

The Effects of Days at Sea on Employment, Income, and Hours of Work: Some Preliminary Evidence

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Abstract

Data from the National Marine Fisheries Service, from interviews with fishing crews, and from settlement houses show that between 1993 and 2002 employment decreased, net crew share increased, and hours of work per day increased for New Bedford scallopers and druggers. These results are consistent with predictions from economic theory on the effects of restricting user rights in common space, in this case restrictions on days at sea (DAS) for scallopers and druggers, which began in 1994. However, we cannot claim that the effects were caused by the reductions in DAS because we did not control for changes in biological and other factors over the period. Large scallop stocks in closed areas opened to scallopers and growing stocks in the open areas probably increased the scallop catches. Declining stocks of groundfish reduced the catch in the dragger fishery. As expected, employment dropped more and net crew share rose less for druggers than for scallopers. Frequent changes in both the scale and number of factors affected by regulations and the increasing complexity of the regulations also affected these results.

Keywords: fisheries regulation, U.S. marine policy, user rights in fisheries

Introduction

Starting on March 1, 1994 for scallop vessels and two months later (May 1) for multispecies (or groundfish) vessels, management plans created by the New England Fishery Management Council limited the number of days per year that vessels could fish (Days at Sea or DAS).² DAS marked a significant change from relying on regulations that limited fishing effort and catch to focusing on regulations based on user rights that limited the DAS per year for licensed ves-

sels.³

Amendment 5 to the Multispecies Fishery Management Plan (FMP) initially reduced DAS by 10% per year for five years (Wang et al. 1997, 363-364). Shortly thereafter, a stock assessment performed by the National Marine Fishery Service (NMFS) concluded that the total biomass of most of the 13 species in the plan had continued to decline, reaching its lowest point in the summer of 1994. As a result, DAS reductions were decreased by 50% over three years rather than over five years in order to accelerate stock rebuilding. These regulations also extended closures to fishing areas to over 6,000 square nautical miles, about 1/3 of Georges Bank (Environmental Entrepreneurs 2005, 4).

As with the Multispecies FMP, amendments to the Scallop FMP initially limited scalloping to 204 DAS in 1994, to 182 DAS the next year, to 142 DAS in 1998, and to 120 DAS in 1999 (New England Fishery Management Council 2003, 3.1).

In addition to DAS, crew size and gear restrictions in the scallop management plans, large fishing areas were closed to scallop vessels, as noted above. Scallop stocks grew quickly in these closed areas at the same time that scallop stocks became depleted in open areas, due to the heavy fishing in these areas. In 1999, after scientists found large concentrations of scallops in the closed areas, scallopers were allowed trips that counted for 10 DAS but only took four or five days into some of these areas with a 10,000-pound trip limit (U.S. Environmental Protection Agency 2000, 397-398). Scallop stocks improved to such an extent in both the closed and open areas that trip limits in the closed areas were increased to 15,000 pounds in 2001.

This paper focuses on the changes in employment, net crew share, and hours of work for off-shore scallopers and druggers in New Bedford between 1993, before DAS began, with the same variables in 2002, nine years later. Other changes, however, affected these fisheries. Stock sizes in-

creased or decreased in part due to landings, but also due to other factors, mostly environmental. Other fishing regulations also changed during this period. The simple comparison of these variables from one period to another, therefore, cannot be attributed to the effect of DAS restrictions alone.

Research Methods and Data Collection

Estimating employment, income, and hours of work requires defining the population of vessels that makes up New Bedford’s full-time fleet. While some vessels fish inshore from New Bedford and some New Bedford off-shore vessels target other species, the fishing industry in this port centers on off-shore vessels that target groundfish, scallops or both. In order to estimate employment and crew share, we eliminated inshore vessels and off-shore vessels that target species other than groundfish and scallops.

Defining the New Bedford off-shore fleet was the next challenge because vessels docked in one port may land in another port, and the owner may reside in a third port. For 1993 and 2002, we examined several sources of data for New Bedford vessels. After much trial and error, we decided that the best source to define the New Bedford off-shore scallop and dragger fleet was the NMFS landings data for vessels whose home or principal port was New Bedford, and the NMFS permit file.

Using these data, we estimated that the number of off-shore scallopers in New Bedford increased from 104 vessels in 1993 to 105 vessels in 2002. Off-shore draggers declined from 113 vessels in 1993 to 83 vessels in 2002 (see Table 1).

