Fishing Effort and Resource Allocation in the Florida Stone Crab (*Menippe*) Fishery

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ABSTRACT

Fishery managers and fishermen have proposed limiting fishing effort in the Florida stone crab fishery because fishing effort increased substantially in the 1990s and there was no commensurate increase in landings. However, before the type of effort limitation could be decided upon, managers needed to quantify fishing effort and understand how effort limitation would affect the overall fishery as well as individual fishermen. In this study, we first determined the current number of traps in the fishery and developed a data set based on the fishing habits of individual fishermen. We then used this information to evaluate the seven fishing-effort allocation alternatives being considered as a means to limit the number of traps a fisherman could use.

By evaluating each of the alternatives for allocating fishing effort during the planning stages of the effort-limitation program, we were able to give both fishery managers and fishermen the data necessary to understand the consequences of each alternative. We concluded that the alternatives that use a single "bench-mark" year, selected from several past fishing seasons, included many retired or former fishermen and would allow more traps to be allocated to the fishery as a whole than were currently in use. Conversely, allocation alternatives that required several years of participation in the fishery tended to exclude recent entrants to the fishery. After examining our evaluations of the effort-allocation alternatives, fishery managers and the Florida legislature decided to allocated traps to fishermen based on any one fishing season during the most recent three seasons. This alternative would reduce current fishing effort, would include a high percentage of fishermen, and should have limited potential to affect future landings.

KEYWORDS: Fishing effort, limited entry, *Menippe adina*, *Menippe mercenaria*, stone crab

INTRODUCTION

The demand for fishery resources is increasing, and the allocation of these resources to competing interests is an important issue in many fisheries. To resolve these issues, the Magnuson Fishery Conservation and Management Act provides for the fair and equitable allocation of fishing privileges among commercial fishermen (16 U.S.C. 1801 *et seq.*, Loomis and Ditton 1993). In Florida, intense competition

and overcapitalization in the stone crab fishery jeopardizes the sustainability of this fishery, so some form of resource allocation among fishery participants is required.

Stone crabs support a large fishery in Florida that in the past 10 years, has usually exceeded 3 million pounds (1,300 mt) of claws (Florida Fish and Wildlife Conservation Commission, unpubl. data). The fishery targets two species of stone crabs: *Menippe mercenaria* and *M. adina* and their hybrids (Bert 1986, Gulf States Marine Fisheries Commission 1995). Only the claws are harvested; claws greater than 2-3/4 inches (70 mm) are removed, and the crab is released back into the water to regenerate either one or both claws. Sullivan (1979) found that 20 - 25% of legal-sized crabs were regenerating claws, but the 20 - 25% reflects only the number of crabs missing one or two claws who have survived; it does not tell us if these crabs grew to sufficient size to re-enter the fishery (Davis et al. 1979). Other studies estimated that between 7.6% and 19% of claws in the harvest were regenerated (Savage et al. 1975, Simonson and Hochberg 1992, Wilber 1995, Muller and Bert 2001).

Landings of stone crab claws increased progressively from the 1960s to the early 1990s (Bolden 1994) but have remained stable from the 1990 - 91 fishing season to the present (Figure 1). According to those in the industry, the increased landings in the 1990s were the result of fishery expansion into previously underused areas. However, since 1992, increases in the number of traps have not resulted in increases in landings (Figure 1). Several studies have concluded that the resource is partitioned among too many traps (Sullivan 1979, Zuboy and Snell 1980, Southerland 1988, Ehrhardt et al. 1990, Phares 1992, Bert 1992). Muller and Bert (1997) concluded that the estimated 798,000 traps in the fishery in 1995 - 1996 was perhaps twice the number of traps required. They have subsequently revised their estimates of the number of traps in the fishery, and these estimates are shown in Figure 1 (Muller and Bert 2001).

Because of their concern about the continued expansion of the stone crab fishery, the Florida Legislature and the Gulf of Mexico Fishery Management Council (GMFMC) – with the advice of the commercial fishing industry – enacted moratoriums on new stone crab fishing licenses in 1995. Both moratoria were subsequently extended until July 1, 2001 (Florida Statute 370.13, GMFMC 2000). However, the moratoria did not restrict the number of traps each license holder could use, and the number of traps in the fishery continued to increase.

