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Shellfish Relay:

A Preliminary Review of Potential Gains From Alternative Property Rights In Southeastern North Carolina

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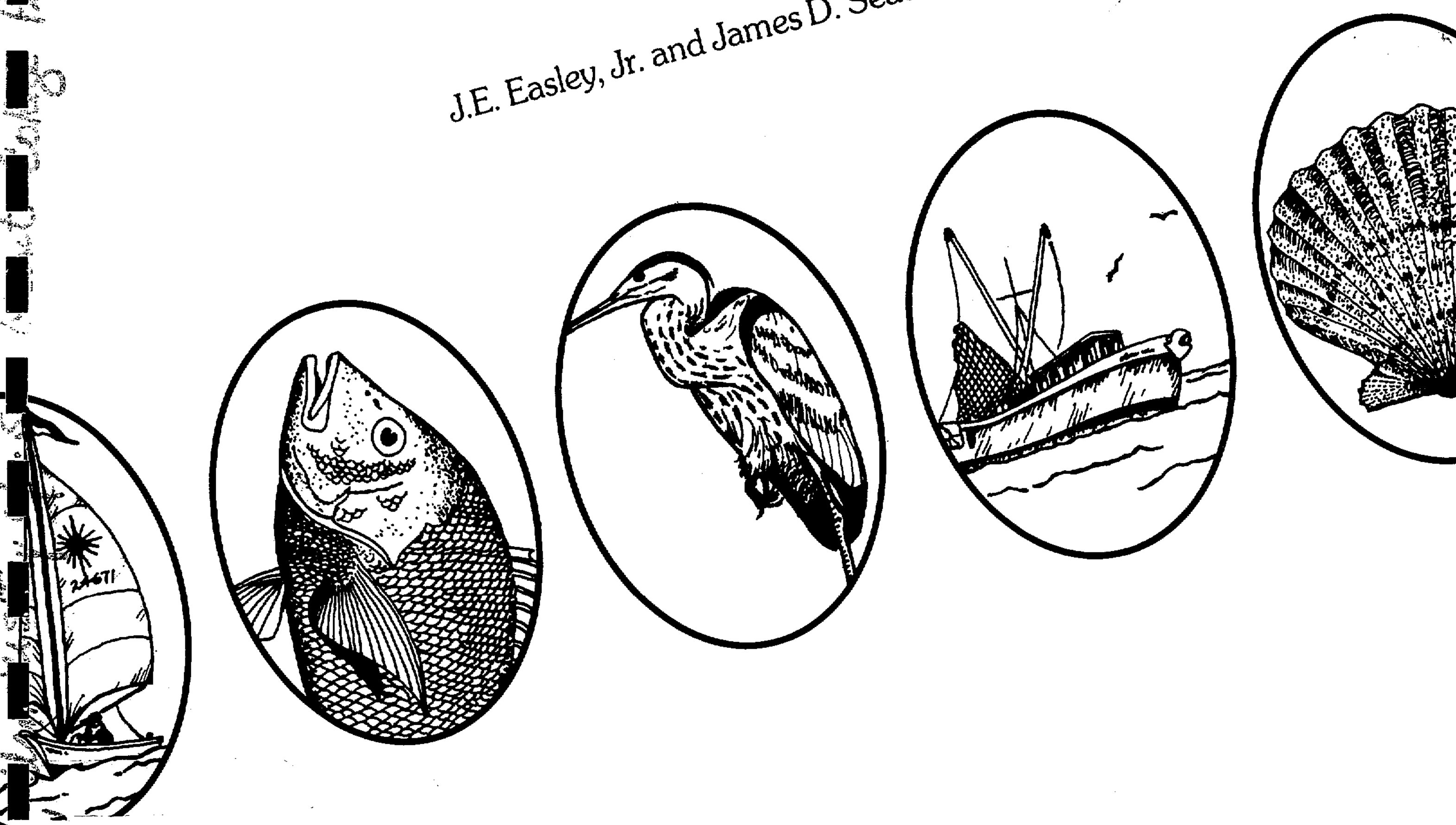