In order to estimate employment and hours of work, we hired and trained seven interviewers who had connections with the New Bedford fishing community, including three native Portuguese speakers. After asking permission from cap-

tains or owners, they interviewed captains and their crews while they took a break from gear work. Interviewers collected the names of those scheduled to crew the vessel for the coming trip, their ages, years at sea, time on the vessel, and non-fishing jobs. They also collected information on the previous trip, including the names of the crew, hours of work, including time for gear work, steaming time, length of the trip, length of watches, time spent on taking out the catch, lay shares, and whether they hired lumpers. They also asked for information prior to 1994 when DAS were implemented, including crew size, hours of gear work, length of watches, lay shares and changes in expenses. Finally, they asked several open-ended questions about the crew’s perceptions of management plans that included DAS. In 2004, they interviewed 69 scallop crews and 46 dragger crews.

There is a lapse in time between 2002, for which we have vessel landings and financial data, and the interviews conducted in 2004, which we used to estimate employment and hours of work. Coordination between interview data and recorded data is always difficult, because interviews usually refer to the present and recorded data refer to the past.

In order to estimate crew shares and employment, we collected data on annual payments to fishermen from settlement houses, which are accounting firms hired by vessel owners to collect payments from buyers and pay trip expenses, including fishermen’s pay.

Currently there are five settlement houses in New Bedford and Fairhaven, including a vessel owner who does his own settlements and those of other vessels. Four agreed to give us names of crewmen, and the annual net crew share paid by vessels or groups of vessels for 1993 and 2002. Another settlement house owner gave us information for some vessels. We collected these data for 39 off-shore scallopers for 1993 and 61 scallopers for 2002. For off-shore draggers, we collected data for 68 vessels for 1993 and 60 vessels for 2002.

Table 1. Off-shore Draggers And Scallopers in New Bedford

	1993	2002
Off-Shore Scallopers		
Number of Vessels	104	105
Crew Interviews		69
Percentage of Total		64%
Settlement House Data	39	61
Percentage of Total	38%	57%
Off-Shore Draggers		
Number of Vessels	113	83
Crew Interviews		46
Percentage of Total		55%
Settlement House Data	68	60
Percentage of Total	60%	72%

Sources: NMFS landings data, vessel data, and permit data, crew interviews and settlement data.

Employment

Estimating employment of fishermen is more complicated than estimating employment for most occupations. Most fishermen are paid neither an hourly rate nor a salary, but a share of the value of the catch, according to a payment system called the lay that divides revenues and expenses between crew and vessel owner. Fishermen are typically hired by the trip, although often they have informal long-term agreements that loosely tie them to a vessel. These fishermen work on board between trips repairing gear and preparing the vessel for the next trip. Fishermen shift job sites more frequently than other workers do and tend to spend much of their shore-time on the docks, in order to learn the availabil-

ity of sites on vessels, recent landings, and current prices. Finally, normal distinctions between labor and management do not hold for fishing. Captains, while in charge of the vessel and its crew at sea, share the work and pay with their crews.

Prior to this study, total employment was rarely estimated. White (1954, 20) reports employment for fishers in New Bedford at 1,350 during the early 1950s. Hogan et al. (1991) report full-time employment for fishermen in New England in 1989 at 4,000 with employment in New Bedford around 2,000. Georgianna (2000) estimated New Bedford full-time fishing employment in 1997 as about 1,000 employees. All of these figures rely on U.S. BLS data supplied by the Massachusetts Division of Employment and Training.

Fishermen paid through the lay system can be considered as either employees or independent contractors. As employees, fishermen own neither the physical capital that they use nor the product of their labor. They also work under the direct management of the captain, who is sometimes the vessel owner. As independent contractors, fishermen contract for a service, for which they are paid a share of the product's value similar to lawyers and other professionals. This distinction was a moot point until the social reforms of the 1930s, when the classification of employee brought certain benefits to fishermen, including unemployment compensation and Social Security.

In New Bedford, fishermen were considered employees by union contract and by the courts until 1978, when the Fishermen's Union, at a general membership meeting, voted to become self-employed while retaining their union membership in negotiating income and benefits. The vessel owners welcomed this change because it relieved them from paying their share of Social Security (FICA) and Medicare taxes.