Fishery managers and some members of the fishing community agreed that too many traps were in the fishery. Individual commercial fishermen indicated that they supported some form of fishing-effort limitation, but they lacked information on the optimal number of traps for the fishery and how limiting fishing effort would affect them. The need to decease the number of traps for the entire fishery conflicted with the individual fisherman's desire to increase his own harvest by using more traps. In other words, the goals of the group were in conflict with the goals of the individual (Leventhal 1976), and a classic example of the "tragedy of the commons" (Hardin 1968) had developed. Resolution of the fishing-effort conflict required that considerable attention be focused on the initial determination of how many traps

each participant should be allocated, herein referred to as the "individual fishing-effort allocation" or for the entire fishery, the "trap allocation".

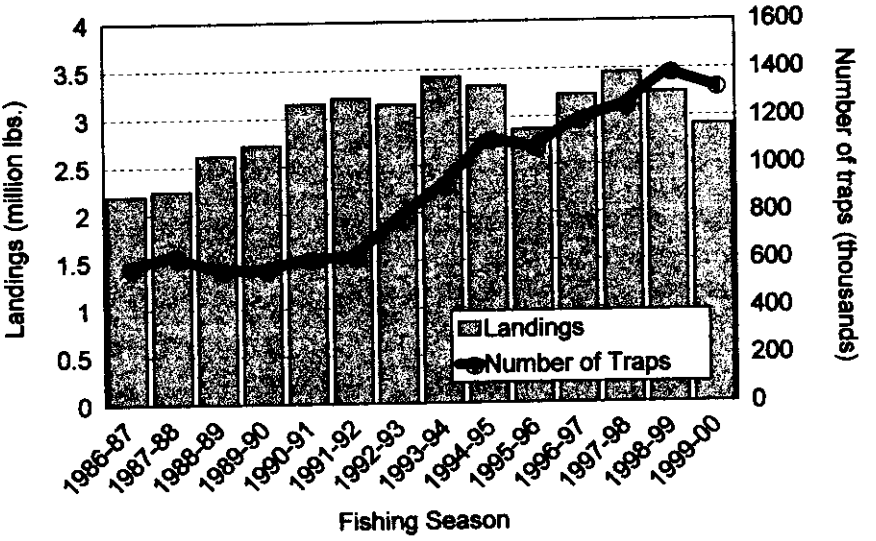

Figure 1. Commercial landings of stone crab claws from Florida during the 1986-87 to 1999-2000 fishing seasons as reported in the Florida Marine Fisheries Information System. The number of traps in the fishery is from the National Marine Fishery Service General Canvass except for 1992-93 through 1996-97 and 1999-2000; these were estimated from the number of traps on the Saltwater Products License applications (Muller and Bert 2001).

The Florida Fish and Wildlife Conservation Commission (FWC) organized a series of workshops in which an individual fishing-effort allocation plan and guidelines for limiting fishing effort in the stone crab fishery could be developed. The workshop participants developed general guidelines for an effort allocation plan but were unable to resolve which fishing seasons or how many fishing seasons would be used to qualify an individual fisherman for an initial trap allocation. Fishery managers and fishermen identified six alternative methods by which to qualify an individual for a trap allocation, but they were unable to resolve which allocation alternative best met the goals of the program. A seventh alternative was later added by the Florida Legislature. The purpose of this study was to evaluate the seven trap allocation alternatives. Each trap allocation alternative was evaluated with respect to how closely the number of traps allocated to the entire fishery matched the current number of traps in the fishery, how many fishermen were included in the plan, and how landings might be affected.

MATERIALS AND METHODS

We developed an individual fishing-effort database that contained information describing the fishing history for each stone crab fisherman in Florida. Saltwater Products License (SPL) applications were one of our sources for the number of traps each fisherman used. Florida's Marine Fisheries Information System (commonly known as trip tickets) contains records of each fisherman's landings. A phone survey of commercial stone crab fishermen was conducted to obtain additional data on the fishing habits of individual fishermen. The FWC–in cooperation with two commercial fishing industry organizations, Monroe County Commercial Fisherman (MCCF) and Organized Fishermen of Florida (OFF) – used this information to identify how different fishermen use traps and ultimately to develop seven fishing effort allocation alternatives.

The original fishing effort allocation alternative developed by the FWC (FWC1) was as follows:

> "Cap the fishery by issuing to each permit [fishing license] the maximum number of traps stated on the permit qualifier's SPL application during 1993 - 1994 to 1997 - 1998 fishing years but do not issue more traps than the permit qualifier's highest annual landings (during that period) divided by two pounds per trap."

