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The American Economic Review, Vol. 72, No. 5. (Dec., 1982), pp. 1005-1022.

Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28198212%2972%3A5%3C1005%3ACPARTC%3E2.0.CO%3B2-8

The American Economic Review is currently published by American Economic Association.

Contracting Problems and Regulation: The Case of the Fishery

By RONALD N. JOHNSON AND GARY D. LIBECAP*

The inefficiencies of common property fisheries are of continuing concern to economists.[1] The early work by Scott Gordon (1954) and Anthony Scott (1955) outlined the problem and later studies by James Crutchfield and Giulio Pontecorvo (1969) and Frederick Bell (1972) provided empirical estimates of the losses that result. Those studies were followed by the dynamic models of Colin Clark (1976), and James Quirk and Vernon Smith (1970) of optimal harvest rates and the use of corrective taxes or quotas to achieve them. But in spite of a large and growing literature and the persuasiveness of the outlined efficiency criteria, most fisheries retain common property aspects with overcapitalization and excessive labor input. Why those conditions persist and the failure of the regulatory response to them are the issues addressed in this paper.

We examine a number of fisheries, but focus on the Texas shrimp industry, which is one of the nation's most valuable fisheries for a single species and which shares the common property characteristics observed elsewhere. It is considered overcapitalized and catch per unit of effort is falling.[2] Examination of the fishery reveals the many margins along which rent dissipation occurs and the nature of the regulations necessary for controlling fishing effort to avoid those losses. The regulatory environment in Texas is complicated by conflict within the fishery between inshore and offshore fishermen. The latter assert that bay shrimping reduces the number of shrimp that successfully migrate to the Gulf. The inshore fishery is highlighted by another issue—the recent resettlement of some 30–45,000 Vietnamese refugees, including many fishermen, along the Texas Coast (Marine Advisory Service, Paul Starr). Their entry has been met by hostility and violence from existing shrimpers who recognize that they are in an environment characterized by the absence of property rights. Bay shrimpers have lobbied the Texas Legislature for broad limits on new entrants. Yet, ironically, the sale of additional boats by individual shrimpers to the Vietnamese has facilitated entry of the refugees into the fishery.

Regulations in the Texas shrimp and other fisheries are incomplete, leaving many options for rent dissipation uncontrolled, because of high contracting costs among fishermen and political factors that mold government actions. Contracting costs are high among heterogeneous fishermen, who vary principally with regard to fishing skill.[3]

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[1]Throughout this paper we use the terms common property and open access interchangeably. Here the terms describe a situation where no property rights, group, or individual exist(s) for the resource.

[2]Catch per unit of effort in the inshore Texas Gulf and Federal Gulf waters is presented for 1963–77 by W. L. Griffin, C. G. Tydlacka, and W. E. Grant. They show catch per unit of effort generally falling in inshore and offshore waters. While catch per unit of effort fluctuates from year to year, it falls from approximately 360 kg shrimp per unit of effort to 220 kg from 1963 to 1977. The common property nature of the fishery is reflected in the following statistics. Since 1975 the number of vessels has grown by 23 percent (Nelson Swartz). For fish houses the record of entry is similar. Between 1970 and 1977, the number of firms grew from 259 to 287, though during that period, many left the industry as others entered. The number of fish houses was calculated from license data supplied by the Texas Parks and Wildlife Department. The record of entry by fish houses suggests that monopsony as discussed by Colin Clark and Gordon Munro is absent in the fishery.

[3]There may be minor differences in labor-leisure choices and capital, but our statistical evidence and discussions with fishermen indicate that catch variations are largely due to skill. Government regulations in the Texas bays restrict capital, and our empirical evidence shows boats to be relatively homogeneous.

The differential yields that result from heterogeneity affect the willingness of fishermen to organize with others for specific regulations. In developing this point, we deny the traditional assumption of zero economic rents in an open access fishery. Regulations that recognize existing rankings of fishermen, while increasing total yields, will be supported. By contrast, regulations that pose disproportionate constraints on certain classes of fishermen will be opposed by those adversely affected. This suggests that fishermen are unlikely to readily agree to individual quotas such as those described by Clark (1980) and David Moloney and Peter Pearse (1979).

Political constraints affect the solutions offered by governments. Both federal and state governments emphasize the right of all citizens to access fisheries and other wildlife. They refuse to assign private territorial rights to areas large enough to cover migratory species. Moreover, informal voluntary efforts to control entry are opposed by the Justice Department and the Federal Trade Commission as violations of the Sherman Act. Further, antitrust actions have been taken against fishermen unions along the Gulf and Pacific Coasts when they attempted to regulate prices and to limit entry. The regulations generally adopted by governments are visible, yield-enhancing policies that avoid more controversial restrictions. Accordingly, the arrangements that achieve consensus from both heterogeneous fishermen and politicians allow many of the relevant margins of fishing effort to continue unregulated.

In the following section we describe the private agreements that have been reached in a number of fisheries in the absence of government support. Those agreements reflect the contracting problems that also must be overcome by either a governmental regulatory agency or by a firm, if sole ownership were a viable political alternative. The issue of heterogeneity and its implications are outlined in Section II. In the third section we consider the specific case of the Texas shrimp fishery in detail. Finally, we offer some concluding thoughts on why satisfying certain marginal conditions in fishery management is likely to remain an elusive goal.

I. Contracting in the Absence of State Support

Models of fishery exploitation generally begin by noting that property rights to the resource stock are absent. Entry under open access conditions is described as continuing until the average cost of catching a standard unit of fish equals the market price. At the limit, then, the rental value of the fishery is dissipated. But if the absence of property rights to the stock is the source of the problem, the assignment of such rights would appear to solve it. Yet, sole fishing rights have been historically rejected by the federal and state governments as leading to monopoly control of the fishery.[4] Where they have existed, private territorial rights to fugitive fisheries have been dismantled in the United States and elsewhere in response to egalitarian pressures.[5] Thomas Lund describes the elimination of fishery rights arrangements in U.S. inshore waters in the early nineteenth century. Similarly in the twentieth century, George Rogers shows that aboriginal use rights to Alaskan salmon were outlawed by the 1924 White Act which provided that "no exclusive or several right of fishery shall be granted therein..." (1979, p. 784). White Act provisions were later incorporated in the Alaskan constitution to prevent feared, nonresident control of the salmon fishery.

Government ownership of fisheries for their common use by all citizens and the associated rejection of alleged monopoly controls have been repeatedly emphasized by federal and state courts.[6] For example, the Texas Supreme Court in 1950 rejected state legislation to limit entry in Texas coastal waters: "...If allowed to stand, the statute and action already taken under it are rea-

[4]An exception is the occasional granting of private leases to oyster beds. See Richard Agnello and Lawrence Donnelley. Also in inshore Japanese fisheries customary rights are recognized and enforced by the state. See Salvatore Comitini.

[5]Breton describes the rejection of fishing rights in the Caribbean off Venezuela. Established in 1821, they were broken up after a 1928 revolution in response to redistribution pressures.

