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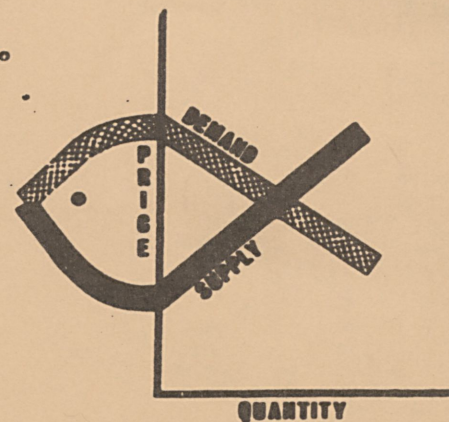
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NOT FOR QUOTATION

ECONOMIC ASPECTS OF FISHERIES MANAGEMENT -
THE NORTHERN INSHORE LOBSTER FISHERY,

Contract No.: N-043-30-72

By

James Wilson
University of Maine

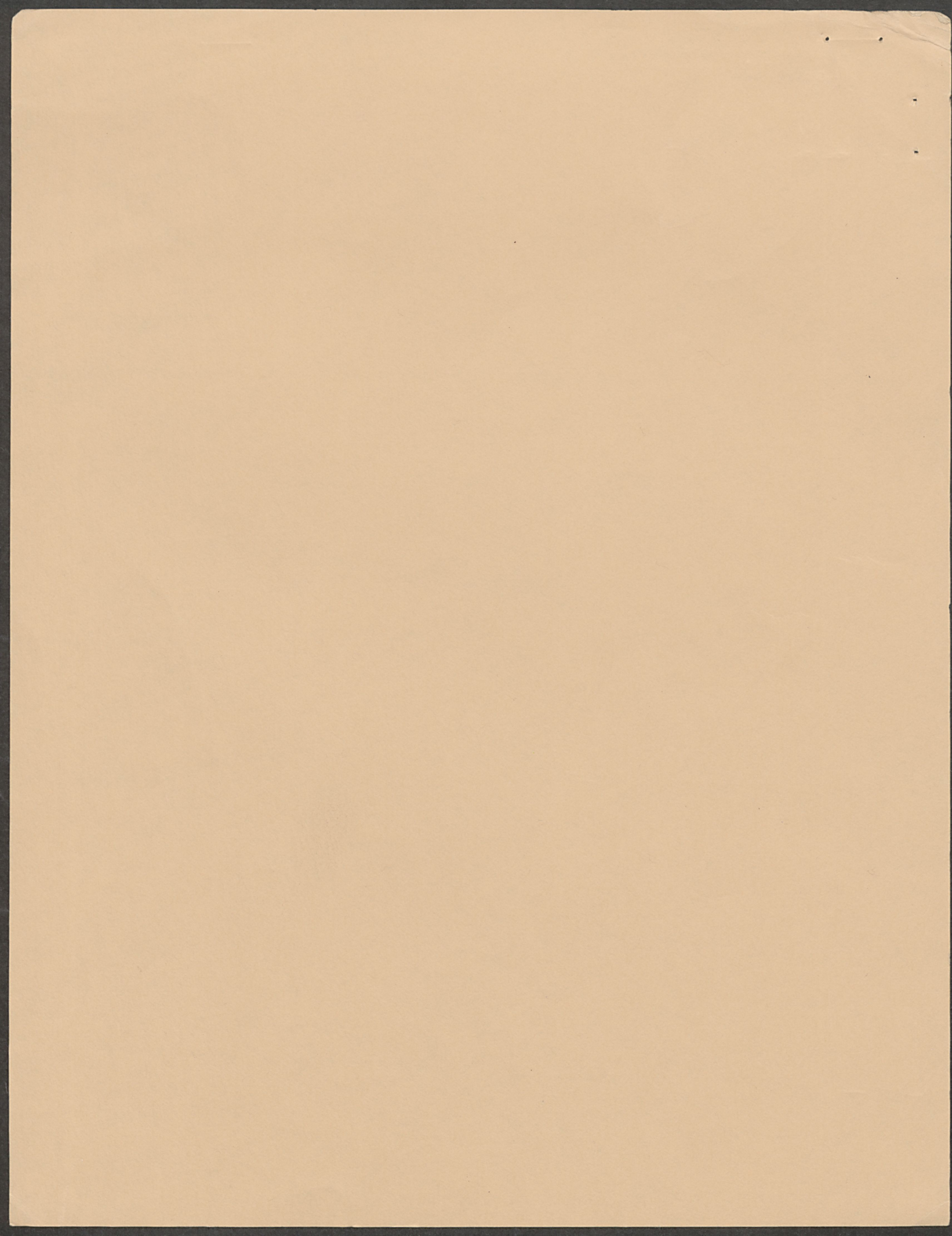
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Administrative I

