballots of characteristics describing skate taste (Tables 6, 7 and 8). Broiling for 10 minutes was the standard method of sample preparation. Fresh and frozen cownose ray wings averaged 5.2 kg. Small ray wings averaged 0.5 kg. Canadian skate wings averaged 1.9 kg. Rating of product characteristics was made in reference to a 14 point scale. Panel sessions were conducted on broiled vs. fried cownose ray; fresh vs. frozen ray, large vs. small ray, and ray vs. Canadian skate. Texture (Table 9) and flavor (Table 10) were rated during the same session.

Broiled cownose ray was texturally very similar to fried ray, but frying masked certain undesirable flavors and aromas, i.e., blood, ammonia, iodine, metallic. Undesirable flavors were more noticeable in the unbreaded samples. Cornmeal with no added spices was used to bread the fried ray. Panelists commented that they would not eat broiled ray by preference, but would purchase ray for frying. Fried ray flavor was described as a mixture of oysters, scallops and fish, and the firm texture was like tender beef.

There were no major differences in the textural and flavor attributes of fresh ray versus ray which had been frozen for one or two months at -29°C. Frozen storage did not noticeably alter the texture of the meat. Ray meat flavor was milder after frozen storage, i.e., ammonia aroma and blood

flavor decreased. This result is in keeping with the chemical analyses which demonstrated the chemical stability of the muscle tissue during frozen storage for one month (Table 5). Panelists did not specify a preference for fresh or frozen ray. Broiled ray was simply not prefered by any panelists.

The size of the wing appears to be a dominant feature influencing the textural attributes of cownose ray. Smaller ray wings were softer and yielded a mushy resistance to mastication. The prefered texture was the firm meat typical of the large broiled and fried ray wings. Wing size did not appear to effect flavor ratings. However, sufficient data were not gathered to statistically substantiate the effects of wing size on either flavor or texture.

The texture and flavor of the Canadian skate wings were distinctly different from that of the cownose ray. The skate was a much softer product than larger rays, but had a firmer texture than noted with the smaller rays. Broiled skate had the firm, cohesive mouthfeel prefered by panelsists. Skate flavor was milder than large rays, i.e., it showed lower panel ratings for blood, ammonia and iodine. Although the skate was rated highest in metallic flavor, it was the only meat in which a sweet after taste was noted. Panelists commented that they would eat broiled skate, but prefered fried skate.

Summary of Results for Objective II

Commercially, skate and rays are jointly referred to as skate. However, there are distinct differences between skates and rays, and between various species of skate or ray. To avoid costly misunderstanding prospective dealers should become acquainted with such differences and communicate in specific terms which identify the particular species. The marketable yields

of skate and ray were similar for species examined, but they differed in shape, skin color, meat color and size. Chemical analysis revealed that the meat of skate and ray wings was low in fat and high in protein. The urea concentration in skate and ray was less than that typically found in most sharks. The chemical composition of skate and ray meat was stable during one month of frozen storage at -29°C. Taste panel results confirmed the stability of the meat during frozen storage. Trained taste panelists preferred the larger fried cownose rays to broiled and/or smaller rays. Texture and flavor of cownosed ray meat was distinctly different from that of Canadian skate, Raja batis.

Objective III. Initiating Development of a North Carolina Skate and Ray Fishery

Presently there exists no intentional fishery for skates and rays in North Carolina. Development of such a fishery could be an economic boon to the fishing industry and would aid in balancing the foreign trade deficit in the United States. Success of this new venture will depend on the fishermen's ability to harvest quantities to satisfy contractile demands, the processors' ability to handle and package the product, and the scope of existing and potential skate markets. In an effort to provide assistance in these areas the results of this project were continually communicated to North Carolina fishermen and processors so as to gain their interest and participation.

Project Interactions with Fishermen

Most fishermen of North Carolina are receptive to any new idea in fisheries which will increase or stabilize their annual income. The general concensus of most fishermen is that skates and rays are nuisance fish which need to be controlled. Scallop fishermen are particularly concerned with the cownose ray which migrates into the North Carolina sounds

to prey on scallops. A vocal group of fishermen, the Harkers Island Committee for the Protection of the Rights of Commercial Fishermen, issued a request for help in controlling ray predation on scallop beds. Following numerous meetings with local fishermen and Marine Advisory agents, Hughes Tillet and Skipper Crow, it was decided that the cownose ray should be the major candidate species for conducting a trial harvest.

Large schools of cownose rays enter the North Carolina sounds in March-April during their northern migration, break-up into smaller groups during their summer residence in the sounds, then reschool in large numbers prior to their departure on their southern migration in September-October. Following the recommendations from the Harkers Island Committee, Dan Yoeman, a local fisherman experienced in the techniques of the long haul fishery, was contracted to harvest cownose rays during their spring migration.

Large schools of cownose rays were first sighted in Back Sound (Figure 4) on April 19, 1978. This unusual late arrival date for the migration was due to record low winter temperatures. A cooperative effort from various state agencies was organized to assist in the harvest. The N. C. Division of Marine Fisheries provided a cameraman, Jim Tyler and a spotter pilot, Arthur Rose; East Carolina University Marine Advisory agent, Skipper Crow, and N. C. State University personnel provided labor; and the Harkers Island committee provided a boatload of vocal encouragement. Dan Yoeman's crew (3) did most of the work.

