

**Geospatial Information System (GIS) Analysis of
Florida Keys National Marine Sanctuary Fishing Panels**

Prepared for Thomas J. Murray & Associates

By

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Introduction

Since 1997, the Florida Keys National Marine Sanctuary (FKNMS) has implemented a network of no-take zones, consisting of ecological reserves, sanctuary preservation areas, and special-use areas. The socioeconomic effects of these zones have been addressed for the commercial fishing industry (Milon et al., 1997; Suman, Shivlani, and Milon, 1999), dive operators (Shivlani and Suman, 2000; Suman and Shivlani, 1998), and local communities (Suman, Shivlani, and Milon, 1999). More comprehensive efforts have been focused on the Dry Tortugas commercial fishery (NOAA, 2000; Shivlani, Suman, and Murray, in preparation). However, most of these studies have represented a “snapshot” of the socioeconomic effects resulting directly from FKNMS management and less directly from the FKNMS no-take zones. By contrast, our research and monitoring program tracks the commercial fishing industry over time and across fisheries and regions. The program, divided into four distinct fishing panels, determines the long-term effects of marine zoning on commercial fishing, including changes in catch, effort, costs, investments, and attitudes and perceptions concerning marine resources.

In its fifth year of research, the project has continued with the collection of spatial data. Specifically, we have developed a Geospatial Information System (GIS) framework to collect fishery spatial data through field surveys, link that data into existing base maps for the FKNMS, and to then analyze the importance of spatial distribution with a variety of parameters, including distance from fishing port, boundary fishing around no-take zones, and fishing by bottom type, gear type, and species. Although the first three years’ worth of data are by themselves useful in descriptive analysis, we believe that a multi-year collection database will provide invaluable information on the long-term effects of no-take zones on fishing activities, as well as identifying inter-annual patterns in catch and effort.

The results presented in this report are indicative of all four panels used in the survey effort: Dry Tortugas, Sambos, General, and Marine Life fishery panels; the data depicted in the maps are based on the 1999-2000, 2000-01, and 2001-02 seasons. The data is limited to the entire sample, as the intent of this report is illustrative (although we expect to perform both panel-based and regional analyses, as well as stratified mapping, in future efforts). The maps created, using GIS, depict total catch by species for the entire FKNMS. All data collected for outside the FKNMS has been cropped. Each map is described in a separate section.

Total catch in the FKNMS

The spatial information provided represents the data of 22 panel members in the 1999-2000 season, 26 panel members (including four alternates) in the 2000-01 season, and 22 panel members (including two alternates) in the 2001-02 season. Over the past three years, a total of 21 fishers have provided information for all three seasons, five fishers have provided information for two seasons (comprised of two original members and three alternates), and four fishers have provided information for a single season (comprised of

two original members and two alternates). Thus, as in past reports, it must be noted that the inter-annual comparisons continue to represent fine resolution changes in fishing patterns among panel members, but it must also be acknowledged that the fishing patterns represent the combined effort of selected fishers affiliated with a geographical region in the case of the DTER and SER, a type of fishery in the case of marine life collectors, and the absence of protected area use in the case of General Fishery Panel members. The composition of the selected fishers, as described above, has changed slightly to accommodate changes in participation; therefore, the following maps show overall trends in spatial catch profiles from 1999 - 2002, rather than a track of individual member use over the same time period.

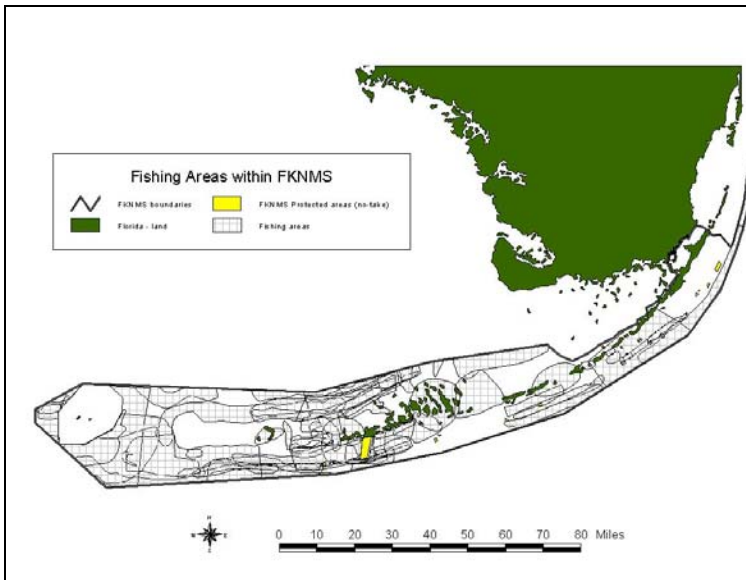


Figure 1: Fishing areas in the FKNMS: 1999-2000

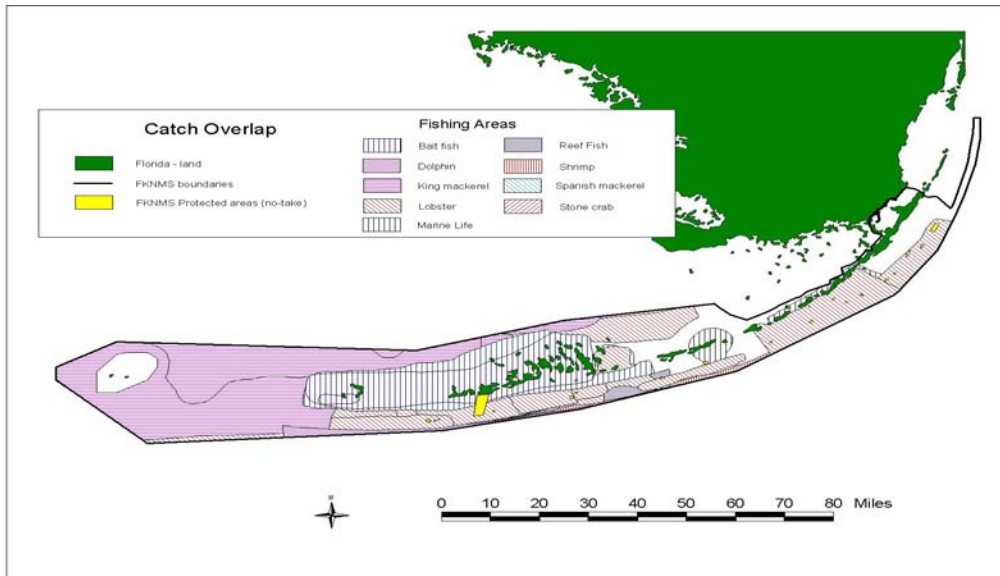


Figure 2: Fishing areas in the FKNMS: 2000-01

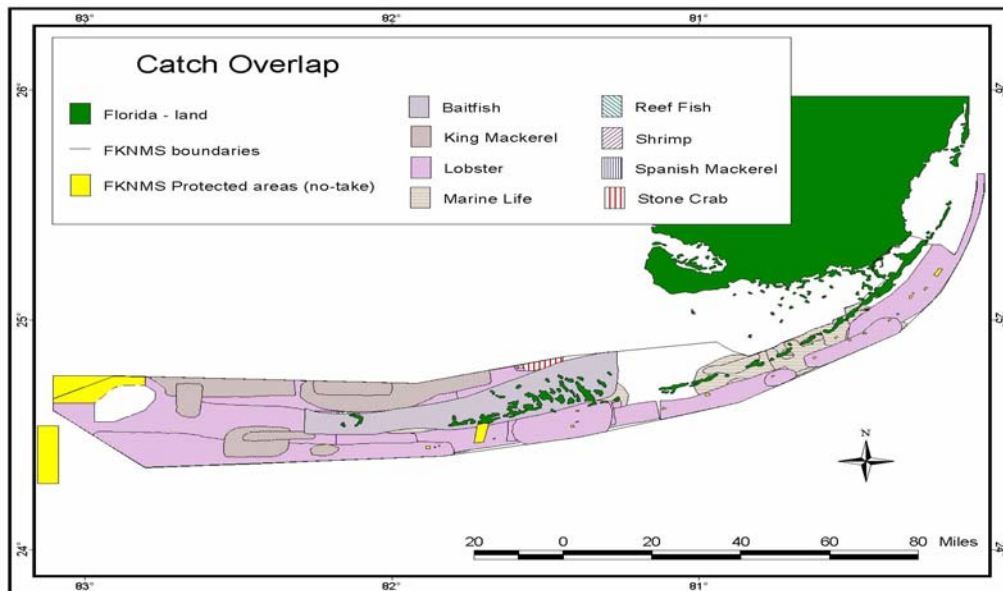


Figure 3: Fishing areas in the FKNMS: 2001-02

Fishing areas in the three seasons did not change much. It does appear that the fishers targeted more areas in the 2000-01 and 2001-02, as most of the FKNMS was utilized by commercial fishing activities. Also, it is clear from all three seasons that there is extensive use around the FKNMS no-take zones. In the 2001-02, Fishers used the area around Tortugas North (the northern component of the DTER) extensively, displaying considerable boundary fishing.