[6]*McCready v. Virginia* 94 U.S. 391 (1887), *Toomer v. Witsell* 334 U.S. 385 (1948), *Stephenson v. Wood* 34 S.W. 2nd 246 (1931), *Dodgen v. Depuglio* 209 S.W. 2nd 588 (1948).

sonably calculated to perpetuate in effect a monopoly of commercial fishery for the favored class" (*Dobard v. State*, 233, S.W. 2nd 440). The courts have not allowed state governments to discriminate against out-of-state residents in devising regulatory schemes. Limited entry arrangements for inshore and state territorial waters must include all U.S. citizens. That requirement no doubt reduces the incentive of state legislatures to effectively regulate fisheries, since any resulting gains must be shared with outsiders and cannot be restricted to voting residents.

Even though formal private rights are absent, fishermen have frequently resorted to informal contracting and the use of unions and trade associations to mitigate open access conditions. The record reveals, however, that both have provided limited gains because informal arrangements lack enforcement, and because of government opposition to union attempts to restrict fishing effort. Examination of informal contracting and fisherman unions reveals the types of regulation to which fishermen can agree and the nature of the government response.

A. *Informal Contracting*

In Texas, bay shrimpers and Vietnamese refugees have attempted to informally restrict the entry of additional boats into Galveston and San Antonio bays where refugee resettlement has been most intense. On Galveston Bay an agreement included: "The Vietnamese agree to discourage other Vietnamese against moving into Seabrook or buying any more boats. The Vietnamese agree to sell their shrimp for the same price as the native shrimpers or within 10 to 15 cents of that price. The Vietnamese would also not drag one net with two boats..." (News release, January 7, 1981).[7] The agreement has not been binding and conflict has resulted as additional boats have entered the bay. Moreover, the agreements are considered by the FTC to be in violation of antitrust laws.[8] There is related, but limited, contracting among shrimpers for sharing information regarding the location of shrimp. Such information is closely held and exchanged only within small cliques. Limited sharing of information may increase costs to newcomers who are typically denied access to it, and hence retard entry. Knowledge of the location of shrimp is valuable. Not only do locators get first opportunity for the shrimp, but they get to them before they are scattered by repeated trawling. (See also Raoul Andersen, 1972, and David White.)

Anthropological studies (see Yvon Breton; John Cordell; Shepard Forman), while pointing to the existence of territorial rights and hostility toward outsiders, reveal the breakdown of informal agreements, particularly as competition for the resource increases. Significantly, the studies show few intragroup controls on effort. For example, James Acheson discusses voluntary contracts among Maine lobstermen for territorial rights which are enforced by surreptitious violence. Yet, he shows that many areas are not adequately defended and approach common access conditions. James Wilson's study (1977, p. 109) of the same locality notes that voluntary contracting is absent in over 90 percent of the fishery. Bell's examination of the northern U.S. lobster fishery confirms that the agreements are incomplete, since he estimates that economic efficiency (as he defines it) could be achieved with half the observed level of effort. Similar territorial schemes in the early inshore Newfoundland cod fishery have been investigated by Andersen and Geoffrey Stiles, Andersen (1979), and Kent Martin. Private fishtrap sites were established on unused spots following informal arrangements. They, however, broke down in the face of disputes and the advent of offshore fishing.

[7]Seabrook, Texas Police Department. A similar document titled a "Statement of Concensus" dated 10 May 1980 was written at Palacios, Texas, and signed by represented shrimpers. Copy provided by the Marine Advisory Service, Texas A&M University.

[8]In December 1980, John Townsend, chairman of the Texas Governor's Task Force for Indochinese Resettlement, was warned by the FTC that voluntary agreements to limit the number of boats in the Texas bays was in violation of the Sherman Act (personal communication with the authors, January, 1981).

B. *Fishermen Unions*

As a more structured arrangement for restricting outsiders and for policing compliance of members, fishermen unions and trade associations are an alternative to more nebulous informal agreements. They emerged along the U.S. coasts to limit entry and to negotiate price agreements with wholesalers and canneries. Unions were particularly active from the 1930's through the 1950's, and they implemented policies to increase member incomes. But they were subsequently dismantled by the federal government as violations of the Sherman Act.[9]

The *Gulf Coast Shrimpers and Oystermens Association v. U.S.*, 236 F. 2nd 658 (1956) case is of particular interest because of its relation to shrimping and because of the detailed regulations imposed by the union. The union was organized in the 1930's to regulate shrimping and to set prices along the Mississippi coast. The 5th Circuit Court of Appeals affirmed earlier convictions of the association and its officers for violation of the Sherman Act. The court found that the union had not merely attempted to fix prices, but also had excluded from the market those not complying with association rules. Practically all commercial shrimp and oyster fisherman operating from the five major ports in Mississippi were members.[10] They were permitted to sell only at or above the association's floor price and to packers who agreed to its rules. In its opinion the court denied the association protection from antitrust prosecution as provided for labor unions by the Norris-La Guardia Act (29 U.S.C.A. 113). Further, the group's actions were found to have exceeded the exemptions provided by the Fisheries Collective and Marketing Act (15 U.S.C. Sec. 521). Crucial in the denial of union status in this and other cases was the finding that fishermen either owned their own boats or worked for shares and were hence independent entrepreneurs.[11] Conflicts over negotiated prices were not considered a legitimate labor dispute; nor, ironically, was conservation a justification for group action: "A cooperative association of boat owners is not freed from the restrictive provisions of the Sherman Anti-trust Act, section 1-7 of this title, because it professes, in the interest of the conservation of important food fish, to regulate the price and the manner of taking fish unauthorized by legislation and uncontrolled by proper authority" (15 U.S.C.A. Sec. 522).

By fixing prices to control the fishing of certain size classes of shrimp and restricting entry, the union could provide some increase in member income even though shrimp were sold in a national market.[12] A study of the transcript in the *Gulf Coast* case and interviews with individuals knowledgeable of the union indicate that price fixing had the objective of increasing the value of total catch by directing effort toward larger, more valuable shrimp.[13] Minimum price lists based on shrimp size (tails per pound) were distributed among packers and members. By setting a minimum price for smaller shrimp that generally exceeded prices elsewhere, the association reduced the quantity demanded by packers.[14] Indeed, testimony in the case shows that whenever the market price for small shrimp fell below the association floor price, as was frequent, packers closed down

[9]Major cases included *Columbia River Packers v. Hinton* 315 U.S., 520 (1942), *Manaka v. Monterey Sardine Industries* 41 F. Supp. 531 (1941), *Hawaiian Tuna Packers v. International Longshoremen's and Warehousemen's Union*, 72 F. Supp. 562 (1947), *McHugh v. U.S.* 230 F. 2nd 252 (1956), and *Local 36 of International Fishermen and Allied Workers of American et al. v. U.S.* 177 F. 2nd 320 (1949).

[10]Captain Joe Ross, who was a union member, estimated membership at 1,800 men with 600 boats (phone conversation with authors, March 24, 1981).

[11]On the issue of share payments to crew members Crutchfield notes: "The roots of the legal problem of fishermen's unions lie in the nearly universal practice of compensating fishermen on a share or 'lay' basis" (1955, p. 542).