On April 24, 1978 this armada descended on an unsuspecting school of cownose rays swimming 1/2 mile west of Horse Island just inside Barden Inlet. Using 450 yards of typical long haul netting, fished in the usual fashion, Dan Yoeman harvested an estimated 10,000 pounds of cownose rays

(Figure 5). An estimated 60-75,000 pounds could have been harvested in the school fished. Time from set to bailing was less than 2 hours. Only 2000 pounds of ray were bailed from the bunt and the remaining 8000 pounds were released. On return to Yoeman's dock (3 1/2 hours after the set) the rays were hand loaded into a truck filled with ice. Iced, whole rays were returned to the lab for processing. Rays were processed and packaged with manual labor typically employed by existing seafood firms. Wings were cut from the body, washed to remove excess blood, then packaged as pairs in plastic bags prior to slow freezing at -29°C.

A subsample from the harvest was weighed and sexed to describe the catch composition (Table 11). Twice as many males were caught as females. More than 90% of the females were carrying developing embryos, 'pups'. The long life span for cownose rays, typical of most elasmobranchs and the evidence of only one pup per adult female suggest cownose rays are vulnerable to overfishing (Smith and Merriner, 1978, Personal Communication).

This harvest represents the first time in the history of North Carolina fisheries that a fisherman has intentionally harvested skate or ray. It stands as proof that cownose rays can be harvested with existing conventional gear. Success of the operation has stirred the interest of fishermen along the coasts of North Carolina and Virginia, and brought the attention of processors which previously had been skeptical about harvesting rays.

In a follow-up to the harvest, a ray-frying was conducted at Dan Yoeman's fish house to demonstrate the preparation and cookery of cownose ray. The demonstration was open to the public and specifically aimed at the Harkers Island fishing community. Since this event, several fishermen have reported that they have cut wings from cownose rays, taken them home to eat, and

packaged them in freezers. One fisherman even developed his own special recipe, "stew-fried whifferee"("whifferee" being the local term for skate and rays).

Project Interactions with Processors

The participation of North Carolina processors has been encouraged by direct contact through Marine Advisory and Extension Agents, and the North Carolina Fisheries Association. The general consensus from most processors is that they are interested in handling skate and ray but are unfamiliar with marketing products overseas. Some have stated that they are willing to handle skate and ray, even at a low profit margin, if they could sell directly to a brokerage firm which would manage the responsibility of international marketing. The profit margin which they felt was required for their involvement would depend on the ease with which processing of rays could be integrated into their existing operations. One benefit of handling cownose rays which they noted was that these fish are abundant when supplies of more traditional species are lacking or absent.

The processing and cooking of cownose ray and Canadian skate has been demonstrated to several individual processors. Conventional, existing equipment can be used to process skate and ray, but particular care would have to be exercised to assure the meat is washed free of blood, wrapped to prevent dehydration, and frozen immediately. Processors have been warned that European seafood firms are skeptical of the ability and desire of United States firms to package a quality product.

Project Interactions with the General Public

Preparation and cooking demonstrations have been conducted in an effort to educate the public of our attempts to promote utilization of North Carolina

skate and ray. Public demonstrations were conducted in the N. C. Division of Marine Fisheries Building and in the N. C. Marine Resource Center, both in Morehead City, N. C. Attendents were asked to rate the flavor and texture of fried skate and ray on a 5 point scale (Table 12).

The 33 participants at the Marine Fisheries Building rated the acceptability of fried ray and skate as being equal to or better than conventional fried seafood. Participants (59) at the Marine Resource Center also rated the flavor and texture of fried ray highly and asked where they could purchase the ray meat. Participants at both demonstrations were extremely surprised with the excellent taste of ray and felt the firm texture was a desirable attribute. Flavor was described as being similar to oysters and scallops.

In an attempt to develop more recipes for cownose ray, the N. C. State University Seafood Lab nutrition leaders, under the direction of Specialist Sam Thomas were asked to work with ray meat as a new form of seafood. They were impressed with the product and rated all their recipes as being above average in acceptability (Table 13 and 14).

Summary of Results for Objective III

Many fishermen and processors have expressed interest in initiating a fishery for skate and ray in North Carolina. Two incentives for this fishery are the hope for additional income and a means of management of skate and ray predation on other valuable seafood resources. Experimental harvest operations have proven the cownose ray can be caught and handled in large quantities. Pilot processing operations indicate existing methodology can be used to package skate wings. Processors have expressed an interest in handling skate and ray depending on the profit margin, but most do not want to deal directly with foreign seafood firms. Processors have been

cautioned that quality should be a foremost consideration when packaging a seafood for international trade. Public demonstrations of skate preparation and cookery have been well received and suggest that there is potential for domestic promotion of skate and ray utilization.

CONCLUSIONS

Foreign market trends, product characteristics of domestic skate, and fishermen/procesors interests indicate potential for development of a skate and ray fishery in North Carolina. The demand for skate in Europe has forced foreign seafood firms to seek non-traditional sources of skate and ray. North Carolina fishermen have proven that they can harvest skate, and processors are willing to handle the product if it brings enough profit margin to allow dealing through international brokers. The major North Carolina species for promotion is the cownose ray, Rhinoptera bonasus. This ray is seasonally abundant when other traditional fisheries are slow, and it poses a predatory threat to more valuable seafood resources, i.e., scallops. The cownose ray yields 'wings' of comparable size and chemistry as those marketed in Europe, but the red color of the meat is an undesirable attribute in some European markets. The cownose ray meat is distinctly different from skate typically marketed in Europe, i.e., Canadian skate, Raja batis. There is no comparable European species of ray similar to cownose ray. Promoters of cownose ray should consider introducing this species with consideration for differences in color, flavor and texture. Some European markets have indicated that they are familiar with pink flesh in skate. A proper, cautious promotion directed toward researched markets should find market potential for the

cownose ray. A strong selling feature for ray may be their stability during frozen storage. Perhaps foreign markets other than Europe would be more receptive to importing cownose ray. Other North Carolina skate and ray species deserve further consideration, although availability of these species does not approach that of the cownose ray. The favorable impressions of domestic tasters of skate and ray suggest domestic promotion of North Carolina skate and ray is a definite long range possibility.