Even though total fishing coverage appears to have remained similar between the 1999-2000, 2000-01 and 2001-02 seasons, there were some interesting spatial patterns for individual species that might demonstrate tenure systems for some species and

opportunistic effort for others. These patterns are described for each major species landed by panel members, below.

Spiny lobster catch in the FKNMS

A total of 12 (54.5%) of the 1999-2000 panel members reported landing spiny lobster. That total increased to 16 (61.5%) in 2000-01. In 2001-02, 15 (62.5%) panel members reported landing spiny lobster. In the last two years, there was greater participation among panel members from the Tortugas and Sambos panels than in the 1999-2000 season. In 1999-2000, five spiny lobster fishers belonged to the General panel, three each to the Tortugas and Sambos panel, and there was one marine life panel member. In 2000-01, six spiny lobster fishers belonged to the General Panel, five to the Tortugas panel, four to the Sambos panel, and there was one marine life panel member. In 2001-02, six spiny lobsters belonged to the General Panel, four to the Tortugas panel, four to the Sambos panel, and there was one marine life panel member. Almost 95% of the lobster catch reported by the panels in 2001-02 was landed in the FKNMS, contrasted with 81% and 90% in 1999-2000 and 2000-01, respectively.

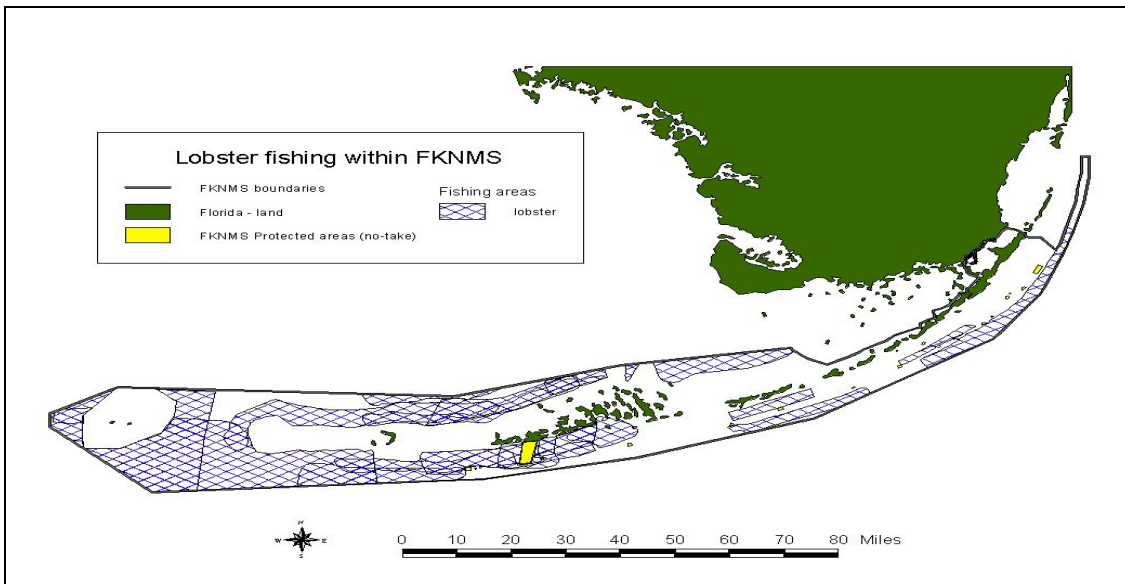


Figure 4: Spiny lobster catch: 1999-2000

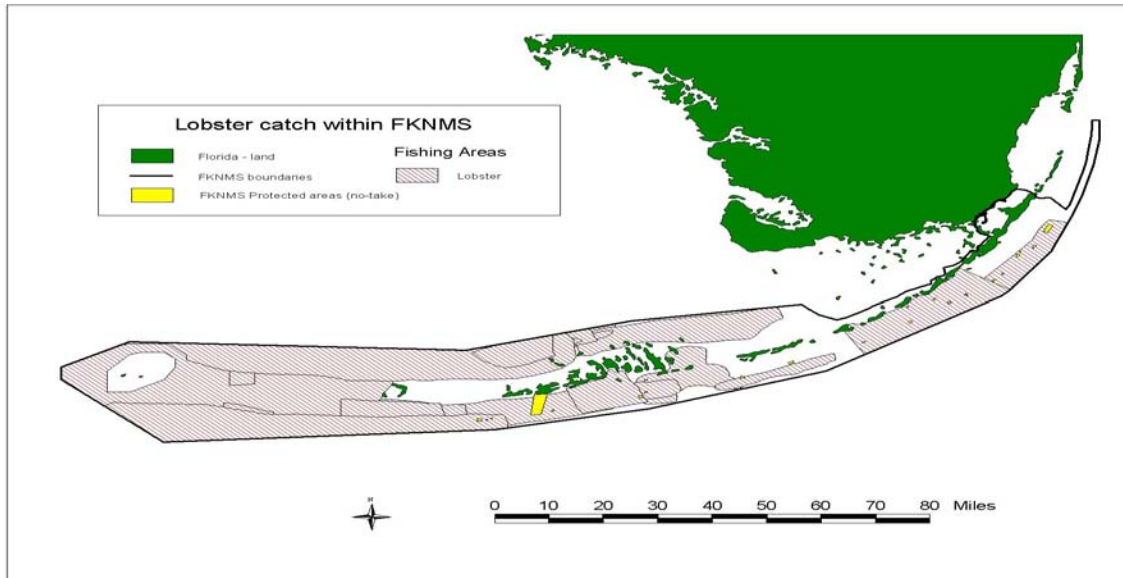


Figure 5: Spiny lobster catch: 2000-01

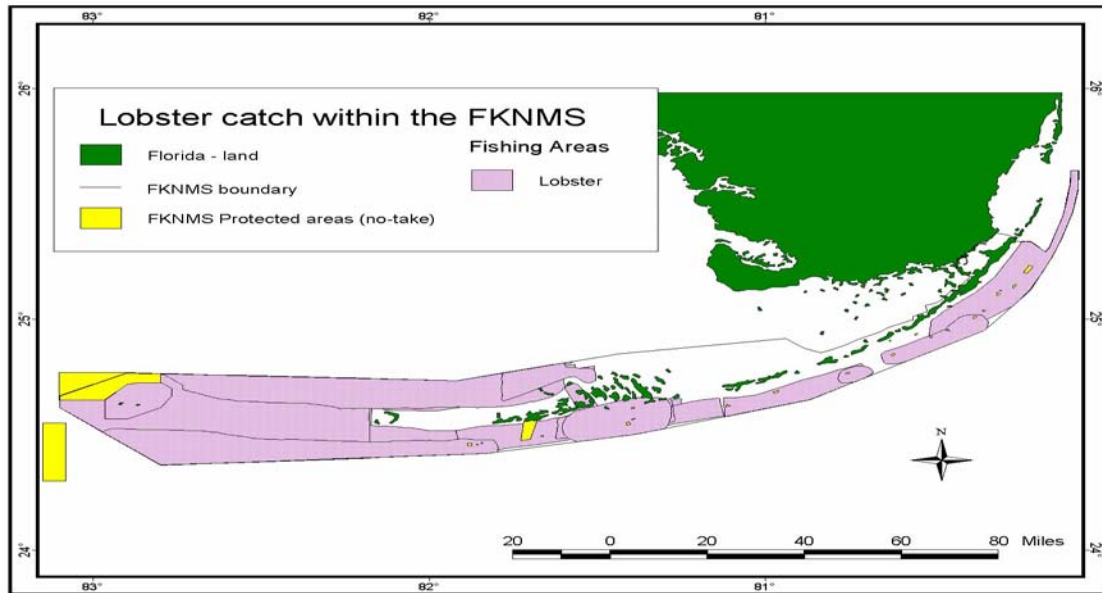


Figure 6: Spiny lobster catch: 2001-02

As is evident in all three fishing seasons, spatial catch locations are concentrated along the western parts of the FKNMS. Tortugas and Sambos panel fishers cover most of the fishing areas west of Key West, whereas the General panel fishers fished the Lower Keys and Upper Keys tracts. A majority of the catch and trips for all three years were reported from within the FKNMS, demonstrating the importance of FKNMS waters to panel members. Also, there is considerable fishing activity around the no-take zones, especially along the boundaries of the larger Dry Tortugas Ecological Reserve and Sambos Ecological Reserve. Finally, it is observed that lobster fishing, for the most part, continues to occur as a local activity; that is, fishers, with the exception of the Tortugas fleet, generally fish in their immediate location. This is especially true for the Sambos

panel members, who reported fishing in and around the Sambos area (a 15 mile swath around Key West) for a majority of their lobster trapping. It is also true for General panel members who utilize the fishing grounds adjacent to their ports, such as the Upper Keys reef tract and the South Atlantic (or ocean side) of the Middle and Lower Keys.

Marine life collection in the FKNMS

Marine life collectors represent 22.7% of the panel members from the 2001-02 season, compared to 11.5% in the 2000-01 season and 22.7% in the 1999-2000 season. A majority of the collectors are based in the Upper Keys, and all of the collection reported by the group for the three seasons occurs exclusively within FKNMS waters. In fact, it is the only group, for all years, that does not extend into non-FKNMS waters.