[12]In 1951, Mississippi accounted for 3.8 percent of total Gulf catch (U.S. Department of Commerce, 1951).

[13]Transcript of Record, *Gulf Coast Shrimpers and Oystermen's Association v. United States*, pp. 51–53, Government Exhibit #6; phone interviews with Captain Joe Ross, Biloxi, and J. Y. Christmas, Gulf Coast Research Laboratory, Ocean Spring, Mississippi, March 24, 1981.

[14]Although the prices were occasionally changed up or down, they were apparently fairly rigid (Transcript of Record,..., pp. 65–67, 90).

and shrimpers stopped fishing.[15] The higher price for smaller shrimp, then, acted as a conservation measure by reducing catches of smaller, immature shrimp, thereby increasing the yield of higher-valued, larger shrimp later in the season. The price per pound for larger shrimp was at least double that for smaller shrimp, and union minimum prices for larger shrimp were generally at or below the market price in adjoining states.[16] With the price floor reducing fishing effort for small shrimp and with Mississippi's small share of the national market, the association's actions established a quasi quota for small shrimp on the Mississippi coast.

The price-setting efforts of the union coincided with the establishment in 1934 of a legal minimum size count for Mississippi shrimp of 40 per pound, larger than the 4 inch or 68 per pound requirement in neighboring Louisiana.[17] The union was apparently an advocate of the legislation, and it attempted to enforce it. If shrimp smaller than the minimum were brought to a packing house, union peelers refused to peel them.[18] To further enforce the rules, the union required that all captains fishing for small shrimp carry a purchase contract from a buyer at the association price. Fines and suspension from fishing were levied for failure to comply.[19]

The union's efforts were directly aimed at obtaining larger shrimp. Its efforts were seemingly successful. Louisiana shrimpers were attracted to Mississippi waters, but union members opposed entry from outsiders.[20] The association pressured packers not to buy below the union price, and to deny ice and fuel to nonunion shrimpers. Testimony from a packer clearly illustrates when and how the union enforced its rules against nonmembers:

> Q. And the crews of ships were from where?
> A. The majority of them were from Louisiana.
> Q. Did you have any difficulty with the defendant association...?
> A. We did in July, 1951.... We were buying the shrimp on the same basis that we would buy shrimp in Louisiana —different sizes and different prices ...On the large shrimp we were paying, I believe $70.00 a barrel, and I think the association price was around $45.00 or $55.00, I don't recall; but on the smaller shrimp, they were $35.00 a barrel; we were paying $25.00 or $30.00 for that particular size shrimp because the market wouldn't justify it. During that period I was contacted by members of the Association because we were not paying union price.
>
> [Transcript of Record,..., p. 95]

The confrontation in July 1951 between association members and out-of-state crews led to eviction of Louisiana shrimpers from Mississippi waters as the testimony reveals:

> Q. During this period of time did the boats that were at dock in Pascagoula leave?...
> A. In other words, all those boats...we didn't own those boats.... Those boats went back to the points in Louisiana and all of them never have been back to this day.
>
> [Transcript of Record,..., p. 108]

The association's emphasis on protecting small shrimp is currently repeated by every Gulf Coast state through minimum size limits, though significantly none include limited entry as part of the regulatory

[15] Testimony of Joe Castigliola, a packer (Transcript of Record,..., pp. 78–99).

[16] Oliver Clark, a packer, testified that his prices for large shrimp were above the association floor price (Transcript of Record,..., p. 174).

[17] Louisiana size regulations, Louisiana Department of Wildlife and Fisheries, New Orleans. For Mississippi size regulations, see Food Commission, State of Mississippi, Ordinance #3, 1934.

[18] Phone interview, Captain Joe Ross, union member, March 24, 1981.

[19] Gulf Coast Shrimpers and Oystermen's Association *By-Laws*, p. 11 (Transcript of Record,...).

[20] Captain Joe Ross, Biloxi, phone conversation March 24, 1981. He emphasized the importance of protecting small shrimp to increase the catch of larger shrimp. He also argued the union was effective, and that union members were hostile to any outsiders and denied them fuel and ice.

scheme.[21] In the absence of such controls on entry, some rent dissipation will occur. Mississippi's limit is now 68 whole shrimp per pound, corresponding to neighboring states (Gulf of Mexico Fishery Management Council, Section 3, pp. 31, 32).

The *Gulf Coast Shrimpers* case illustrates the nature of union agreements to restrict fishing effort. They were designed to increase the value of the total catch for members, but, notice, none of the court cases examined showed that unions implemented individual effort constraints on their members. In the following section we document the heterogeneity of fishermen with respect to skill, and argue that under such conditions, limits on individual effort are extremely costly to agree to and enforce. Those costs not only limit the type of voluntary agreements that can be reached within fishing groups, but they reduce the ability of fishermen to act as a cohesive political force in seeking government regulation.

II. Heterogeneity and Contracting

Following Gordon, standard analyses of the fishery problem generally assume homogeneous fishermen. The supply curve of aggregate fishing effort is then infinitely elastic, and under open access conditions the resource rent is totally dissipated. Effort is added until the value of the average product equals the opportunity cost of labor. The usual remedy is either a call for taxes on catch, or for individual quotas instituted and enforced by the government. Such facile solutions and the assumptions on which they are based abstract too far from actual fishery conditions. In particular, the assumption of homogeneity leads to neglect of the high costs of contracting, either through political channels for government regulation or through private arrangements among fishermen to limit catch. Indeed, if fishermen had equal abilities and yields, the net gains from effort controls would be evenly spread, and given the large estimates of rent dissipation in many fisheries, rules governing effort or catch would be quickly adopted. With the ease of contracting implied by homogeneity, the rules selected would not only include restrictions on entry, but also regulations covering other margins where significant dissipation occurs. For example, total effort could be restricted through uniform quotas for eligible fishermen. But if fishermen are heterogeneous, uniform quotas will be costly to assign and enforce because of opposition from more productive fishermen. Without side payments (which are difficult to administer), uniform quotas could leave more productive fishermen worse off than under common property conditions. As A. Adasiak (1979) has shown, egalitarian pressures are likely under government quota schemes, and even if rent maximization calls for equal quotas, resistance is probable.[22]

Recognition of differential abilities among fishermen has been noted in much of the descriptive literature on fisheries, though the implications for contracting have not been drawn. For example, Scott notes: "Fisheries experts repeatedly speak of durable groupings of skippers, vessels, and crews according to the size of their catch or earnings, year in and year out" (1979, p. 733). Our own research reveals that Texas shrimpers categorize fishermen on the basis of their fishing ability.[23] Repeated success by some fishermen (higher than average catches) is primarily attributed to knowledge of how to set nets

[21] There is evidence that the association was effective in restricting entry and increasing the value of yield. Average shrimp price data from 1948, when data are first available, through 1959 in Mississippi and Louisiana show significant differences between the two states (U.S. Department of Commerce). If Mississippi catch had a greater proportion of larger, more valuable shrimp, the average price would be higher. A one-tailed t-test of the difference in the means of the ratios of Mississippi to Louisiana prices for 1948–53 (the period the union was active) and 1954–59 (the post-union period) shows that they are significantly different from zero at the 95 percent confidence level.