Nationwide, the courts have ruled on both sides of this issue with a current ruling that fishermen are employees unless they sign individual contracts for each trip (Supreme Court of the State of Alaska 1993). Virtually all fishermen in New Bedford are classified as self-employed, which obligates them to pay the self-employed FICA tax, even though few sign contracts for each trip.

According to the U.S. Census Bureau, Current Population Survey, Definitions and Explanations, most fishermen are neither full-time nor year-round employees. A full-time worker is one who worked 35 hours or more per week during a majority of the weeks worked during the preceding calendar year. A year-round worker is one who worked for 50 weeks or more (including vacations) during the preceding calendar year. While these definitions fit many workplaces, they do not apply to fishing.

Many fishermen fish on more than one vessel, and in some cases, whole crews switch between vessels with the same owner. Most, if not all, fishermen take a few trips off

during the year, and others leave the site either by their or the skipper's choice to take a site on another vessel. While most New Bedford vessels now take fewer trips per year than 10 years ago due to management regulations, most, if not all, full-time fishermen on off-shore vessels, either draggers or scallopers, work only as fishermen. Part-time fishermen work at a variety of shore-side jobs. Consequently, there are four types of fishermen employed on New Bedford off-shore scallopers and draggers:

1. Full-time steady crewmen with regular sites on either a single vessel or on two or three vessels with a single owner;
2. Full-time transients who fish most of the time but on different vessels;
3. Part-time transients who fish occasionally, and
4. First-time fishermen (called shackers on scallopers) who are on their first or second trip, training for a permanent site on the vessel.

There are probably as many mixes of steady crew and transients on vessels as there are vessels in the fleet. There are, however, three categories:

1. All steady crew with part-time transients replacing crewmen for individual trips;
2. A majority of steady crewmen with full-time transients filling in for the rest of the crew and part-time transients replacing crewmen who take time off or leave the vessel, and
3. A minority of steady crewmen with full-time and part-time transients filling most of the crew positions.

Number of Vessels

Data collected from dealers and supplied by the Northeast Fishery Science Center of NMFS show the annual value of landings of groundfish, scallops, monkfish, and other species by vessel that listed New Bedford (or Fairhaven) as either their principal or home port and the number of trips for each vessel. From the population of vessels with full-time scallop permits or multispecies permits, we included those vessels that landed over \$75,000 worth of groundfish, scallops, and monkfish and took more than three trips per year.

Using these criterion, off-shore scallopers increased from 104 vessels in 1993 to 105 vessels in 2002 (see Table 1). Off-shore draggers decreased from 113 vessels in 1993 to 83 vessels in 2002.

The Federal buyout program for New England draggers caused some of the decrease in the New Bedford off-shore dragger fleet in 1996. The Emergency Supplemental Appropriations Act and the Interjurisdictional Fisheries Act allocated \$24.4 million to purchase 79 fishing vessels and their per-

mits, removing 19% of the catch capacity from the New England fishery. However, in 2000, a GAO (2000, 4) report on fishing vessel buyback programs concluded that, “62 additional vessels have become active since the buyback because no steps were taken during the program to prevent previously inactive vessels from engaging in fishing.” In other words, funds obtained in the buyback may have been used to purchase vessels with permits, which were not actively fishing. The GAO (2000, 4) report continues, “These vessels have begun to erode the capacity reductions made by the buyback because they have replaced fishing capacity by as much as two-thirds of that purchased through the buyback.” Another study of capacity reduction reported that the buyback of fishing vessels in 1996 was matched by an increase of the utilization rate of the permits that remained in the fishery (NMFS 2004). In other words, vessel owners applied latent permits to vessels that were not previously in the fishery. These results mirror the effects of other buyback programs (Holland et al. 1998, 68).

In New Bedford, 25 draggers were sold by their owners in the buyback program. As the GAO reported, some vessels new to the port were probably purchased with funds from the buyback program, but we cannot show any direct connections between these funds and purchases of newer vessels. Ownership of vessels and the funds used to buy them are not easily traced.

Crew Size

Since the start of the modern fishing era in New Bedford during the 1930s, crew size in New Bedford has depended on tradition, union rules, expectations of the catch, and management regulations.

Higher expected catch call for larger crews in order to reduce the workload per crewmember. Lower expected catch and value generally lead to smaller crew size in order to maintain the payment per crewmember. From the 1940s through the 1970s, union rules and customs generally prescribed 11 member crews in the scallop fishery, 1,000 pounds per crewmember per trip, and eight day trips with four days in dock between trips (Cass 1998, 48). The 11 member crew on scallop vessels probably continued for many vessels until the fishermen’s strike late in December 1985.