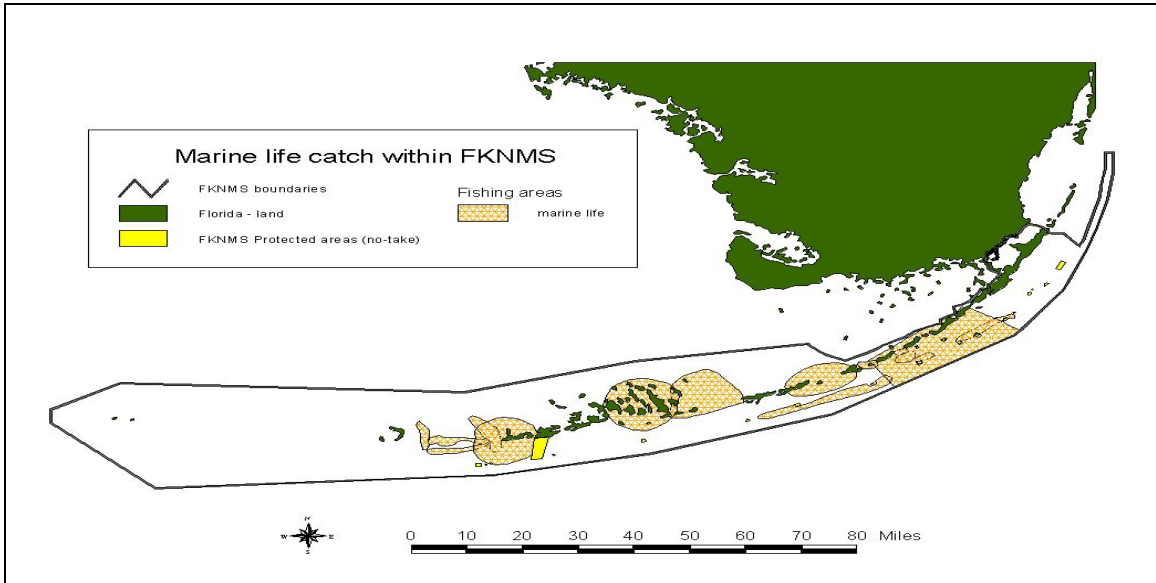


Figure 7: Marine life catch: 1999-2000

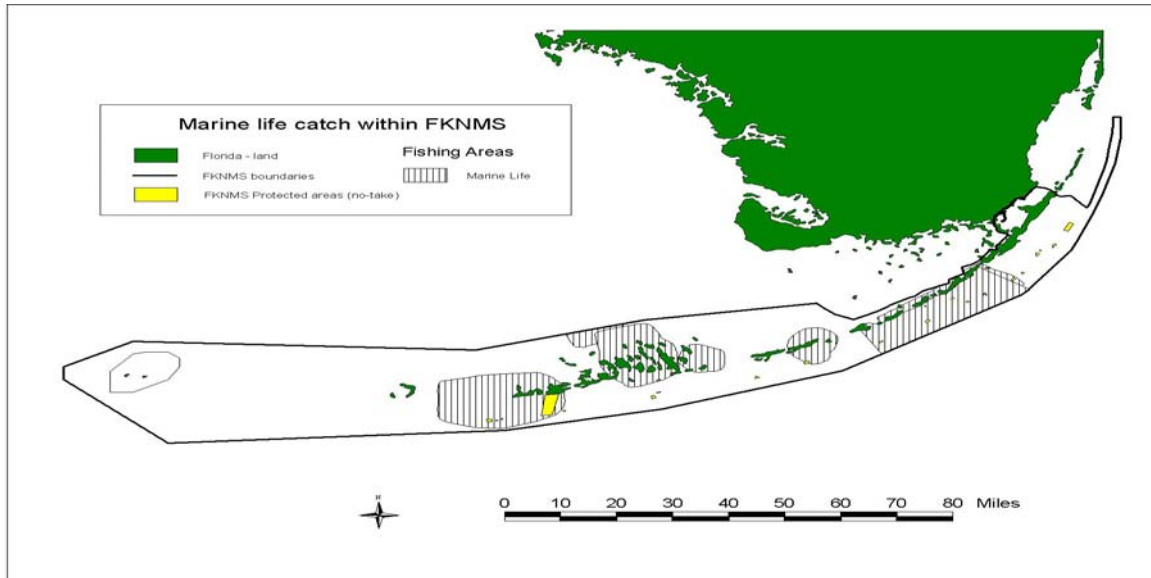


Figure 8: Marine life catch: 2000-01

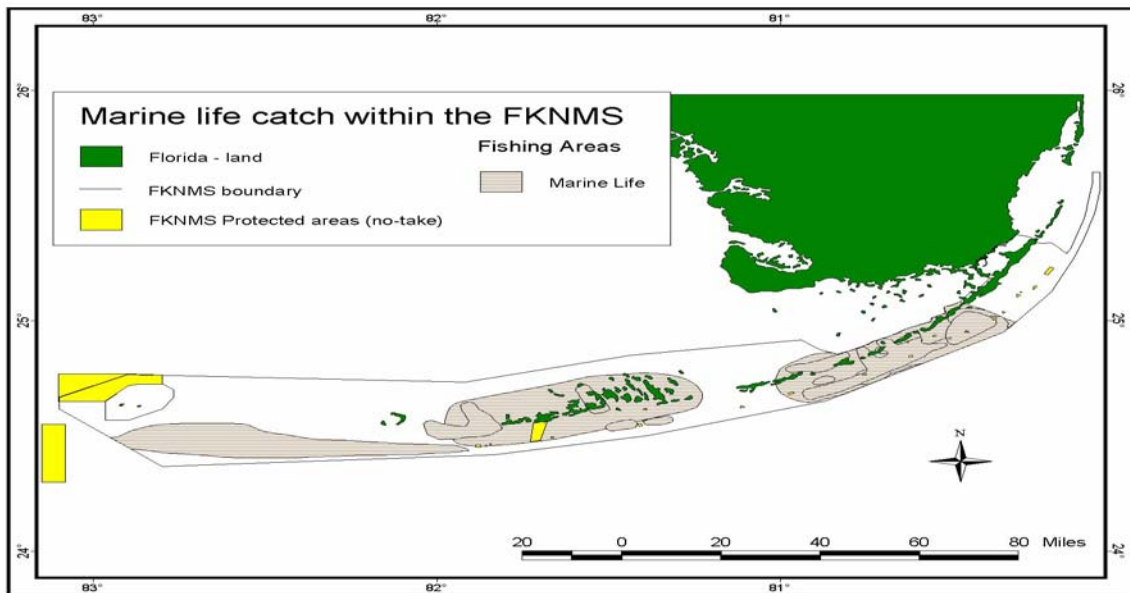


Figure 9: Marine life catch: 2001-02

Collector use of FKNMS areas increased somewhat in 2001-02, compared to previous seasons. There was more extensive use of the Lower Keys, including the SPAs and the Sambos Ecological Reserve. Overall, however, marine life collectors display very consistent fishing trends, in that they appear to use very similar areas on an inter-annual basis. While this does not necessarily denote a form of tenure, it does suggest that there are areas of inter-annual productivity, or so-called hot spots, on which collectors disproportionately rely. Their effort in all three seasons is concentrated around the islands and certain no-take zones. Also, as mentioned in the previous report, it is difficult to discern the bottom habitat types used by the sample due to the large number of species

they target. However, due to the fact that marine life collectors generally dive for their species, it can be assumed that most the bottom habitats utilized include coral reef, hard bottoms, sea grasses, and sandy bottoms.

Reef fish catch in the FKNMS

A total of six panel members reported landing reef fish in both the 2001-02 and 2000-01 seasons, compared to four reef fish fishers in 1999-2000. Panel members ranged in affiliation from the Sambos, General, and Tortugas Panels; however, in each of the three years, fishing effort originated from the Lower Keys. In 2001-02, panel members reported harvesting all reef fish from within the FKNMS, compared to 98% in 2000-01 and 58% in 1999-2000.

