<u>The Relative Sport Value of Various Types of Fishing in the Charter Boat Fishery of the Florida Keys</u>

[Restored and transferred to electronic form by M. J. Bello NOAA) in 2001 as part of the Coastal and Estuarine Data/Document Archeology and Rescue (CEDAR) for South Florida. Sponsored by the South Florida Ecosystem Restoration Prediction and Modeling Program. Original stored at the Library, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Minor editorial changes were made.]

Albia Dugger,BLR

Dr. B. Austin

Dr. N. Ehrhardt

Dr. J. Van Leer

Table of Contents

Introduction

Sport fishing, including charter boat fishing, is a major American industry, providing not only recreation, but significant inputs in food production and economic impact. "Among Americans, fishing is by far the most popular outdoor activity that depends on a renewable natural resource base. In fact, in 1982, fishing ranked third in popularity among all participatory sporting activities .... There are indications that recreational fishermen account for approximately 50 percent of the total U. S. finfish harvest used for food .... Including multiplier effects, the total economic impact of marine recreational fishing in 1980 was $7.5 billion" (Prosser, 1985).

Information on recreational catch and effort is essential to the proper management, as required by the Magnuson Fishery Conservation Act of 1976, of many of the fish species found in South Florida. Since the fish stocks affected by recreational fishing are a multi-user domain under State and Federal jurisdictions, it becomes the task of fishery managers to determine what regulations are appropriate for management (Richards and Bohasack, 1982). "Fisheries with large recreational components pose special problems for fisheries managers, because real-time estimates of either total catch or total effort and catch per unit effort (CPUE) must be made to determine closure points…, the landings data being accumulated by State and Federal agencies are in most instances not adequate for determining catch quotas or catch levels within necessary time frames .... Although many efforts have been made to generate such statistics (NMFS, 1980; McEachron and Matlock, 1983), most researchers agree that estimating totals for recreational fisheries is very costly and difficult and cannot be accomplished within acceptable time frames. Clearly another approach is needed to manage mixed or recreational fisheries." (Brusher, et al., 1984; Williams and Brusher, 1984; Williams, et a1. ,1984).

Brusher et al. (1984) determined that the best source for marine recreational fishing data is the charter boat captain who records his own catch and effort data. They reported unusual efficiency in collecting and reporting recreational fishery data using charterboat surveys, and a response rate of 90.4 percent, which is significantly higher than others reported for mailed in questionnaires or log forms, including Browder, et al. (1981) 31.25 percent; Rose and Hassler (1969), 20 percent and 39 percent in 1961 and 1962; and Brusher, et al. (1978), 58.2 percent.

The study by Browder, Davis and Sullivan (1981) distinguished 4 types of charter boats in the Florida Keys: l.offshore charter boats, 2.inshore/offshore (I/0) charter boats, 3.guide boats, and

4.head boats. The major ports in the Florida Keys for offshore charter boats were Islamorada, Marathon, and Key West. I/0 boats were located primarily in Key West.

Browder, Davis, and Sullivan (1981) give percent fishing effort figures based on single estimates by captains in a mail-in questionnaire. The accuracy of these guesses is uncertain. Browder, Davis and Sullivan report a significant percent of blue fin tuna Thunnus thynnus effort, although that fish is rarely found in the Keys (NMFS,1980; NMFS, 1983).

The most comprehensive one year study of charter boat catch and effort , interms of completeness of data, was done by Gentle III, (1977), on the east coast of Florida. Daily dock census' resulted in accurate records of one year's catch and effort by the offshore fleet in Dade County. The Florida Keys charter boat fishery, with more than four times the number of charter boats, and a richer, more diverse fishing area, is more highly developed and has an enormously greater socioeconomic impact on it's relatively small and remote area, (Browder, 1979; Stark,1969).

In the survey by Browder, Davis and Sullivan (1981), no catch data werecollected. Charter boat captains were asked to estimate their seasonal effort in targeting different species. Browder, Davis and Sullivan list several problems which "could be totally resolved only by visiting all the active boats in an area or by talking with a local person who knew all the active operators in the area...".

Browder, Davis and Sullivan (1981) recognize the importance of the Florida Keys as a major charter boat base, and addresses the major fishing concerns of the area, including type of operations, distribution, species dependence and percent fishing effort, and perceived problems in the fishery. The charter boat captains surveyed during that study indicated a level of environmental awareness by a=pressing concerns about fish traps and "excessive catches" by sport fishermen, and a "fear that overfishing of the reefs will result". These concerns affect individual release policies and will be discussed as a decision factor in this paper. Browder, Davis and Sullivan (1981) state that there were "declines in catch per unit effort noted by the captains", and that changes noted in the Florida Keys since the survey by Moe (1963) include a shift in relative importance of target species, with a larger, more diverse group of targets in 1981, and an increase in the relative level of activity in the Keys in relation to other Florida areas. They conclude that the charter boat industry had increased by more than 5O percent in the Florida Keys in the preceedíng 17 years.

Brusher et al. (1984) also differentiate the Florida Keys in their charter boat surveys, the first to obtain a sample of catch and effort data for charter boats in the Florida Keys in real-time. In analyzing their data they found the Florida Keys to be unique in certain aspects of fishing, which are reflected in their results. For puposes of analysis, they divided fishing effort in the Florida Keys into oceanic waters less than 10 fathoms, and greater than 10 fathoms; and fishing methods into "trolling" and "bottom fishing".

Brusher et al. (1984) calculated catch per boat hour (CPH) in the Florida Keys, by species and by month, for nine months (March-December in Key West). They found that "the effort distribution by fishing zone and method is not necessarily representative of the overall charter boat fishery in any region..." and "with each region being represented by only 1 or 2 boats, captains' specialties strongly influenced reported effort". They state that "the influence of effort classification must not be overlooked since our definition of fishing method caused some apparently unusual results.".

Currently, selected captains in the Florida Keys are required by the NMFS to keep fishing records, and to supply the NMFS with catch and effort information.

Determining sources of uncertainty and accomodating variability in the data are essential parts of fisheries management (Gates,1984; Smith, 1984).

The best avaiable source for this information is from the professional recreational fishermen, i.e. the charter boat captains themselves (Brusher, et. al. 1984).

According to Gates (1984) the principal types of uncertainty in fishing operations are catch rates, equipment performance, prices, weather, quality of the captain and crew, and fisheries management measures (such as 1imits and quotas). This paper deals with the uncertainties faced by the charter boat captain in making his daily fishing decisions, the outcome of which is illustrated by their catch records.

For this paper I have both visited all the active boats in the Florida Keys (in 1984) and extensively interviewed active operators. Fishing types and methods are defined in terms actually used in the charter boat fishery. The fishing records of three volunteer Florida Keys charter boat captains were analyzed for trends in Fratio and CPUE by season, month, boat type, target type, and catch type. Sources of uncertainty which might be introduced by not distinguishing target type or tackle type subdivisions in fishing methods, and bay, estuarine or other specialty fishing targets within effort categories are discussed. A number of behavior variables which could affect management Policies are brought out. The decision making process, as performed by Florida Keys captains, is summarized in 2 parts: the decisions regarding daily targeting of effort, and the decisions regarding the disposition of caught fish.

OBJECTIVES

One of the characteristics of charter boat fishing is that catch per unit effort (CPUE) is highly variable compared to other fisheries. Charter boat fishing is not only a multi-species, but a multi-valued fishery. In other words, the same fish species has different values at different times and on different occasions.

As in commercial fishing, value is what motivates fishing effort, which in turn determines Fratio (the percentage of days fished for a given type of catch). In commercial fishing, value is one-dimensional; it is defined as economic value. The valve of sport fishing is measured by a wide range of subjective variables, which are social as well as economic, (thus multi-valued).

This study examines five types of fishing that have value to charter boat fishermen in the Florida Keys, relates the types to fishing effort, and discusses sources of uncertainty which may be important considerations for fisheries managers.

This study examines five types of fishing that have to charter boat fishermen in the Florida Keys, relates the types to fishing effort, and discusses sources of uncertainty which may be important considerations for fisheries managers.

METHODS

The Captain's Records

For this study, three charter boat captains donated their catch records for five consecutive fishing seasons, from 1979-80 to 1983-84. A fishing season is described as the seven months beginning in October of a given year, and continuing through April of the following year. This time segment is selected due to the custom many Florida Keys captains have of fishing outside the Keys area during the intervening months.

This 3-boat sample of catch and effort records is used to illustrate how the valve system affects the relationship between three factors:

1. the TYPE of fish being targeted by five different fishing methods (Target Type),
2. the NUMBERS of target type fish caught per target day (CPUE), and
3. the PERCENT of total days fished, per month, of each target type (Fratio).

The variables examined were boat (specialty or location), aonth (seasonal abundances or tournament effort), and season (yearly variability) .

Each captain fished on a given boat, A, B, or C. Boats A and B fished all or part of each season in the Florida Keys (catch from days fished outside the

Keys is not included). Boat C did not fish the fifth season in the Keys, resulting in a total of fourteen boat seasons of data.

The records available for each fishing day consist of seven Items:

I. Date

II. Fishing Area

In the Florida Keys, fishing areas are divided in four sections, east to west, by population areas:

1. Key Largo/Tavernier

2. Islamorada

3. Marathon

4. Key West

Each boat has it's own home port, where most fishing occurs. In this study, boats A and B operate out of Islamorada, and boat C operates out of Key lest, a distance of 80 miles. Boat C, therefore, fishes a different area of the Keys than boats A and B.

III. Boat

A second difference is type of boat. Boats A and B are medium size offshore vessels, while boat C is a smaller inshore/offshore (I/0) skiff. Boat characteristics affecting fishing effort are found in Table 3.

IV. Target Type

There are five target types, which are unique in method and area of fishing, such that a charter day would usually consist of fishing in only one or two categories:

1. inshore/reeffishing

2. offshore/trolling

3. billfishing

4. sharkfishing

5. tarpon/flats fishing

V. Species Code

Each species of fish caught is assigned a number which corresponds to one of the f five f fishing types. as seen in Table 1. The first digit of the fish code is it's "target type". Within types, even 10's designate related groups as follows:

10= groupers

20= snappers

30= jacks

40= tunas/mackerels

The final digit indicates the species within the group, in alphabetical order. For example, 123 is in the inshore/ reeffish category, snapper group, red snapper species. Only those fish most commonly reported by the three captains studied are listed by species. Rarely captured species, such as swordfish and spearf fish, or incidental catch, such as grunts and triggerf fish are lumped in the appropriate general categories.

Species of fish which are usually caught while engaged in a given type of fishing are combined to form a "target group". Often no particular species is sought, but a category will be "targeted". Examples of targets reported by captains are listed in Table 2. Targets are condensed into their respective target types so that each fishing day has a "target" corresponding to the five general categories.

When more than one target category per day is reported, the more specialized of the two is designated as the target group. The higher numbered categories are considered more specialized than lower numbered categories. In nearly all cases, group 1 was the second type targeted.

For example, a day divided into half a day of yellowtail fishing (fish amber I24), and half a day of patch fishing (group 100), is assigned to target type 1; but a day divided into sailfishing (301) and reeffishing (100) is assigned to target type 3.