Stone crab fishermen were also required to land 300 lbs (135 kg) or more claws in at least one fishing season from 1993 - 1994 to 1997 - 1998 to qualify for an allocation. This alternative was later modified to specify that each qualifying permit would receive a trap allocation and that the allocation would then be assigned to an individual. The intent of the allocation alternative was to allocate each fisherman the number of traps he used as reported using on his SPL application but only after the minimum landings per trap were verified (Table 1). In all subsequent fishing-effort allocation alternatives, the rules and intent of FWC1 were maintained, but the qualifying years for valid SPL applications and which fishing seasons were used to meet the landings requirements were changed. The FWC also proposed FWC2 and FWC3. Representatives of MCCF proposed MCCF1, MCCF2, and MCCF3. The Florida Legislature developed the seventh allocation alternative (FINAL), which was ultimately implemented. The FINAL allocation alternative would require fishermen to qualify for an allocation by having landings of a least 300 lbs in one season during the 1993-94 to 1998-99 period. Once qualified, the allocation was determined by using the landings records and number of traps reported on each SPL application from any one fishing season from 1995 - 96 to 1997 - 98. The allocation was determined by whichever was less:

i) The number of traps on the SPL application or,
ii) The total landings for the season divided by 2 (representing a minimum landings requirement of 2 pounds per trap).

Table 1. Requirements for fishing-effort allocation alternatives for the Florida stone crab fishery. Fishing-effort allocation alternatives were developed by the Fish and Wildlife Conservation Commission (FWC), Monroe County Commercial Fisherman (MCCF), and the Florida Legislature (FINAL). Number of traps allocated was the hypothetical total number of traps given to all fishermen by the allocation alternative. The "Saltwater Products License (SPL) application qualifying fishing season" lists which fishing season(s) license applications may be used to determine trap allocations. The "trip ticket landings qualifying fishing season" lists which fishing season(s) landings may be used to verify trap allocations.

Allocation Alternative	Number of traps Allocated	SPL Application Qualifying Fishing Season	Trip Ticket Landings Qualifying Fishing Season
FWC1	1,577,390	Any 1 season 1993-94 to 1997-98	Any 1 season 1993-94 to 1997-98
FWC2	1,474,181	1 season 1997-98	Any 1 season 1993-94 to 1997-98
FWC3	969,787	1 season 1997-98	1 season 1997-98
MCCF1	1,354,675	Any 2 seasons 1993-94 to 1997-98	Any 2 seasons 1993-94 to 1997-98
MCCF2	1,258,320	Any 1 season 1996-97 to 1997-98	Any 1 season 1996-97 to 1997-98
MCCF3	1,048,725	Any 3 seasons 1993-94 to 1997-98	Any 3 seasons 1993-94 to 1997-98
FINAL	1,294,734	Any 1 season 1995-96 to 1997-98	Any 1 season 1995-96 to 1997-98

Two phone surveys were conducted in 1998. The first included all 1,487 licensed fisherman whose reported landings were 300 lbs or greater from any fishing season between October 1993 and May 1998. In the second survey, we contacted 500 of the 3,500 licensed fishermen whose landings were less than 300 lbs. (including those with no landings) for the same time period. The questionnaire used in both surveys was designed cooperatively with Responsive Management Inc. (Duda et al. 1998). We requested fishermen's opinions on limiting fishing effort, the number of traps they fished, their trap storage locations, and when they built traps.

A concentrated effort was made to visit every trap storage location in the state to identify the owner of and count every stone crab trap. Trap storage locations were identified during the phone surveys and by systematic searches of coastal roads

and known fishing communities. In many instances, local fishermen acted as guides to the trap storage locations. Trap ownership was determined by the stone crab permit number on each buoy or in the concrete of the trap and cross-referencing that number with the SPL database. When possible, fishermen at the trap storage locations were interviewed to ascertain the number of additional traps they planned to build and deploy and how many traps they wanted to deploy in the upcoming fishing season. The trap count was conducted during the five weeks preceding the date traps could be deployed (October 5, 1998) to minimize the effect of additional trap construction after the survey.

The SPL applications constituted one of four sources of data used to estimate the number of traps in the fishery. Many fishermen had multiple SPLs, and duplicate records of traps were common. To resolve this issue, the number of traps reported on the SPL applications were categorized as active, inactive, or unreported: traps were considered active if the corresponding license had landings, traps were considered inactive if the corresponding license had no landings, and traps were considered unreported if the corresponding license had landings but did not report the number of traps used. The number of unreported traps was estimated based on the average pounds-per-trap from each fisherman that reported landings on trip tickets and the number of traps utilized on their SPL. The pounds-per-trap estimate was recalculated as traps-per-pound which was multiplied by the number of pounds of stone crab claws landed as reported on licenses that had no indication of the corresponding number of traps.