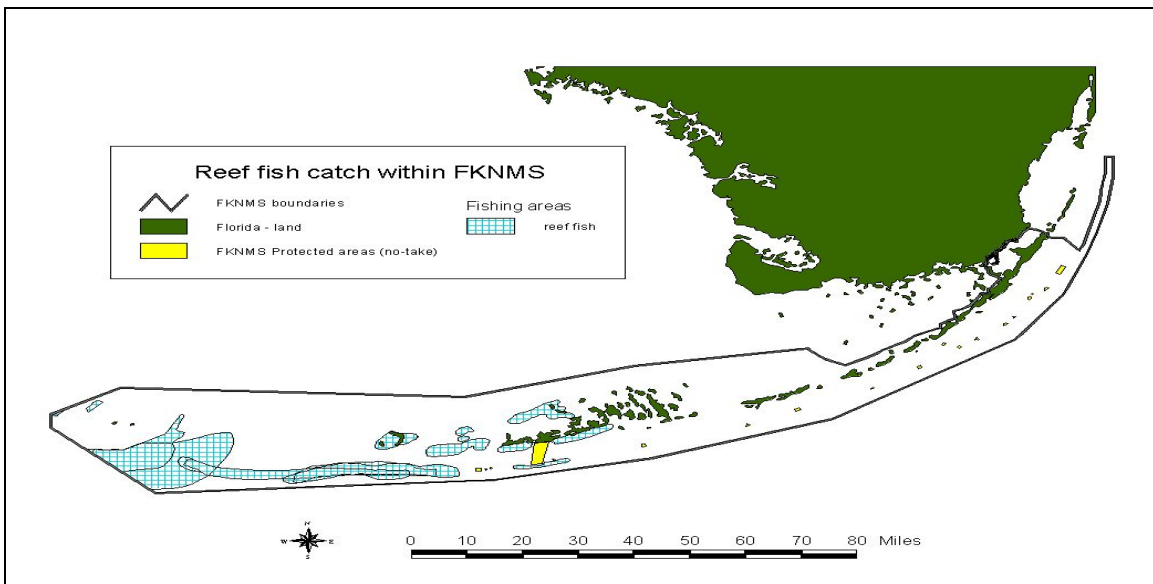


Figure 10: Reef fish catch: 1999-2000

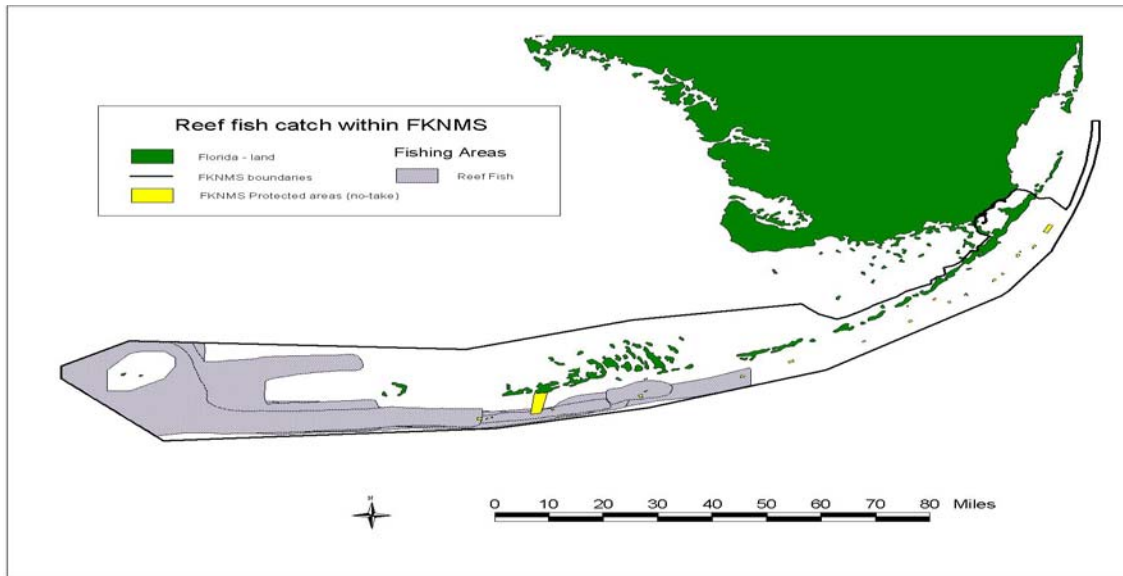


Figure 11: Reef fish catch: 2000-01

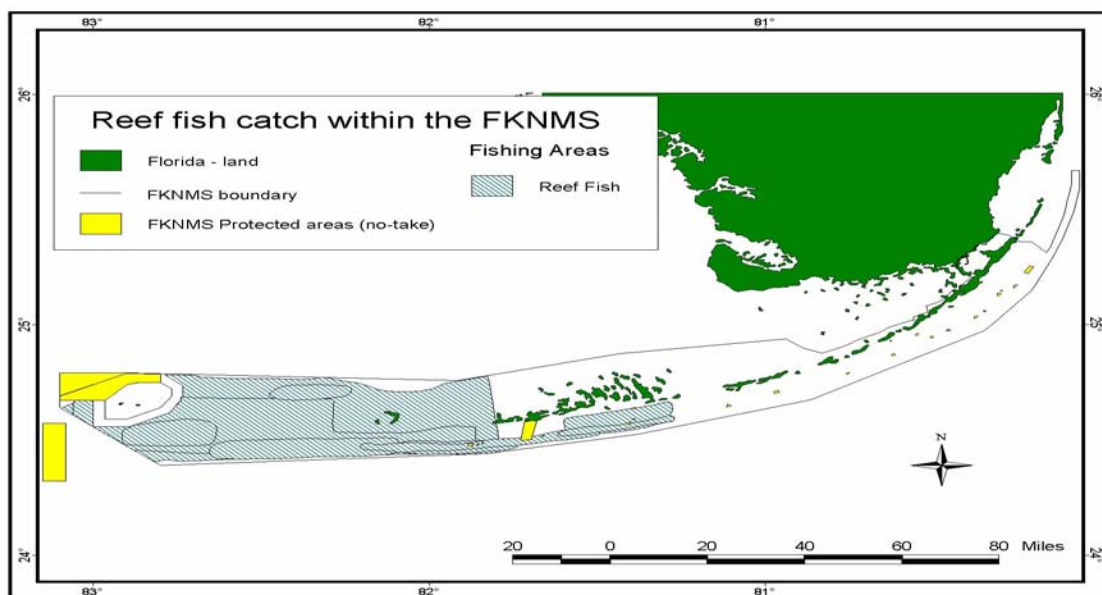


Figure 12: Reef fish catch: 2001-02

As is evident from the figures above, the western half of the FKNMS remains very important to reef fish fishing among panel members. The Tortugas region accounted for a large proportion of catch (greater than 61% in 2001-02, compared to 41% and 30% in 2000-01 and 1999-2000, respectively), followed by the region between Key West and Rebecca Shoal Areas between Key West and Long Key yielded over 5% of the reported catch. Interestingly, as in previous years, there was no catch reported by the panel members in the Upper Keys. Also, unlike in 1999-2000, when use in the Tortugas was restricted to the southern half of the region, panel members reported using the entire Tortugas region in 2000-01 and 2001-02.

Boundary fishing continued in the 2001-02 season, especially around the Lower Keys no-take zones. Fishers reported targeting reef fish around the Sambos ER (concentrating on the southern third of its boundary) and surrounding SPAs and SUAs. Use was also pronounced around Tortugas North and the Dry Tortugas National Park in 2001-02, where fishers reported fishing next to the boundaries of these marine reserves. Finally, in all three years, use was primarily restricted to the South Atlantic side of the Lower Keys; that is, no reef fishing harvest was reported in the Content Keys or the Gulf of Mexico side of the Lower Keys.

Shrimp catch in the FKNMS

Shrimp harvest data for the 2001-02 and 2000-01 seasons included all three shrimpers who participate as part of the Tortugas panel (the 1999-2000 data was incomplete, as it only included information from one shrimper).