VI. Numbers of Fish Caught

VII. Disposition

Disposition is divided in several areas which are related to value:

1. landed fish

   A. consumed by clients (food fish)

   B. sold commercially (food fish)

   C. mounted (sport catch)

2. released fish

   A. released/tagged fish (sport catch)

   B. undersized fish and excess catch

   C. trash fish

3. bait fish

Analysis of variance

In order to test for differences between the types 1-5, the Kruskal-Wallis (K-W) test, or analysis of variance by ranks, was used. The K-W test is similar to the standard analysis of variance, ANOVA, but uses rank sums instead of means to compare the samples. This nonparametric analysis is applied when the k samples do not come from normal populations, or when the k population variances are heterogeneous, and where k>2.

When the K-W test rejects the hypothesis (Ho) that all groups are from the population, as in this case, testing Fratio and CPUE by Type, it is not known which groups differ from which other groups, only that at least one difference exists.

To locate differences when using the single factor ANOVA, the Student Nenman-geuls procedure is used. Similarly, the K-W test is followed by a nonparametric comparison which parallels the Nueman-Keuls test, using rank sums inatesd of means, and requiring samples with equal numbers of data in each of the k groups (Zar, 1974) .

Rationale of the Fishing Trip: Definitions of terms and techniques.

"Caught" fish include any fish caught by hook and line during a day's charter, whether brought back to the dock (landed) or not. Caught fish can be divided into several categories depending on the angler's goals and the ultimate disposition of the fish. Value affects catch analysis because fish that are not considered important may not be reported by captains in their daily catch records. Value may vary from trip to trip, or between boats as in the following examples:

I. Bait

A. Cast Net

Boats A and B specialize in live bait fishing. The type of bait available often determines the captain's choice of targets. The main types of small live bait fish used are ballyhoo, pilchards and cigar minnows, caught at the beginning of the fishing day using a specialized cast net, either from the bait skiff or the charter boat itself. Catching bait in a cast net from the charter boat requires anchoring in shallow water and establishing a chum slick to attract the bait fish to the boat, whereas catching bait from the skiff is strictly visual, without the use of chum. A variety of other small fish are often attracted to the chum slick, and are also caught in the cast net and used for bait. Fish caught in the cast net are not reported as catch.

B. Hook and Line

Bait fish are also caught by hook and line. Some species are particularly sought after, such as mackerel, tunas, "bonitos", blue runners, grunts, pinf ish, asd barracudas. Other varieties are used opportunistically, as caught, such as snappers and some jacks. Any fish brought to the boat dead may be used as pat bait. Any bait fish alive at the end of the day are usually released. Fish caught on hook and line and used for live, dead, or cut bait may or may not be recorded as part of the catch, but are rarely itemized as bait. Days spent fishing exclusively for bait are not reported as charter days, and the catch is not reported. For boat C, baitf ish are always recorded; baits used by boats A and B are rarely recorded.

II. Catch and Release

A. "Trash" Fish

Trash fish are released regularly throughout the fishing day, including small jacks, triggerf fish, grunts, blue runners, small snappers, amberjack, barracuda, and most other reef fish. These are almost never recorded and are considered incidental unless used for bait. Occasionally a large jack, barracuda or reef fish is retained and recorded. There are no good estimates for trash fish released.

B. Undersized fish and excess catch

Most captains have their own criteria for keeping or releasing f ish.

Many feel that releasing small food fish such as snapper, grouper, kingfish, and dolphin contributes to the conservation of their fishing stocks, and practiced the release of fish even before the current minimum size limits were established. The captains also voluntarily limited the numbers of each species caught. usually keeping a "box full" of larger fish, and releasing smaller fish when mixed sizes were abundant. Most consider the overall quality of a catch composed of a few large fish superior to one of many smaller fish.

Fish frequently released as excess include barracuda, amberjack, "bonito", blackfin tuna, little tunny, jacks, and mackerels.

Boat C reported all fish released. Boats A and B do not.

C."Sport" Fish and Game Fish

Any fish caught primarily for recreation is a "Sport" fish, regardless of its ultimate disposition.

“Gamefish” are those fish caught for wich the methods , techique and tackle used to catch the fish are equally importanr as the fish itself. Often gamefish have no intrinsic value other than placed on them by the sport fisherman , which may be considerable.

Gamefishing is a prestigious and specialized segment of sport fishing, the subject of innumerable local and international tournaments, and requires a great deal of expertise on the part of the captain and the crew as well as the angler. Detailed standardized rules for fishing with various tackle and line tests are published by the International Game fishing Association (IGFA), which certifies record catches worldwide.

The purpose of game fishing is, generally, not to kill the f fish, but to capture it using specialized or light tackle, and release it unharmed or tagged. Only trophy fish are usually killed.

Offshore gamefish include sailfish, marlins and other billfish, large sharks, jacks and tunas. Tarpon, bonefish and permit are among the shallow water gamefish targeted by boat C.

Gamefish caught, tagged, released, and mounted are accurately recorded.

III. Landings

A. Trophy Fish

Any fish can be a trophy or mounted fish. Of the fish reported as mounts, approximately 50% are game fish and 50% are in the reef fish, or other categories. The total number of fish mounts was less than one half of one percent of the total reported catch. Trophy fish are accurately reported.

B. Commercial Catch

Most charter boats have commercial licenses for the sale of fish to wholesale fish houses or restaurants, but few if any days are spent exclusively commercial fishing. The portion of the catch available for sale is derived from regular charter days on which the catch exceeds that desired by the clients for their personal use is landed. The fish most commonly sold to fish houses are snapper, grouper, king mackerel, and dolphin. Occasionally tuna, amberjack, cobia, and shark are also sold to restaurants. Very few fish are sold directly off the dock.

Commercial sales are considered confidential and accurate records are not available. The number of fish reported as sold is about 5% of the total catch, which may or may not be reliable.

C. Food Fish

The majority of the catch landed is cleaned and filleted for the personal use of the clients. The most popular food fish are snapper, grouper, dolphin bluefish, pompano, mackerel, cobia, tuna, and wahoo. Billfish, when landed, are sometimes smoked or mounted. Amberjack and kingfish are also smoked if not consumed directly.

The less desirable edible species are sometimes retained but not always consumed. These include small reef fish, jacks, amberjack, little tunny, blackfin tuna, “bonitos”, mackeral, and small sharks.

Food fish are accurately reported in the catch record

Economic factors

One of the greatest diversities of fish species in any area is found in the Florida Keys (Stark,1969), giving captains a choice of many specialties, including reef fishing, off shore fishing, billfishing, shark fishing, or shallow water fishing. The type of boat used, its equipment and tackle, reflect the fishing specialties, involving size, range, power, and draft of boat, electronics, live well bait capacity, and light, heavy or electric tackle, in fly, spin, or conventional modes.

Investments in boat, equipment, and tackle are some of the economic factors which directly affect fishing effort. The inshore/off shore boat, compared to the larger offshore charter boat, is much less expensive, with lower cost, maintenance, repair, dockage, and fuel consumption (Browder, 1979). It's size limits fishing as far as conveniences; equipment, tackle carried, weather ability, and crew usually of one rather than two, but excels in light tackle maneuverability, fishing range, and accessibility to flats and shoreline.

Offshore boats are economically divided into (1) owner operated businesses, primarily working boats fishing for a profit, and (2) corporation owned boats, often "convertible" yachts, which may operate at a deficit. To increase fuel economy, a captain may opt to spend a day anchored, rather than trolling or running off shore. Some owner/operators may sacrifice the speed and maneuverability of a twin screw engine for the more economic single screw vessel, occasionally compromising fishing range, agility in fighting a game fish, or time with lines in the water.

The economic considerations of the crew require that wages be supplemented by tips, fish mounts, tournament winnings, or sale of commercial catch, depending on opportunity. These are significant sources of income, and often influence the choice of fishing target.

(NOTE: In this draft the symbol a is used to represent the statistical alpha for lack of a compatible keyboard character)

Results and Discussion

Data accuracy

The first step in managing biological resources where there is uncertainty about resource dynamics is to explicitly recognize the nature of the uncertainty (Smith, 1984). A goal of this paper is to recognize and point out some of the sources of uncertainty which have previously been averaged over, using comprehensive interviews and existing records of 3 volunteer charter boat captains. As Smith states, "Fishermen sample fish stocks far more efficiently and extensively than can most research vessels."

Studies of risk and uncertainty in fishing harvest assume "1. there exists a typical or representative decision maker with choices and 2. The outcome of his decision are only partly within his control, either because of random events or strategic reactions to his decisions" (Gates, 1984).

The fisheries scientist studies these decisions as "an exercise in pattern detection and hypothesis formulation". Gates illustrates the example of "specifying spatial and temporal confines which give rise to variation" such as, "seasonal variations may be very important for explaining fishermen’s short term behavior and the consequences of management policies".

The data collection method used by the National Marine Fisheries Service (NMFS) is the Marine Recreational Fishery Statistics Survey (MRFSS), which was instituted in Florida in 1981. The MRFSS estimates participation, catch and effort by marine recreational fishermen, using commercial contractors to perform data collection and processing. I have been a sub-contractor on this project since its inception.

The reports include tables for each year's data which are grouped over large geographical areas, species groups and time intervals, even though catch is recorded originally on a per-trip, fish by fish basis, (NMFS, 1980; NMFS, 1983).

According to Gates (1984), "The data base of the NMFS is potentially valuable for analysis of behavior under uncertainty. The reliability of this data base since 1977 has been questioned .... Elimination of vessel descriptors could render the data base useless for analysis of uncertainty in fishing operations, since averaging procedures erase the variability experienced by the individual fishermen."

In this paper definitions of fishing methods and captains fishing specialties are examined. Some of the sources of uncertainty which, if not allowed for, can cause anomalous results in data analysis are discussed.

Data averaging conceals much of the variability experienced by fishermen on individual trips. "In order to capture the effects of uncertainty on fishermen's behavior, it is necessary to have micro-data, ideally at the individual vessel trip level."(Gates, 1984). Data in this paper, and from Brusher et al. (1984), indicate that the ideal micro-data unit may be even smaller, with divisions in CPH by target or gear type when applicable.

Captains records: CPUE, Fratio, "V"

The three captains' fishing records were analyzed for trends in CPUE and Ratio with the following results:

Each fishing day is identified by target type, and catch for that day categorized by target group. Days fished and catch types are grouped by month for convenience. (See Table 4, Target days and target catch).

The number of days fished, by each boat for each month, in each target type are shown in bar graph form, Figure (la,b,c). The distinction between the offshore boats A and B, and the I/0 boat C, is seen in the absence of tarpon/flats (type 5) fishing in the former.

Plots of Ratio with CPUE by target type, for each boat and season, showed little variability, and were combined for a total of 260 data pairs over 97 boat months. Each data pair represents one boat-months of a given target type (Fig. 2)

Using the Kruskal-Wallis test, significant differences between fishing types were shown for CPUE and Ratio ($p<0.00001$ for both CPUE and Ratio, Table 6).

From each group a sample the size of the smallest group, $n=19$, was selected by a table of random numbers for the purpose of nonparametric multiple comparisons between the five groups.

The CPUE's of each type are significantly different from each other type ($a=0.05$), except for billfishing and tarpon/flats fishing, types 3 and 5, for which Ho is not rejected at the $a=0.001$ level.

Similarly, the Fratio's for each type are significantly different from each other type ($a=0.05$), with the notable exceptions of two sets of types. Billfishing, type 3,and tarpon/flats fishing, type 5 have indistinguishable Fratio's, and offshore fishing, type 2, and shark fishing, type 4 are comparable (a=0.05).