The second estimate of the number of traps in the fishery was determined from the trap counts at trap storage locations. These traps were also categorized as active, inactive, or unreported. A trap counted during the survey was classified as active if the owner of the trap had reported landings from the previous fishing season. Traps were categorized as inactive if the trap owner had no reported landings from the previous fishing season. It was likely that some traps were missed during the trap count, and if the fishermen had landings from the previous fishing season, these traps were considered unreported. The number of traps associated with the landings of fishermen whose traps were missed during the trap count was estimated from a pounds-per-trap estimate that was developed from the landings associated with traps that were reported during the trap count.

The third estimate of the number of traps in the fishery was determined from the phone surveys. The traps an individual fisherman reported in the survey were classified as active if that fisherman reported landings on trip tickets from the previous fishing season or as inactive if no landings were reported. Traps were classified as unreported if no survey response was received from the fisherman and if the fisherman reported landings from the previous fishing season. The number of traps associated with the landings for fishermen not participating in the survey (unreported) were calculated from a pounds-per-trap estimate that was developed from the landings associated with traps that were reported during the survey.

The trip-ticket database provided data for the fourth estimate of the number of traps in the fishery. For each fishing trip, the number of traps retrieved and the soak

time (the number of days a trap was deployed) were multiplied to calculate the number of trap-fishing days. The number of trap-fishing days for each fishing trip was then summed for each month. For records with trap soak times spanning multiple months, the number of trap-fishing days was divided appropriately between each month based on the date the trip occurred. The number of trap-fishing days each month was then divided by the number of days in the month to determine the number of traps deployed each month. This method underreported the number of traps deployed in months when traps were initially deployed or were returned to land, so the estimated number of active traps was based on the average number of traps determined for November, December, and January–the second, third, and fourth months of the fishing season. The number of unreported traps was determined for incomplete trip ticket records–trip tickets without the number of traps used or soak time–by multiplying the total number of pounds of stone crab claws landed from incomplete records by the traps-per-pound estimate calculated from complete records. Because the trip-ticket records are based on landings, we were not able to estimate the number of inactive traps in the fishery from trip-ticket records.

The number of traps allocated to each fisherman was determined for each of the seven fishing effort allocation alternatives following the methods described previously and summarized in Table 1. For each allocation alternative, all individual trap allocations were summed and the total number of traps allocated to the fishery was determined.

Each allocation alternative was evaluated to determine its potential effect on landings and participation in the fishery. We calculated the percentage of landings and the percentage of fishermen that would have had landings or been allowed to use traps during past fishing seasons as if each trap allocation alternative had been in place during that season. The percentage of landings included was calculated by dividing the sum of the landings attributed to those fishermen that hypothetically would have received a trap allocation by the total landings of that fishing season and converting the result to a percentage. The percentage represented the landings each fishing season attributed to fishermen who would have received a trap allocation for each allocation alternative. The percentage of fishermen who would have received a trap allocation was calculated for each fishing season by dividing the number of fishermen potentially receiving a trap allocation by the total number of fishermen who had landings that season and converting that number to a percentage. This percentage represented the fishermen with landings greater than 300 pounds who hypothetically would have received a trap allocation from each allocation alternative.

RESULTS

Data from the Florida Marine Fisheries Information System (trip tickets) was used to provide some insight into participation in the fishery. Of those fishermen with landings, many did not participate in the stone crab fishery every fishing year. Of the fishermen with landings each fishing season, almost one-third did not have landings in the previous fishing season and about one-third did not have landings the following season (Table 2a). To a lesser extent, the same trend existed for fishermen with landings of 300 lbs or more: one-fourth of the fishermen entered and one-fourth left the fishery each season (Table 2b). Nearly two-thirds of licensed stone crab fishermen did not fish for stone crabs. During the 1997 - 1998 fishing season, 1,400 of 4,684 licensed stone crab fishermen landed and sold stone crab claws (Table 2a), and 883 of those 1,400 landed and sold more than 300 lbs of claws (Table 2b). The overall number of fishermen with landings declined after 1993-94 (Table 2a), but the number of fishermen with more than 300 lbs of landings increased during the same period (Table 2b). In the survey of license holders with no landings or with landings less than 300 lbs, 29% stated that they maintained their license because it was free, 29% had fished for stone crabs, 20% wanted to fish for stone crabs in the future, and 10% landed stone crab claws as bycatch from other fisheries.