During the early 1980s when groundfish and scallops were plentiful, crew sizes on large draggers ranged between four and seven members, including the captain (Doeringer et al. 1986, 38) with six as the port standard. Scallop crews varied between nine and 13 during the same period (Doeringer et al. 1986, 40). When catches fell during the early 1990s, dragger crews declined to four or five, and scallop crews fell to seven or eight.

In 1994, Amendment 4 to the Scallop FMP limited the crew size on full-time scallopers to seven, including the captain, as part of the stock rebuilding plan (New England Fishery Management Council 2003, 3-9). The crew size on some scallopers had probably fallen to or below this number due to stock shortages, but the FMP limited crew size to seven in order to limit the catch if stocks began to recover by limiting the ability of the crew to shuck scallops.

Interviews with 69 scallop crews reported a decline in average crew size for the scallop crews (including the captain) from 10 before DAS to seven in 2004 (see Table 2). These results require some interpretation, however. We took current crew size from counting the crew as listed by the crew themselves. These data are probably quite accurate. Earlier crew size was taken from the interview question that asked “crew size before DAS.” This could have been interpreted in different ways, with at least some respondents looking back to the good old days, far before 1993.

Table 2. Employment of Fishermen in New Bedford

Off-Shore Scallopers	1993	2002
Number of Vessels	104	105
Average Annual Crew per Vessel	16.8	13.8
Average Crew Size per Trip	7.0	6.5
Total Employment	1,747	1,449
Off-Shore Draggers	1993	2002
Number of Vessels	113	83
Average Annual Crew per Vessel	8.9	6.1
Average Crew Size per Trip	5.0	4.1
Total Employment	1002	508

Sources: NMFS landings data, vessel data, and permit data, crew interviews and settlement data.

More intensive interviews with four captains also cast doubt on this decrease in scallop crew size between 1993 and 2003 or 2004. They reported that scallop crew sizes in 1993 had declined to a range between six and eight in an effort to maintain individual income by sharing the declining catch among fewer crewmembers. The average crew sizes from settlement house data support this conclusion because they report crew size of seven for scallopers in 1993. By 2002, larger scallop catches called for larger crews but management regulations limited crew sizes to seven.

The average crew size from interviewing 50 dragger crews declined from five before DAS to four in 2004. Settlement houses report the same decline for dragger crews. As shown in the section on income, average gross stock per vessel for draggers declined over this period after accounting for inflation. It seems most likely that dragger crews declined over this period in an attempt to maintain individual income.

Crew size on draggers was not restricted by management plans, probably because larger crew size would not increase the catch in this fishery.

Decline in Employment

No data are available either to separate steady crew members from transients or to separate full-time from part-time fishermen. Neither NMFS nor the Coast Guard collects information on crew members, either by year, vessel, or trip.

Interviews in 2004 with skippers and crew while they were doing gear work show an accurate snapshot of the crew size and fishermen who made the previous trip and those who are scheduled to make the next trip. For scallopers, the average crew size was seven and for draggers, the average crew size was four (see Table 2). We assume that these crew sizes did not change from 2002. For 1993, settlement house data show an average of seven crewmembers for scallopers and five for draggers. In all cases, crew sizes include skippers.

Settlement house data show the names of fishermen by vessel who were paid at any time during 1993 and 2002 for samples of 39 scallopers and 68 draggers for 1993 and 61 scallopers and 60 draggers for 2002. Eliminating duplicate names of fishermen who fished on more than one vessel show that 25% of fishermen had fished on more than one scalloper and 24% of fishermen had fished on more than one dragger in 1993. For 2002, 30% of fishermen had fished on more than one scalloper and 25% of fishermen had fished on more than one dragger. Fishermen who fish on different vessels for the same owner are usually listed only once, because owners of more than a single vessel typically combine these vessels into a single corporation for settlement purposes.

In order to estimate the average annual number of fishermen per vessel, we divided the number of fishermen's names minus duplicates by the number of vessels in the sample. This method of estimation showed a decline in the average annual crew (fishermen who had gone on at least one trip) for a scalloper from 16.8 in 1993 to 13.8 in 2002 and the average annual crew for draggers declined from 8.9 in 1993 to 6.1 in 2002. Multiplying the average annual crew per vessel by the total number of New Bedford vessels in each fishery shows a total decline from 1,747 fishermen on scallopers in 1993 to 1,449 in 2002 and a decline from 1,002 fishermen on draggers in 1993 to 508 in 2002.