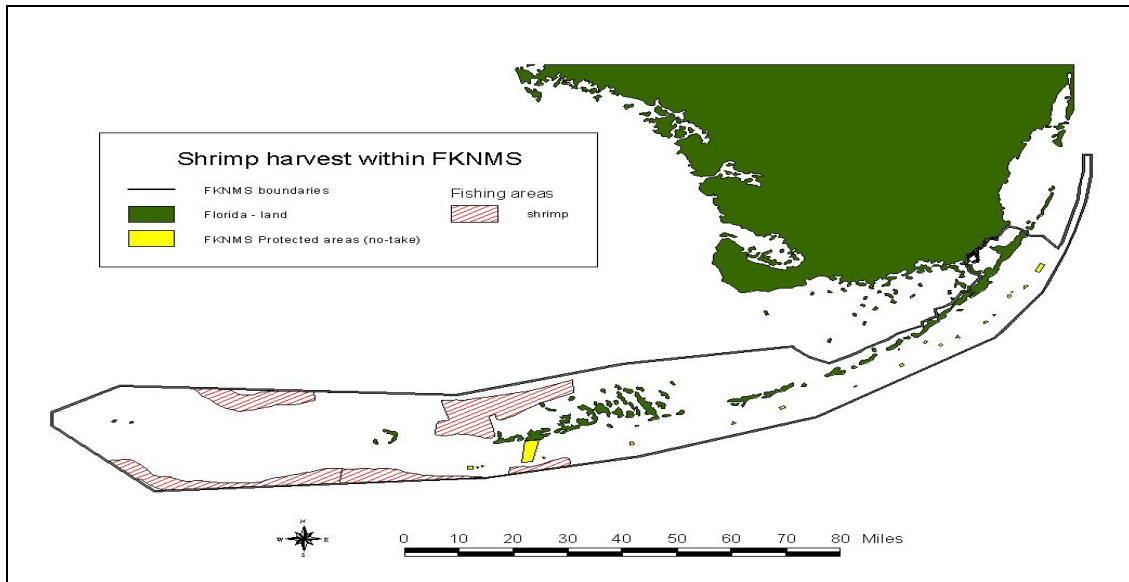


Figure 13: Shrimp catch: 1999-2000

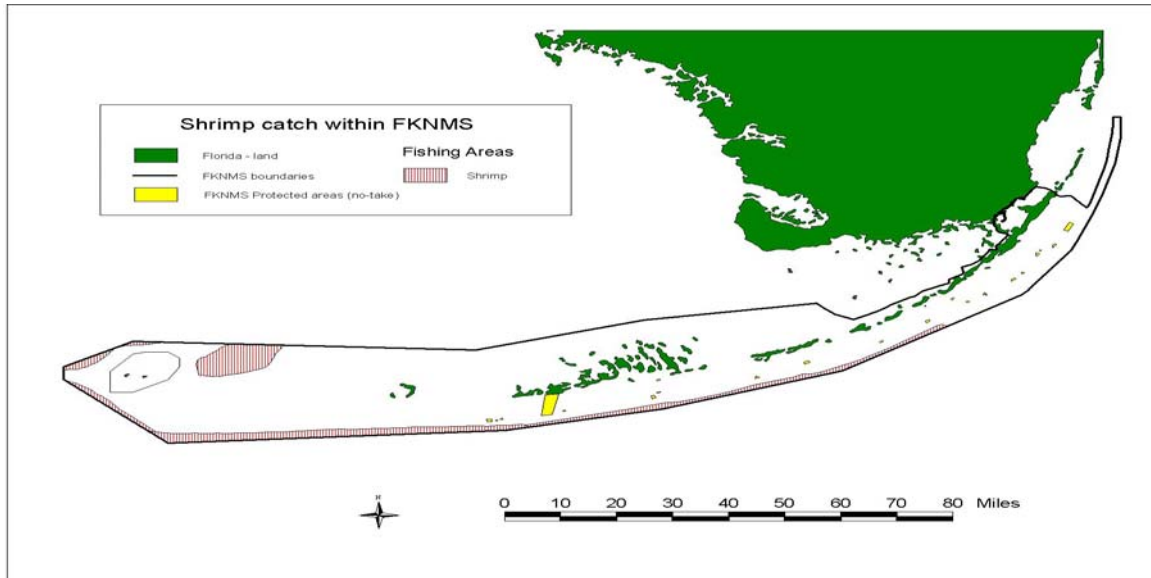


Figure 14: Shrimp catch: 2000-01

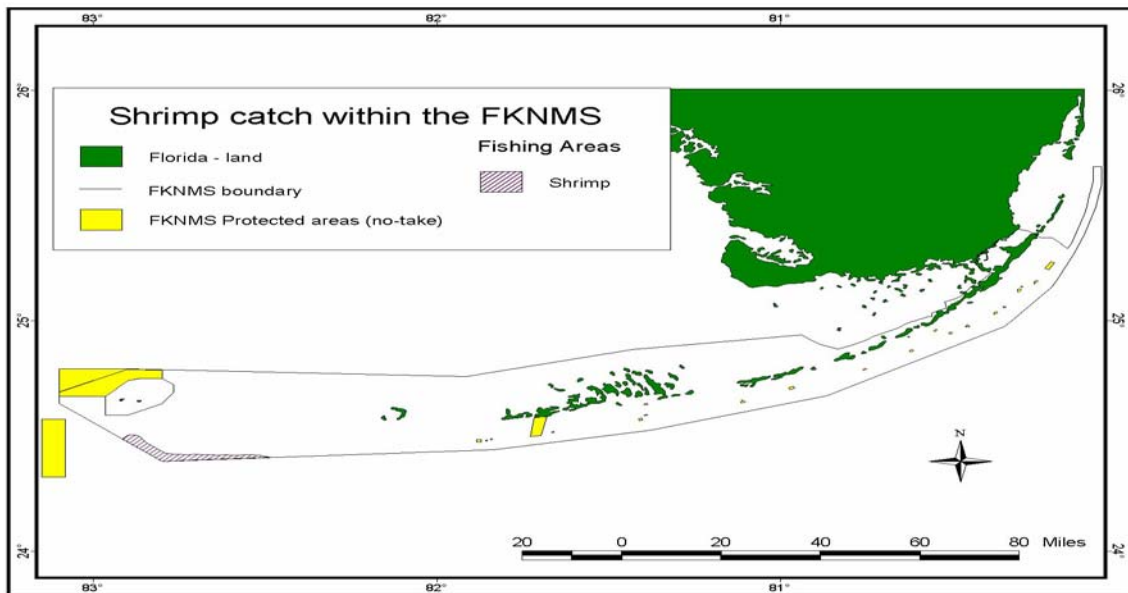


Figure 15: Shrimp catch: 2001-02

The shrimp harvest shown for all seasons demonstrate that the FKNMS does not contain many shrimping areas, and most of the grounds shrimped is along the southern boundary of the FKNMS and the western and northern portions of the Tortugas. In 2001-02, less than 5% of the catch was harvested within the FKNMS. Of the three shrimpers reporting landings, one did not even fish within the FKNMS. In 2000-01, a similar amount, or 4%, was landed along the southern boundary within FKNMS. The majority of shrimp landed within FKNMS waters during all three seasons was harvested in the Tortugas region. With respect to FKNMS no-take zones, shrimpers generally avoided the DTER in the 2001-02 season, although that area was used in 2000-01. Shrimpers reported not using

that area specifically due to the area closure in July 2001, explaining that they prefer to trawl around the DTER than adjacent to the reserve. The spatial information from the three seasons shows that shrimping has not been very active in FKNMS waters between 2000 and 2002; however, it should be noted that the areas west of Rebecca Shoal through the DTER do contain important shrimp fishing areas (as stated by the panel members), and that areas may be utilized by panel members in the future.

Spanish mackerel catch in the FKNMS

In 1999-2000, only one person – a Sambos panel member – reported netting Spanish mackerel in federal waters (as gillnet fishing has been banned in State of Florida waters since 1995). In 2000-01, five fishers, including three Tortugas panel members and two Sambos panel members landed Spanish mackerel. Of these, only one fisher used nets to target Spanish mackerel; the others used hook-and-line gear. Finally, in 2001-02, only two fishers, one each from the Tortugas and Sambos panels, reported landing Spanish mackerel; both used hook-and-line gear.