RECOMMENDATIONS

1. Information concerning skate and/or ray biology, availability, abundance and predatory damage are required before the reasonable development of a skate and ray fishery can be initiated in North Carolina. Although fishermen have advocated harvest as a means to decrease ray predation on scallops, evidence suggests that cownose rays are vulnerable to overfishing. Should a full scale fishery develop, information is needed to aid in determination of quotas which will hopefully diminish predation on scallops but avoid erradication of the species.
2. Market surveys for North Carolina skate and ray should be expanded to include other foreign markets other than Europe and the domestic market.
3. Operational use of a telex machine is paramount for any survey pertinent to international marketing of seafood.
4. Fishermen and processors should be cautioned that most foreign seafood firms are more sophisticated than typical seafood firms in the United States and are skeptical of the ability of U. S. fishing industries to supply a continuous volume of quality seafood.
5. Before marketing of North Carolina skates and rays can proceed, further work is needed in the technology of their utilization, including

(a) determination of the relationships between product quality and such biological factors as size, sex, and seasonal factors (b) examination of the handling problems to increase efficiency through mechanization (c) storage and packaging studies to insure adequate shelf-life (d) toxicological studies to insure low levels of harmful pesticide in heavy metal residues in these species, (e) analysis of byproducts for maximization of their use as feeds, vitamin extracts, or other industrial uses.

Anticipated Follow-up Studies

As a result of this study several projects have been initiated or proposed to continue the exploration of the marketing potential for cownose rays. The Department of Economic and Community Development of the State of Maryland, Office of Seafood Marketing, has submitted samples of cownose rays for organoleptic and technological evaluation to the National Marine Fisheries Service labs in Oxford, Maryland and Gloucester, Mass. Preliminary reports from the Gloucester laboratory indicate some progress has been made toward adapting a mechanical skinning device for the processing of cownose rays. A full report of their evaluation is due soon, however.

In addition, the Gulf and South Atlantic Fisheries Development Foundation, Inc. has contracted with the Office of Sea Grant, North Carolina, to conduct a marketing study in the spring and fall of 1979 at Morehead City, N. C. The Seafood Lab of the Department of Food Science, N. C. State University, will assist in this study which will involve a local fish processor in the harvesting, processing, and implementing of test shipments to domestic and foreign markets. The project will be greatly aided by the lease of a telex machine for international communications. Plans are also underway to initiate additional technological and resource assessment studies by N. C. State University and Virginia Institute of Marine Science researchers should funds become available.

LITERATURE

AOAC. 1975. "Official Methods of Analysis," 12th ed. Assoc. of Official Agricultural Chemists, Washington, D. C.

Archibald, R. M. 1945. Colorimetric determination of urea. J. Biol. Chem. 157:507-518.

Bligh, E. G. and W. S. Dyer. 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. and Physiol. 37:911-917.

Collins, J. W. 1887. Notes on the use of squid for food in the United States. Bull. U. S. Fish. Comm. 1:127-128.

Crocker, C. L. 1967. Rapid determination of urea nitrrogen in serum or plasma without deproteinization. Am. J. Med. Tech. 33:361.

Daniels, J. 1978. Seafood Extension Agent with the Food Science Dept., Cornell Univ., Ithaca, N. Y.

Department of Commerce, NOAA, NMFS Project Report No. 4-36731, prepared by Fisheries Development Limited, 37 Queen St., London EC4RIB4 for the New England Fisheries Development Program.

Gordievsknya, V. S. 1971. Shark flesh in the food industry. Pacific Scientific Research Institute of Marine Fisheries and Oceanograph (TINRO), Vladivustock, Russia, 26 p. (Transl. from Russ. by ISR. Prog. Transl. Jerusalem, 1973).

McHuoy, H. R. 1977. Export opportunities for New England fishery products. Marine Fish. Rev. 39:26-29.

Morris, R. F. and J. R. Stouffer. 1975. New food products from sharks. New York's Food and Life Science Quarterly 8:3-7.

Otwell, W. S. and G. L. Crow. 1977. Utilization of North Carolina skates and rays. UNC Sea Grant Mini-Project Final Report. 23 p.

Rathjen, W. F. 1977. Fisheries development in New England - A perspective. Marine Fish. Rev. 39:1-6.

RonsivalIi, L. J. 1978. Sharks and their utilization. Marine Fish. Rev. 40:1-13.

Simudu, W. and K. Oisi. 1951. Studies on the putrefaction of the aquatic products. I. The mechanism and the speciality of development of ammonia in the shark muscle. Bull. Japan Soc. Sci. Fish. 16:423-427.

Smith, J. and J. V. Merriner. 1978. Fisheries scientists studying the biology of cownose rays Rhinoptara bonasus. Virginia Inst. of Marine Sci., Gloucester Pt., Va.

Suyama, M., T. Tokuhiro, and Y. Suyama. 1951. On the urea content and the ammonia formation of the muscle of shark-fish. Bull. Japan. Soc. Sci. Fish. 16:211-214.

Washington Post. 1977. Oyster-eating cownosed ray-now man's prey. August 14.

Wheeler, A. C. 1969. Fishes of the British Isles and North-west Europe Mich. State Univ. Press. East Lansing, Michigan. 613 p.

Table 1. Landings and import levels of skates wings England, France and Belgium in 1973. Figures cited are in millions of pounds of wings.

	Domestic Landings	Imports	Total Wings Marketed	% Imported
England	15.5	5.0	20.5	24%
France	4.5	3.0	7.5	40%
Belgium	1.7	0.5	2.2	23%
	21.7	8.5	30.2	

*Figures extracted from Department of Commerce Project Report No. 4-36731.