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Economic Aspects of Fisheries Management - I

The Northern Inshore Lobster Fishery, I

Administrative III

Administrative IV

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Administrative V

Administrative VI

Administrative VII

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I. Introduction

The purpose of this study is to devise and evaluate alternative management proposals for the inshore lobster fishery in the State of Maine. The reason for undertaking the study in the first place was the fear that rising levels of fishing effort are leading to depletion of the lobster resource and the consequent impoverishment of the fisherman and rural communities dependent upon the fishery. The biological extinction of the lobster is apparently not a problem given its fecundity and the available or permissible technology of harvest.

Generally, the procedure of such an evaluative study is akin to a long range accounting of the costs and benefits (defined in the broadest possible sense) which would be expected to result from each of the proposed policy approaches. The procedure is relatively straight forward and reasonable provided the costs and benefits of each policy alternative are measurable in comparable units (which implies, of course, that the results of policy actions are predictable). Furthermore, the procedure is reasonable if it is closely tied to realistic management policy possibilities. Given the legal status of the fishery in the State of Maine (i.e. the preeminence of the legislature), an evaluative study of this sort is of reasonable value only if the alternatives it considers are in some sense within the boundaries of political possibility.

Needless to say these two criteria of reasonableness are difficult to achieve. Staying within the realm of political possibility is especially

difficult in a situation of political flux such as that which characterized the industry this past year. To stay within the realm of political possibility we have maintained as close contact as possible with the opinions of the lobstermen, their associations and concerned state legislators. From that point on, judgment of political possibilities are merely that - judgments.

With respect to the predictability and measurement of the costs and benefits of policy alternatives, we have found that the state of knowledge of the various aspects of the fishery is not sufficient to conduct a reasonable cost-benefit analysis of alternative management policies for the fishery. The reasons for this are somewhat complex but may be summarized by stating three questions which are of ultimate importance to a cost-benefit approach. We do not feel that answers to these questions exist in a form which is sufficiently reliable for confidence based quantitative cost-benefit analysis. The three questions and their importance to the evaluation of policy alternatives are:

- 1) At what rate is the commercial fishery approaching the point of depletion? This may be restated in the policy oriented form:
How quickly must our policy measures be implemented? From the point of view of social policy this question is very important because the timing of policy measures is crucial to the incidence and magnitude of social costs and benefits.
- 2) What is the relationship between changes in (current) fishing effort and changes in the (future) harvestable biomass? In other words, a calculation of the social costs and benefits of any particular policy must be made in terms of "what do we gain tomorrow by giving up something today?"