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SHELLFISH RELAY: A PRELIMINARY REVIEW OF POTENTIAL GAINS FROM ALTERNATIVE PROPERTY RIGHTS IN SOUTHEASTERN NORTH CAROLINA

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INTRODUCTION

Increasing attention in recent years has been given the decline in North Carolina oyster landings. Around the turn of the century, landings per year were four to five million pounds. They remained above one million pounds until the early sixties (Chestnut and Davis). Beginning in the early sixties, an erratic downward trend developed, with the lowest quantity recorded being 332,000 pounds in 1976 (Chestnut and Davis; N. C. Division of Marine Fisheries). One reason frequently cited for this decline is deteriorating water quality, which would include reductions in salinity as a result of upstream or shoreside development, wetland drainage for agriculture, etc. Table 1 presents oyster landings and values for the last 10 years.

Table 1. N. C. oyster landings, 1970-79.

Year	Quantity	Value
	(1,000 lbs.)	($1,000)
1970	383	269
1971	424	289
1972	470	344
1973	549	446
1974	559	436
1975	425	330
1976	332	291
1977	365	354
1978	449	548
1979	665	926

Source: N. C. Division of Marine Fisheries.

The problem with pollution is perhaps more acute in the southeastern corner of the state than elsewhere. Larger and larger areas have been closed to shellfishing in recent years, with nonpoint effluent discharges believed to be the major source of the pollution. As a result of this pollution, the N. C. Division of Marine Fisheries has recently begun mechanically moving oysters and clams out of polluted areas to cleaner waters for reharvesting after the shellfish are purged of contaminants. The purpose of this report is to summarize alternatives for removing the shellfish from polluted waters and, where possible, discuss potential economic effects, incentives, etc.

THE FISHERY

Clam and oyster landings accounted for about 20 percent of the $25.6 million of total North Carolina shellfish landings for 1979.

Table 2. Clam and oyster landings, 1979*.

	Clams		Oysters	
	Quantity	Value	Quantity	Value
State	1,454,870	$4,475,327	665,439	$925,964
Brunswick	219,900	781,011	81,900	93,292
New Hanover	114,200	408,356	32,800	48,994

Source: National Marine Fisheries Service, North Carolina Landings December 1979 (State Totals), and North Carolina Division of Marine Fisheries.

* Preliminary estimates. Quantities in pounds of meat.

The industry traditionally has been small when measured in terms of value or quantity, but has involved significant numbers of people. This has resulted in large part from use of hand gear, low entry costs, and probably low opportunity costs of fishermen. The major exception to hand gear usage is the oyster dredge, and its use is heavily regulated. Additionally, fishing is highly seasonal; hence, most clam and oyster fishermen participate in other fisheries. In the southeastern waters of the state; however, fishermen do not have ready access to the quantity or range of species available in, for example, Pamlico Sound. Hence stocks are probably subjected to more pressure than elsewhere in the state. The closure of so many acres of shellfish waters because of pollution has intensified the problem, especially in Brunswick and New Hanover Counties.

Statewide, 10,925 oyster and clam licenses were sold in 1979, and of those, 1,841 were sold in New Hanover and 2,408 in Brunswick Counties. Of the 1.1 million acres of shellfish waters in the state, only 35,200 acres are located in these two counties (12,950 in New Hanover, and 22,250 in Brunswick). Hence, about 39 percent of the harvesters are working about 1.6 percent of the available area. The effective area is even smaller after accounting for closed acreage. Table 3 summarizes acreages and acreage per licensee for the state and two counties.

Table 3. Shellfish acreage per licensee.

	Estimated total shell-fish acreage	Open acreage*	Number of clam & oyster licenses**	Open acreage per licensee
State	1,100,000	1,042,000	10,925	95.38
Brunswick	22,250	3,420	2,408	1.86
New Hanover	12,950	5,368	1,841	2.92

Source: N. C. Division of Marine Fisheries.
* As of March 17, 1980
** Issued for 1979

Differences in open acreage per licensee between the two counties and the state are large. However, there are also large differences in natural productivities and management by water areas. Some part of the total state acreage is both less productive and less intensively managed than Brunswick and New Hanover water; hence, the open acreage per licensee for the state is artificially large.[1]

Even with this caveat, it is apparent from Table 3 that a serious problem exists for Brunswick and New Hanover Counties. In late April, 1980 only 3,420 acres were open in Brunswick County. Recently some waters have been reopened, but over 70 percent were still closed as of August 4, 1980. Table 3 reveals that 58.5 percent of New Hanover's waters were closed in mid-March, while the proportion closed for the state was slightly over 5 percent. Tables 2 and 3 translate into the following income per licensee.