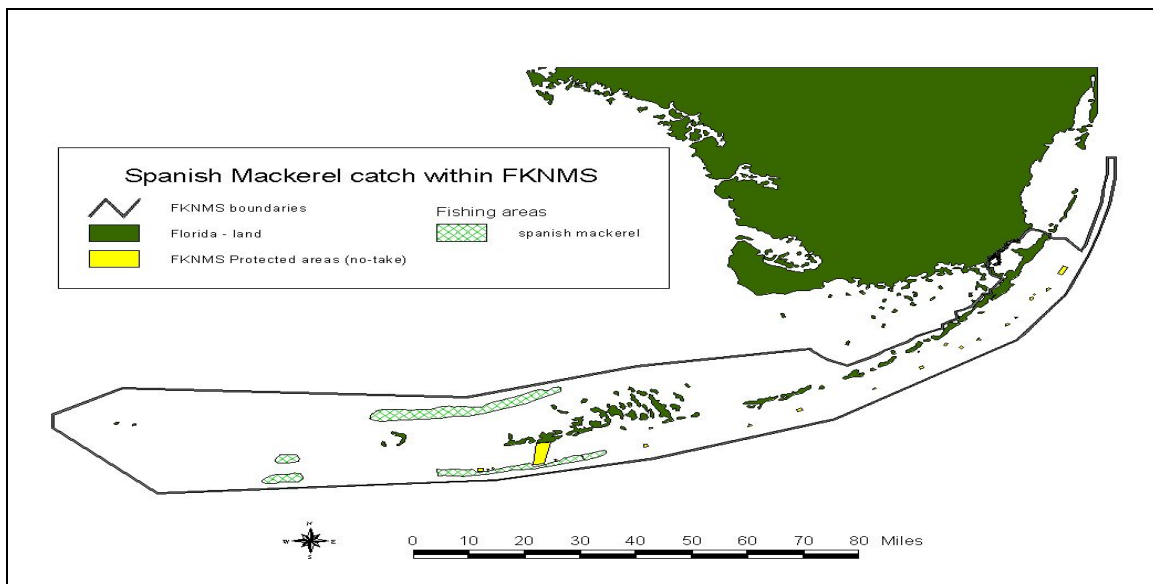


Figure 16: Spanish mackerel catch: 1999-2000

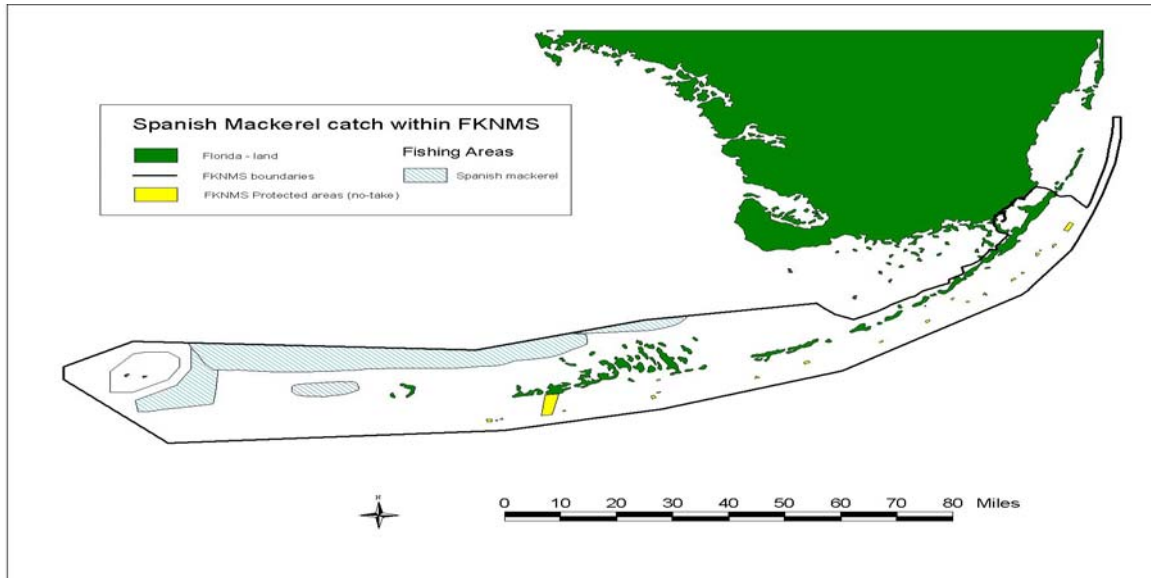


Figure 17: Spanish mackerel catch: 2000-01

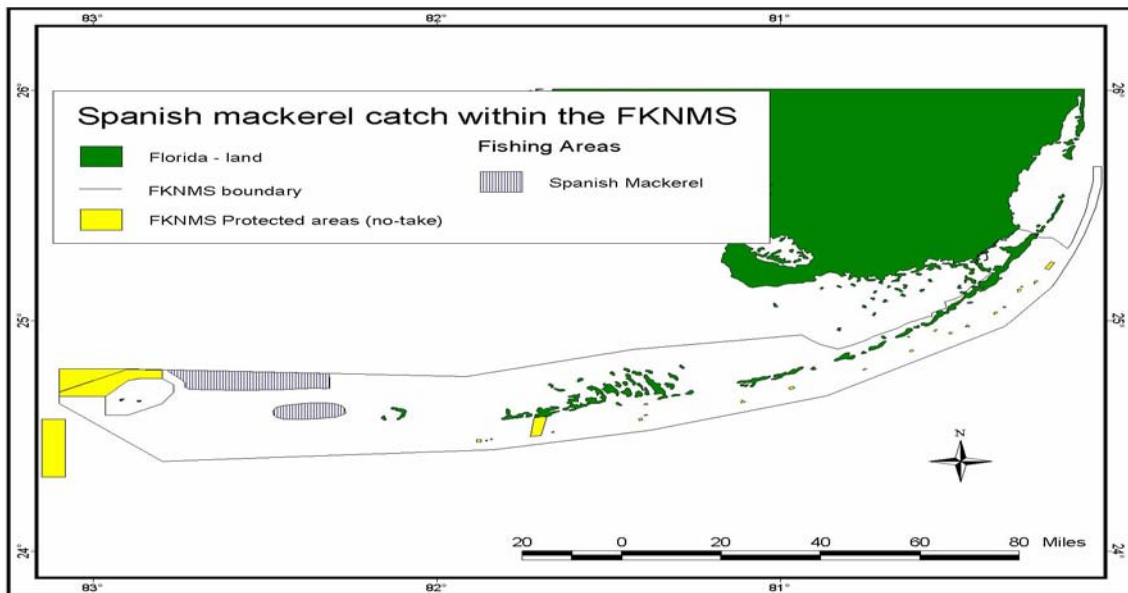


Figure 18: Spanish mackerel: 2001-02

Panel members landed Spanish mackerel exclusively west of Key West (west of the Marquesas to the eastern boundary of Tortugas North) in 2001-02. The areas fished were more discreet than in the previous year, when much of the northwestern FKNMS was fished for Spanish mackerel. This is to be contrasted with the fishing effort in 1999-2000, when fishing focused on both the Gulf of Mexico and South Atlantic sides of the FKNMS. All of the Spanish mackerel harvested by panel members in 2001-02 was landed in FKNMS waters, unlike in 2000-01, when over 55% of the catch came from the Gulf of Mexico outside the FKNMS boundary. This is because in 2001-02 (and in 1999-2000), all Spanish mackerel catch resulted from hook-and-line gear. As stated in an

earlier report, it should be noted that the within-FKNMS catch represents mostly one gear type, hook and line, whereas the outside-FKNMS landings are almost all net-caught fish.

Stone crab catch in the FKNMS

Stone crab is among the most important commercial species in the Florida Keys on a perennial basis. Because it is generally landed in distant (greater than 10 miles) Gulf of Mexico waters by our panel members (who tend to fish further), catch is restricted to the northern edges of the FKNMS. Six panel members (27.2%) landed stone crabs in 2000-01, but one member did not fish within FKNMS waters. In 2000-01, seven panel members (26.9%) reported landing stone crab. In both the 2001-02 and 2000-01, members from the Tortugas, Sambos, and General Panels participated in the stone crab fishery. By contrast, in 1999-2000, only four panel members (18.1%) of the group, all from the General Panel, reported landing stone crabs. Of these, only two members fished within the FKNMS.