Table 2a. The number of stone crab licenses in Florida, the number of people with landings each fishing season, and the number of people that did not have landings in the previous or subsequent fishing season.

Fishing Season	Total Number of Licenses	Number of People with Landings	Number of People without Landings in the Previous Season	Number of People without Landings in the Subsequent Season
1993-94	6624	1621	.	602
1994-95	7237	1604	585	581
1995-96	6040	1502	479	400
1996-97	5388	1555	453	465
1997-98	4684	1400	310	.

Table 2b. The number of people in Florida with 300 lbs or more landings of stone crab claws each fishing season and the number of people that did not have 300 lbs of landings in the previous or subsequent fishing season.

Fishing Season	Number of People Landing >300 lbs	Number of People without Landings in the Previous Season	Number of People without Landings in the Subsequent Season
1993-94	619	.	170
1994-95	667	218	174
1995-96	723	230	149
1996-97	885	311	248
1997-98	883	206	.

Landings records for the stone crab fishery, which were substantiated by data from the mail surveys, also indicated depressed landings-per-trap for most participants, despite sustained total annual landings of more than three million pounds of claws for all but two fishing seasons since the 1990 - 1991 fishing season (Figure 1). From the phone survey, fishermen landing more than 300 lbs reported harvesting an average 4.75 lbs of crab claws per trap per season, but almost 50% of these fishermen reported landing 2 lbs or less per trap and 25% reported landing 6 lbs or more crab claws per trap per season.

The disparity between fishermen with high landings, those with low landings, and the nonfishing members of the industry resulted in a diverse array of opinions concerning the stone crab fishery. Among the respondents who landed more than 300 pounds of claws, bad weather (33%) and trap robbing (29%) were reported almost equally as the most important problems. Regulations were the biggest problem for 17% of the fishermen, and 17% considered fishing effort issues–either cost (3%), number of traps (3%), or the number of other fishermen (11%) – to be the most important problem in the fishery. Slightly more than one-half of the fishermen (51%) believed that additional stone crab traps would hurt the future harvest of stone crabs in Florida, whereas 34% did not believe so. Two thirds of all respondents supported limiting the number of new stone crab fishermen, but only 40% supported limiting the total number of traps through a certificate program. Approximately 38% of the respondents were members of commercial fishing organizations (Duda et al. 1998).

The number of traps in the fishery estimated from SPL applications increased by 650,000 from 1993 - 1994 to 1997 - 1998 even though the number of license holders in the fishery declined (Table 2a). However, the accuracy of this estimated increase was compromised because individuals had multiple licenses and inconsistently reported the number of traps used on each license. Another indication that the number of traps did indeed increase was a 19% increase in trap soak time over the same time period calculated from the trip ticket database. An independent estimate of the number of traps in the fishery was not available for this time period.

The four methods used to estimate the number of traps in the fishery all determined the number of active traps independently, but relied on trip-ticket records to determine unreported or inactive traps (Figure 2). The number of traps in the fishery, estimated from SPL applications in 1997 - 1998, indicate that fishermen with landings used 1.540 million active traps. The best estimate of the number of traps in the fishery from the SPL database would include only the active and unreported traps. Fishermen without landings reported approximately 1.47 million inactive traps. These inactive traps were probably traps that were reported on the fishermen's second SPL and existed only on paper. In Florida, many fishermen have both individual and vessel fishing licenses (SPL) for one fishing operation. An estimated 234,000 traps may have been unreported. The estimate of 234,000 unreported traps was the average number of traps that would be required to land the additional 459,000 lbs (208 mt) of claws that were landed by fishermen who did not report using traps on their SPL application (Figure 2). It is unlikely that

these stone crab claws were landed by other fishing methods because phone survey results indicated that only a small fraction (3.5%) of stone crab landings were landed as bycatch from other fisheries. The number of active and unreported traps estimated from the SPL database are probably real, suggesting that 1.774 million traps were in the fishery.