Therefore, with regard to both CPUE and Ratio, each type is separate and distinguishable from each other type, with the exception of types 3 and 5, billfishing and tarpon/flats fishing, which group together. These results are seen in the plot of means, Ratio vs CPUE, Fig. 3b.

Within types, the K-W test was used to test for homogeneity of Ratio and CPUE between months. Only type 2, offshore fishing, was found to differ significantly between months (CPUE a=0.0518, Ratio a=0.0034). Marlin and sailfishing, type 3, although seasonal, does not show significant monthly differences (CPUE a=0.5979, Ratio a=0.0906) because, between the months of October and April, it is possible to fish for one or the other of bill fish species in any given month.

In Table 7, CPUE and Ratio for offshore f fishing, type 2, by month are listed by rank. Using a sub sample of n=4 for a multiple comparison test, it was determined that, for Fratio's, October, March and April (months 1,6,7) formed one group, and November through February (months 2,3,4,5) a second group (a=0.05). Offshore effort was lower November through February, when dolphin abundance is least, and offshore sea conditions generally rougher (amberjack and offshore species targeted in winter months).

The multiple comparison test for CPUE of offshore fishing, type 2, indicates months 1-5, October through February, form a group such that CPUE is less for October through February, than for either March or April, the CPUE's for which are successively greater (a=0.05).

For offshore fishing, the pattern of CPUE vs Ratio by month is seen in the scattergram, Fig. 4. The grouping of month 1, October, with the late spring months (March and April) in Ratio, but with the winter months in CPUE, indicates that the boats carry their summer fishing patterns on through October, even though catch ability is declining.

It is also interesting to note the relative order of mean rank of month 5, February, third in CPUE, but fifth in Ratio, suggesting a comparable lag in beginning to fish offshore early in the season when abundance of dolphin apparently first begins to rise.

As seen in Figure 2, there is no linear relationship between Ratio and CPUE for any of the target fishing types, as would be expected if quantity of catch were the value which motivated fishing. Rather it is the type of catch itself which determines the relationship between CPUE and Ratio.

Examining the scattergram of Ratio with CPUE by Type (Fig. 2):

I. Type 2 pairs cluster loosely in two distinct groups.

II. Types 3, 4 and 5 combine to form a third separate pattern. The combination of these types will be called "specialty fishing".

The three groups seen in the scattergram:

Description	Target	Plot Character	No. of cases
1. inshore/ reeffishing	1	High CPUE Moderate to high Ratio	95
2. offshore/ trolling	2	High CPUE Low to moderate Ratio	52
3. specialty fishing	3, 4, 5	Low CPUE Variable Ratio	

The ranges, means and variances of CPUE and Ratio for each target type are found in Table 5, and the means plotted in Fig. 3b. Target types 3,4,5 combine to form target type S.

Target types 1 and 2 are similarly distributed with respect to CPUE, with means in the high range. They are differentiated visually by their range of Fratios.

The specialty fishing group S, composed of types 3,4 and 5, covers the full range of Fratios, with means intermediate to types 1 and 2, but are clearly differentiated from the other types by their range of CPUE, with means more than as order of magnitude less.

In Table 5, a non-linear variable "V", (/CPUE), has been calculated as a means of illustrating the relationship between CPUE and Ratio by fishing type , Regarding value, it would be expected that species of different values attract amounts of effort disproportionate to abundance or catch ability, changing the ratio "V". Species of high value should attract greater effort, in coax n to CPLTE, and have a high "V" ratio. Species of low value would attract less effort, regardless of abundance, resulting in a low "V" ratio.

We now have three methods of ranking the five types of f fishing according to importance. CPUE relates to abundance and catchability. Ratio describes the amount of work time apportioned to each type, which relates to commercial value, but the ratio "P' is most descriptive of the fort value of the type, the disproportionate amount of effort expended to catch a less common or more challenging sport fish.

Ranking fishing types by importance

Rank	**CPUE**	**Ratio**	**"V"**
I	1	1	5
II	2	5	3
III	4	3	4
IV	3	2	1
V	5	4	2

The primary species of fish belonging to each fishing type above, targeted by each of the three boats daring the first recorded season, are seen in Table 2. The species checked for each boat were considered very important within their type that season. The categories of the species indicate the primary use or disposition of the fish, food and bait being important commercial attributes, and game the primary sport attribute. Types 3, 4 and 5 are, almost exclusively, game categories (not all sharks, type 4, are considered game species). Type 2, offshore fish, is combination food and gamefish, and Type 1, containing most of the commercial species, primarily food or small-game fish. Of course, gamefish have their own commercial aspect, in tournaments and mounts; and many inshore/reeffish, particularly mackerels, barracuda and grouper, are attractive as small-game. The value of each of these species varies according to it's intended use on a given trip, as determined by the captain in his decision making process.

The actual order of target pressure can be measured by the Ratio, but the target preference is revealed by the sport value,"V", an indication of perceived intangible value.

It is important to remember that these rankings are only for the one I/0 and two offshore charter boats described in Table 3, and only for the October-April season. Specialties do vary between boats in general, and emphasis on fishing type does change considerably in the summer months when Type 2 fishing for dolphin becomes prominent in both catch and effort. None the less, these three boats display a well rounded and highly competent example of charter boat fishing in the Florida Keys, and this technique is s readily applicable to any combination of boat and season data.

Model accuracy

More than 80 percent of all fishing effort and catch presented in this paper are derived from reef fishing, which is the subject of extensive research worldwide (Munro, 1982).

Two of the ultimate goals presented by Richards and Bohnsack (1982) for coral reef management are to "develop management models that can accurately predict population changes as a result of natural and human influences" and "to integrate biological, social, economic, political and legal factors into management policies, practices and priorities".

Bannerot and Austin (1983) studied a segment of Florida Keys reef fishing, the headboat fishery for yellowtail snapper (***Ochyurus crysurus)*** in Islamorada. Bannerot and Austin discuss the inherent errors in using mean catch per unit effort to estimate the relative abundance (N) of fish, and suggest that knowledge is required of the CPUE distribution per fishing unit (e.g. boat-day). They state that "sport fish harvests should show characteristic CPUE frequency distributions, the skewness of which should depend on the amount of skill required to capture a species". Their observations are based on the skill gradient of 12-45 anglers fishing the same chum slick with a fairly homogenous yellowtail population, in which changing catchability due to skill gradient is reflected by a change in the skewness of the CPUE distribution with changes in N. In their study they observed an increasing rightward skew in CPUE distribution with increasing N, such that changes in mean CPUE "are increasingly smaller relative: to the magnitude of changes in N as N decreases".

Bannerot and Austin add that "one would expect the CPUE frequency distribution to become increasingly normal and less sensitive to changes in N with decreasing skill gradient, accompanied by a decreased bias in mean CPUE as an abundance estimator", and that "Fo probably will not be the replacement index for most commercial fisheries. Zero catches are less frequent and the gradient of skill…..is probably less".

In a guided sport f fishery such as the charter boat, the angler to some degree takes on the knowledge and preparation of the crew. Correct bait, tackle gone-on-one coaching by the crew practically eliminates Fo, the frequency of zero catch, (outside of specialty fishing for gamefish or use of specialized tackle which reduces catchability) making the CPUE distribution on the basis of skill closer to that of a commercial fishery. Fo is probably not suitable as a replacement for mean CPUE as an index of abundance in charter boat fishing, and other methods of reducing the bias in CPUE as an index of N in charter boat fishing must be considered. "Catchabilty models designed to make fishing effort proportional to the instantaneous fishing mortality coefficient" may not assume that CPUE is primarily density dependent in charter boat catch at all (Bannerot and Austin, 1984), but may relate more to factors affected by values on a given trip, such as tackle type and target preferences.

The decision making process.

“A wide array of 'satisfactions' are inherent in a successful fishing trip is addition to catching fish for food" (Prosser, 1985). Using any combination of measures of importance, the charter boat captain designs a trip to give value to the customer.

The charter captain is required to make daily decisions based on prevailing conditions and opportunities, in an attempt to produce the most successful, or optimal, fishing experience possible for his party on that day.

The factors which determine catch and effort in charter boat fishing are complex, and unlike the two-part relationship (fish and vessel) of fisheries which maximize catch, vary daily according to the overriding needs of a third party- the charter customer, which may range from a family outing, to a high stakes tournament, to an expedition to fill the home freezer.

Some conditions are given: season, boat capabilities, weather conditions, abundance and distribution of target fish. The captains' skills are relied on for knowledge of availability of bait and target fish, his ability to find them, attract them, and orchestrate their capture. Based on existing conditions and anglers' goals, the captain decides on the best target or combination of targets for that trip's effort, often offering the client a choice of options. Thus Ratio is actually determined by social considerations as well as fisheries practices.

CPUE is similarly affected. While the actions of the charter boat captain the size or abundance of a target fish, the catchability changes from trip to trip, by changing the difficulty of capture with tackle restrictions. The 1ighter and more specialized tackle, such as 1ight test, spin, plug, or fly, increases the sport and decreases the CPUE. Heavy test, wire line, or electric reels may be used to decrease the sport and increase the catch. The type of tackle to be used depends on the anglers goals, and is one of the variables affecting target options as well.

The effects of tackle types on CPUE can be seen by comparing the offshore boats, A and B, which specialize in live bait and spinning tackle, with the inshore/offshore boat C, which specializes in artificial lures, particularly plug and fly (see Table 3). The CPUE of boat C, in reef fishing and bill fishing, is significantly lower than that of the other boats (Table 8) because of fishing for species such as permit, jacks, and sailfish using the more specialized tackle. (p=0.0004, all fishing types combined). Unfortunately, the lack of consistency of boats A and B in reporting the types of tackle used on a daily or per catch basis prevents the CPUE's for different tackle types from being calculated here, but the offshore boats do report a marked decrease in CPUE on the relatively few occasions of fishing with fly or other highly restrictive tackle.

In terms of the fishing trip, value is not measured so much by quantity of fish, but by the overall "success" in satisfying the anglers goals, easily recognized, but more difficult to quantify. Success is dependent on the captains's expertise at evaluating the potential of each fishing option in conjunction with the variable requirements of the charter party.

Captain's decisions, which ultimately determine Ratio and CPUE, are influenced by a large number of considerations: economic, social and environmental. The flow charts, Models 1 and 2, summarize the important elements considered by captains during the decision making process regarding daily targeting of effort and disposition of caught fish in charter boat fishing is the Florida Keys.

Model 1, the decision making process determining target type, emphasizes knowledge of natural conditions and physical limits which modify the general social goals of the angler. The number of combinations of individual decisions is great and more than one target type per day often results. Because captains did not record catch by tackle type, target types are defined only by area and species fished for- although tackle type is equally important as a target type delimiter. In Model 1, tackle type is the first decision made, called "tournament restrictions", which includes all IGFA specifications for record fish, whether caught during an actual tournament or not. Tackle type is also a major consideration in Angler preference (3.), sport fishing, in which tackle is usually specified.

The factors considered in killing a fish or returning it 1 five to the water are laid out in Model 2. The criteria for releases vary greatly from catch to catch, even within species. Captains' recorded catches consist primarily of landings for inshore/ reef fish and offshore species, even though large numbers of fish in these categories are caught and released. The opposite is true for the larger game fish. Recorded catch of billfish and tarpon are almost entirely released fish.