Table 2. Species of skate which are commonly marketed in Europe.*

Species	Size (max. length)	Commercial Value	Comments
Raja batis, Blue or Grey skate	170-190 cm	excellent	most common skate in Europe
Raja clavata, Roker (thornbach skate)	80-90 cm	considerable	abundant inshore
Raja naevus, Cuckoo ray	65-75 cm	considerable	common
Raja radiata starry ray	70-80 cam	considerable	trawl harvest in northern England
Raja alba bottlenosed on Bondened skate	150-180 cm	minimal	rare
Raja oxyriuchus long-nosed skate	110-130 cm	minimal	

*Tabulated data was extracted from Wheeler (1969).

Table 3. Composite analysis of important market attributes for skate and ray, as outlined in letters from European fish firms**.

	Wing Six Categories		Desired Color	Marketed Species, (Genus Raja)
England	.75-1.25#*	1-3#	not specified	not specified
	1.25-2.50#	3-5#		
	2.5 -4.00#	5-7#		
France	-	-	not specified	not specified
Belgium	150-200 g, smalls mediums 3-4 kg, larges		white	R. batis, clava radiata and montagni
Italy	Min. 500 g Max. 4-5 kg		not specified	R. erinacea, fyllae garmani, radiata, and senta
Spain	100-400 g 400-800 g 800 g		pink	R. batis and clavata

*Size categories vary in England depending on dealer. # implies pounds.

** Table extracted from Otwell and Crow (1977).

Table 4. Body size and marketable yield for various skate and ray species.

Species	No.	Average Wing Span (cm)	Average Total Body Weight (kg)	Average Wt. (Kg) Wings/Skate Skin-On	Average Wing Yield
Cownose Ray, *Rhinoptera bonasus*	10	90.5 ± 3.3	12.50 ± 1.4	5.2 ± 0.9	42%
Clearnose Skate, *Raja eglanteria*	6	38.9 ± 2.0	1.30 ± 0.2	0.46 ± .07	36%
Canadian skate* *Raja batis*	10	-	1.92 ± 0.2	0.68 ± .05	35%

*Body weights for the Canadian skate were back calculated based on an estimated yield of 35% wings. Whole skate sample were not available from Canada. Skate wings were purchased from Bonavista Cold Storage, Inc. in St. Johns, Newfoundland.

Table 5. Basic chemical composition of muscle tissue from wings of various skate and ray, fresh and frozen for one month at -29°C. At least four replications of each analysis were performed on pooled samples of meat from at least two separate skates.

Species		% Protein[a]	% Fat[b]	% Moisture[c]	% Ash[c]	% Urea	% Nitrogen[c]
Cownose Ray	fresh	20.86	1.13 ± .02	76.26 ± .06	1.25 ± .03	0.5 ± 0.1[d]	3.85 ± .09
Rhinoptera bonasus	frozen	21.11	1.41 ± .02	75.48 ± .03	1.40 ± .02	0.6 ± 0.2	4.27 ± .07
Clearnose Skate	fresh	19.65	0.80 ± .01	77.08 ± .05	1.27 ± .02	1.2 ± 0.1[e]	4.17 + .05
Raja eglanteria	frozen	20.31	1.01 ± .02	76.28 ± .06	1.30 ± .01	1.1 ± 0.1	4.30 ± .08
Canada Skate *Raja batis*	frozen at least one month	25.42	0.96 ± .03	81.88 ± .28	1.34 ± .02	0.4 ± .2[e]	3.37 ± .10

[a]Protein calculated as 100- Σ average % Moisture + Fat + Ash + Urea.
[b]Fat determined by Bligh and Dyer (1959) methodology.
[c]Moisture, Ash, and Nitrogen determined by standard methods (AOAC), 1975).
[d]Urea determined by method of Archibald (1945).
[e]Urea determined by method of Crocker (1967) sold in kit form No. 535 by Sigma Chemical Co., St. Louis, Mo.

Table 6. Typical ballot used by trained flavor profile panel to rate skate and ray flavor.

MODIFIED FISH FLAVOR
FOR SKATES AND RAYS

NAME _____ Date _____

SAMPLE IDENTITY			
AROMA			
Fish Meat			
Other			
Ammonia			
Iodine			
FLAVOR			
Fish Meat			
Sweet (basic)			
Ammonia			
Iodine			
Other			
Other			
AFTERTASTE			
OVERALL COMMENT:			

Does sample have flavor similar to any other seafood or food you have eaten, if so, what? _____

Table 7. Typical ballot used by trained texture profile panel to rate skate and ray texture.

SKATE TEXTURE

NAME _____ Date _____

SAMPLE IDENTITY			
I. PRIOR TO MASTICATION			
Surface Moisture			
Other			
Springiness			
II. FIRST BITE			
Hardness			
Other			
Other			
III. MASTICATION			
Chewiness			
Moisture Release			
Cohesiveness of Mass			
Other			
Other			
Other			
IV. DESCRIPTION OF BREAKDOWN			
Ease of Swallow			
Other			
Other			

Table 8. Definitions of some characteristics used to describe skate and ray texture and flavor.

SKATE TEXTURE DEFINITIONS

I. Surface Moisture - awareness of moisture felt by lips, tongue, and other mouth surfaces.

Springiness - degree to which sample returns to shape after deformation.

II. Hardness - force required to bite through sample with molar teeth.

III. Chewiness - number of chews required to prepare sample for swallowing.

Moisture Release - degree to which sample releases juices.

Cohesiveness of Mass - degree to which chewed mass holds together.

MODIFIED FISH FLAVOR FOR SKATES AND RAYS DEFINITIONS

Fish Meat - aroma or flavor typical of fresh fish flesh.