- 3) What will be the distribution of costs and benefits among the current and potential direct and indirect participants in the fishery? In other words, how will the pie be divided? The importance of this question for social policy relates primarily to questions of political feasibility and also to matters of social equity (e.g., will limited entry of one sort or another have an especially harsh impact on a group of current or future participants who have few other economic alternatives?). Needless to say matters of this sort are inextricably bound up in value judgements.*

Faced with the difficulty of obtaining reasonably confident quantitative answers to these questions we chose to abandon the traditional cost-benefit evaluative procedures and instead substituted an evaluative procedure which emphasizes the ability of any particular policy to be flexible and adaptive. That is, we do not feel that the predictability of biological and economic policy initiatives is precise enough to be able to impose a definitive policy at this point in time. Rather the interaction and consequences of various economic and biological policies will probably have to be learned as experience with the active management of the fishery accumulates. Consequently we have tended to place a premium on policy or strategy alternatives which promote the accumulation of this experience and which provide for the ability to respond and adapt to the lessons learned from this experience. Additionally since learning can often be an expensive process we have attempted to consider the likely costs of learning, valuing highest, of course, those policy alternatives which promise to minimize these costs.

*A more complete treatment of the importance of these questions is contained in sections II, III, & IV of this paper.

By and large we feel that this methodological approach to the problem of fisheries management has a much wider applicability than is suggested by this study. In general crucial questions relating to the dynamics of fish populations and the impact of alterations in the level of fishing effort (either in terms of total gear and labor input, or in terms of alteration of gear design or legal size requirements) are only well understood at the theoretical level. As a practical matter data limitations, especially, tend to shroud our real world application of our theoretical knowledge in a cloud of uncertainty. As a consequence, policy making decisions often take on an unavoidably probabilistic character.

We have found that persons concerned with fisheries policy are fully aware of this nature of their charge and are, in general, uncomfortable with its implications. Furthermore, policy making discussions appear to be dominated by the search for a reasonable means of dealing with the uncertainty inherent in the management problem. By and large there seems to be a consensus that the most reasonable course of action at any particular moment is to pursue policies which appear to be optimal in the light of admittedly imperfect knowledge and to push ahead as quickly as possible on scientific research most relevant to policy matters.

The findings of this study do not constitute a fundamental challenge to this consensus. Rather the essence of the study is that the thrust of the consensus is correct, but in need of further articulation and, especially, the delineation of specific policy alternatives. In terms of further articulating the consensus, we suggest that it would be most useful to begin considering the social and economic environment of the fisherman as a tightly integrated part of the total biology of the fishery. Essentially, this means the explicit conceptualization of the fisherman as a predator

and the consequent inclusion in fishery analyses of the factors which influence the "effective population" of the predator/fisherman. In the past, human populations appear to have attained a stable relationship with their natural environment. There is considerable anthropological evidence that the role of culture was, in major part, to provide a means of internalized population control and a set of rules of behavior compatible with man's ecological niche.*

Unfortunately the biological nature of man and culture is a forgotten aspect of fisheries policy. This is unfortunate because the explicit consideration of the biological nature of the fisherman population and culture would appear to make available to fisheries management a whole range of policy alternatives not now actively considered. What we mean by this is that it should be possible to devise and apply institutions (specific cultural forms) which have the capability of searching out the equilibrium niche of the fisherman population. The example of animal predator populations and human hunting and gathering societies suggests that internalized population controls are mechanisms for achieving ecological equilibrium even in the absence of articulated knowledge of the natural environment. Since current fisheries management problems are completely circumscribed by the uncertainty of our biological knowledge, we suggest that policies designed to internalize fisherman population (total effort) controls are likely to be a useful, and perhaps powerful, addition to fisheries policy alternatives.

*Interesting discussions of the anthropological evidence relating to man's ability to find, or adapt to, his environment are contained in Richard Wilkinson's Poverty and Progress (Praeger, 1973) and Sir Alexander Carr-Saunders' The Population Problem (Oxford, 1922).

In the paper which follows sections II-IV expand upon the importance of answering the three questions cited above and the apparent reasons why the questions cannot be answered with sufficient certainty for the purposes of cost-benefit evaluation. Section V discusses the implication of uncertainty for management strategy and suggests appropriate socio-economic evaluation criteria. Section VI is a brief over view of the methodology of the study and Section VII contains the evaluation of individual management alternatives.