The decision making process regarding caught fish is especially important to estimates of CPUE and N when released catch is not recorded as part of the daily catch. "Anglers frequently release fish that are large enough to keep under prevailing fishing laws. However, fisheries managers usually estimate only fishing effort and number of fish harvested when assessing a fishery, and simply assume this voluntary release of fish is unimportant."(Clark, 1983). Clark's work with trout indicated that the release of legal-sized fish reduced the total mortality rates of the populations, and that as release rates increased, total harvest decreased, total catch (including fish released) increased, and harvest of trophy fish remained constant. He states that "release rates higher than 10 percent change the interpretation of conventional creel census estimates of catch and fishing mortality. The actual catch will be higher than indicated by a survey of fish in the creel, and the fishing mortality rates computed from these data will underestimate the true catch rate. Thus the relationship between catch and effort in recreational fisheries will change as the views of the fishermen on releasing fish change. Managers of sport fisheries need to estimate the voluntary release rate, along with harvest and fishing effort, if they want to assess a fishery accurately."

Summary

This paper shows evidence of the influence of target type on CPUE (numbers of a given target type caught per boat-day) and Ratio (percent target type days fished per month) for one inshore/offshore and two off shore charter boats in the Florida Keys, using seasonal catch records for a five year period.

Target types were divided into five categories: (1) inshore/ reeffishing, (2)offshore/trolling, (3)billfishing, (4)shark fishing, and (5)tarpon/flats fishing. Each day fished, and each fish caught, was assigned to a target type. Mean CPUE and Ratio for each target type were calculated by boat and month.

For the three boats examined, the difference between fishing areas and boat types did not demonstrably affect Ratio of target types, or CPUE far offshore, shark, or tarpon fishing.

The data presented indicate that target type is a significant factor influencing both CPUE and Ratio. The divisions of (1) inshore/reef fishing, (2t offshore fishing, (3)billfishing, and (4)sharkfishing , all are shown to be distinctly unique by comparing their catch and effort parameters using a combination of Ratio and CPUE. For the inshore/offshore type vessel, the shallow water type (5) fishing grouped with the billfishing type (3) of the offshore boats in CPUE and Ratio.

A "sport value" statistic "V" was def fined as the ratio/CPUE, which relates the proportion of actual effort devoted to a given target type to the actual catch rates observed for that target type. The "V" statistic is nonlinear and is used to rank the relative importance of the different target types to game fishermen in terms of sport value. For the combination of offshore and inshore/offshore boats examined by this rating system, tarpon/flats fishing and billfishing ranked as most valuable, followed by shark, inshore/reef and offshore fishing.

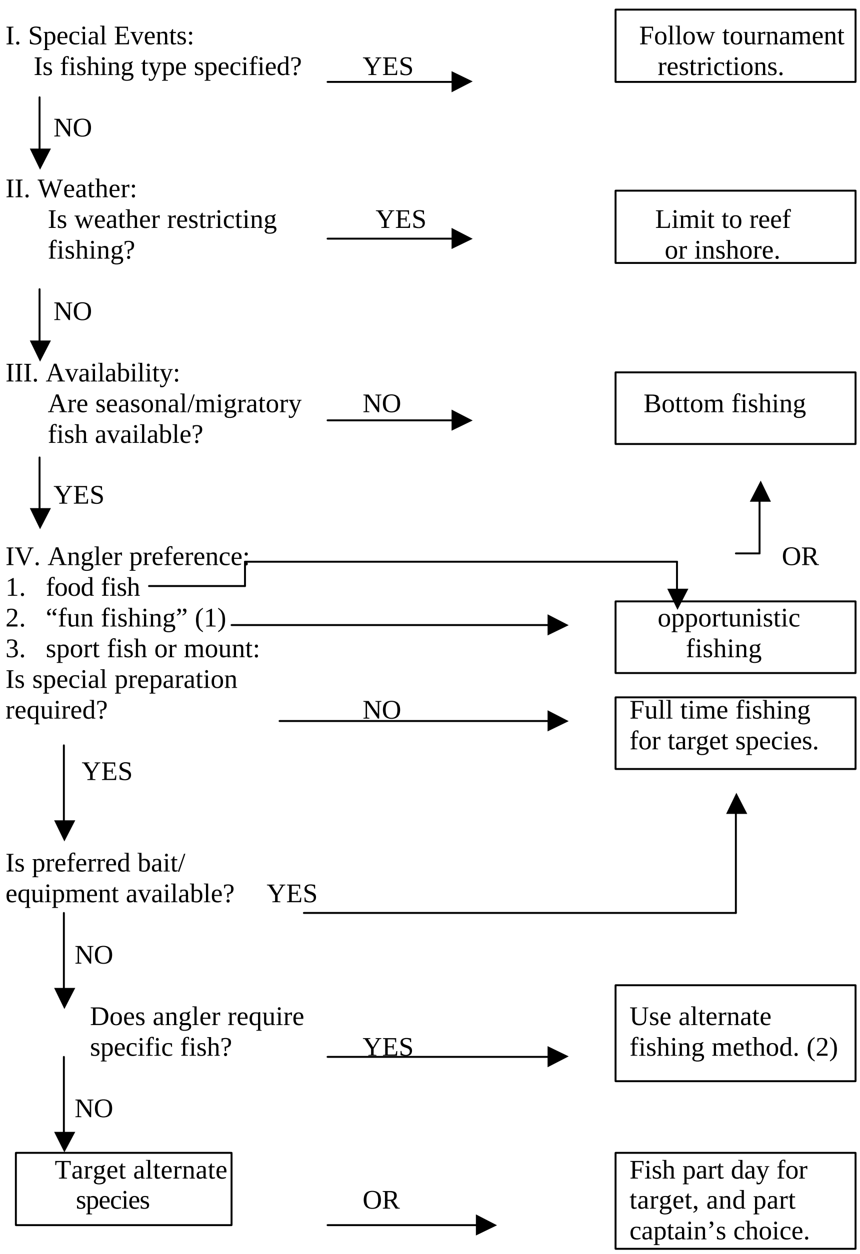
Tackle types were assumed to be comparable within each target type and were treated as a constant, which caused some anomalous results. CPUE differed significantly within target types when different tackle types were used, according to the stated preferences of the captains. The inshore/offshore boat in particular used primarily fly or very light test line in fishing for certain species, or while attempting to catch record fish. The result was significantly lower CPUE's for the inshore/offshore boat, only for fishing types in which specialized tackle was preferred, indicating

that for a true and accurate description of sport fishing CPUE tackle type must be considered as well as target type.

The recording of released catch is the third major variable, which affected CPUE data. The criteria for recording releases varied tremendously from type to type (and from boat to boat). For the game species, particularly billfish and tarpon, fish were released as a sporting gesture as well as a conservation measure, and recorded catch consists primarily of fish released. A number of inshore/reeffish and offshore/trolling fish caught are released as excess or undesirable, or used for bait, and not recorded in the total catch. The charter boat CPUE for inshore/ reeffish and offshore/trolling fish, already high, would be even higher if the total catch, including fish caught but not delivered to the dock, were accurately recorded. Without such recordings, charter boat CPUE for these types of catch is more an index of how many fish the captains choose to retain than an index of abundance.

A combination of uncertainty factors are used to describe the daily decision making processes of the three captains in determining target type. Captains used knowledge of existing conditions and practical limits to modify the general social goals of the angler, producing one or several options for the day’s fishing, and more than one target type per day often resulted. Each test-day was assigned to it's dominant or most specialized target category. The results indicate that a complete and accurate description of catch and effort , should take into account possible changes in, or combinations of, target types within one fishing trip, and should identify the catch according to the target at the time.

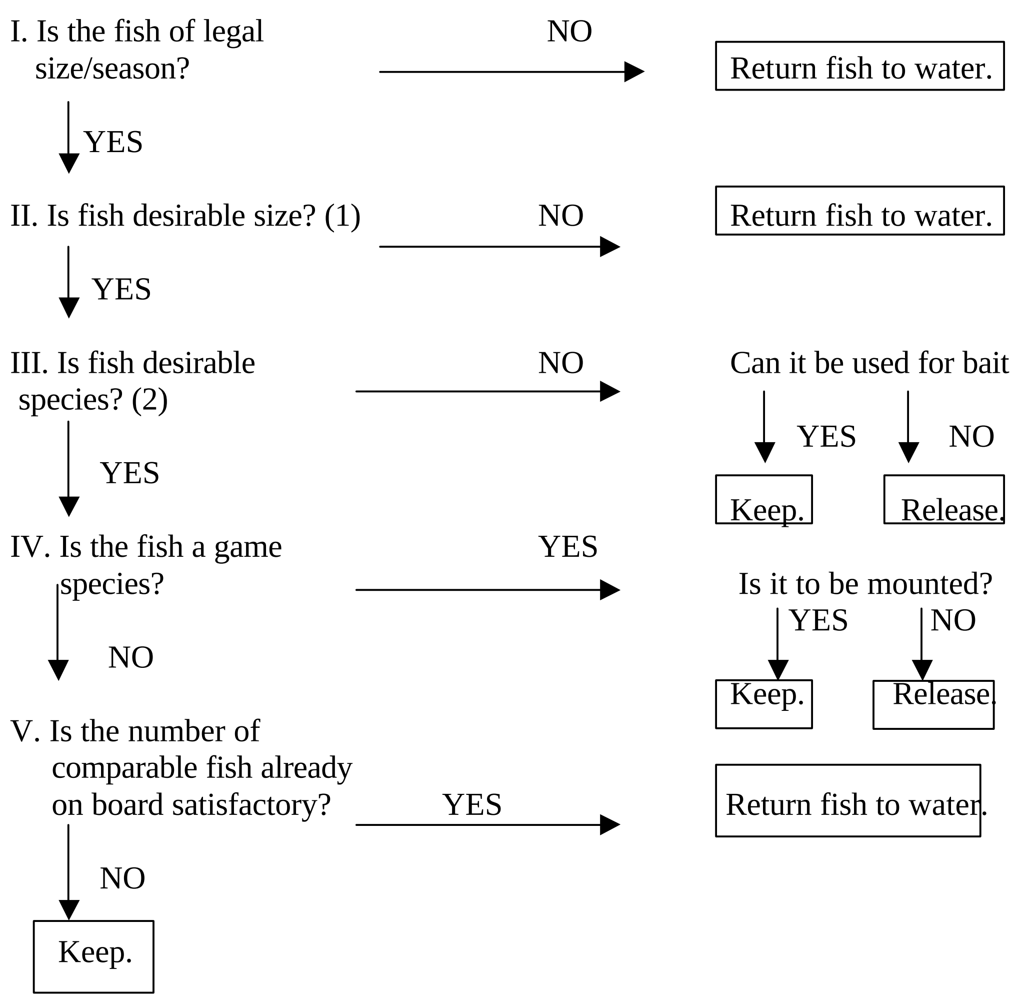
MODEL 1: Daily Decision Making in Charter Fishing



(1) "fun fishing options may target: big fish, large numbers of fish, exploratory fishing, commercial fishing, other boating, swimming or diving.

(2) Other live bait, dead bait or artificials.

MODEL 2: Decision making regarding caught fish.



(1) Compare to other fish caught that trip, or a good size for bait.

(2) Edible, unusual, or commercially valuable.