Table 4. Average Value of Landings per Licensee, 1979.

	Clams		Oysters		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
State	133.17	$409.64	60.91	$84.76	194.08	$494.40
Brunswick	91.32	324.34	34.01	38.74	125.33	363.08
New Hanover	62.03	221.81	17.82	26.61	79.85	248.42

Source: Computed from Tables 2 and 3. Quantity in pounds of meat.

[1]Very productive acreage is capable of producing marketable oysters in as little as 18 months, and the poorest quality produces marketable oysters in four to five years.

The estimates of the average value of landings shown in Table 4 are surprisingly low. However, it is probably the case that many oysters are sold directly by fishermen to consumers and are not included in the estimates of landing values. It is also likely that many harvesters fish part-time, thus lowering the average catch. In any event, there is probably significant redundant effort (i.e., more resources are being allocated to the harvesting of shellfish than necessary to achieve maximum economic return).

THE POLLUTION PROBLEM

The shellfish of polluted waters are rendered inedible by viral and bacterial infestation; if eaten, infectious hepatitis and/or gastroenteritis can result. Shellfish harvesters are understandably reluctant to surrender their livelihoods or change their lifestyles; hence, enforcement of closed areas is an increasing problem. Thus, the area suffers from a large number of harvesters, closing of areas due to pollution, and resulting enforcement problems.

The closing of shellfish waters stems from a high coliform bacteria count. Should water tests show more than 70 coliform bacteria per 100 ml. the area may be closed. In addition, no more than 10 percent of the samples can exceed 330 bacteria per 100 ml. The shellfish can become contaminated by sewage treatment plants and septic tanks allowing raw sewage or partially treated sewage to enter the shellfish waters. Clams and oysters feed on suspended particles in the water, and thus absorb the contaminants (Gerba and Goyal). Some of the closings stem from buffer zones around sewage treatment plants which are inevitable with the area's present level of applied waste treatment technology.

In addition to tests of water areas, shellfish being processed may also be ruled unfit for consumption. The meat itself is tested in processing establishments, as are other sanitary indicators, such as water being used, etc. Regarding the meat test, any count over 230 fecal coliforms per gram of meat is currently considered unsafe for human consumption.

Standards in North Carolina are written in terms of total coliform counts, but fecal coliform are also taken as a check. The underlying presumption is that the possibility of pathogenic organisms is higher where coliform counts are higher. Current research is underway to improve our understanding of the relationship between viruses and coliform bacteria. Questions are being raised as to whether coliform bacteria counts are accurate indicators (Gerba and Goyal, p. 747; Sobsey, et al., February 1980), and whether tests for viruses can be improved and/or developed for field use. One implication of this work is that if future standards can more accurately reflect the health dangers of the pathogenic organisms--together with more accurate and field-applicable tests--then it is possible that smaller areas will be closed. It may also be possible that such tests could find viral contaminants in areas void of coliform contaminants. Hence, until the relationship between the occurrence of viruses and coliform bacteria is better understood, no estimate of the potential change in closed acreage is possible.

While improved tests and standards offer potential for harvests of shellfish from larger areas, a longer-run solution to the problem is the installation of sewage treatment plants along the southeastern coast. Given many small towns and developments, treatment would be an expensive undertaking compared to the loss of income from closure of shellfish waters. This is obviously not the only benefit to be gained from treatment plants, but it apparently is the one of most immediate concern.

Another solution to the problem of unfishable waters is shellfish relay--the movement of shellfish from polluted waters to cleaner waters for purging and later reharvesting. This has been practiced by the Division of Marine Fisheries since the mid 1960's. Mechanical relay is now under experimentation and limited use. The remainder of this report examines some implications of alternative arrangements for large-scale relay.