During the trap count, observers found and counted 1.086 million stone crab traps. Of these traps, 951,000 belonged to fishermen who harvested 2.53 million lbs. (1,148 mt) of claws during the 1997 - 1998 fishing season. These traps were considered active. The remaining 135,000 traps had no landings from the previous fishing season and were considered inactive; these traps may represent the traps of new entrants in the fishery. An additional 351,000 traps may have existed and were considered unreported. The number of unreported traps was calculated based on the average number of traps that would be required to account for the landings of fishermen whose traps were not counted. Our interviews with fishermen at the trap storage locations indicated that less than 1% of the traps we counted might not be used during the upcoming fishing season; consequently all 1,437,000 of the active, inactive, and unreported traps counted or estimated during the trap count may be in the fishery.

In the phone surveys, we received responses from fishermen who used a total of 781,000 traps to land 1.962 million lbs. (890 mt) of claws in 1997-98 fishing season. These traps were considered active traps. An additional 64,000 traps were reported but had no associated landings that season and so were considered inactive. The estimated 604,000 additional traps that would be required to account for the remaining landings that season were considered to be unreported. Although the 64,000 inactive traps were reportedly used during the 1997 - 1998 fishing season, the landings from those traps were probably included in the calculations that determined the number of unreported traps. Therefore, the inactive traps should probably be excluded from the phone-survey estimate of the number of traps in the fishery, so the phone survey yielded an estimate of 1.385 million traps being used in the fishery.

Trip ticket records that included the number of traps used, soak time, and landing data were also used to estimate the number of active traps in the fishery. These records indicated that an estimated 468,000 traps were used during the peak of the fishing season–November, December, and January. An additional 145,000 traps may have been unreported based on the average number of traps required to harvest the poundage of stone crab claws associated with incomplete records. This method resulted in the lowest estimated number of traps in the fishery, 613,000.

DISCUSSION

The stone crab fishermen strongly supported limiting additional entrants into the fishery, but less than half were willing to impose fishing-effort limitation upon themselves. These attitudes are understandable for a well-established fishing community, and may allow fishery mangers the opportunity meet the desires of

current fishermen while obtaining long-term reductions in fishing effort by limiting the number of trap permits issued to new participants. The proposed fishing-effort limitation plan would allocate trap permits (one permit allows the use of one trap) to individuals, and the number of trap permits would be reduced when the fishermen sold their fishing business; thus, through attrition of existing fishermen, the number of trap permits (and thus traps) would decline. The reduction of traps as fishermen leave the fishery on their own volition has been termed "passive trap reduction". This plan appears feasible because of the irregular participation of the participants in the fishery; the more transfers of trap permits there are, the more the number of trap permits can be reduced. The program will also stop the rapid increase in fishing effort among existing fishery participants.

The allocation of trap permits and a passive trap reduction was acceptable to fishermen because it limited additional entrants to the fishery but did not limit an individual participant's current fishing effort. Ideally, current fishermen would be unaffected by the new regulations except for a modest fee for each trap permit, which would be recouped when they left the fishery and sold their trap permits.

The relationship between the number of traps in the fishery, landings, and the sustainability of the fishery is unclear. Muller and Bert (1997) estimated that there were 798,000 traps in the fishery in 1995 and concluded that this was more than double the number of traps required to maintain landings. Estimates of the number of traps in the fishery for the 1998 - 1999 fishing season varied widely, but our two independent measures, the phone survey and the trap count, indicated that 1.437 or 1.385 million traps were in use. The large number of inactive traps with no associated landings encountered during the trap count may have been attributed to new stone crab fishermen who were building traps for use in the subsequent fishing season. Likewise, some traps would have been attributed to fishermen who had landings in the 1997 - 1998 fishing year, but who no longer fished in 1998 - 1999. Trap estimates from SPL applications include many inactive traps that may have been associated with an individual's second SPL and so probably do not represent real traps. By disregarding the number of traps listed on SPLs that did not have landings during the most recent fishing season, the SPL trap estimate was 1.77 million active and unreported traps. This estimate may still be high, because the SPL application was an estimate of how many traps each fisherman intended to fish during the upcoming season, not the number of traps that were fished. Estimates of the number of traps from the trip ticket data were calculated from trap-soak time and the reported number of traps retrieved each fishing trip. The soak time and number of traps fished did not vary on many trip tickets and appeared to report intended trap soak times, not actual soak times. No direct observations of stone crab trap soak time are available, but after comparing the soak times for lobster traps reported on trip tickets to direct observations of lobster traps, we concluded that soak times were often underreported on trip tickets by up to 50% (Hunt et al. 1994). If soak times were longer than reported on trip tickets, there were probably more traps in the fishery than estimated from the trip ticket records.