Index of Figures and Tables

Table 1: Fish Codes and Target Groups

**100 REEF FISH	
Bermuda chub, cottonwick, grunts, margate, rainbow runner, sand perch, santile speedo, triggerfish, trunkfish	Pomadasyidae, Balistidae, etc.
101 baracuda	Sphyraena barracuda
102 bluefish	Pomatomus saltarix
103 cobia	Rachycentron canadum
104 hogfish	Lachnolaimus maximus
105 porgies	Sparidae
*110 GROUPERS	Serranidae
coney, strawberry	
111 black	Mycteroperca bonaci
112 gag	Mycteroperca microlepsis
113 Nassau	Epinephelus striatus
114 red	Epinephelus morio
115 scamp	Mycteroperca phenax
116 jewfish	Epinephelus itajara
*120 SNAPPERS	Lutjanidae
blackfin, glasseye, lane,	

silk, vermillion, yelloweye

121 mangrove	Lutjanus griseus
122 mutton	Lutjanue analis
123 red snapper	Lutjanus campechanus
124 yellowtail	Ochyurus crysurus
125 cubera	

*130 JACKS	Carangidae
almaco, barjack, yellowjack	
rainbow runner	
131 blue runner	Carnx crysos
132 crevalle jack	Caranx hippos
133 pompano	Trachinotus carolinus
134 African pompano	Alectis critinus
135 permit	Trachinotus falactus

*140 MAKEREL	Scombridae
141 cero mackerel	Scomberomorus regalis
142 Spanish mackerel	
Scomberomorus maculates	
143 king mackerel	Scomberomorus cavalla

**200 OFFSHORE FISH

ocean perch, rudderfish

201 dolphin	Coryphaena spp.
202 tilefish	
203 amberjack	Seriola dumerili

*210 GROUPERS	Serranidae
yellowfin	
211 speckled hind (Kitty Mitchell)	Epinephelus drummondhayi
212 snowy grouper	Epinephelus niveatus
213 warsaw grouper	Epinephelus nigritis
*240 TUNAS	Scombridae
arctic, bonito, skipjack	
241 yellowfin tuna (Allison)	Thunnus albacares
242 blackfin tuna	Thunnus atlanticus
243 little tunny (bonito)	Euthynnus alletteratus
244 skipjack tuna	Katsuwonus pelamis
245 wahoo	Acanthocybium solanderi
*300 BILLFISHES	
spearfish, swordfish	
301 sailfish	Istiophorus platypterus
302 blue marlin	Makaira nigricans
303 white marlin	Terapturus albidus
*400 SHARKS	
Cuban night shark, bonnethead, dusky,	
lemon, nurse, spinner	
401 hammerhead	Sphyrna spp.
402 mako	Isuris oxyrhinchus
403 tiger	
404 bull	
500 tarpon	Megalops atlanticus

501 bonefish	Albula vulpes

Table 2: Species designated as targets, by boat, season 1

	A	B	C	category
100 reeffish	x	x	x	food fish
120 snappers**	x	x		food fish
124 yellowtail**	x	x		food fish
135 permit			x	gamefish
140 mackerels	x			bait/food fish
143 king mackerel**	x	x	x	food/gamefish
200 offshore fish	x	x	x	food/gamefish
201 dolphin**		x		food fish
230 amberjack-		x		game/bait fish
240 tunas-		x	x	food/gamefish
300 billfish		x		gamefish
301 sailfish	x	x	x	gamefish
302 blue marlin		x		gamefish
400 sharks-		x	x	gamefish
500 tarpon*			x	gamefish
501 bonefish*			x	gamefish

* inshore/offshore boats only

** commercial market

- secondary commercial market, mostly restaurants

Table 3: Boat Characteristics, season 1

Charter boat	A	B	C
Year capt. began charter in keys	1973	1976	1972
Home port	Islamorada	Islamorada	Key West
Fishing specialty	live bait/ light tackle	ive bait/ light tackle	art. lures/ light tackle
Boat manufacture	Bertram	Enterprise	Seacraft
Boat length	38’	37’	20’
Boat draft	3’ 8”	3’ 4”	24”
Day fishing range	30 mi.	30 mi.	60 mi.
No. of crew	2	2	1
Max. passengers	6	6	4
Suitable for flats	no	no	yes
Bait/tarpon skiff	17’ Mako	17’ Mako	-

Table 4: Catch and Effort by Target Type

B=boat	Targ1=reef/inshore fish	(100's)
M=month	Targ2=offshore fish	(200's)
D=days/month	Targ3=billfish	(300's)
F=fish/month	Targ4=sharks	(400's)
S=season	Targ5=shallow water fish	(500's)

B	M	Targ1		Targ2		Targ3		Targ4		Targ5		Total		S
		D	F	D	F	D	F	D	F	D	F	D	F	
1	1	05	069	00	000	01	01	00	00	00	00	06	070	1
1	2	16	542	01	014	02	04	00	03	00	00	17	563	1
1	3	10	571	03	073	06	05	00	00	00	00	19	649	1
1	4	08	207	02	014	03	02	00	00	00	00	13	223	1
1	5	10	368	03	074	04	01	00	00	00	00	17	443	1
1	6	07	204	03	055	03	08	00	00	00	00	13	267	1
1	7	08	133	02	018	00	01	00	02	00	00	10	154	1
2	1	07	139	00	002	02	04	02	03	00	00	11	148	1
2	2	13	304	01	013	02	02	00	01	00	00	16	320	1
2	3	10	268	01	026	08	10	01	00	00	00	20	304	1
2	4	07	182	00	004	07	08	00	00	00	00	14	194	1
2	5	14	272	02	026	08	05	00	00	00	00	24	303	1
2	6	18	520	00	011	07	11	00	01	00	00	25	543	1
2	7	10	290	04	111	00	00	00	00	00	00	14	401	1
3	1	19	276	01	038	00	00	00	04	00	00	20	318	1
3	2	15	239	00	015	02	00	01	05	00	00	18	259	1
3	3	19	421	00	041	01	00	00	00	03	02	23	464	1
3	4	17	558	00	016	00	01	00	00	07	15	24	590	1
3	5	15	531	00	019	00	00	01	02	07	06	23	558	1
3	6	09	231	01	030	00	00	14	22	00	00	24	283	1
3	7	10	064	00	022	00	01	05	03	7	17	22	107	1
1	1	09	200	04	052	00	00	00	00	00	00	13	252	2
1	2	08	387	01	004	04	00	00	00	00	00	13	391	2
1	3	00	000	00	000	04	07	00	00	00	00	04	007	2
1	4	09	243	03	03	05	02	00	02	00	00	17	279	2
1	5	13	601	02	056	07	04	00	01	00	00	22	660	2
1	6	14	486	06	123	01	03	00	02	00	00	21	614	2
1	7	09	387	03	149	11	44	00	01	00	00	23	581	2
2	1	08	245	04	052	02	02	02	01	00	00	16	300	2

2	2	17	611	00	001	01	05	00	00	00	00	18	617	2
2	3	18	676	100	006	05	04	01	02	00	00	24	688	2
2	4	11	360	00	000	10	06	00	00	00	00	21	366	2
2	5	13	427	03	062	07	16	00	00	00	00	23	505	2
2	6	20	785	00	030	04	01	01	01	00	00	25	817	2
2	7	09	345	07	331	05	09	01	01	00	00	22	686	2
3	1	10	220	09	364	00	00	00	02	00	00	19	486	2
3	2	11	109	00	010	00	00	00	02	00	00	11	131	2
3	3	15	315	00	015	00	00	00	02	08	03	24	335	2
3	4	19	420	00	046	00	00	00	00	00	00	19	466	2
3	5	08	277	00	019	00	00	00	00	06	16	14	310	2
3	6	07	189	00	035	00	00	10	15	05	00	22	239	2
3	7	07	062	00	045	00	00	01	04	17	25	25	136	2
1	1	09	275	01	008	00	01	00	02	00	00	10	286	3
1	2	09	302	03	072	04	01	01	01	00	00	17	376	3
1	3	10	552	00	011	05	05	01	00	00	00	16	568	3
1	4	12	607	01	028	08	18	00	03	00	00	21	656	3
1	5	15	576	03	072	02	02	00	01	00	00	20	651	3
1	6	18	534	06	118	00	03	00	01	00	00	24	656	3
1	7	15	616	06	177	00	00	00	01	00	00	21	794	3
2	1	10	286	00	005	01	00	00	00	00	00	11	291	3
2	2	13	592	01	012	05	00	00	00	00	00	19	604	3
2	3	06	371	00	005	16	31	00	00	00	00	22	407	3
2	4	11	465	00	008	12	29	00	00	00	00	23	502	3
2	5	09	809	00	004	05	09	00	00	00	00	24	822	3
2	6	21	747	02	045	03	03	01	01	00	00	27	796	3
2	7	13	450	06	180	00	00	00	00	00	00	19	630	3
3	1	09	143	01	035	06	05	00	00	01	00	17	183	3
3	2	05	137	00	017	05	02	01	07	00	00	11	163	3
3	3	17	392	00	007	01	00	03	05	00	05	21	409	3
3	5	12	272	00	015	00	00	04	04	05	03	21	294	3
3	6	11	153	00	025	00	00	04	03	10	13	25	176	3
3	7	06	066	02	063	00	00	03	02	13	08	24	139	3
1	1	05	131	02	005	05	03	00	01	00	00	11	140	4
1	2	06	280	01	019	12	09	00	00	00	00	19	308	4
1	3	10	552	01	035	06	04	00	00	00	00	17	591	4
1	4	19	693	00	014	04	03	00	01	00	00	23	711	4
1	5	15	732	01	044	03	05	00	01	00	00	19	782	4
1	6	05	352	01	055	01	00	04	03	00	00	11	410	4
1	7	09	508	03	060	02	03	00	00	00	00	14	571	4
2	1	05	215	03	049	06	03	02	01	00	00	16	268	4
2	2	11	648	00	025	04	03	00	00	00	00	15	676	4
2	3	12	641	01	011	11	08	00	01	00	00	24	661	4

2	4	16	768	00	007	06	02	00	00	00	00	22	777	4
2	5	14	644	01	019	03	05	00	00	00	00	18	668	4
2	6	15	450	00	010	02	02	00	00	00	00	17	462	4
2	7	09	266	08	242	01	00	00	01	00	00	18	209	4
3	1	00	013	00	000	00	00	00	00	01	0	01	013	4
3	2	11	133	01	025	07	03	00	00	01	00	20	161	4
3	3	14	195	00	018	02	01	00	01	04	03	20	218	4
3	4	11	092	01	024	00	00	00	0	01	00	13	116	4
3	5	13	169	00	056	01	00	00	00	02	00	16	214	4
3	6	06	111	00	012	00	00	10	07	00	00	16	130	4
3	7	09	066	03	106	00	00	05	06	06	05	23	183	4
1	1	04	200	02	062	00	02	00	01	00	00	06	265	5
1	2	04	188	00	034	11	04	00	01	00	00	15	226	5
1	3	14	673	00	049	08	04	00	00	00	00	22	726	5
1	4	04	250	00	001	01	02	00	00	00	00	05	253	5
1	5	22	1216	01	088	02	05	00	00	00	00	25	1309	5
1	6	13	1054	04	152	07	09	00	02	00	00	24	1217	5
1	7	10	208	12	416	01	00	00	01	00	00	23	625	5
2	2	06	267	00	014	12	07	00	00	00	00	18	288	5
2	3	10	470	00	006	11	12	00	00	00	00	21	488	5
2	4	09	836	00	018	06	07	00	00	00	00	25	861	5
2	5	16	571	00	006	05	03	00	00	00	00	21	580	5
2	6	17	941	04	102	04	07	00	00	00	00	25	1050	5
2	7	18	692	03	172	00	02	01	02	00	00	22	868	5

Table 5: Mean values of CPUE and Ratio.