While we have no data to separate full-time from part-time fishermen, it seems reasonable that part-time fishermen made up most of the loss in employment. Full-time fishermen are probably more productive and there is little wage differential between part-time and full-time fishermen.

Settlement house data also show few fishermen who make trips on both scallopers and draggers. Only 18 fisher-

men showed up on both scallopers and draggers in the settlement house data for 2002. A few vessels in New Bedford own and use DAS for both scallops and multispecies. Landings data for 2002, for example, show four scallopers with more than one-third of their landings value in groundfish. These vessels were counted as scallop vessels.

In 2004, information on fishermen's ages, years spent as fishermen, and years on that vessel was collected from crew members, while they were maintaining gear between trips (see Table 3).

Table 3. Average Age and Fishing Experience in New Bedford (2004)

	Off-Shore Scallopers	Off-Shore Draggers
Number of Fishermen	428	202
Average Age	40	46
Years at Sea	19	26
Years on Vessel	3	7

Source: Crew interviews

Of the 428 scallopers who reported their ages, 14 were less than 25 years old and three were over 60 years old. This was the first trip fishing for three crewmembers. Five had been fishing for one year or less. This was the first trip on their reporting vessel for 41 crewmembers, whose average age was 38 years old and who had fished for 17 years.

This snapshot shows that New Bedford scallopers are professional fishermen in their prime years of experience, with few young and few old. Very few vessels hire shackers. Length of time on the boat gives an indication that most of these fishermen consider themselves steady crewmembers on their reporting vessel, and only a small number were transients.

As with scallopers, this snapshot shows dragger crewmembers as professional fishermen with many years of experience. On average, fishermen on draggers are older than those on scallopers, with very few young and a few over 60 years old. Four were less than 25 years old, and six were over 60 years old. Only one had fished for less than one year. For 19 crewmen, this was the first trip on that vessel. Their average age and years of experience were roughly the same as the total sample.

Income

Annual net crew share depends upon the value of the vessel's annual catch (gross stock), and the lay or share system used to determine net crew share (based on revenues and expenses).

The value of landings of draggers and scallopers in New Bedford depends upon the quantity of landings and the prices

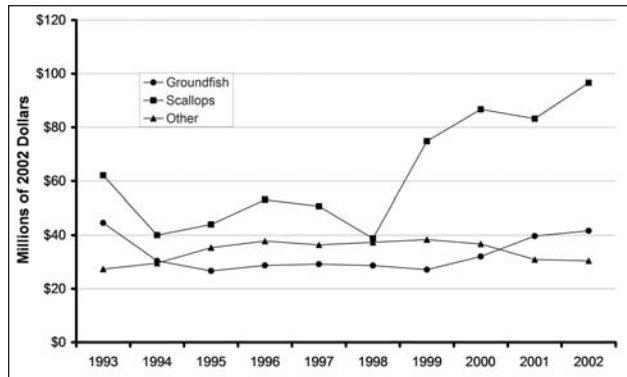


Figure 1. Value of Landings in New Bedford, adjusted for inflation using the CPI with 2002 as base year (Source NMFS Landing Data)

paid for those landings. It is beyond the scope of this paper to investigate either the amounts or causes of these variables, which are complex. Suffice it to say that quantity of landings increased between 1993 and 2002 and prices adjusted for inflation have decreased for these species. The net result of these forces, the annual real value of landings between 1993 and 2002, increased sharply for scallops and decreased slightly for groundfish (see Figure 1).

A 1997 operating cost survey of scallop vessel owners in New Bedford (Georgianna et al. 1999) reported an average split of 59% for the crew and 41% for the owner with most vessels at 60/40. Operating costs for fuel, food, ice, oil, grease, and filters were deducted from the crew share. Boat owners paid for overhead costs such as repairs, liability and hull insurance, and the mortgage for the vessel. Boat owners also paid the captain’s bonus of 10% of the boat share. For the 69 scallop vessels whose crews we interviewed in the present study, crew share dropped from 59% (the same result as the survey of Scallop costs in 1997) in 1993 to 55% in 2004. A few crew members reported that some new costs, such as the cost of Boatracs transponders and dues for the Fisheries Survival Fund were paid from the gross stock, which would reduce the amount going to the crew share.