[22] Adasiak shows that the allocation of licenses in Alaska was based on notions of "social considerations," "minimum social dislocation," and "excess profits occurring to some," (pp. 775). We are not arguing such considerations should be ignored, but rather are saying that they increase contracting costs.

[23] Based on interviews with fishermen and county extension marine agents, conducted July 1980 at Galveston, Dickinson, Seadrift, Port Aransas, Port Lavaca, and Bay City, Texas.

and regulate their spread, correct trawling speed, and the location of shrimp. While skill is apparently the most important determinant of catch, more productive fishermen also tend to have somewhat better equipment. Capital in the Texas bays, though, is relatively homogeneous because state regulations restrict the size and number of nets which can be pulled by each bay vessel.

Heterogeneity of fishermen can be seen from an analysis of daily catch data from one fish house for the fall 1978 bay shrimp season. A fish house is a packing house that buys shrimp from fishermen and sells it to dealers and processors. The data covered the period September 15–December 14, 1978, and were for commercial food shrimp. Twenty-nine full-time shrimpers were included in the sample, where full time applied to all shrimpers who fished at least three days a week for at least five weeks.[24] Daily catches were listed by fishermen, and they were regressed against an intercept term, identification dummy variables for each of the fishermen, and dummy variables for each day of the season. The dummy variables for each day were used to account for day-specific effects such as those of weather and tidal changes:

$$(1)\quad Catch_{ij} = a + \sum_{i=1}^{n-1} b_{1i} Day_i + \sum_{j=1}^{k-1} b_{2j} Fishermen_j + e_{ij},$$

$$n = 86; \qquad k = 29.$$

The joint F-value for the day variables is $F(85, 1107) = 3.01$, and the joint F-value for the fishermen identification variables is $F(28, 1107) = 12.81$; both are significant at the .01 level.[25] Thus, differential performance of individual fishermen is a crucial feature of the sample.

To further illustrate the differences that exist among fishermen, as well as to show the existence of consistently successful fishermen, the sample was divided into good, average, and poor shrimpers on the basis of average catch. Those categories, though, mask wide variation within the classes. Mean daily catches for each shrimper and a sample mean were calculated; we classified as good those fishermen with catches more than one standard deviation above the sample mean; as poor those having mean catches below one standard deviation. The remaining fishermen are labeled average.[26] Weekly catch means for the three categories were then calculated for each of the thirteen weeks of the season. The catch of good fishermen ranged from a weekly mean of 1,098 pounds to 485 pounds. For average, the range was 652 to 286, and for poor ranges were 515 to 150. These results show persistent differences in catch, underscoring the regression results, with better shrimpers routinely catching more than their less-skilled counterparts.

The observed differences in fishing ability are largely attributed to acquired knowledge and innate skills. Since those skills are unlikely to be readily transferable assets, economic rents exist in the fishery, even under open access conditions (see Richard Bishop).[27] The aggregate supply curve for fishing effort is thus positively sloped and inframarginal fishermen receive rents. The likelihood of upward-sloping effort supply curves was previously noted by Steven Cheung, Parzival Copes, and Colin Clark (1980), but they did not develop the implica-

[24]The full-time criteria was arbitrarily selected to avoid weekend shrimpers and those fishing during vacations from other occupations with one month assumed to be the vacation limit. There were 29 full-time shrimpers, and 86 days out of the possible 91 were fished due to poor weather for 5 days.

[25]$R^2 = .36$ with $F(113, 1107) = 5.47$.

[26]The means used were least squares means calculated for unbalanced designs in analysis of variance tests. The classification, based on one standard deviation from the sample mean, resulted in 2 good fishermen, 6 poor fishermen, and 21 average fishermen.

[27]Fishing skills are not the same as managerial talents, and it does not follow that better fishermen are good managers. Hence, there may be no advantages to skilled fishermen in forming fleets. Since fishing skills are not easily transferable and fishermen are paid on a share basis, the higher yields of good fishermen may not be captured by fleet owners. Ship-shore operations are also costly to coordinate for fleets as pointed out by Andersen (1972, pp. 124–26).

tions of heterogeneity for contracting. Such heterogeneity limits both the nature of voluntary agreements and the effectiveness of fishermen as political lobbyists.

To illustrate the impact of heterogeneity on contracting we introduce heterogeneous fishermen into the H. Scott Gordon model. In that model the average and marginal products of fishing effort decline as effort increases. The stock of fish enters into the catch function, and it declines as aggregate effort increases. Hence, there is a direct relationship between catch and aggregate effort in the fishery. A regulatory scheme establishing catch quotas accordingly implies commensurate levels of effort, and effort quotas commensurate catches. Following Gordon, we abstract from more dynamic considerations that require the use of time and appropriate discount rates since for our purposes, they are unnecessary.

If there are N fishermen, the catch for each can be expressed by

$$(2) \qquad h_i = f(e_i, X); \; i = 1,2,3,\ldots N.$$

Here e_i denotes the units of standard fishing effort exerted by fisherman i; X is the stock of fish. The stock of fish is affected by total catch ($\Sigma_{i=1}^{N} h_i$), and we assume h_i alone has no significant impact on X. As total effort (E) is increased the stock of fish is reduced, and average catch per aggregate unit of effort falls. Aggregate fishing effort (E) is usually defined as the sum of the number of fishing vessels times their individual catching power (the proportion of the stock each vessel is capable of catching per unit of time).[28] Here, we define (E) to be the sum of individual efforts e_i, where each e_i is a function of capital, labor, and the specific abilities of fishermen that affect catching power. Individual effort, then, as shown in equation (2), is an input in the catch function. With individual effort measured in standard units the partial derivative of equation (2) with respect to e_i is a constant and the same for all fishermen. Hence, the value of the marginal and average products of effort as viewed by each individual fishermen are equal. The cost per standard unit of effort, however, varies across fishermen because of differences in fishing abilities.[29] The cost of supplying individual effort is independent of total effort in the fishery. The net rents received by fishermen i after considering all opportunity costs, $C_i(e_i)$, is given by

$$(3) \qquad rents_i = Pf(e_i, X) - C_i(e_i),$$

where P, the price of landed fish, is constant and exogeneously determined. We further assume $C_i'(e_i) > 0$, and $C_i''(e_i) > 0$ in the relevant range. Only for the marginal fishermen will rents be equal to zero such that the value of the marginal product of individual effort equals average cost

$$(4) \qquad P \cdot \partial f / \partial e_i = C_i(e_i)/e_i.$$

Figure 1 illustrates the complications differential skills provide for fishery regulation. Panel (a) of the figure shows the effort supply curves for two distinct categories of fishermen: Good fishermen $\hat{S}$ and less productive fishermen $\bar{S}$. Fishermen in each category are identical, and the supply curves $\hat{S}$ and $\bar{S}$ are the sums of the marginal costs for fishermen in the two categories. We assume that the supply functions are equal until effort level H is reached, and diverge thereafter. That assumption clarifies the discussion, but the main results do not depend on it. Panel (b) of the figure shows aggregate fishing effort with MR_E and AR_E the monetized marginal and average product curves. Both curves de-

[28] The concept of fishing effort is vague, as noted by James Wilen. Fishermen employ various combinations of capital (vessel length, tonnage, well configuration) and labor inputs. Our concept of effort embodies those choices and is consistent with the usual definition (see Scott, 1979, p. 727). We present our arguments using the cost of producing effort, rather than the cost functions for catching a unit of fish. The latter, as indicated by equation (2), contains the cost of producing effort but would necessarily shift with changes in the stock levels. On the other hand, the cost curves for producing effort are independent of stock levels, thus simplifying the presentation and allowing us to show equilibrium conditions.