Type	s		X	s	Range		"V" *
1	95	CPUE	34.89	17.32	6.40-92.89		0.01779
		Fratio	0.621	0.184	0.25-1.00		
2	52	CPUE	26.08	15.12	2.50-88.00		0.00617
		Ratio	0.161	0.118	0.04-0.52		
*3	68	CPUE	1.07	0.97	0.00-5.00	*	0.25887
*		Ratio	0.277	0.191	0.04-1.00	*	
*							
S-*4	26	CPUE	1.88	2.27	0.00-10.00	*	0.08564
*		Ratio	0.161	0.166	0.04-0.63	*	
*							
*5	19	CPUE	0.84	0.85	0.00-2.67	*	0.36547
*		Ratio	0.307	0.234	0.05-1.00	*	
S	113	CPUE	1.22	1.40	0.00-10.00		0.20902
		Ratio	0.255	0.199	0.04-1.00		

* "V"= ratio of the means,/CPUE

Table 6: Mean Ranks: Kruskall-Wallis 1-way ANOVA

I. CPUE

	p	Mean Rank	n	Type	
	1	194.48	95	1	
	2	170.04	52	2	
	3	67.62	26	4	H=193.4313 corrected for ties
	4	55.22	67	3	p<0.00001
*					
	5	47.05	19	5	
			259	Total	

II. Ratio

	p	Mean Rank	n	Type	
	1	201.25	95	1	
	2	115.82	19	5	
**					
	3	106.47	67	3	H=148.7698 corrected for ties
	4	69.33	52	2	p<0.00001
**					
	5	62.02	26	4	
			259	Total	

Results of pairwise nonparametric multiple comparisons, k=5, n=19 subsamples.

* Accept Ho: groups are the same at =0.001
** Accept Ho: groups are the same at =0.05 and =0.001
Reject Ho for all other pairs at =0.05 and =0.001

Table 7: Type 2: Offshore fishing, K-W 1-way ANOVA

I. CPUE, n=52

	p	Mean Rank	n	Months	
	1	36.46	12	7	
	2	29.50	8	6	
	3	28.81	8	5	
	4	26.38	4	3	H=12.4944 corrected for ties p=0.0518
*	5	22.33	9	1	
	6	16.38	4	4	
	7	14.57	7	2	

II. Ratio, n=52

	p	Mean Rank	n	Months	
	1	38.21	12	7	
*	2	33.67	9	1	
	3	28.56	8	6	H=19.5275 corrected for ties p= 0.0034
	4	21.13	4	4	
	5	18.81	8	5	
**	6	14.43	7	2	
	7	13.00	4	3	

* Accept Ho: groups are the same at =0.05
** Accept Ho: groups are the same at =0.01
Reject Ho for all other pairs at =0.05

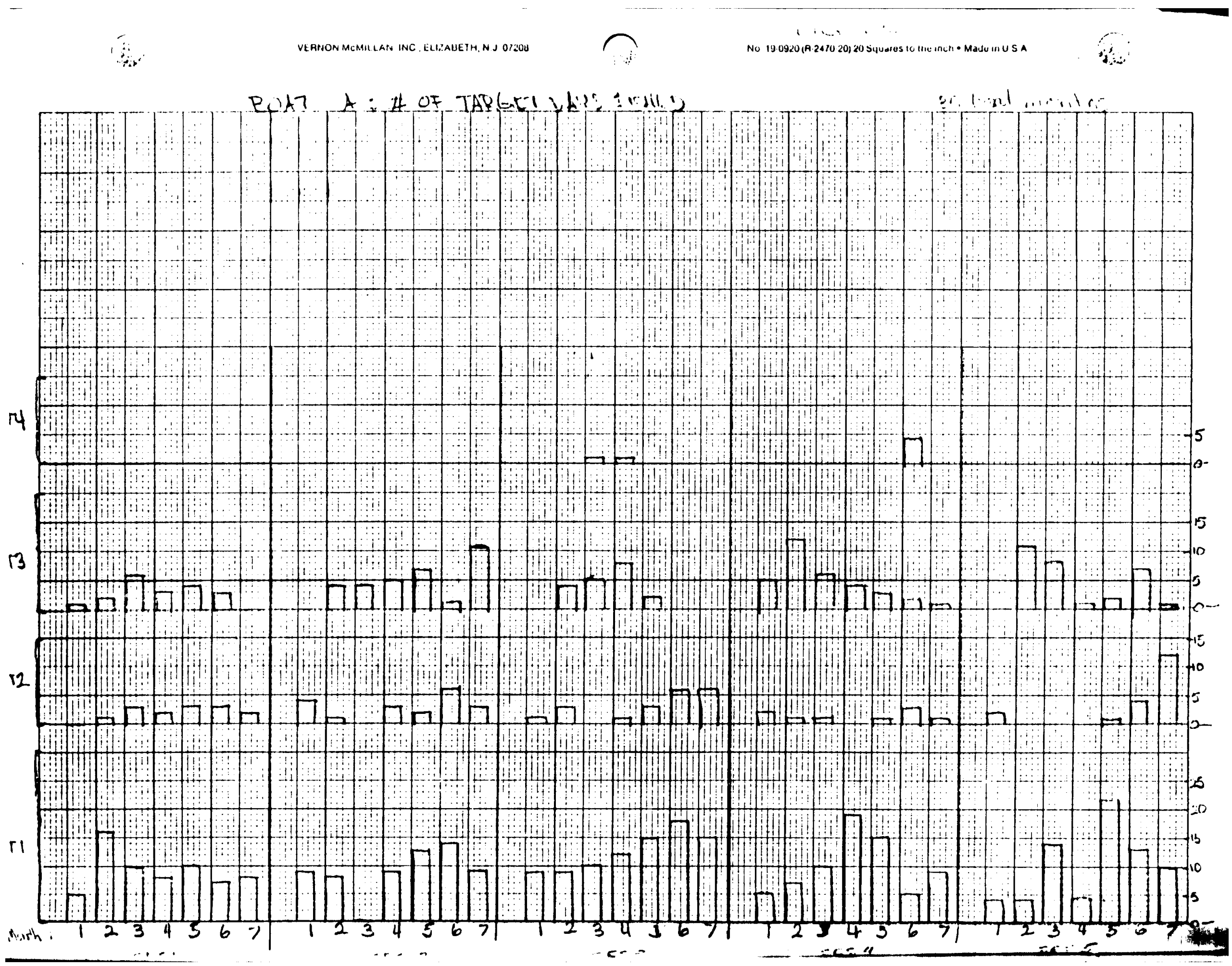
Table 8: Mean Ranks of Boats

I. CPUE

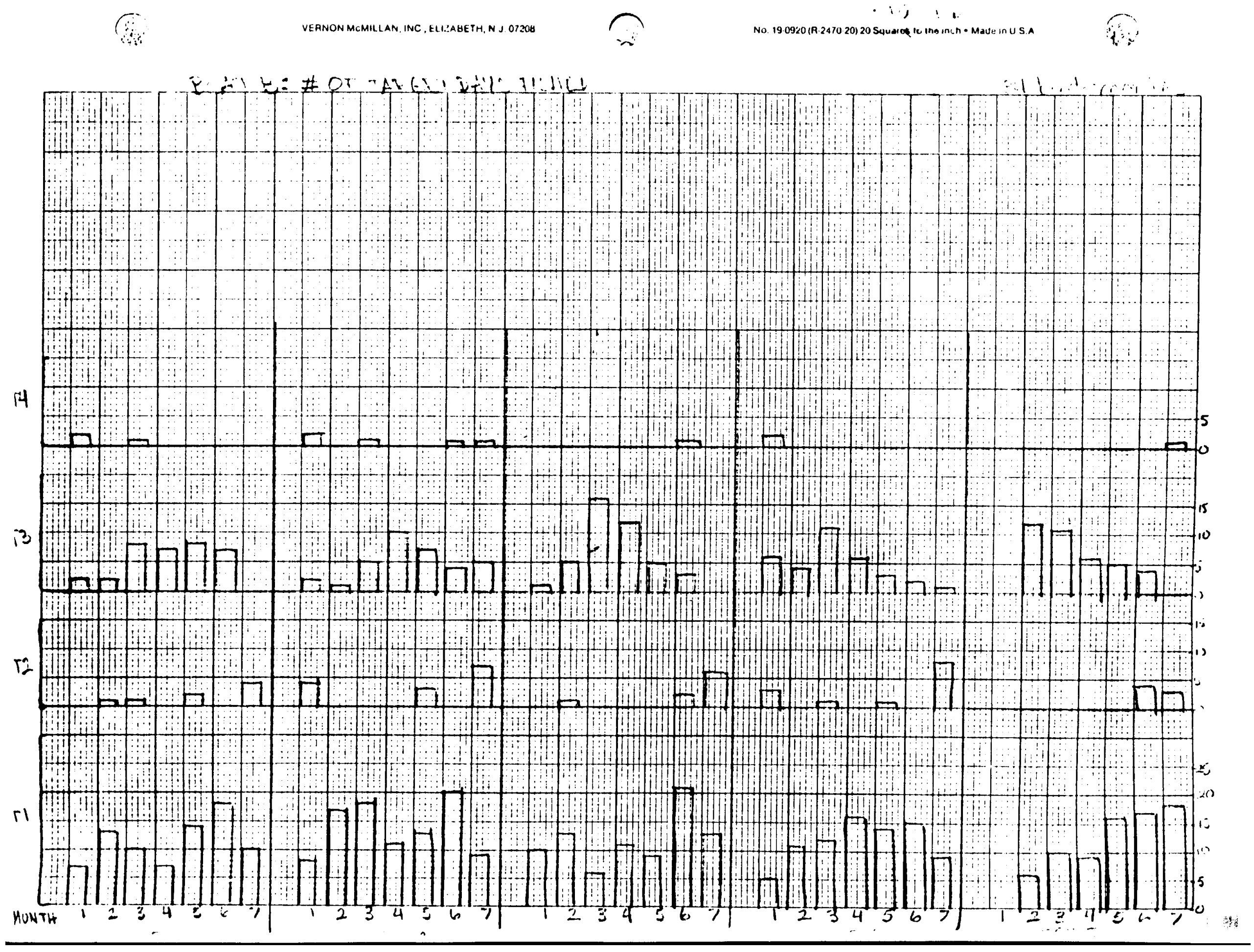
Type	Boat	n	Mean Rank	
	A	34	60.81	
1	B	34	57.56	H=39.6138 corrected for ties
	C	27	19.83*	p<0.00001*
	A	15	14.70	
2	B	10	12.30	H=2.5142 corrected for ties
	C	3	20.83	p=0.2845
	A	28	36.45	
3	B	31	37.08	H=10.1213 corrected for ties
	C	8	13.50*	p=0.0063*
	A	3	7.33	
4	B	9	11.44	H=4.3130 corrected for ties
	C	14	16.14	p=0.1157
5	C	boat C only		
	A	80	134.62	
ALL	B	84	124.09	H=15.7939 corrected for ties
	C	71	92.07*	p=0.0004*