Interviews with dragger crews showed a decrease in crew share from 54% to 51% of the gross stock. More than half of the draggers paid 50/50 split in 2004, the lowest crew share that any vessel reported. Before DAS, only about one-fourth of the draggers paid 50/50. For most New Bedford off-shore draggers, trip expenses, except for food, were paid from the gross stock with the remainder divided between the crew and the boat owner. The crew paid for food and the boat owner paid the captain’s bonus and overhead expenses, such as insurance, repairs, and mortgage costs.

Increase in Net Crew Share

Average annual gross stock per vessel, after adjusting for inflation, increased sharply for the samples of scallopers for which we obtained income data from settlement houses (see Table 4). Average annual net crew share (including the captains’ bonuses) increased by a larger percentage than the increase in gross stock, with the net share paid to the crew increasing from 34% of the gross stock in 1993 to 47% in 2002.

Table 4. Average Income for sample of New Bedford off-shore vessels (Values adjusted for inflation using the CPI with 2002 base year)

Off-Shore Scallopers	1993	2002
Sample Size	39	61
Average Annual Gross Stock	\$731,623	\$933,032
Average Annual Crew Share	\$246,141	\$434,801
% Crew Share	34%	47%
Off-Shore Draggers	1993	2002
Sample Size	68	60
Average Annual Gross Stock	\$473,057	\$457,612
Average Annual Crew Share	\$186,729	\$204,100
% Crew Share	39%	45%

Sources: NMFS landings and settlement house data

This increase was not due to an increase in the crew share of the gross stock, which declined, but due to the decrease in annual operating expenses, which the crew pays from their share. Scallopers caught more scallops in fewer trips (an average decline from 22 trips per year to 10 trips per year).⁴ Fuel prices declined slightly, adjusted for inflation, between 1993 and 2002, which indicates that operating costs remained roughly constant per trip.⁵ Annual operating costs declined, however, due to the decrease in number of trips, while the gross stock increased, both of which would increase the net crew share for scallopers. While we did not investigate this directly, annual overhead costs probably did not change with the declining number of trips, and many vessel owners reported that insurance costs, a major overhead expense, increased over the period.

For draggers, the average annual gross stock decreased slightly in real terms, but the net average crew share increased slightly, with the net crew share increasing from 39% to 45% of the gross stock. Unlike scallopers, the average number of trips decreased only slight from 27 trips in 1993 to 25 trips in 2002. The average annual number of days fished per vessel, however, decreased sharply from an average of 198 days to 101 days. The gross stock per day, therefore, increased sharply. As fuel prices declined slightly over the period, it seems reasonable that operating costs per day remained roughly constant, which indicates a decline in oper-

ating expenses per year, reducing costs for both crews and owners because fuel costs are deducted from the gross stock for draggers.

In short, net crew payment per trip or per day increased for both samples of draggers and scallopers (with larger increases for scallopers than for draggers) because gross stock per trip and per day increased while operating costs stayed constant.

Increase in Hours of Work

Fishermen work on shore and off-shore. On shore, they unload the catch from the previous trip, repair and clean nets and other gear, clean and paint the vessel, buy supplies, and load gear, ice, and supplies for the next trip. Off-shore they navigate the vessel, maintain the boat, engine, and gear, prepare meals, set out and retrieve the gear, process the catch, and load the catch into the hold.

Hours of work per day fishing per crew member are inversely related to the crew size because the work is shared and fishing gear is set out continuously on the fishing grounds except in the worst weather. Smaller crews translate into longer hours of work because at least two or three crew members (in addition to the captain or mate operating the vessel and winches) are needed to handle the gear and process the catch. With a constant crew size, the hours of work per day are directly related to the catch. The intensity of work also varies directly with the size of the catch and inversely with the size of the crew.

We would expect the hours of work to increase with the size of the catch and the constant crew size in scalloping. Results from interviews with 69 scallop crews in 2004 show an average increase in hours on during watches and a decrease in hours off (see Table 5).

Ten crews reported current watches of six on and six off, and 20 reported eight on and eight off. All others reported more work hours per watch than rest hours. Almost all crews reported equal hours on and off (either six on and six off or eight on and eight off) before DAS. More than half of the scalloper crews that we interviewed reported that their work increased by four hours per day. Average gear work between

trips changed little between 1993 and 2004.