[29] Note that cost functions can also vary across fishermen if their opportunity costs are different. We return to this point when discussing the role of part-timers in the fishery.

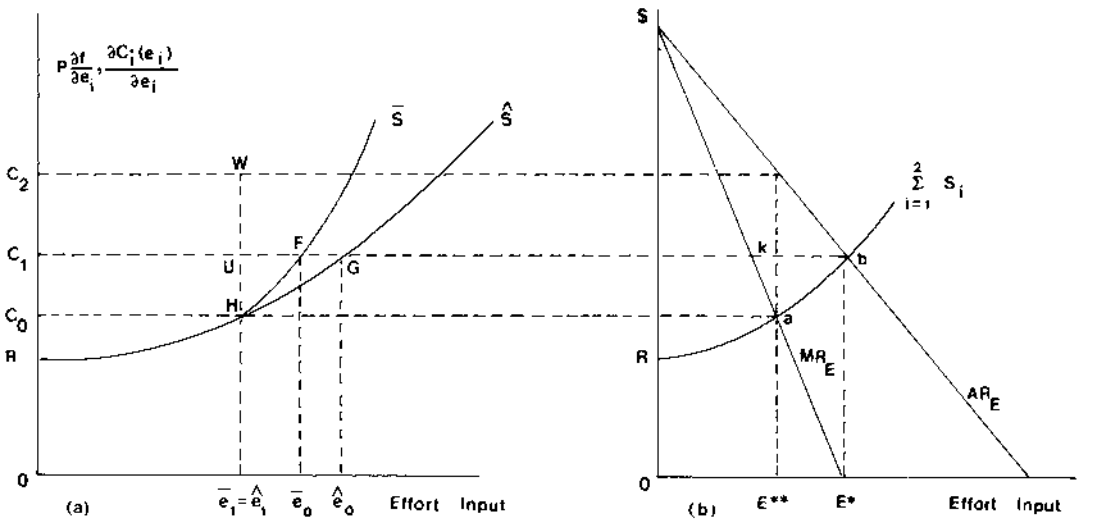

FIGURE 1. QUOTAS AND DIFFERENTIAL RENTS

cline as the stock X falls in response to greater aggregate fishing effort.[30] The supply of total effort is the sum of the effort curves for both classes of fishermen. Under open access conditions, total effort equals E^* (arbitrarily chosen to equal maximum sustained yield). The level of total effort E^* and a corresponding equilibrium stock of fish result in a value of the average catch per unit of effort equal to C_1. In panel (a), fishermen in the two categories provide $\bar{e}_0$ and $\hat{e}_0$ units of effort, equating the relevant supply curves with C_1. To maximize rents in the fishery, however, aggregate effort must be reduced to E**. Following Adasiak's point that egalitarian pressures are common in quota schemes, we have constructed an example where maximization calls for equal quotas $\bar{e}_1 = \hat{e}_1$. Those quotas lead to aggregate effort E^{**} and provide a net gain in rents equal to abE^*, where

$$(5) \qquad abE^* = (C_2WUC_1 - UGH) + (C_2WUC_1 - UFH).$$

The first right-hand term in (5) is the net gain or loss to better fishermen, while the second applies to the less productive fishermen. With the cost curves assuming arbitrary slopes beyond H, there is no reason why the first term in (5) cannot be negative, if the second term is sufficiently large to leave abE^* positive.[31] In that case, without side payments, better fishermen would oppose quotas.

Opposition to quotas could be mitigated if they were assigned on the basis of historical effort or catch and made transferable, thereby lessening the constraints on more productive

[30] The MR_E and AR_E functions as shown in Figure 1 are derivable from biological models with steady-state yields; see Clark (1976, pp. 14–15).

[31] With the cost curves assuming arbitrary slopes beyond H, the only constraints are

$$(a) \qquad UG\hat{e}_0\hat{e}_1 + UF\bar{e}_0\bar{e}_1 < 2C_1U\hat{e}_10,$$

$$(b) \qquad \hat{e}_1HG\hat{e}_0 < UG\hat{e}_0\hat{e}_1,$$

$$(c) \qquad \bar{e}_1HF\bar{e}_0 < UF\bar{e}_0\bar{e}_1.$$

The first condition follows from the upward-sloping supply function in panel (b) and the linear average catch function, implying that $C_1k = kb$ and $(E^* - E^{**}) < kb$. The last two conditions follow from the upward-sloping individual supply functions. For instance, if $\hat{e}_1HG\hat{e}_0 = 4.9$, $UG\hat{e}_0\hat{e}_1 = 6$, $\bar{e}_1HF\bar{e}_0 = .8$, $UF\bar{e}_0\bar{e}_1 = 1$, $2C_1U\hat{e}_10 = 8$, and $2C_2w\hat{e}_10 = 10$, the above conditions will be met. abE^* equals .7, but the net gain to better fishermen is $-.1$. Without compensation, better fishermen in this case will oppose quotas.

fishermen.[32] Further, the individual effort curves in Figure 1 show only one of many possible outcomes. All parties in some cases may gain even if the relative gains vary. Nevertheless, the assignment of effort or (more common) catch quotas are an assignment of wealth. Competition for that wealth is unlikely to produce a unified, collective effort by fishermen for a quota system. Even assuming that a regulatory bureaucracy were concerned with efficient outcomes, the problem remains. With heterogeneous fishermen and limited knowledge of individual effort supply functions, quota systems are costly for regulatory agencies to devise, and, as a result, disputes over the distribution of gains is likely. In addition, the fish stock is rarely known with precision and is subject to changing biological conditions. In that setting, individual quotas (generally thought of as a fixed percent of the total allowable catch) would have to vary across seasons. The assignment of individual seasonal quotas, however, will not control all rent dissipation. With the stock of fish included in the catch function each fisherman has incentive to harvest early, when stocks are high. The resulting rush raises the aggregate cost of landing the allowable catch. Optimality, then, calls for variable quotas during the season.[33] These complications cannot be taken lightly. Not only are the costs high of managing a quota system in a stochastic environment, but fishery managers will not be able to specify the potential gains of the system to each fisherman. The reluctance of those who have adapted well to open access conditions and are earning rents to support quotas is predictable.

Empirical evidence from the Bay of Fundy herring fishery reveals the difficulty of designing quota arrangements which achieve an efficient allocation of effort and minimize political opposition. Limited entry quotas based on historical catch patterns, and fishermen subsidies were instituted in 1977 after persistent falling catch. Nevertheless, conflict emerged and some fishermen attempted to leave the government cooperative around which the regulations were based. Further, preliminary data indicate that catch per unit of effort continued to fall under the regulatory arrangement (Harry Cambell, 1980, Table 3.3a).