Ammonia - aroma or flavor aromatic resembling ammonia.

Iodine - aroma or flavor typical of chemical iodine.

Sweet - basic sweet taste as perceived by taste buds.

Table 9. Results of trained texture profile panel evaluation of skate and ray texture.

	Cownose Ray					Canadian Skate
	Fresh Broiled	Fresh Fried	Frozen/Broiled 1 month	2 months	Small Broiled	Frozen Broiled
Prior to Mastication						
Springiness	9	9	8	8	1	2
First Bite						
Hardness	9	7	8	9	3	6
Mastication						
Chewiness (chew count)	32	35	29	30	14	30
Moisture Release	7	3	6	4	9	8
Cohesiveness of Mass	10	8	9	8	3	8
Fibers	11	9	11	11	2	12
Moisture of Mass	4	8	3	5	3	7
Residual Phase						
Ease of Swallow	6	9	6	7	5	6

Table 10. Results of trained flavor profile panel evaluation of skate and ray flavor.

	Cownose Ray					
	Fresh Broiled	Fresh Fried	Frozen/Broiled 1 month	Frozen/Broiled 2 months	Small Broiled	Canadian Skate Frozen Broiled
Aroma						
fishmeat	3	4	5	4	4	4
blood	4	1	4	3	4	1
sweet	3	4	3	3	4	4
ammonia	7	2	4	3	7	5
iodine	4	2	4	5	4	4
Flavor						
fishmeat	2	4	3	4	2	3
blood	6	2	4	4	6	3
ammonia	4	2	5	4	5	4
iodine	3	1	3	4	3	2
metallic	6	2	6	6	4	7
sour	5	4	5	3	5	6
bitter	6	4	7	6	7	4
After taste						
metallic	4	3	4	3	5	6
sour	4	3	5	-	6	4
bitter	3	2	4	4	4	2
sweet	-	-	-	-	-	4

Table 11. Catch composition and description of the April 24, 1978 experimental harvest of cownose rays, Rhinoptera bonasus.

	No.	Total Weight	Wing Span (cm)
Males	36	12.29 ± 1.2 kg	
Females	21	12.86 ± 1.8 kg	
Adults	57	12.50 ± 1.4 kg	90.5 ± 3.3
Embryos*	19	312 ± 36 gm	26.3 ± 1.9

* Only one embryo was carried by one adult female.

Table 12. Texture and flavor as rated by participants in public demonstrations of skate and ray cookery. Rating scale was 1-5. A rating of 5.0 was maximum acceptability.

Site	No.	Flavor	Texture
Division Marine	33		
Fisheries Building			
Cownose Ray		4.3	4.0
Canadian Skate		4.3	3.8
N. C. Marine Resource	55		
Center			
Cownose Ray		4.4	4.2

Table 13. Cownose ray recipes formulated by the N. C. State University Seafood Lab's nutrition leaders under the direction of Specialist Sam Thomas

---

PAN FRIED RAY

Cut meat into 1/2 inch chunks. Salt and pepper. Roll in flour until well-covered. Pan fry in oil at 350° until nicely browned and tender.

BATTER FRIED RAY

Fillets of ray
2 tsp. baking powder
1 egg, separated
1 Tb. melted fat
1 cup flour
1/4 tsp. salt
1/4 tsp. black pepper
1/2 cup lukewarm water

Sift flour, baking powder, salt, and pepper in a bowl. Drop egg yolk in. Add water and fat and mix well. Fold in beaten egg white. Dry fish pieces and dip in batter. Fry at 350° for 4-6 minutes or until golden brown. Drain on absorbent paper.

RAY CAKES

2 cups minced ray
2 cups bread crumbs
2 eggs
3 Tb. mayonnaise
2 Tb. Worcestershire sauce
1 small onion, minced
Juice of 1/2 lemon with scraping of rind
1/4 lb. margarine, melted
1/2 tsp. parsley
Pepper
1/4 tsp. salt
Chicken broth
Paprika

Mix bread crumbs, eggs, mayonnaise, Worcestershire sauce, onion, lemon juice, margarine, parsley, salt, and pepper. Add meat to mixture. Use chicken broth to adjust consistency to that similar to bread dough. Shape into cakes or stuff into shells and sprinkle with paprika. Bake in moderate oven, 350°F, for 20-30 minutes or until slightly browned.

MOCK SCALLOPS*

2 Tb. butter
1 cup sliced mushrooms
3 stalks celery, diced
4 Tb. grated onion
1/2 cup minced green pepper
1/8 tsp. basil

Melt butter in large saucepan over medium heat. Add other ingredients. Simmer for 10 minutes or until celery is tender but not soft.

While this is simmering, prepare the following:

4 Tb. butter
4 Tb. flour
1/2 tsp. salt
1/4 tsp. pepper
Pinch of nutmeg
2 cups cold milk

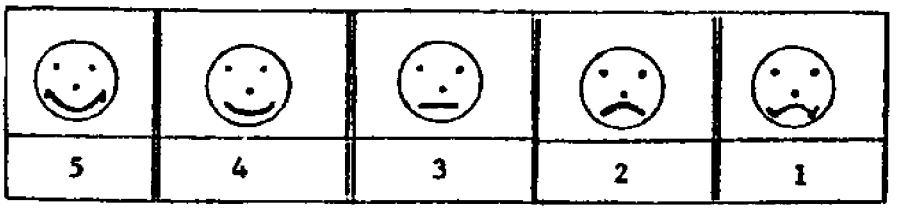
Melt butter in top of double boiler and, stirring constantly, gradually add flour. Add seasonings. Slowly pour in milk. Cook and stir for about 6 minutes, until sauce is thick and smooth.