II. Socio-economic Policy and Uncertainty About the Rate of Depletion

At this time there does not appear to be sufficient knowledge of the fishery to allow us to state with certainty the time frame for policy initiatives. We do not know whether the urgency of the problem is such that we must attempt to avoid a commercial disaster two or ten years from now. This causes extreme uncertainty with respect to the social and economic aspects of management policy. For example, if the fishery is slowly approaching the point of depletion, then relatively low cost social policies which rely upon normal attrition and slightly restricted entry to reduce effort are likely to be optimal. On the other hand, if the fishery is rather quickly approaching the level of effective effort consistent with a state of depletion, then optimal policies will be those which virtually terminate entry in the short run and bring about an artificially high rate of attrition of persons already in the fishery and reductions in the effective effort of those who remain. In other words, the period of time over which policies are, or have to be, implemented will to a large extent determine the magnitude of social costs and benefits associated with management of the fishery. For this reason, a reasonably sure time frame is crucial to the choice of optimal social policies. Unfortunately the state of our knowledge of the fishery does not permit the precise, confidence laden time estimates which would be so desirable.

2.

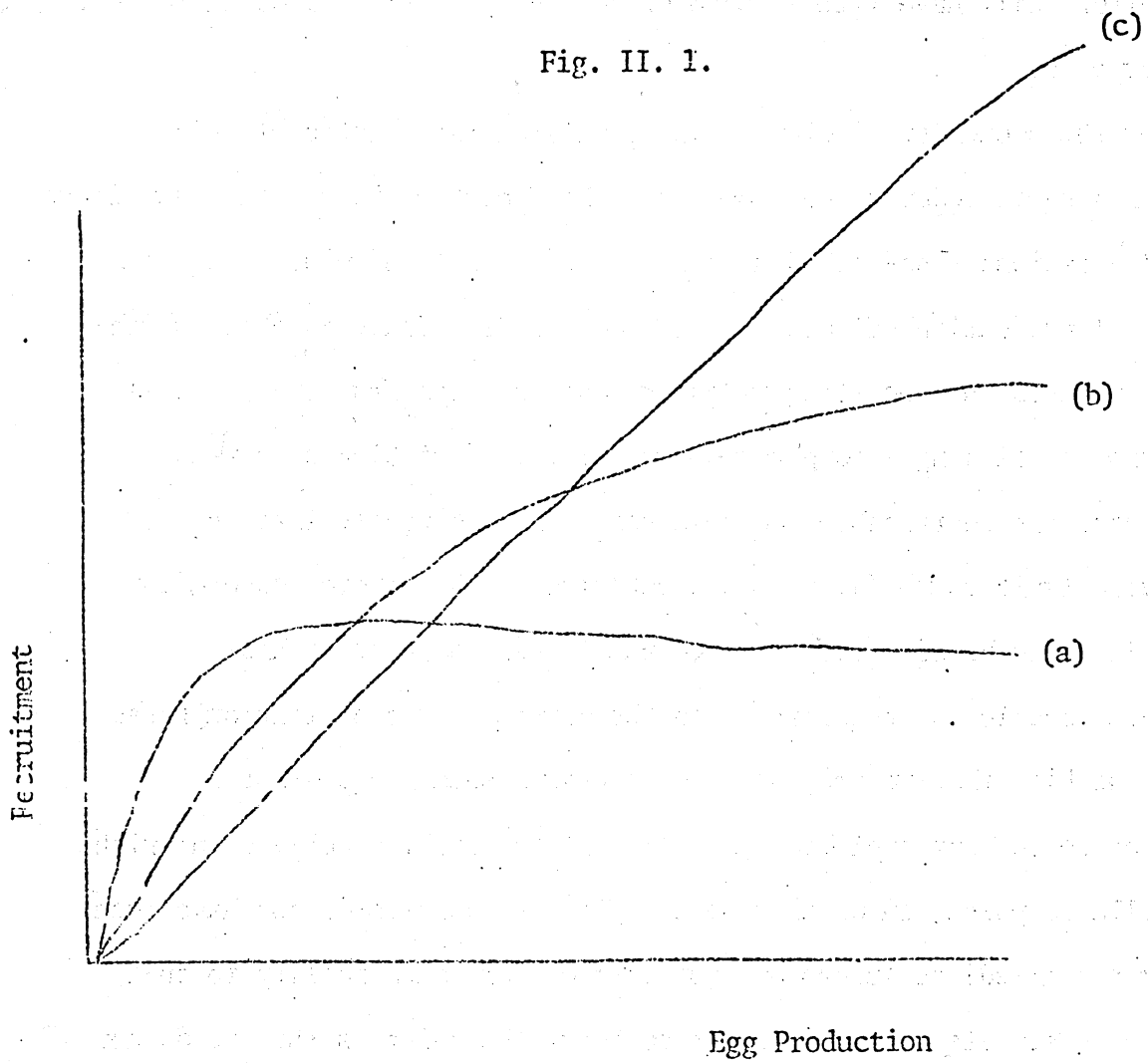
This lack of knowledge cannot be explained other than by noting that the lobster is a very difficult creature to study. The stock-progeny relationships of the lobster appear to be central to the question of the rate of depletion of the commercial fishery. Beverton and Holt present a graph showing the relationship between the number of eggs and recruits under several hypothetical population dynamics which is of some value in illustrating the problem of determining the rate of depletion.* The essential elements of the graph are produced here as fig. II. 1.