The Bay of Fundy herring fishery was biologically overfished at the time quotas were introduced. That condition reduces opposition to quotas. To see why, consider Figure 1. If aggregate effort is initially beyond the maximum sustainable yield point ($MR_E = 0$ in panel (b)), then total catch could increase with the imposition of the quota system and provide a net gain to more productive fishermen.[34] Quotas or other property rights arrangements will also be less costly if they are assigned when the fishery is undeveloped. In that case, there will be no preexisting claims that must be reconciled in the new system. T. F. Meaney provides an example of the Shark Bay fishery in Australia where the government has permitted a single firm to operate the majority of the shrimping vessels in a previously undeveloped area for over twenty years. Catch and earnings have risen dramatically with no evidence of excessive rent dissipation.

Another commonly advocated management tool is a corrective tax on either effort

[32] Scott (1979) and David Moloney and Peter Pearse have presented arguments in favor of transferable catch quotas. Although they consider various ways that initial quota assignments can be made, their discussion focuses on the efficiency aspects of quotas once they are in place.

[33] Paul Bradley offers one of the earliest discussions of controlling effort during the season and across seasons.

[34] Essentially, we are arguing that gains from contracting increase as the fishery becomes progressively overfished. In a dynamic setting, that would imply falling average catch over time as a falling stock eventually reduces recruitment. A system of quotas could increase the stock and subsequently raise average catch. To see the argument within the context of our static model, however, allow for a new, steeper AR_E function to pass through point b in panel (b) of Figure 1. The corresponding new MR_E function pivots at point k, intersecting the old MR_E function from above. Accordingly, the new sustainable yield point will be to the left of E^*. The level of aggregate effort under open access remains the same (E^*). While the new rent-maximizing level of effort would necessarily decrease, moving $\bar{e}_1$ and $\hat{e}_1$ to the left in panel (a), average catch will increase. The gains of a quota system to more productive lower-cost fishermen must eventually overcome any losses if the AR_E function is made sufficiently steep.

or catch, but taxes have even less chance of being supported than do quotas. With heterogeneous fishermen and upward-sloping effort supply schedules, a corrective tax would lower rents received by fishermen (for example, a unit tax equal to *WH* in Figure 1). Hence, corrective taxes negatively affect the group most likely to seek fishery regulation, an ironic result since fishery programs are generally aimed at raising the income of fishermen rather than economic efficiency (Scott, 1979, p. 729). A system of lump sum payments to fishermen from tax revenues is possible; but it would encounter the same problem of the distribution of gains among heterogeneous fishermen. It is not surprising that fishery experts are unable to point to a single example where regulatory taxes or royalties on either effort or catch are in use.[35]

Other forms of regulation are more common, such as season closures, a total allowable catch for the entire fleet, and controls on entry. These more limited arrangements are often criticized because each regulates only one of the many options for rent dissipation, (for example, see Wilen). The 1950 Texas Supreme Court ruling, *Dobard v. State*, is instructive because it shows that the court early recognized that rent dissipation would occur at other margins if only entry restrictions were enacted: "...It cannot be said with the least certainty that reduction or increase in the number of boats, especially without any provision as to the size or other characteristics of the boats, would reduce or increase the total number of shrimp taken..." (233 S.W. 2nd 440). Meaney also shows that limited entry in the western Australia rock lobster fishery has been accompanied by dramatic increases in horsepower and other attributes of lobster boats as existing fishermen compete to raise catches. Alex Fraser, and Pearse and Wilen reveal similar reactions to limited entry in the British Columbia salmon fishery. Crutchfield (1979, p. 746), however, argues that although dissipation occurs at unrestricted margins, it is not complete as exhibited by positive values for fishing licenses. Further, with heterogeneous fishermen and a fixed level of fishing knowledge and skills limited entry can be expected to provide some gains to existing fishermen.

Those potential gains and the fact that few internal constraints are typically involved, suggest that limited entry will be supported by fishermen as a general objective. Once again, however, heterogeneity will lead to conflict over the details of any limited entry program. For example, part-time fishermen are often candidates for exclusion by means of entry restrictions; however, without adequate cost data one cannot conclude which group should be removed from the fishery.[36] It is possible that rents may be higher for less-skilled fishermen, who catch fewer fish, because of generally lower opportunity costs. State-sponsored buy-back programs such as in British Columbia support the objectives of limited entry by retiring vessels and licenses through government purchases (see Fraser). The program, though, is costly and controversial. Finally, if limited entry involves the assignment of transferable fishing licenses, disputes may arise over the issue of transferability.

To see why, we illustrate the problem by using three distinct categories of fishermen, where fishermen are identical in each category. Further, group contracting does not take place. Panel (a) in Figure 2 shows the aggregate effort supply curves for each of the three categories. Panel (b) shows the aggregate effort supply S_0 and value of catch per unit of effort AR_E. Under initial open access conditions and fish prices equal to P_0, only individuals in categories 1 and 2 with marginal costs $C_1'(e_1)$ and $C_2'(e_2)$ are actively fishing. The imposition of a limited entry program that grants transferable licenses to only active fishermen does not in itself change the equilibrium conditions. If for exogenous reasons, however, the price of fish rises to P_1, the value of the average catch per standard unit of effort shifts to AR_E^1. Under those conditions, a third category of fishermen (with the same number of fishermen as

[35]"So far as I know, no regulatory tax or royalty on catch is anywhere in effect today" (Scott, 1979, p. 735).

[36]Scott (1979, p. 731) also questions the arbitrary elimination of part-timers arguing that the literature on fishing has little to say on the issue.