SHELLFISH RELAY AND THE RESOURCE

The movement of polluted shellfish to clean water and later harvesting is an accepted practice made possible by the ability of shellfish to purge themselves of enteric bacteria and viruses (see Haven _et al._; Gerba and Goyal; Sobsey, _et al._, Feb. 1980; Sobsey, _et al._, May, 1980). There are problems with rates of purging: e.g., viruses are not eliminated at the same rate as bacteria. The rate of purging appears to be negatively related to water temperature (Sobsey, _et al._, May, 1980). Viral elimination during winter and spring months has been found to be extensive after 30 days in clean water (in excess of 99.99 percent elimination, Sobsey, _et al._, May, 1980). The lower the water temperatures (but perhaps bounded), the shorter periods of time needed. Relay thus appears to be a viable technique for purging during colder months.

In the past and to a limited degree currently, oysters have been gathered by hand, hand tongs and rakes and transferred to clean areas; however, given quantities in polluted waters and opportunity costs approaching even minimum wage rates, this technique does not appear to offer an efficient solution. More recent work has been the experimentation of a mechanical harvester for moving large quantities of shellfish. Harvesting is done by a rotating drum with tines that pick up the shellfish. Some grading is accomplished by the placement of the tines; other grading is done by hand as the shellfish enter the barge on a conveyor. Hence, only harvestable size shellfish are selected from these waters. Early estimates of productivity and operating costs appear favorable, with almost 33,000 bushels harvested in 131 hours of operation. Average operating costs were reported of approximately $.15 per bushel, with average total costs of about $.50 per bushel (Godwin). This latter estimate will likely be significantly lower as larger quantities are moved, operating procedures are better established, and machinery innovations are completed. Once large-scale movement is underway, the cost of harvesting and moving additional bushels should be relatively small, particularly when compared with prices of approximately $1.40 per pound of meat in 1979 (and an average yield of 5.25 pounds of meat per bushel). If we are talking about an average operating cost of, say $.10 - $.15 per bushel, cost per pound of meat is then approximately $.02 - $.03. Thus the operating cost of the relay equipment would be approximately 1.5 to 2.5 percent of meat prices received in 1979, and total cost approximately 7.5 percent of those prices. Hence, additional costs of relay are relatively small compared to prices received in 1979.

The Division of Marine Fisheries' experiments demonstrated that relay of large quantities of clams and oysters is technically and economically feasible. Another important question that was also addressed in the experiments was the potential resource in polluted waters. According to the Division of Marine Fisheries' survey, 10 sites in the southern coastal area could be harvested by mechanical means. These 10 areas hold an estimated 283,145 bushels of oysters. The estimated resource in Brunswick County is 109,067 bushels and in New Hanover County, 52,577 bushels. It is also estimated that these stocks will renew themselves every two to three years (Godwin). Recalling from Table 1 that in 1979 total state oyster landings were 665,000 pounds, and given that only the southern part of the state was included in this survey, then it is obvious that significant improvements in landings are possible. As resource estimates were made only for oysters, the remainder of the discussion will address some potential benefits of alternative incentive structures using only the oyster resource. However, it should be noted that similar arguments would apply to clams as well. The final section addresses different incentive structures, or more appropriately, different patterns of resource ownership.

MAXIMIZING THE GAIN FROM OYSTER RELAY

Many of the shellfish areas closed to fishing because of pollution are likely to be fairly productive areas. These tend to be close to shore, with more productive bottom and higher nutrient content of the water (ignoring potentially positive effects of pollution on growth rates). If natural productivity is higher in these areas, there might be payoff to more active management of these areas rather than some less productive areas. The resource in polluted waters should be viewed as a capital stock, with harvesting over time at some rate below that which would diminish the stock. Determining the optimal rate of harvests for relay from these polluted waters would probably be a worthwhile project.