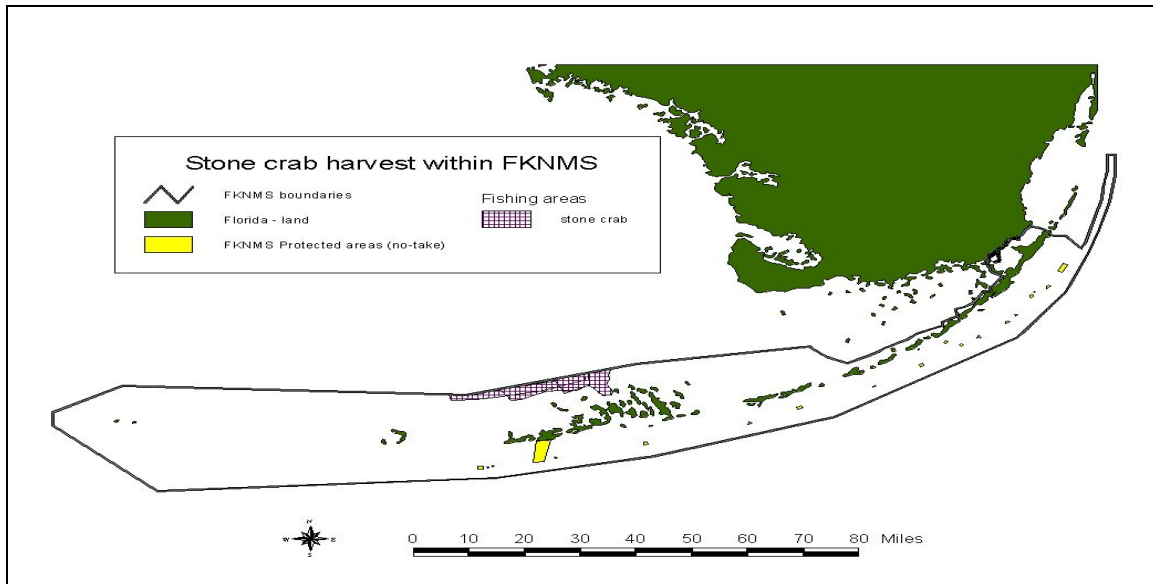


Figure 19: Stone crab catch: 1999-2000

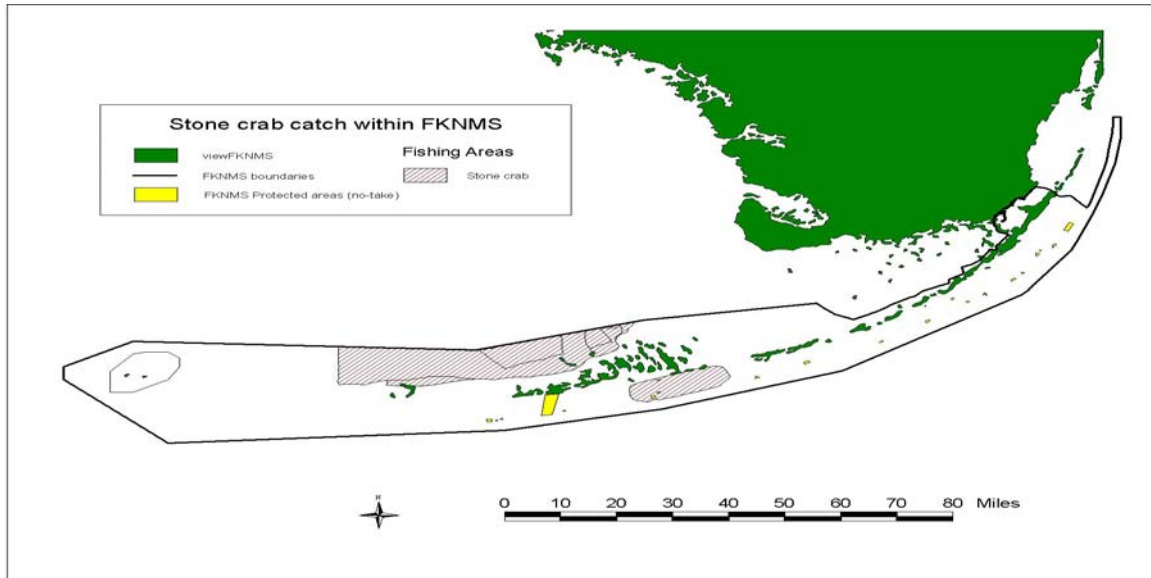


Figure 20: Stone crab catch: 2000-01

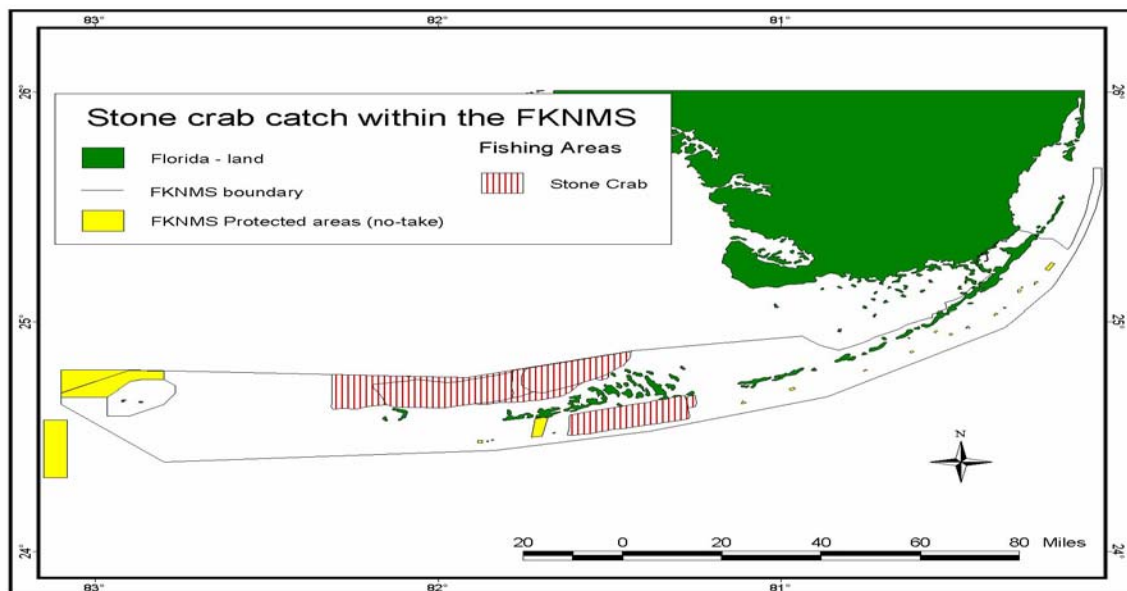


Figure 21: Stone crab catch: 2001-02

Stone crab catch within the FKNMS increased from the 1999-2000 season to the 2000-01 and 2001-02 seasons. Along with the increased effort within FKNMS waters, panel members also expanded their fishing areas within the FKNMS. In 1999-2000, traps were placed mostly from north of Key West to the western Content Keys, in the Lower Keys. In 2000-01 and 2001-02, however, traps were placed further south (reaching some of the Lower Keys themselves) and westward into the Marquesas, and catch was reported on the Atlantic side off the Lower Keys, including around the Looe Key SPA, Looe Key SUA, and Newfound Harbor Key SPA. However, as determined in previous research (Shivlani et al., in preparation) and from the three-year panel data, no stone crab harvest is reported

from the western portions of the Florida Keys (in the Tortugas, specifically). Also, while there was some effort on the Atlantic side in the Lower Keys, most of the catch is harvested along the Gulf of Mexico side (and in non-FKNMS waters).

King mackerel catch in the FKNMS

King mackerel, or “kingfish” as most fishers in the Florida Keys call it, is an important highly migratory species for both net fishers and hook and line fishers. In 2001-02, six panel members, from the Tortugas and Sambos panels, reported landed king mackerel, but only three members caught the fish within FKNMS waters. This is to be contrasted with the previous season (2000-01), during which a combination of nine Tortugas and Sambos panel members landed king mackerel within the FKNMS. As demonstrated with other species, king mackerel is an important species to especially Lower Keys fishers; however, its importance depends on inter-annual availability, which is then set as quotas. The panels include several members that target king mackerel using nets and hook and line.

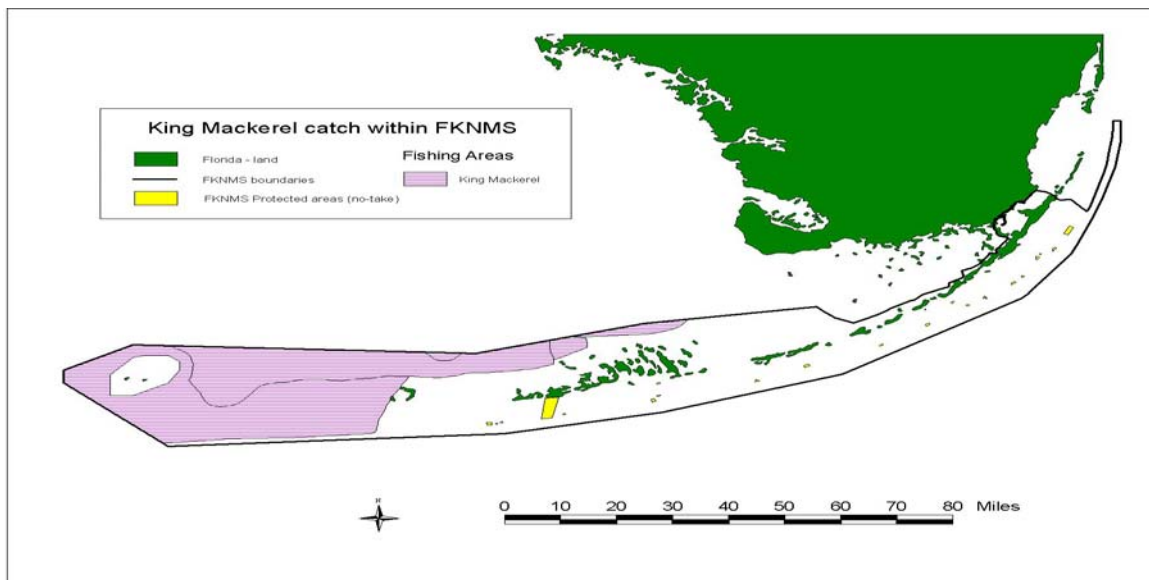


Figure 22: King mackerel catch: 2000-01

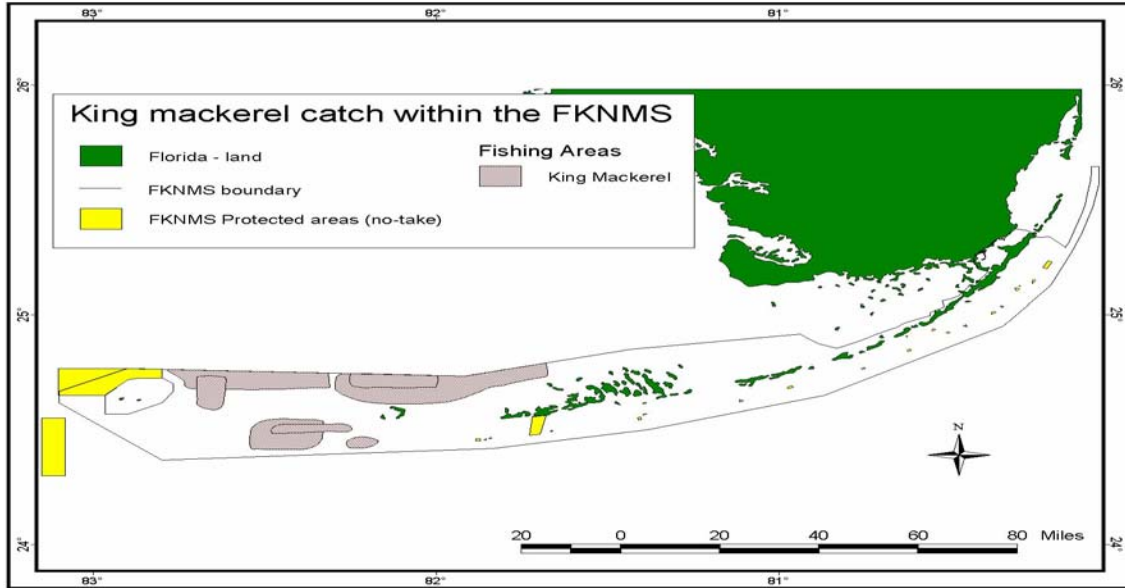


Figure 23: King mackerel catch: 2001-02

As demonstrated in figures above, king mackerel was landed in much of the western portion of the FKNMS, as well as the northern sections of the Lower Keys. The majority of the catch in the 2001-02 season resulted from fishing trips outside the FKNMS, in the Gulf of Mexico; in the 2000-01 season, panel members focused their efforts within FKNMS waters, from the Content Keys west to the Dry Tortugas. With the closure of the DTER in 2001, it appears that effort has shifted to the east and southeast. Also, effort seems to abut the eastern boundary of Tortugas North and the Dry Tortugas National Park, a hotspot identified by previous research (NOAA, 2000). However, as stated previously, king mackerel represents a highly migratory stock, and one that is variable in its spatial location on an inter-annual basis. Therefore, future years' worth of data collection may reveal further changes in spatial profiles.