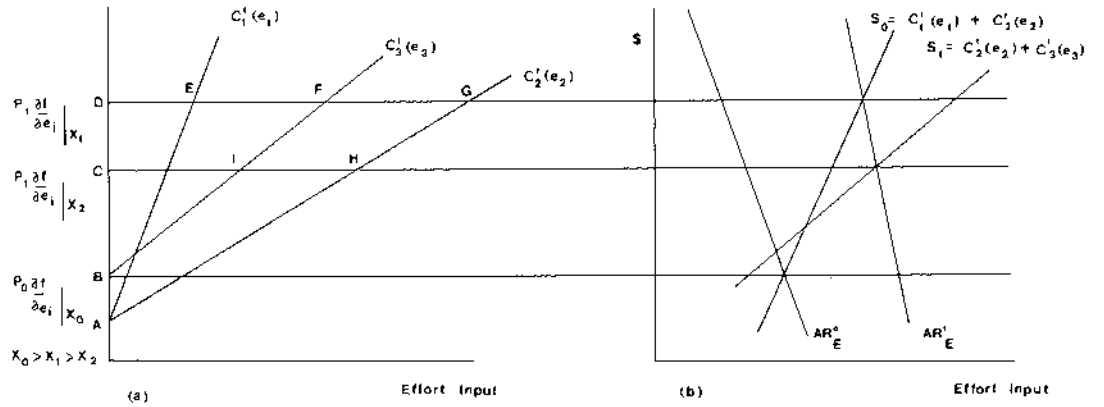

FIGURE 2. TRANSFERABILITY OF RIGHTS AND AGGREGATE RENTS

licenses in category 1) with costs represented by $C_3'(e_3)$ will enter the fishery through purchase of licenses from those in category 1, if area CIB exceeds ADE; that is, transactions will occur if individual rents for fishermen in category 3 exceed those for fishermen in category 1. With the transfer of licenses to more productive fishermen, however, aggregate effort expands along supply curve S_1 in panel (b). We assume that fishermen in category 3 recognize the effect of increased aggregate effort in calculating gains from purchasing the licenses. The greater effort resulting from the transfer of licenses reduces the rents earned by fishermen in category 2 who were not party to the transaction. Aggregate rents increase only if $CIB > ADE + DGHC$, but with individual contracting we only know that $CIB \geq ADE$. Hence, fishermen in category 1 will support license transfers, while in the absence of compensation, those in category 2 will oppose it.

The example employs considerable foresight by fishermen on the effect of entry by different groups, more foresight than they may possess. But uncertainty over the details of limited entry such as transferability, contributes to dissention and raises the political costs of the program. The example also points to the importance of well-defined property rights for efficient resource use. Limited licensing assigns only a right to fish, not a property right to the fish resource; hence dissipation of rents still occurs. The example shows that transferability of licenses in the absence of well-defined rights to the resource need not provide any improvement in aggregate wealth. Indeed, it can reduce it.[37]

Figures 1 and 2 illustrate the effects of heterogeneity on the success of fishery management. To illustrate our argument, the figures simplify the problem by focusing on well-defined categories. Empirical data, however, reveal wide-ranging differences among fishermen, which raise the costs of internal agreements among fishermen to regulate individual effort. Reasonably cohesive groups may form if there are sharp intergroup distinctions, such as those between commercial fishermen employing different types of capital (see Robert Higgs) or as in Texas between bay and Gulf shrimpers. To the extent well-defined groups exist, intergroup conflict and bargaining result as each attempts to impose differential constraints on other fishermen. For the successful group, the total available catch is at least temporarily increased and internal controls avoided.

The discussion demonstrates the hazards for existing fishermen of quota assignments, taxes, and limited entry with transferable licenses. If enforcement costs are comparable, the uncertainty of government activities, largely outside the control of fishermen,

[37] This conclusion contrasts with the beneficial effects of transferability described by Crutchfield (1979, p. 746).

would lead them to prefer regulation by fishermen unions or trade associations. Since that has been denied, government controls remain the only possibility to formally limit effort. Yet heterogeneity among fishermen suggests they will not lobby for an efficient allocative scheme until pressure on the fishery is sufficiently intense to raise the net gains from lobby group formation. Until that occurs, fishermen are more likely to support arrangements that do not affect status quo rankings and that increase their total catch—season closures, hatcheries, gear restrictions to protect juvenile fish, and controls on fishing by members of other groups.

The desire of the fishermen to enhance total catch coincides with the interests of politicians and bureaucrats. Since property rights have been historically denied to fisheries, access is determined by the political process. Catch-enhancing policies are popular among politicians because they forestall the implementation of controversial allocative schemes. Accordingly, the heterogeneity of fishermen and the self-interest motives of politicians and bureaucrats lead to similar predictions for the types of regulations sought and provided for in the Texas bay shrimp fishery. Those regulations are examined in the following section.

III. Empirical Evidence of Regulation in the Texas Shrimp Fishery

A. *Limited Entry*

Shrimp are an annual crop with no clear relationship between population size and annual recruitment (Lee Anderson, 1977, p. 103). Even though the fishery cannot be biologically overfished, catch per unit of effort is falling. Despite the potential gains offered by limited entry for existing fishermen, we predict it will not be advocated by shrimpers until economic conditions in the fishery become critical. Even then, the emphasis will be on constraining outsiders rather than established fishermen. The reluctance of shrimpers to support limited entry stems from the uncertain and possibly negative effects of government administration of the regulation—who will be restricted, how will entry limits change, and how will rules on transferability affect existing fishermen? The prediction is supported by the evidence. There are currently no formal, limited-entry programs in the fishery. Efforts to restrict access have focused on outsiders—against Louisiana shrimpers in 1947 and 1949 (both statutes declared unconstitutional), and against Vietnamese in 1981.[38]

The lack of support for limited entry is also reflected by the absence of informal access controls. The bay shrimp fishery is divided into three separate bay systems: Galveston, Matagorda, and Aransas. Within a bay, shrimpers could deny dock space, ice, and fuel to outsiders to reserve local waters. Yet, there is no evidence of efforts within communities to define territorial waters or to deny outside shrimpers support facilities. The incentive for such actions is reduced by the need for frequent migration to other areas in response to local catch fluctuations due in part to pollution and fresh water discharge. Access to other areas requires reciprocal privileges to local waters to outside shrimpers. Analysis of annual catch data for the three bay systems reveals the need for temporary migration and access to distant waters. The catches do not move together, so that a poor season in one area is not replicated elsewhere.[39]

[38] The first law levied a $2,500 license fee on out-of-state vessels and a $200 fee on individual fishermen. While upheld in *Dodgen v. Depuglio* 209 S.W. 2nd 588 (1948) by the Texas Supreme Court, the U.S. Supreme Court rejected discriminatory licensing fees in *Toomer v. Witsell* 334 U.S. 385 (1948). The Texas Legislature responded with the limited licensing scheme, ruled unconstitutional by the Texas Supreme Court, in *Dobard v. State* 233 S.W. 2nd 435 (1950).

[39] Based on interviews conducted July 1980. Shrimpers argued that catch fluctuations were not shared across bays, and they accordingly wanted temporary access to areas of better catch. Local controls on entry were viewed as bringing retaliatory restrictions on access to other bays. We collected annual catch data for the three bays from the *Annual Reports* of the Texas Parks and Wildlife Department for 1939–49. Annual catches for each bay were regressed against a constant and time, and the residuals examined to determine the extent to which catches fluctuated together. Correlations of the residuals show no statistically significant relationship:

	Galveston	Matagorda
Matagorda	−.57	
Aransas	.14	.30

B. *Season Closures, Gear Restrictions and Minimum Shrimp Size*

We predict support from fishermen for these measures because they increase the value of the total catch by protecting juvenile shrimp and do not allocate individual effort. Further, the conservation of small shrimp is consistent with the biological management goals of the administrative agency, the Texas Parks and Wildlife Department. Their joint efforts are reflected in the following passage from the agency's *Annual Report*:

> "After conferring with the canners, wholesale dealers and fishermen, the Coastal Division's Marine Biologist prepared a discussion on the shrimp situation and recommended certain seasonal restrictions.... The suggestions were adopted and agreed upon by a mass meeting of the shrimp fishermen and dealers held at Port Lavaca and were later presented to the Legislature and enacted into law.
>
> [1940, p. 39].