Currently, contaminated oysters mechanically relayed are transferred only to public bottom. Hand tongs or rakes may be used to gather polluted oysters for relay to leased bottom, but not mechanical gear. Some exceptions are that private relaying of clams by hydraulic dredge and clam kicking may be authorized in some areas. Oyster dredges have also been used for this purpose in Pamlico Sound and its tributaries. With the mechanical harvester recently tested large quantities of shellfish can be relayed, as noted earlier. Experiments thus far have placed all mechanically harvested oysters on public bottom during periods of closed seasons (Godwin). When the season opens, the cleansed oysters are harvested.

Relay makes available more oysters, but the common property resource problem is still perpetuated. This problem simply stated is that it is in the interest of each fisherman to harvest as much as he can as soon as he can. What he does not harvest may not be available for him at some future date because someone else may harvest it. The effects of this have been more generally understood since the work of Scott (1955) and Gordon (1954). More is harvested in the current period than is optimal and the resource is depleted over time. (Thinking of the number of licenses as a proxy for effort--though an admittedly crude proxy--examine again the average value of landings per licensee in Table 4.)

The obvious waste involved in having too many people harvest the relayed shellfish from public waters leads one to think of alternatives. For example, could the state establish a special program of annually leasing small areas to licensed operators for the sole purpose of purging shellfish? The lease in question here would be used for purging as opposed to the grow-out function embodied in current leasing. The area leased for purging would likely be smaller as relayed shellfish would have been size graded. Little if any grow-out would be involved, hence, food supply and other production factors would not be as important, or constraining, as with the usual lease. Given the purpose and short term nature of a lease for purging, higher stocking densities might also be possible.

Research results have been reported that have a direct bearing on this question. Agnello and Donnelley found that prices and incomes were lower when oysters were harvested from public bottoms than from leased bottoms. Depending upon their testing procedures and data, they found price differences of $.05 per pound (meat weight) and $.21 per pound. The higher prices accruing to harvesters of oysters from privately leased bottoms are attributed to better timing of harvests. As noted earlier, with common property rights prevailing the incentive is for every individual to harvest as much as he can as soon as he can upon the opening of the season. The result is that more are harvested early in the season and hence prices are lower. With leases, however, storage is feasible allowing the lease holder to time his harvests to take advantage of higher prices later in the season, or even later seasons as in the case of leases for grow-out. With a mix of private and common waters, or altogether private, fewer oysters are harvested upon the season's opening compared with the situation under common property. Hence prices tend to exhibit smaller fluctuations through the season. Note that a higher average price would result even if we compared identical quantities of oyster harvests in a given season under the two ownership schemes. The implication is, of course, that incomes would be lower with common ownership of the resource. Agnello and Donnelley (pp. 260-61) report the results of two tests that confirm such an implication.

These findings imply that relayed oysters have two potential prices at final harvest: one if placed on public bottom, and a second, higher value if they were privately owned. We will first discuss their value if placed on public bottom. Assume for a moment that we identified the quantity that could be relayed annually, and that all of these were relayed to public bottom. Given the number of existing licensees in southeastern North Carolina, and more importantly, no restrictions on entry to the fishery, we would expect the typical rush to harvest upon opening of the season. The common property problem continues, and market prices tend to be depressed early in the season. This is especially true if southeastern North Carolina landings affect price. If price is determined, as we suspect, by the larger mid-Atlantic market, then the downward price pressure of higher North Carolina landings will be minimal.[2] We assume that harvests could increase by as much as 495,504 pounds of meat per year, which represents a yearly relay and final harvest of one-third the estimated resource in polluted waters.

This quantity represents a substantial increase in North Carolina landings, but would have accounted for only one percent of U. S. landings in 1979 had all of those been relayed and subsequently harvested. Landings for the country in 1979

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[2]A current project will examine in detail the relationship between North Carolina prices and those elsewhere.

amounted to just over 48 million pounds of meats, with 20.4 million of those landed in the Chesapeake states, and 15.3 million in the Gulf states (National Marine Fishery Service, 1980, pp. xi and 3). Hence the assumption that North Carolina prices are not established locally may be reasonable. Local prices may show some variation due to local landings, but these variations would likely be relatively small and limited to some extent by transportation costs. That is, if North Carolina prices fall below the sum of a price elsewhere plus transportation costs to that point then we would expect North Carolina dealers to export oysters. Exporting would then tend to exert positive pressure on North Carolina prices.