Fishing effort needs to be measured and incorporated into stock assessments. Even though landings in the stone crab fishery appear stable, the inability to measure the level of fishing effort required to maintain these landings prohibits fishing-effort-based assessments of the health of the fishery. The yield from regenerated claws to the fishery has been reported to be between 7.6 and 11.9% (Savage et al. 1975, Simonson and Hochberg 1992, Wilber 1995), but recent statewide monitoring suggests that 19% of landings were from regenerated claws (Muller and Bert, 2001). Again, it is difficult assess how a change in the percent contribution of regenerated claws in the landings would affect the health of the fishery. We cannot ascertain if the putative increase in the percentage of regenerated claws is from better handling practices by fishermen, an increase in the percentage of the stone crab population affected by fishing practices, or if the current estimate of the percentage of regenerated claws is simply more inclusive of the entire fishery and nothing has changed.

After evaluating the seven proposed fishing-effort allocation alternatives we realized that allocating more traps would not necessarily distribute traps to more fishermen. The FINAL trap allocation alternative would issue 180,000 fewer traps to the fishery than alternative FWC2, but would issue the remaining traps to 3% more fishermen. None of the proposed alternatives would account for or include all of the landings or fishermen (Table 3). A few fishermen did not complete or improperly completed some portion of their SPL application every year. In the case of FWC1, the most inclusive alternative, 5% of the fisherman, who accounted for 7% of the landings, never indicated how many traps they used. Alternatives FWC1 and FWC2 would allocate more traps than have ever been in the fishery (Table 1), and in the case of FWC2, the additional allocation of traps, compared to several other alternatives, would include fewer fisherman and landings in the more recent fishing seasons. FWC3 would allocate the fewest traps (Table1) and would exclude more fishermen than other alternatives would (Table 4), but considering that FWC3 would allocate 39% less traps than the most liberal alternative would, landings for the fishery would hypothetically be diminished by only 7%. By allowing only one year to qualify, alternative FWC3 would eliminate fishermen who incorrectly completed their SPL application in one year. The probability of these fishermen incorrectly completing the SPL application was lessened when one of several years was allowed to qualify a fisherman for an allocation.

Two of the MCCF proposals were promulgated in an attempt to include fishermen who have multiple years of fishing experience in a trap-allocation plan. MCCF1 and MCCF3 would limit trap allocations by requiring two (MCCF1)or three years (MCCF3) of participation in the fishery (Table 1). These alternatives provided trap allocations to fewer fishermen, but the fishermen included accounted for a disproportionately high amount of the landings (Table 3). MCCF1 and MCCF2 were intended to include fishermen with consistent fishing histories. However, these allocation alternatives include few fishermen because they inconsistently reported their fishing activity between years. MCCF2 would allocate a number of traps slightly below that estimated from the trap count (Table 1 and Figure 2) and would

include the second highest number of fishermen (Table 4) and quantity of landings (Table 3) from the most recent fishing seasons.

The FWC recommended MCCF2 as the best allocation alternative for the stone crab fishery. The number of traps that would be allocated by MCCF2 was near that suggested by the trap counts, would account for an average of 93% of the landings in more recent fishing seasons (Table 3), and would include 89% of current fishermen (Table 4). MCCF2 allocated 320,000 less traps than the most liberal alternative did but appeared to provide little disruption to the current fishermen's participation or landings. The Florida Legislature amended MCCF2 to include the 1995-96 fishing season, and the FINAL allocation alternative was scheduled for implementation in the 2002-3 fishing season.