Add 2 Tb. butter, then add 1 lb. of skate meat, cut in 1/4 inch pieces, to the mushroom mixture, and stir well. Let this heat for 5 minutes, then combine with the white sauce, stirring well.

Pour the mixture into a casserole; cover with 1/2 cup cracker crumbs. Top with 4 Tb. grated cheese, and dot top with butter. Bake for 25 minutes at 350 F, or until golden brown.

Table 14. Preference rating for new recipes formulated by N. C. State University Nutrition Leaders.

Products were judged on the hedonic scale of 1 - 5 (5 = excellent, 1 = poor).



Average ratings:	Pan Fried Ray	3.8
	Batter Fried Ray	4.1
	Ray Cakes	4.2
	Mock Scallops	4.8

THE UNIVERSITY OF NORTH CAROLINA
SEA GRANT COLLEGE
ADVISORY SERVICES

East Carolina University
N.C. Marine Resources Center
/Bogue Banks
Rt. 1, Roosevelt Dr.
Morehead City, N.C. 28557

919: 726-0125

February 17, 1978

Dear Sir:

Our efforts to initiate exportation of skates and rays from the United States to overseas markets has been continuing since our correspondence in September, 1977, (see enclosed copy of your letter). Your letter was very useful in the planning stages of our efforts, and we are now ready for an exchange of products.

We have cautioned the United States fishermen and processors that buyers in Spain are skeptical about the ability and desire of United States firms to supply the quantity and quality of fishery products demanded in Europe. The United States firms feel they can better understand the quality demands and product forms desired if they can examine a test shipment from Spain. We have promised to secure the test shipment at our expense. We would appreciate your cooperation in preparing a shipment of frozen skate from Spain to Raleigh, North Carolina in the United States. In return, we will pay all product and transportation costs, will send our evaluations of your product, and will make plans to send a test shipment of our skates and rays for your evaluation, again at our expense.

Our next correspondence will be by telex or cable. Hopefully, you can advise us of your decision and suggestions as to the best method of shipment. We want a small test shipment. We would like to see different sizes and species of skate. We want a price quote before shipment.

Thank you for your time and consideration.

Very truly yours,

Gene L. (Skipper) Crow
Marine Advisory Agent

W. Steven Otwell
North Carolina State University

GLC/pp
Enclosure

Figure 1. Copy of the letter used to survey the interest of European seafood firms in North Carolina skate and ray. This letter was an initial attempt to arrange for an exchange of sample products.

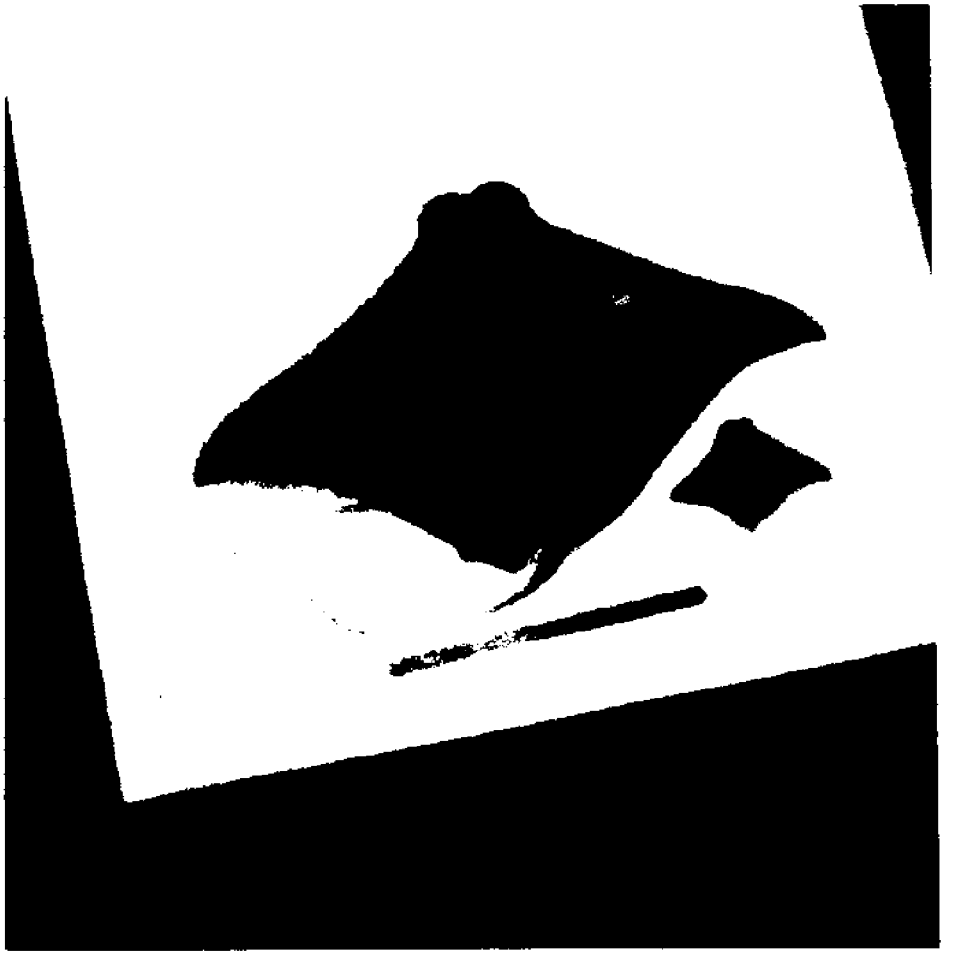


Figure 2. Cownose rays, Rhinoptera bonasus, harvested from Pach Sound in North Carolina on April 24, 1978. The small embryo pictured in the right corner was taken from the adult female in the same picture.