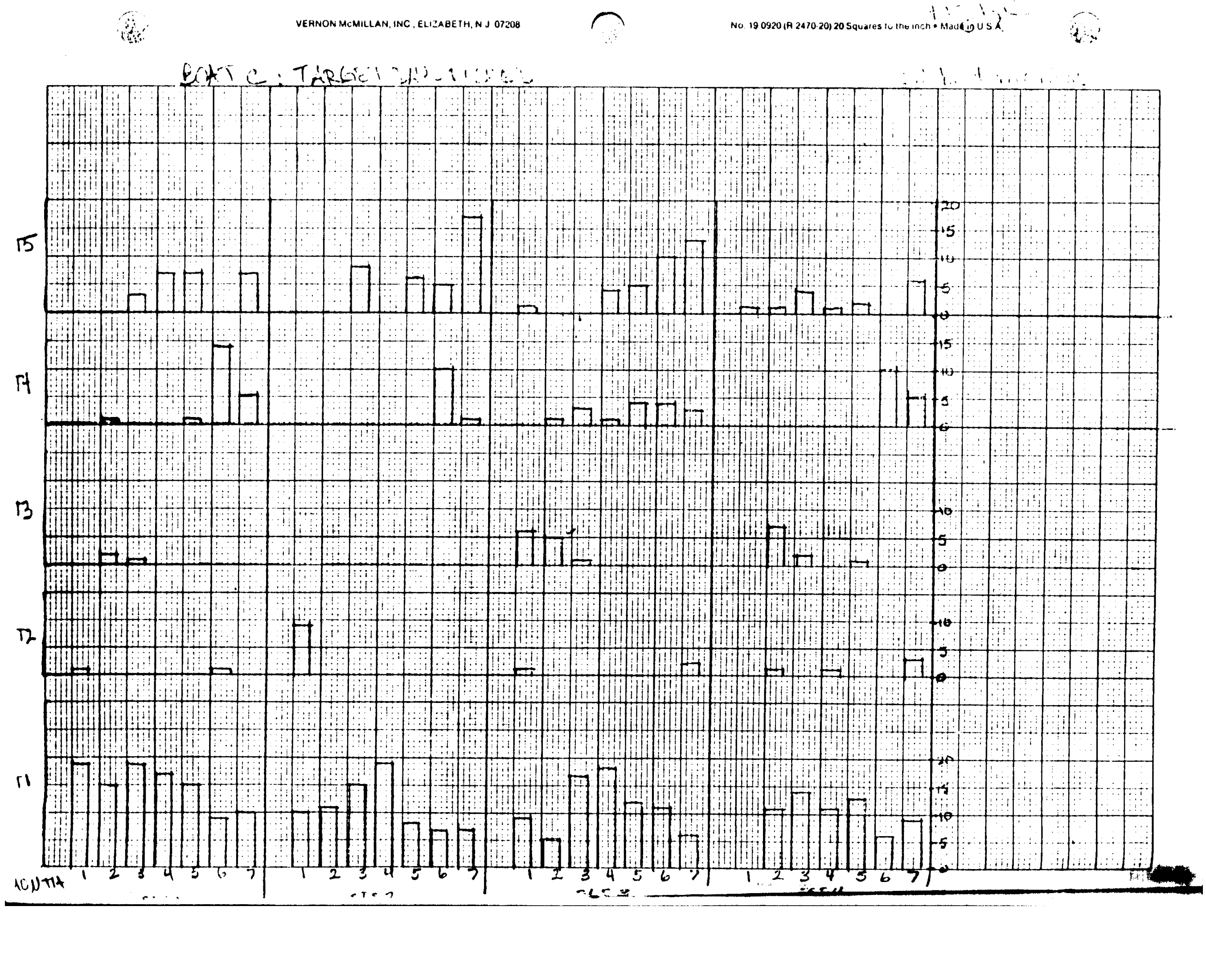
*significant difference

II. Ratio: no significant differences for any boat in any type.



VERNON McMILLAN INC., ELIZABETH, N.J. 07208
No. 19-0920 (R-2470-20) 20 Squares to the inch • Made in U.S.A.
r4
r3
r2
r1
Month: 1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 2 3 4 5 6 7


VERNON McMILLAN, INC., ELIZABETH, N.J. 07208
No. 19 0920 (R 2470 20) 20 Squares to the inch • Made in U.S.A.
MONTH

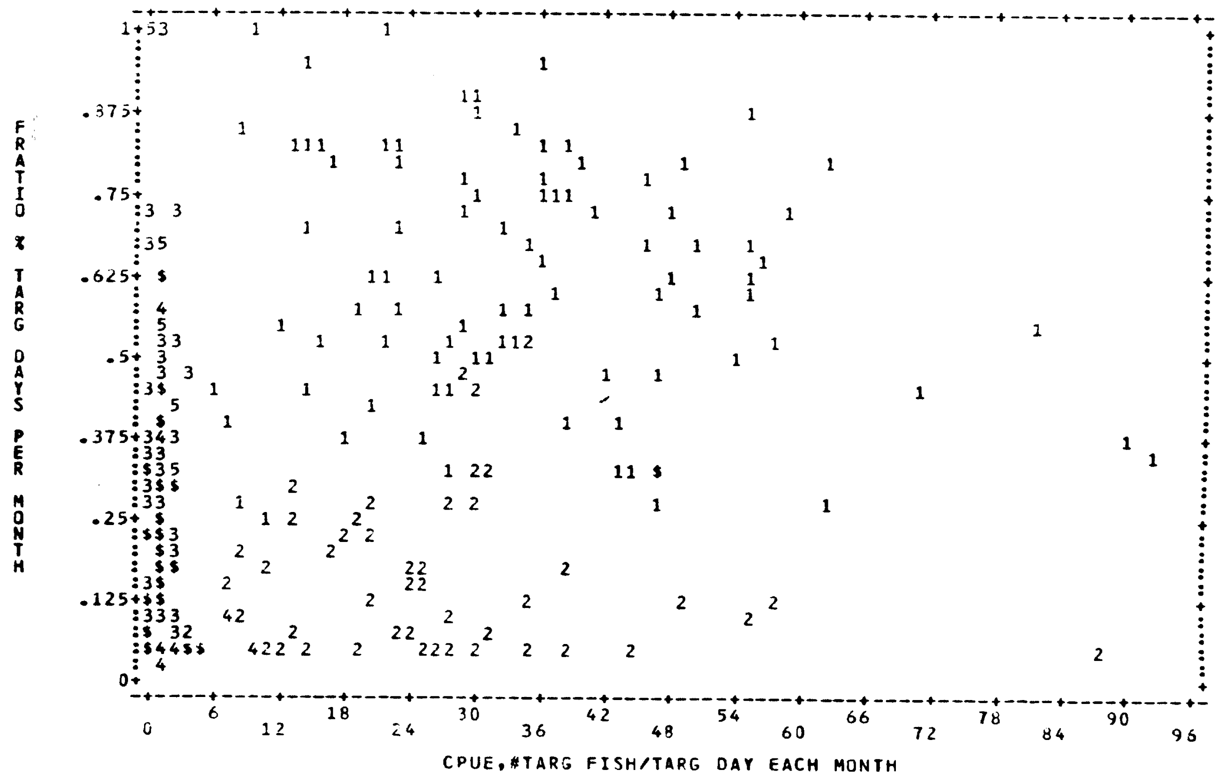


VERNON McMILLAN, INC., ELIZABETH, N.J. 07208
No. 19 0920 (R 2470-20) 20 Squares to the inch • Made in U.S.A.
T5
T4
T3
T2
T1

FIG. 2.

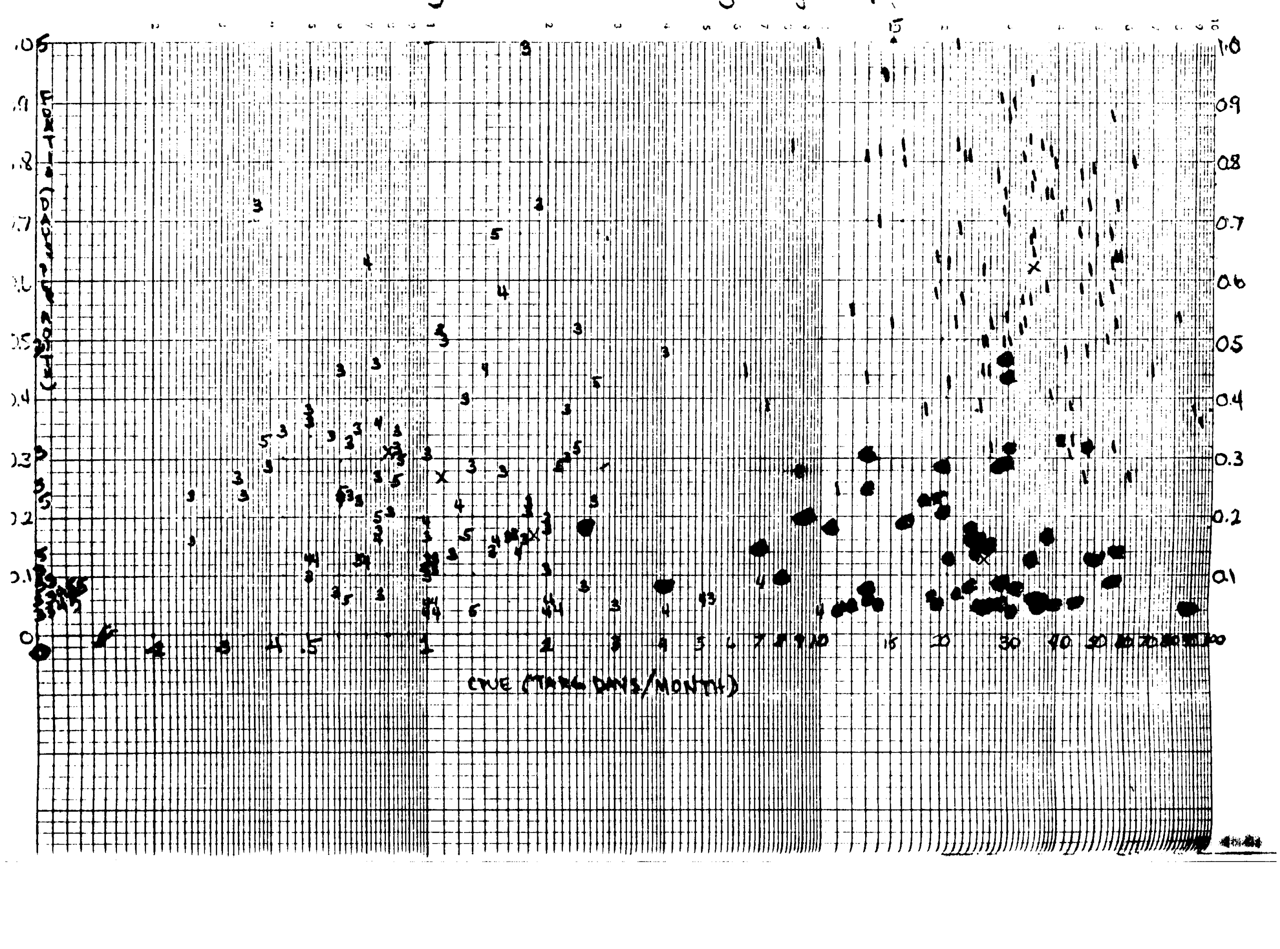
27-JAN-87 SPSS-X RELEASE 2.1 FOR VAX/VMS
12:44:43 RSMAS COMPUTER FACILITY . DEC VAX-11/780 VMS V4.4