While we are confident that these data show an increase in hours worked per day, we are less confident about when the increase occurred because we asked the crew members for information from 11 years before.

The increase in work hours per watch for draggers probably increased because crew size fell. Generally for New Bedford draggers, watches have increased from an average of eight on and four off (the old union rule) before DAS to nine hours on and three hours off for the trip before the interview. About 25% of the crews have retained the old watch of eight and four. In other words, most of the dragger crews added an extra two hours of work per day.

As with scallopers, gear work changed little between 1993 and 2004. Dragger crews do more gear work than scallop crews because they repair and build nets between trips, often tying knots for many hours.

Conclusions

Economic theory predicts that limiting user rights in a commons, as in restricting DAS in fisheries, would affect employment, income and hours of work in complex ways. The decline in DAS would reduce demand for labor. Reducing DAS below the break-even point for many vessels also would reduce the demand for labor due to the marginal vessels that leave the fishery. Raising the cost of an input, such as fishing time, would increase use of other inputs, such as labor, in terms of fishing time. Income for those fishermen remaining in the fishery would probably rise due to more efficient use of other inputs, such as fuel, and institutional restrictions that limit the reduction in the crew lay share.

Our results are consistent with these expectations. Employment declined, net crew share increased, and hours of work per trip increased. Our results suggest that annual operating cost declined because captains and crew members made more efficient use of fishing time due to reductions in DAS.

More efficient use of fishing time translates to increased work per DAS. In scalloping, watches increased due to larger catches with crew size fixed by regulations, and watches increased in dragging due to the reduction in crew size due to declining catches.

The story, of course, is far from over, especially for draggers. On May 1, 2004, Amendment 13 to the Multispecies FMP further reduced DAS for draggers with multispecies permits to 60% of the maximum annual DAS used from 1996 through 2001 (U.S. National Archives and Records Administration 2004a, 909-911). Amendment 13 also called for a further reduction in DAS to 55% of the same baseline from 2006 through 2008, and 45% of the baseline starting in 2009. Framework 42 to the same FMP, implemented in November

Table 5. Average Hours of Work for Sample of NB Off-shore Vessels

	Scallopers		Draggers	
	1993	2004	1993	2004
Gear Work Hours	6.8	6.2	12.7	12.6
Watches				
Hours On	6.9	8.4	8.2	8.6
Hours Off	6.5	6.4	4.0	3.5

Source: Crew interviews

2006, charged two DAS for every one DAS in a trip that fished for multispecies in the Gulf of Maine (U.S. National Archives and Records Administration 2006, 159).

Amendment 13 also allowed vessels to purchase DAS from similar vessels, which would shift DAS from less to more productive vessels. Starting in November 2004, Framework 16 to the Scallop FMP and Framework 39 to the Multi-species FMP allowed all permitted multispecies vessels to land 400 pounds of scallops in shucked weight per trip, giving them access to a more valuable fishery (U.S. National Archives and Records Administration 2004b, 462).

Without further investigation, we cannot claim that the decline in employment, increase in net crew share, and increase in hours of work per day fishing were caused by the reductions in DAS because we did not control for changes in biological and institutional factors. Large scallop stocks in the closed areas, at least partially opened to scallopers, and growing stocks in the open areas sharply increased the scallop catches. Declining stocks of groundfish did the opposite in the dragger fishery.

Using our data in bioeconomic models may sharpen the analysis of the effects of DAS, but modeling institutional changes is a more difficult assignment. The frequent changes in both the scale and number of factors affected by regulations and the increasing complexity of regulations make isolating the effects of these changes difficult.

Endnotes

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2. Scallopers drag a dredge to catch scallops and draggers drag a net to catch multispecies, the category of 12 bottom-feeding species (called groundfish) caught in the Northwest Atlantic: cod, haddock, pollock, yellowtail flounder, witch flounder, winter flounder, windowpane flounder, American plaice, halibut, redfish, ocean pout, and white hake.
3. For more information on these regulations see Georgianna and Shrader 2005 and Olson 2006.
4. NMFS collected the number of trips and days absent from the dock from dealers in 1993 and from captains' logbooks in 2002.
5. No. 2 distillate fuel, the main component of operating cost, decreased from an average of \$.89 per gallon in 1993 to \$.87 per gallon in 2002, excluding taxes and adjusted for inflation. Source: Energy Information Administration, Petroleum Marketing Annual. www.eia.doe.gov/emeu/aer/txt/stb0523.xls

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