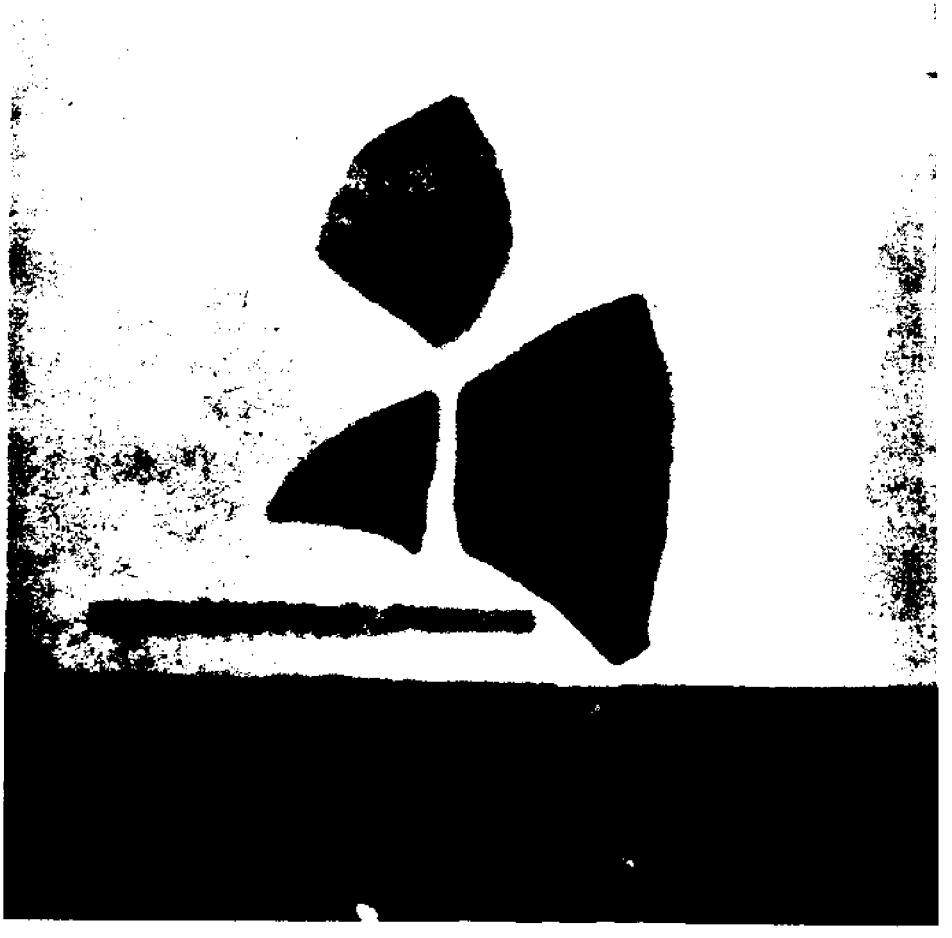


Figure 3. Wings cut from the body of a Canadian skate, Raja batis (top) and a cownosed ray, Rhinoptera bonasus. Edges of the smaller skate wing have been 'trimmed.' The trimmed wing-tip from the ray is pictured (left) beside the main marketable wing portion.