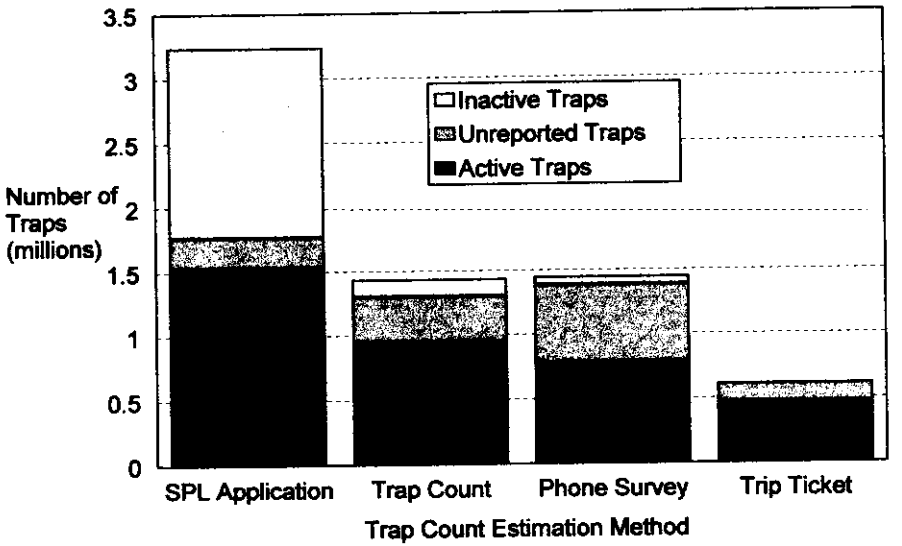

Figure 2. Estimated number of commercial stone crab traps in Florida. The Saltwater Products License (SPL) application estimate was from the number of traps listed on each fisherman's Saltwater Products License application for 1997-98. The trap count estimate was from a physical count of stone crab traps conducted in September 1998. The phone survey estimate was from interviews of fishermen during 1998. Trip-ticket estimate is from the 1997-98 fishing season. Active traps were traps that were reported or counted and had landings on the associated license. Inactive traps were traps that were reported or counted but had no landings on the associated license. Unreported traps were traps that were not reported or counted but had landings on the associated license.

Table 3. The percentage of stone crab landings in Florida each fishing season accounted for by each allocation alternative from the 1993-94 to 1997-98 fishing seasons. Fishing-effort allocation alternatives were developed by the Fish and Wildlife Conservation Commission (FWC), Monroe County Commercial Fisherman (MCCF), and the Florida Legislature (FINAL). The percentage was calculated by dividing the landings attributed to fishermen receiving a trap allocation by the total landings that fishing season multiplied by 100.

Allocation Alternative	Landings Included (%) Each Fishing Season				
	1997-98	1996-97	1995-96	1994-95	1993-94
FWC1	95	95	91	88	82
FWC2	90	88	83	80	73
FWC3	88	78	75	71	65
MCCF1	90	87	87	84	77
MCCF2	93	91	85	81	74
MCCF3	77	73	75	75	66
FINAL	93	92	86	82	74

Table 4. The percentage of stone crab fishermen in Florida receiving a trap allocation from each allocation alternative from the 1993-94 to 1997-98 fishing seasons. Fishing-effort allocation alternatives were developed by the Fish and Wildlife Conservation Commission (FWC), Monroe County Commercial Fisherman (MCCF), and the Florida Legislature (FINAL). The percentage was calculated by dividing the number of fishermen receiving a trap allocation by the total number of fishermen with at least 300 lbs of landings that season multiplied 100.

Allocation Alternative	Fishermen Included (%) Each Fishing Season				
	1997-98	1996-97	1995-96	1994-95	1993-94
FWC1	93	90	87	79	74
FWC2	86	84	80	73	67
FWC3	84	78	72	61	49
MCCF1	74	73	76	70	63
MCCF2	89	85	74	65	60
MCCF3	53	53	60	56	49
FINAL	89	85	81	75	62

Our evaluation of the different allocation alternatives clearly revealed that with sufficient knowledge of individual fishing practices, allocating of a limited number of traps could provide most fishermen the traps they required to maintain their fishing operations. A critical aspect of any fishing-effort allocation plan is to avoid allocating trap permits to former or infrequent fishermen. In the stone crab fishery this could be accomplished by limiting the number of past fishing seasons that qualify fisherman for a trap allocation. The allocation of traps to former fishermen would

provide a reservoir of traps that could enter the fishery at any time. The allocation of traps to the hundreds of license holders that are not currently fishing could cause a new influx of traps into the fishery, as was seen in the Maine lobster fishery when all lobster license holders, most of which had never used traps, were provided trap fishing permits (Acheson 2001).

Fishery managers for the stone crab fishery have had the luxury of developing a fishery management plan that principally focused on economic and gear-conflict issues. Apparently no biological imperative existed that would require the radical alteration of current fishing practices. By capping the number of traps at the current level and reducing the number of traps through attrition as people leave the fishery, the health of the fishery should gradually improve. A more decisive trap-reduction plan might improve the economic return to the fishery more quickly and might immediately resolve some of the gear-conflict issues with commercial shrimp fishermen and recreational boaters, but it might also force the removal of more than 50% of the current fishermen and their crews. A gradual approach to fishing-effort limitation in the stone crab fishery appears to be a feasible approach for maintaining the stone crab resource and for allowing the uninterrupted activity of the fishing industry.

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