Baitfish catch in the FKNMS

Few panel members target species other than baitfish within the FKNMS on an inter-annual basis. Some members target golden crab and pelagic finfish (including dolphin, tuna, cobia, and amberjack), but the fishing occurs outside the FKNMS. The only species group harvested within FKNMS waters on an inter-annual basis is baitfish (including species such as bluerunners, glass minnows, ballyhoo, etc). Panel members either sell baitfish to fish processors or use them as bait for other species. The species recorded in this section are those that are sold commercially. Three panel members, from the Tortugas and Sambos panels, reported landing baitfish within the FKNMS in 2001-02. In 2000-01, four panel members targeted baitfish.

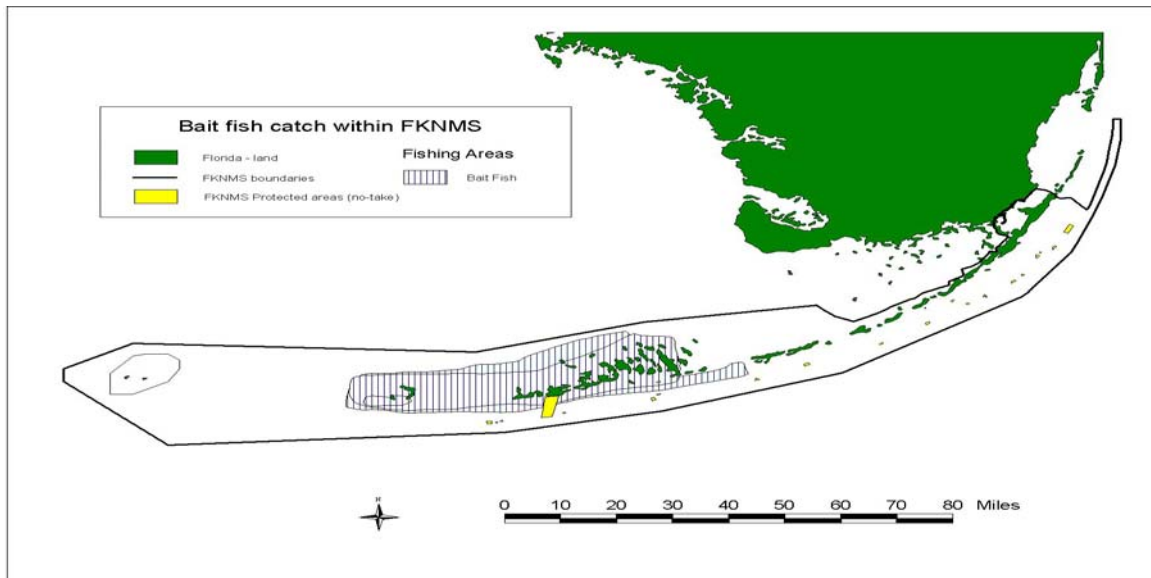


Figure 24: Baitfish catch: 2000-01

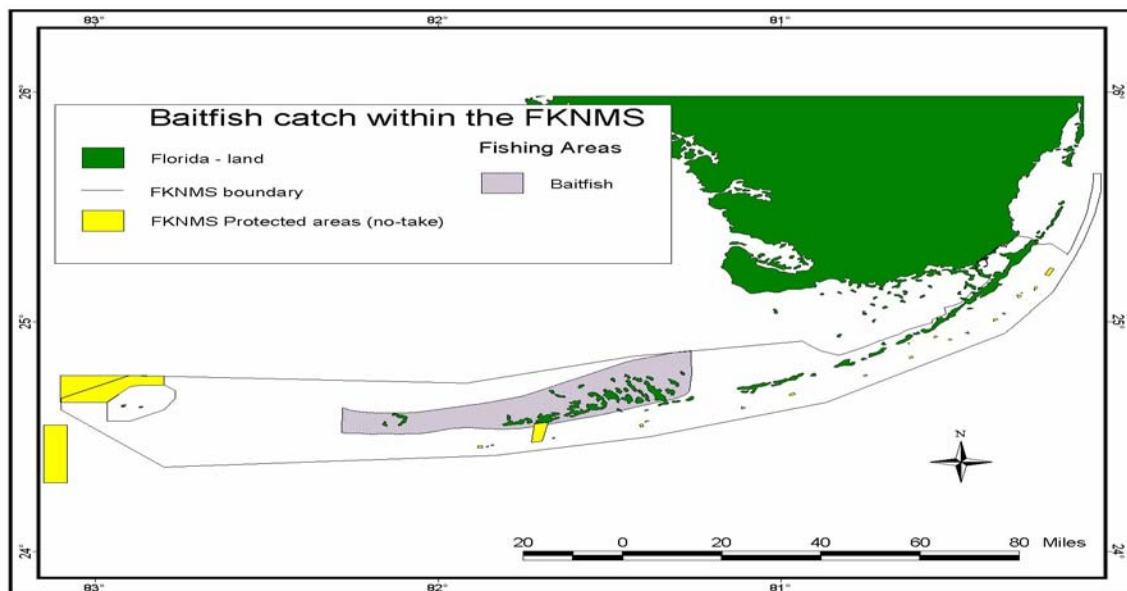


Figure 25: Baitfish catch: 2001-02

Areas fished for baitfish in 2001-02 remained the same as in 2000-01. Panel members used a wide area from Big Pine Key west to the Marquesas in 2001-02, an area almost identical to that reported for 2000-01. In both years, most of the catch was harvested in the Lower Keys, from Key West to the Marquesas. The region between Key West and Long Key was less productive but did present a large fishing area. Effort focused in both seasons towards the Gulf of Mexico side of the FKNMS, suggesting little to no impacts of the no-take zones. Panel members did report using the western part of the FKNMS for baitfishing, but not as far west as the DTER (see Shivlani et al, 1998 for more information on baitfishing areas in the western Florida Keys).

Discussion

It is important to emphasize, prior to commencing on a brief discussion, that the data and results described above are based on a panel member sample (that is not representative of the population).

Our preliminary results, from the 1999-2000, 2000-01, and 2001-02 seasons, suggest that panel member fishing areas in the FKNMS are largely determined by proximity to home ports, with the exception of the Dry Tortugas fishery and certain species (stone crab and king mackerel, in particular, and spiny lobster, occasionally). Also, fishing is quite prevalent around no-take zones, especially the ecological reserves and the Lower Keys SPA complex of Eastern Dry Rocks, Rock Key, and Sand Key. Many of the species (especially lobster, reef fish, and marine life) are harvested near the boundaries of these no-take zones. The Dry Tortugas area (including the region around the DTER) is a major fishing ground for panel members who participate in spiny lobster, reef fish, and king mackerel fisheries. Marine life collection occurs exclusively in the FKNMS, and it is often concentrated in areas near no-take zones, including the smaller SPAs in the Upper Keys. Also of importance in the three year comparison has been the finding that any single year description only represents a “snapshot” of spatial fishing effort. Due to changes in regulatory conditions, financial solvency, and environmental conditions (and perhaps a complex combination of all three factors), fishers decide to expand or contract their fishing areas and activities. For example, in the 1999-2000 season, the survey found that only a few of the total eligible panel members fished for stone crab. In the following year, due perhaps to regulatory conditions, effort in stone crab expanded both spatially (in terms of areas used) and in terms of the fishers actively involved in the industry. Also, shrimping effort declined substantially in 2001-02 within the FKNMS, compared to previous seasons. Panel members reported a combination of two factors that have led to the lowered effort in the FKNMS: the July 2001 implementation of the DTER, and a prevalence of shrimp in more northern parts of the Gulf of Mexico.

Methodologically, the mapping project has continued to demonstrate that we can collect useful, accurate information on various fisheries from panel members. Most importantly, the mapping data has demonstrated that there is consistency of use within certain fisheries, suggesting data reliability; in other fisheries, the changes in fishing patterns has shown that there is considerable movement in the effort, even within the same users on an inter-annual basis. Although the maps above only demonstrate spatial catch information, we have collected corresponding spatial information on effort, costs, and gear.

Finally, as stated in the previous report, it is reiterated that the spatial data can and should be combined with existing physical and biological maps, including those depicting currents, benthic habitats, fish spawning sites, and others. By combining these sets, we can determine the importance of physical and biological parameters on areas fished, as well as to evaluate whether the biological benefits of no-take zones translate into greater fishing success around those areas.

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