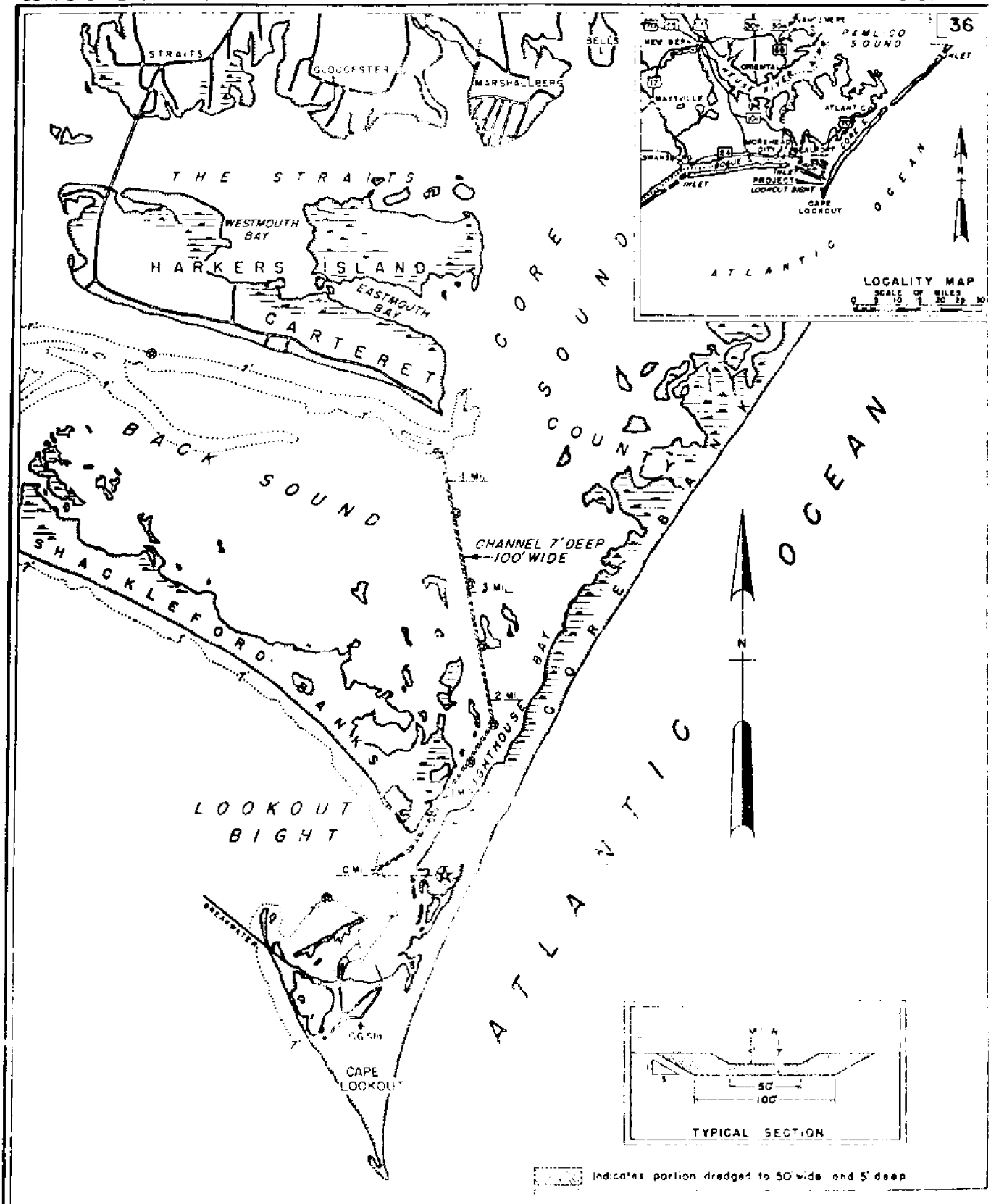
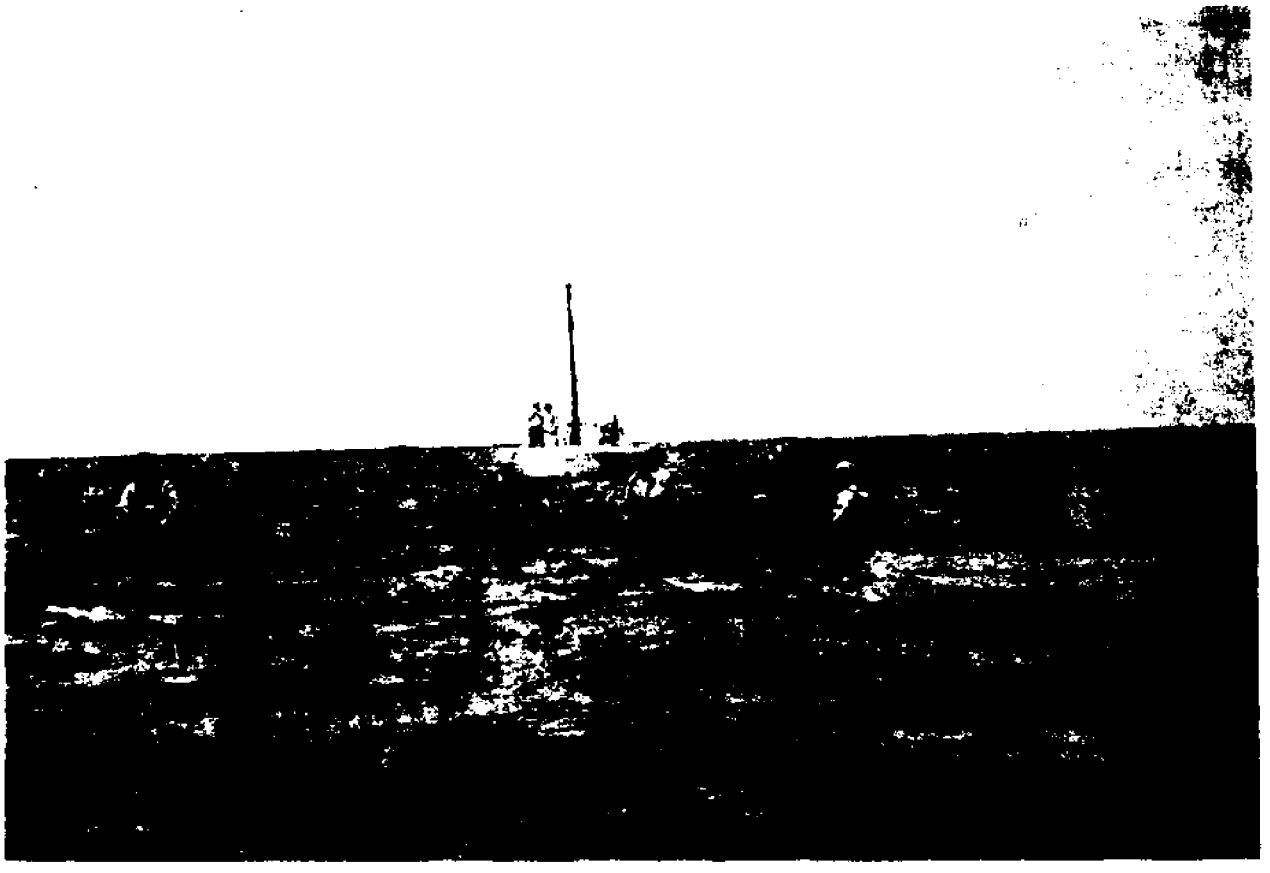


Figure 4. Map showing location of Back Sound in which trial harvest of cownose rays was conducted.



Figures 5. A series of pictures illustrating the harvest procedures used to catch cownosed rays, Rhinoptera bonasus in Kach Sound, N. C. on April 24, 1978.

A. Typical long-haul net is set and drawn in about a school of cownosed rays.

Figure 5B. Long-haul net is being bunted about a school of cownose rays.

Figure 5C. Long-haul bunt is suspended between small work skif and the large boat.

Figure 5D. Cownosed rays are being bailed from the bunt.

Figure 5E. Bailed cownosed rays are released into the bay here.