Curve (a) in the graph illustrates recruitment which is virtually independent of the number of eggs except at very small numbers of eggs (i.e., density dependence at the pre-recruit stage). For the sake of illustration assume that curve (a) is representative of the lobster population dynamic and that the number of eggs is proportional to the number of mature females in the stock which in turn is negatively related to the rate of exploitation. Then, given a continuously rising rate of exploitation, historical experience in the fishery should exhibit relatively constant recruitment (and catch) and then a sudden and drastic decline once a certain critical rate of exploitation is reached. In other words, this particular population dynamic is one which might afford little or no warning of an imminent collapse of the fishery. (A lack of warning in the lobster is quite possible since sampling of the pre-recruit population is apparently very difficult except for the period one year or so immediately before recruitment.)

Another characteristic of this population dynamic which is very important for policy purposes is that, at rates of exploitation lower than

*R.J.H. Beverton and S. J. Holt, On the Dynamics of Exploited Fish Population, (Her Majesty's Stationery Office, 1957) p. 51

Fig. II. 1.



Egg Production

that associated with collapse, management induced changes in the level of fishing effort will have little or no effect on recruitment and, therefore, future harvests.

From the economist's point of view, this characteristic of this population dynamic reduces the economic problem of the fishery to essentially short run questions - so-called mesh size questions (i.e. minimum size) and external production effects result from crowding (such as those which give rise to arguments positing immediate cost savings from trap limits). The question of finding a long run optimum level of fishing effort in order to maximize sustainable economic yield is essentially irrelevant.

Obviously if curve (a) is representative of the lobster population dynamic, it would be of great value to the fishery manager to know the approximate location of the fishery on the curve. Are exploitation rates currently so high that we are about to witness a sudden and drastic collapse or do current exploitation rates put the fishery well to the right of the collapse point, in which case the fishery managers do not have much worry for the immediate future or, for that matter, much ability to enhance future harvests through current action? The point is that we do not know (1) whether this population dynamic characterizes the lobster and (2) if it does, we do not know where we are relative to the collapse point. Obviously both biological and economic policy for the fishery would be improved if this situation were known with greater certainty.

Curve (c) in Fig. II. 1. represents an alternative population dynamic with very different implications for fishery management. In this case recruitment is more closely tied to the number of eggs produced by the mature stock. If the lobster population were characterized by this dynamic the historical record should show a strong negative relationship between the rate of exploitation of mature stocks and subsequent recruitment. In

other words, progressively greater exploitation rates should lead to progressively smaller harvests. From the manager's perspective this is a particularly comfortable situation since it is not one which will produce a sudden collapse. The manager and participants in the fishery receive adequate warning of the results of their actions (i.e., fishing activity) and are, therefore, more capable of planning a rational response. What's more this population dynamic is one in which management decisions affecting the rate of exploitation can produce beneficial effects on future harvests.