What this implies is that had larger harvests been made off public bottom in 1979, average prices would have perhaps been lower, but not by very much. If we value the maximum potential relayed quantity at the price received for oysters harvested off public bottom, the value would have been $683,796 for 1979.[3] Note again that this value represents what would have been a maximum for 1979, and assumes that one-third of the stock of oysters in polluted waters would have been of harvestable size. Oysters mechanically harvested for relay are currently graded for size, with smaller ones returned. With grading and given the polluted areas' relatively short grow-out, the assumption of one-third of the stock being moved may not be unrealistic. If insufficient clean water is available; however, then the estimate of value would have to be reduced, reflecting lower quantities relayed.

What then might we expect the additional value of the resource to be if oysters in polluted southern N. C. waters were transferred to private bottom instead of public bottom? Assume that leases would be available for purging and that the same quantity as used in the preceeding example had been transferred to leased bottom. Note again that these leases would not require as much acreage as the normal grow-out lease. Also assume that the average price that would have been received equaled that for oysters off private leases in 1979--$1.70 per pound of meats. Using this average price, the value of relayed oysters would have been $842,357--a gross gain of $158,561 over the value generated from the same quantity placed on public bottom. The gross gain of $158,561 no doubt represents an upper limit. The price of oysters off leased bottom in North Carolina in 1979 would quite likely have been lower as the relayed quantity would have increased landings off leased bottom several-fold. Oysters off leased bottom may also have been

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[3]The 1979 average price received for oysters harvested off public bottom is $1.38 per pound of meat and is computed from data supplied by the Division of Marine Fisheries. The comparable price computed for oysters harvested from leased areas is $1.70 per pound.

larger, hence, part of the higher price might well have represented a quality premium. But, if this differential (price off leased bottom minus price off public bottom) exists because of timing of harvests, then some differential would be expected to be available to fishermen harvesting off leases for purging. This is especially true if that differential is set in the larger middle-Atlantic and Gulf markets. Using the two price premiums found earlier by Agnello and Donnelley, and the premium found from 1979 North Carolina price data, Table 5 summarizes a range of potential additional gains from leasing for purging in southeastern North Carolina.[4]

Table 5. Estimated Additional Gross Value Per Year of the Harvest of Purged Oysters Due to Leasing

Area	Estimated harvests*	Gross gains from leasing at price premium of: $.05/lb.	$.21/lb.	$.32
	(lbs. of meats)			
Southeastern N. C.	495,504	$24,775	$104,056	$158,561
Brunswick County	190,867	9,543	40,082	61,077
New Hanover County	92,010	4,600	19,322	29,443

* Based on assumption that one-third of estimated stock would be harvested annually, and that one bushel yields 5.25 pounds of meats.

The values in Table 5 tell us that the oysters relayed in just the southern part of the state might be expected to yield an additional $100,000 or more yearly if placed on leased bottom. The additional value (at $.21 per pound) amounts to almost $17 per licensee per year in Brunswick County; $10.50 annually per licensee in New Hanover. On a per-licensee basis, these estimates appear small. However, referring to the value in Table 4, note that the additional value of oysters would raise the comparable 1979 value in Brunswick by about 44 percent, and in New Hanover by about 39 percent. If relay to leased bottom were combined with some reduction in effort on public

[4]These benefits could be realized without any reduction in effort in public waters. The effective constraint would be quantity of bottom available for leasing in clean water.

bottom, then the value of catch per licensee would increase even more.[5]

The estimates above should not be confused with the total value of the resource. They represent the values of yearly harvests as a result of public versus private ownership. The total value of the estimated stock of 283,145 bushels would be the following: $2,051,388, valued at the 1979 price received by fishermen from public waters; and $2,527,072, valued at the 1979 price received from private leases. We again emphasize that the difference in value might well be compressed if all the stocks were, over time, moved to leased areas; hence, it represents something of an upper limit to the premium available to private ownership. Note however that the difference in value would accrue every two to three years, or as often as the stock renews itself. Stock management would be necessary to ensure maximum yield, and questions such as what quantity constitutes optimal relay should be given high priority.