The support among shrimpers for closed seasons is also shown by voluntary, local extensions of closed periods at Palacios, Texas in 1973, and at Seadrift and Rockport, Texas, in the late 1970's to allow immature shrimp to grow.[40]

Gear restrictions are of two types: Minimum net mesh size and limits on the number and size of nets that can be used in the bays. The former reinforce the effect of season closures by allowing small shrimp to escape the pull of the nets. The latter, however, are of a different nature; they are used in the bays to reduce the competitive advantage of large Gulf vessels over inshore boats. There are no restrictions on the number or size of trawl nets used in the Gulf, but in the bays only one net, 25 feet in width in the spring and 95 feet in the fall is allowed per vessel (Texas Parks and Wildlife Department). That restriction effectively keeps the larger Gulf vessels out of the bays.[41]

Support for minimum shrimp size controls is divided along industry lines and depends upon the type of shrimp involved. There are two types at issue: white shrimp, which remain in the inshore bays and are harvested in the fall, and brown shrimp, which migrate as juveniles from the bays to the Gulf. Bay shrimpers have incentive to protect immature white shrimp, since they have access to them after they have grown. There are corresponding minimum size limits for the fall white season. Bay shrimpers do not have that incentive for brown shrimp, and there are no minimum size limits for the spring brown shrimp season in the bays. Group conflict between the bay and Gulf fisheries over the brown season has influenced regulatory efforts in Texas since 1959, when the state's principal shrimp management law was enacted.[42] In that year the Gulf lobby successfully closed the spring season from March 1–July 15. In 1963 bay shrimpers secured an amendment to allow a limited season from May 15–July 15.[43] To additionally restrict fishing in the bays, the Gulf lobby was able to impose individual catch limits on bay shrimpers during the spring brown season. The limits were first 250 pounds per vessel per day and later 300 pounds. No similar restrictions exist for bay white shrimp or brown shrimp on the Gulf. These catch limits are not quotas in the usual efficiency sense, but are the outcome of competition by bay and Gulf shrimpers for brown shrimp. Repeated evasion of the limits was tolerated

[40] Based on interviews conducted July 1980 with shrimpers at Seadrift, Rockport, and Palacios, Texas. A hazard to local extension of a closed season is that shrimpers from other areas may not comply. At Seadrift, when local shrimpers withdrew effort, outsiders appeared; further evidence of the precarious nature of voluntary agreements under open access conditions.

[41] Most Gulf vessels are 55 feet or longer, weigh over 60 tons, have crews of at least 3, and fish for 2 or more weeks per trip (Robert Maril). Bay boats are smaller; during 1975–80, 88 percent were 50 feet or less with most of the newly entering boats 25 feet and under 5 tons (Swartz). Boats are commonly operated with a crew of 2, and fish only in day trips. The common use of gear restrictions as a means of blocking entry by outsiders is described by Higgs, and by Crutchfield and Pontecorvo.

[42] *Statutes of the 56th Texas Legislature* (1959, pp. 407–18). The political pressures behind the 1959 Shrimp Conservation Act are described in the *Corpus Christi, Texas, Caller*, February 10, 1959.

[43] *Statutes of the 58th Texas Legislature* (1963, pp. 895–907).

from their enactment in 1959 until depressed conditions in the Gulf in the late 1970's led to political pressure from the Gulf industry for improved enforcement. In 1980, the Parks and Wildlife Department added fifty additional wardens to the normal ninety to enforce quotas and other restrictions during the bay spring season. The total number of shrimp violations in the bays correspondingly rose from 331 in 1977 to 439 in 1980 (Texas Parks and Wildlife Department, Coastal Law Enforcement Division).

C. *Taxes, Quotas, and Other Internal Effort Controls to Protect the Stock of Shrimp*

Because these regulations pose the greatest possibilities for rent redistribution and reduction, we predict little support for them among fishermen. There are no taxes levied to restrict effort in the fishery, and license fees are minimal, $40 for the bay and $50 for the Gulf. Moreover, there has been no discussion of effort or catch quotas to reduce fishing pressure to meet conservation goals. The fishery remains relatively unregulated.

The empirical record of regulation in the Texas shrimp fishery is consistent with the arguments of the paper: Regulations that expand total catch and are not aimed at redistributing rents have been supported by both fishermen and the regulatory agency; group effort has increased as fishing pressure has grown; and those efforts have focused on outsiders—the Vietnamese in the case of the bay fishery, and bay shrimpers in the case of the Gulf fishery. No internal effort controls have been implemented, except those imposed exogenously by other groups.

IV. Concluding Remarks

Our predictions of the types of agreements heterogeneous parties can voluntarily agree to are likely to apply to similar contracting situations elsewhere in the economy. Our focus here is on persistent common property conditions in fisheries and the nature of the regulatory response to them. Currently, government regulation is the only means of increasing fishery rents, since sole ownership and other private efforts to control entry and effort have been rejected as illegal. Under government regulation numerous options remain for rent dissipation for two reasons: first, heterogeneous fishermen do not form cohesive lobby groups for government controls on individual effort. We have emphasized the hazards facing heterogeneous fishermen from effort or catch quotas, corrective taxes, and transferable licenses and why group agreement in such regulation is costly, at least until the fishery is intensively depleted. Fishermen can be expected to rally for general regulations to raise total yields such as season closures or entry controls on outsiders. Those programs raise rents for existing fishermen above open access conditions, even though dissipation continues along other margins. In the absence of political support from fishermen, politicians, and bureaucrats facing periodic reelection and budget review will not pursue efficiency goals in regulation if the programs are controversial, as is likely. Second, information and measurement costs for regulating migratory species are high. Biological knowledge of the fish stock is uncertain, as is knowledge of the nature of its interdependency with other species, and the impact of environmental changes. Additionally, with heterogeneous fishermen costly measurement of individual effort and catch is necessary for devising quota, tax, and limited entry schemes. Further, enforcement of regulations across large territories is costly, particularly if a general consensus among fishermen regarding the regulations has not been reached. While government regulation may be incomplete with considerable rent dissipation continuing, it does not immediately follow that more regulation is called for. As Ronald Coase pointed out, "But the reason why some activities are not the subject of contracts is exactly the same as the reason why some contracts are commonly unsatisfactory—it would cost too much to put the matter right" (1960, p. 39).

Many of these same costs apply also to voluntary contracting and private arrangements for regulating the fishery, and would be encountered in union or trade association arrangements. Agreement on internal catch or effort restrictions is costly for heteroge-

neous fishermen—hence the broad regulations adopted by the Gulf Coast Shrimp and Oystermen's Association: restrictions on outsiders; price setting to protect small shrimp; no individual specific controls on members. Additional supportive evidence is the absence of voluntary, informal controls on individual effort among Texas shrimpers. One cannot conclude that private contracting will lead to consensus, and that all margins of dissipation will be regulated. This mirrors the cartel literature which is replete with examples of the abrogation of contracts within cartels. There is, though, one crucial advantage offered by sole ownership and trade associations over government regulation: they will internalize the costs of regulation. Accordingly, they should not arbitrarily be denied consideration in the selection of management policies if the elusive goal of maximizing the rental value of the fishery is to be achieved.

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