Thus this particular population dynamic, curve (c), contrasts sharply with the population dynamic characterized by curve (a). The contrast is very pronounced in terms of the time available for managerial response, which, as pointed out previously, has great significance for appropriate social and economic policy. Additionally the two population dynamics present strong contrasts in terms of the relationship between the rate of exploitation and recruitment.

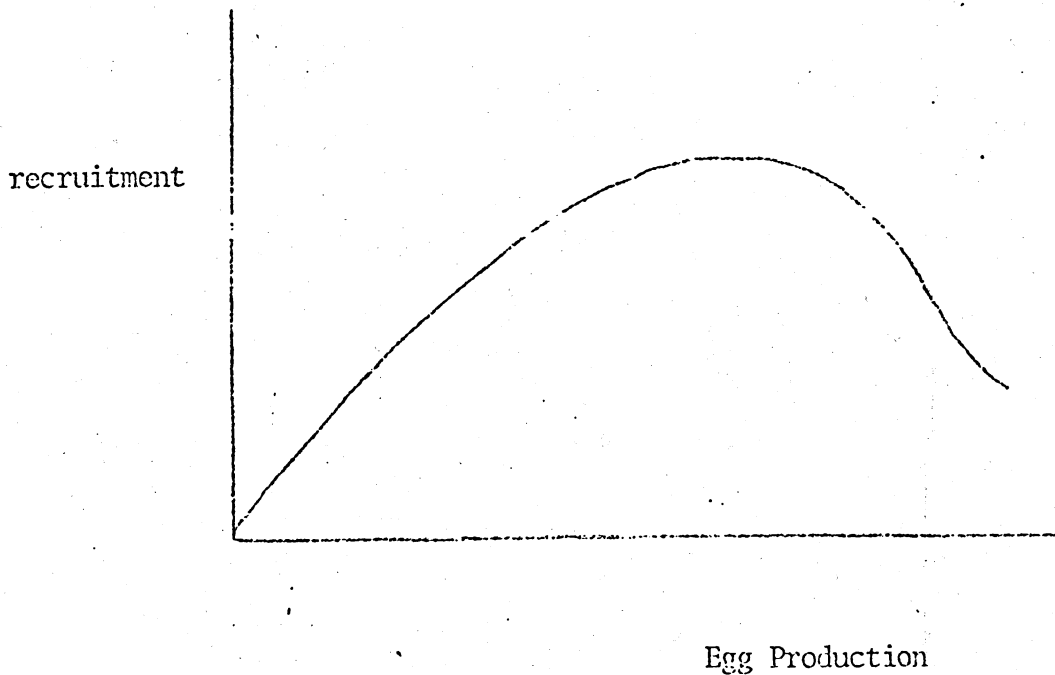
Still another possible population dynamic is illustrated in Fig. II. 2. In this case recruitment is affected by density dependent factors in both the pre- and post-recruit populations. This is the population dynamic specified in the widely used Schaefer model* and give rise to the notion that some optimum level of harvesting can be chosen which will maximize either the long run biological or economic return ~~from the~~ from the fishery. In other words, this particular dynamic describes an intimate and continuous relationship between the level of fishing effort and the rate of recruitment into the harvestable population. This contrasts sharply with the population dynamics represented by curves (a) and (c) in Fig. II. 1. where there is,

*Beverton and Holt, *Ibid.* pp. 55-61 and M.B. Schaefer "Some Considerations of Population Dynamics and Economics in Relation to the Management of the Commercial Marine Fisheries", J. Fisheries Res. Board Canada, XIV, No. 5 (September, 1957), pp. 669-81.

first of all, no long run optimum level of effort implied (in both (a) and (c)) and, secondly, no strong relationship between effort and recruitment (in (a)).