A few comments are appropriate concerning leasing itself. Leasing in Brunswick County was specifically excluded in the legislation granting the Division of Marine Fisheries authority to lease shellfish bottom (G.S. 113-202, c. 876, s. 2, 1967). This exclusion of Brunswick should be examined in view of the potentially higher returns from shellfish relay there. Special legislation may also be required to move shellfish from polluted public bottom to leased bottom in those counties with significant polluted areas. If fishermen are aware of the potential return, it is difficult to understand their resistance to leasing as is purported to be the case unless policing costs exceed those potential gains. If high individual policing costs are a problem, increases in penalties may help reduce them.

At the same time, not all licensed fishermen may choose to purchase a lease. In fact, the Division of Marine Fisheries could make available a certain proportion of the (yet to be identified) optimal quantity of relayed shellfish to lessees for puration. The remaining ones could be moved to public

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[5]One way to achieve some effort reduction or at least to slow its growth--would be to issue no new licenses. Those previously holding licenses could be assigned quotas, with those quotas marketable. Clark has shown this management technique to have the same effect on effort as a tax on catch, the latter generally regarded as being highly effective in achieving economic efficiency, but politically impractical. Assigned quotas may not be so politically impractical and, if marketable, result in the accrual of the benefits of "scarcity" to quota owners (fishermen) instead of government as in the case of taxes on catch.

bottom to satisfy management objectives that are not necessarily keyed to maximizing economic yield of the resource. How could the state make these shellfish available to lessees? One option would be to allow and oversee, the private harvest and relay of shellfish with mechanical harvesters similar to the one now in use. Another option simply might be to auction off some proportion of the polluted shellfish, and use the proceeds to seed, or otherwise improve yields from the polluted areas. Still a third option would be to set lease fees such that costs of harvesting and relaying by the Division would be covered. In any event, a special legislation package may be necessary for this entire problem.

General procedures for acquiring and maintaining a lease are discussed in the current regulations (Division of Marine Fisheries, 1980). There may be economies of scale (cost savings) in the actual granting of leases for purging purposes. One potential economy could be in the surveying of multiple leases at once, rather than individual surveying. Public and private enforcement costs may also be reduced if leases are geographically close or adjacent to each other. Most relayed shellfish would be harvested over a shorter period of time than is the case with normally cultivated shellfish. Stocking densities for purging may be higher, and leased acreage lower, than those on normal leases. Actual relaying costs might be lower if stocking densities could be higher than those currently used on public bottoms, and if leases were geographically close. Also, final harvesting costs might be lower for a given quantity of shellfish than currently incurred by searching larger, public waters. The point is that an active role in relay leasing by the Division of Marine Fisheries would likely improve the returns from shellfish resources in polluted waters.

Other options--some representing variations in the current relay program--should be noted. One of these that has been mentioned is an onshore purging facility. The economic feasibility of such a facility should be investigated before serious pursuit. Another option for puration might be floating cages. Cages may be feasible if there is insufficient bottom in clean water for bottom leasing. By using the water column, less bottom area would be required. It might be interesting to examine costs of such a system compared with, for example, an onshore facility (which would have lower enforcement costs).[6] At the same time, the economic arguments in favor of leasing would apply here as well. Either method would simply represent a different form of holding shellfish for purging and transfer of ownership of the resource would also be required.

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[6]For a discussion of benefit-cost analysis and some application related to water quality, see Hargett, 1979, and Hargett and Seagraves, 1979.

In summary, mechanical relay of shellfish from polluted waters to clean waters offers a feasible technique for increasing harvests in southeastern North Carolina. This study has found that larger economic yields from the resource are possible, but the key is private ownership of the resource. It would be possible to capture most of these higher returns from relayed shellfish with both private ownership (purging leases) and continued public grounds. Ownership issues will be involved in most alternatives for purging, except placing the shellfish on public bottom, as presently done. On the other hand, if relay solely to public waters is continued and free entry prevails, there is no reason to expect any economic rents to accrue to fishermen. In the long run, we would expect little if any significant improvement in real per capita net income. While the leasing alternative poses some potential short run political problems, perhaps the time has come to face those problems as a cost of long run improvements in the fishery.

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