FRATIO WITH CPUE BY TARGET,ALL BOATS



1:F1 WITH E1 95 cases 2:F2 WITH E2 52 cases 3:F3 WITH E3 68 cases 4:F4 WITH E4 26 cases 5:F5 WITH E5 19 cases $:Multiple occ

Log CPUE with Fratio by Target Type



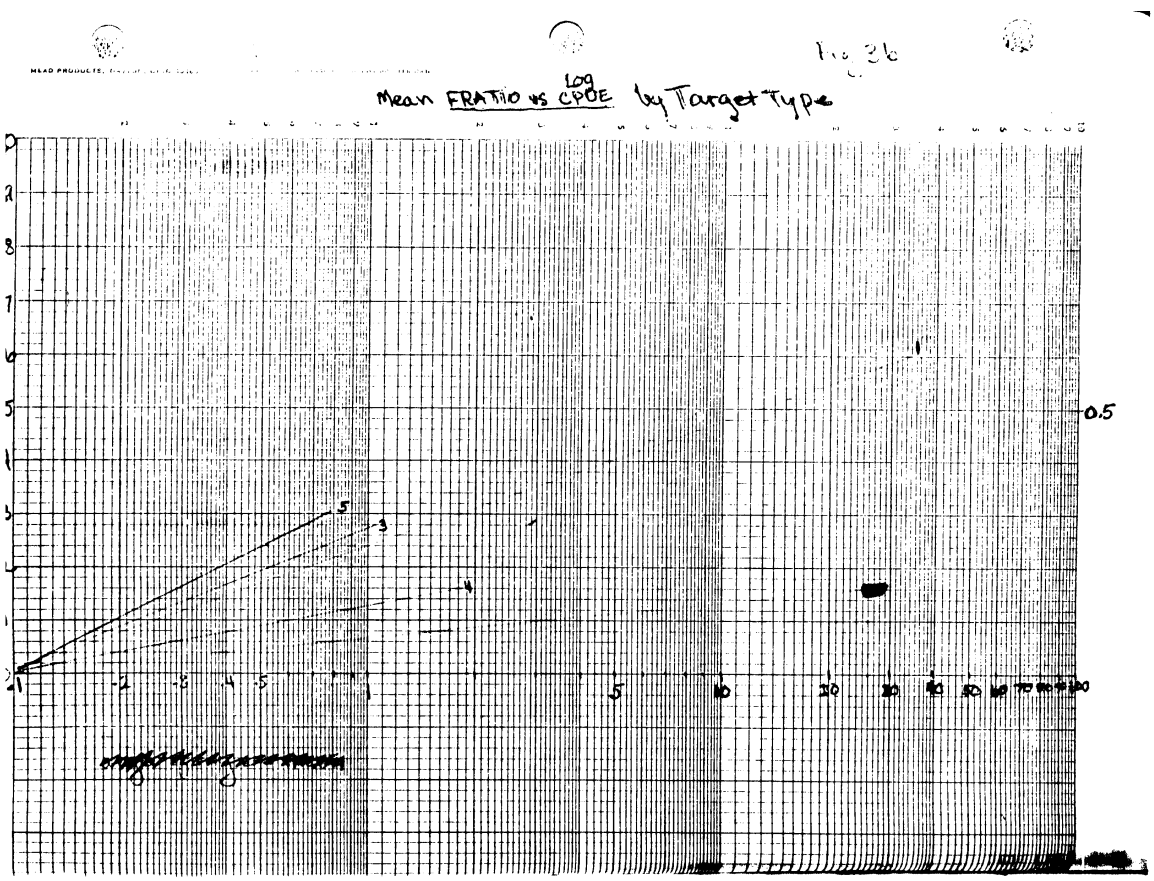
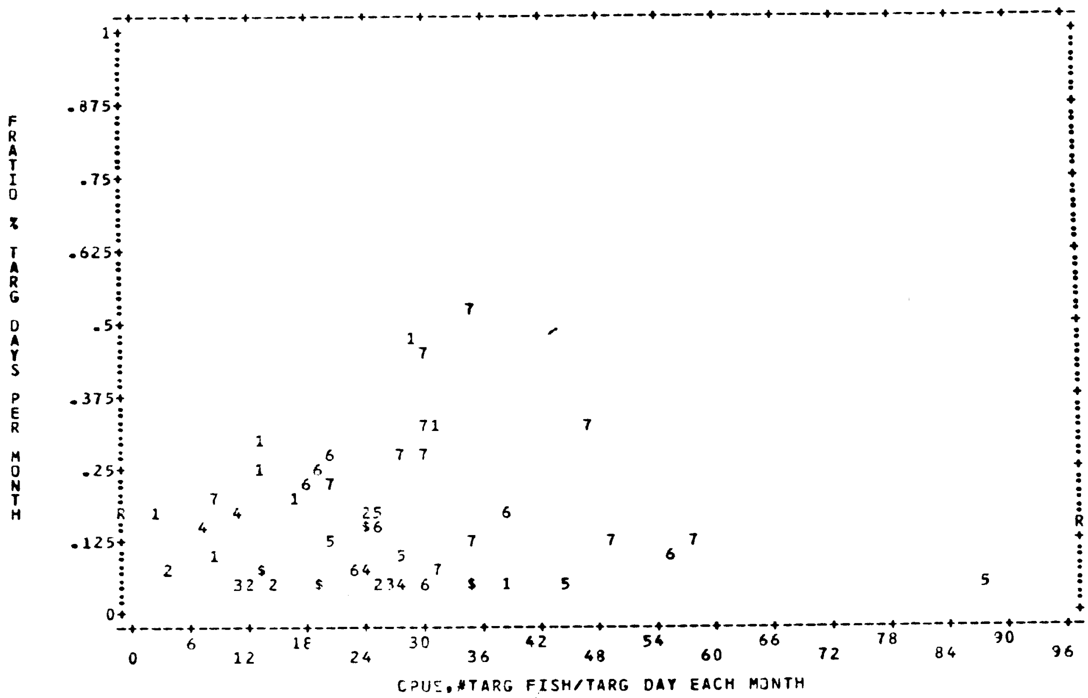


Fig 3b
Mean FRATIO vs log CPOE by Target Type
0.5
5
3
4
.1
.2
.3
.4
.5
1
5
10
20
30
40
50
60
70
80
90
100

FIG 4.

19-MAR-87 SPSS-X RELEASE 2.1 FOR VAX/VMS
15:23:28 RSMAS COMPUTER FACILITY DEC VAX-11/780 VMS V4.4

FRATIO WITH CPUE BY MONTH,TYPE 2



52 cases plotted. Regression statistics of F2 on E2:
Correlation -.01534 R Squared .00024 S.E. of Est .11951 2-tailed Sig. .9141
Intercept(S.E.) .16420(.03329) Slope(S.E.) -0.00012(.00111)
Use first digit of MONTH as plotting symbol and $ for multiple occurrence.

Literature Cited

Bannerot, S. 1982. Incorporating frequency distribution of catch per unit effort into recreational and other fishery starts tics. M.S. Thesis, Univ. Miami, 41p

Bannerot, S. and Austin, B. 1983. Using frequency distributions of catch per unit effort to measure fish stock abundance. Trans. Am. Fish. Soc. 112(5): 608-617

Browder, J. 1979. Study of the structure and economics of the paying passengers recreational fisheries of the Florida Gulf Coast and Keys, from Pensacola to Key West. Project Report. NMFS, Miami, FL. 125 p.

Browder, J., Davis, J. and Sullivan, E. 1981. Paying passenger recreational fisheries of the Florida Gulf Coast and Keys. Mar. Fish. Rev. 43(8):12-20

Brusher, H., Trent, L., and Williams, M. 1978. Recreational fishing for king mackerel in Bay County, Florida, during 1975. In Austin, et al. (eds.), Mackerel Workshop Report, p. 120-142. U. Miami Sea Grant Spec. Rep. 14

Brusher, H., Williams, F., Trent, L., and Palo, B. 1984. Using charterboat catch records for fisheries management. Mar. Fish. Rev. 46(3):48-55

Clark, R. 1983. Potential effects of voluntary catch and release of fish on recreational fisheries. N. Am. J. Fish. Man. 3:306-314.

Gentle, III., E. 1977. The charter boat sport fishery of Dade County, FL M.S. Thesis, Univ. Miami, 162 p.

Moe, M. 1963. A survey of offshore fishing in Florida. Fla. St. Bd. Conserv., Mar. Res. Lab., Prof. Pap.4. 115p.

McClane, A. 1970. Field guide to saltwater fisheries of North America. Holt, Rinehart and Winston, NY, NY. 283p.

McEachron, L. and Matlock, G. 1983. An estimate of harvest by the Texas charter boat fishery. Mar. Fish. Rev. 45(1):11-17

Moeller, G. and Engelken, J. What fishermen look for in a fishing experience J. Wildl? Mgt. 36:1253-1257. 1972

Munro, J. 1981. Some advances and developments in coral reef fisheries research: 1973-1982. ICLARM Contribution 118. 31p.

NMFS. 1980. Marine recreational fishery statistics survey, Atlantic and Coasts, 1979. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Fish. Stat. 8063, 139p.

NMFS 1983. Fisheries of the United States, 1982. U.S. Dep. Commer., NOAA. Natl. Mar. Fish. Serv., Curr. Fish. Stat. 8300, 117p.

Prosser, N. 1985. Marine sportfishing trends. SFI Bull. 362:1-3

Richards, W. and Bohnsac, J. 1982. The conflicts and controversies surrounding the use of reef fish resources. Unpubl.

Rose, C. and Hassler, W. 1969. Application of survey techniques to the dolphin, Coryphaena hippurus, fishery of North Carolina. Trans. Am. Fish. Soc. 98:94-103

Smith, A. 1984. Experimental management of fisheries resources- possible strategies for the future. Australian Fish. 43(3): 40-44

Stark, W. 1969. A list of fishes of Alligator Reef, Florida, with comments on the nature of the Florida reef fauna. Undersea Biol. 1: 4-40

Williams, M., Brusher, H., Palco, B., and Trent, L. 1984 Catch and effort data from a sample survey of charter boat captains in the southeastern United States, 1983. NOAA Tech. Mem., NMFS-SEFC 139. 170p.

Williams, M., Brusher, H., and Trent, L. 1984. Catch and effort data from pilot survey of charter boat captains on the southeastern United States, 1982. NOAA Tech. Mem., NMFS-SEFC 129. 25p.

Zar, J.H. 1974. Biostatistical Analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J. 130-150. 620p.

Filename: dugger
Directory: E:
Template: C:\Program Files\Microsoft Office\Office\Normal.dot
Title: The Relative Sport Value of Various Types of Fishing in the Charter Boat Fishery of the Florida Keys
Subject:
Author: Valued Gateway Client
Keywords:
Comments:
Creation Date: 11/23/2001 4:08 PM
Change Number: 5
Last Saved On: 11/26/2001 9:07 AM
Last Saved By: Valued Gateway Client
Total Editing Time: 25 Minutes
Last Printed On: 11/26/2001 11:47 AM
As of Last Complete Printing
Number of Pages: 54
Number of Words: 9,773 (approx.)
Number of Characters: 55,710 (approx.)