In summary, the choice of appropriate socio-economic policy for the lobster fishery must be made on the basis of firm knowledge of the population dynamics which govern the lobster. Uncertainty with respect to population dynamics means uncertainty with respect to appropriate socio-economic policy, especially in the area of timing of policy.

Fig. II. 2.



III. The Relationship Between Current Fishing Effort and Future Catch

An adequate, or realistic, measure of effort is necessary for the determination of the impact of fishing on the size and characteristics of the fished population. From the practical management point of view, it is essential to know whether or not and to what extent current reductions in fishing effort will have future pay-offs in terms of larger harvests. An answer to a question such as this is dependent upon the manager's knowledge of the lobster population dynamic and his ability to gauge the impact on the characteristics and size of catch caused by fishing effort reductions (increases) resulting from his decisions. The uncertainty introduced into the manager's decision making process by the lack of firm knowledge regarding the lobster population dynamic is compounded by the lack of a reliable measure of fishing effort.

Several methods have been suggested for measuring fishing effort in the lobster fishery. The most obvious measure is number of traps. Trap days is another method,* and a third, suggested by Thomas, is catch in numbers per trap-haul-set-over-day (THSOD).** This latter alternative has

*The sole reliable source of trap-days is contained in a survey of 131 lobstermen conducted by A. M. Aug. This data is summarized in "A Study of the Socio-Economic Impact of Changes in the Harvesting Labor Force in the Maine Lobster Industry," in Ocean Fishery Management: Discussions and Research, A.A. Sokoloski (edition), (NOAA Technical Report NIFS CIRC-371, Seattle, 1973) pp. 159-173.

**James Thomas, An Analysis of the Commercial Lobster (Homarus Americanus) Fishing Along the Coast of Maine, August 1966 Through December 1970 (NOAA Technical Report NIFS SSRF-667) pp. 37-42.

clear advantages in that it more clearly reflects the working time of bait, the escape characteristics of the trap and the fisherman's time on the water, in effect, the actual working time of a trap. Unfortunately, data on THSOD are very limited, very expensive and in terms of the period over which it is available (1966-1971) of little value in determining the relationship between effort and future catch. The same data problems occur with trap days.

Estimates of trap numbers are easily available from the Maine Department of Sea and Shore Fisheries, but are a poor measure of effort for several reasons:

(a) Traps are only one input to the harvesting process. As such traps may be substituted for other inputs (bait, depth finders, skill, radar, etc.) and other inputs may be substituted for traps in order to achieve the same output. For example, interviews conducted this year have left us with the very strong impression that the trade-off between skill and trap numbers is quite marked. Younger men as a group tend to set out more traps and get less return (in pounds/trap) than older men.

(b) The relationship between trap numbers and effort is likely to be less and less marked as the density of traps and the number of traps per boat increases. This is likely to be the case because as the number of traps increases, hauls per trap decrease. Additionally, as crowding becomes more pronounced a larger number of traps are used to mark or defend territory and are placed at depths where current catchability is low but future catchability (because of changes in water temperature) is expected to be better, again for reasons of laying claim to a particular piece of bottom. In short, beyond a certain level or density of traps, productivity of additional traps falls off rapidly (i.e. the

marginal contribution to catch approaches zero) and the effective use, or effort, applied to the traps falls off also.

(c) Finally, trap numbers do not take into account the seasonality of usage which may be associated with different methods of fishing. For example, lobstermen in York County, Maine tend to keep four strings of gear each rigged for a different depth and each used only at a particular time of the year. In this particular case, trap numbers overstate trap use by about four times. A similar overstatement of effort will occur as overfishing tends to compress the effective season.

These characteristics of trap use lead to situations in which large changes in the number of traps have little or no effect on the total catch. For example, Canadian experience with a 35 percent reduction in trap numbers shows a statistically insignificant change in total catch.* This does not mean that trap limitations cannot be beneficial to a fishery. Under conditions of a very low density of traps, reductions in the number of traps will undoubtedly reduce total catch with presumably beneficial effects on the harvested population. Under conditions normally observed in the fishery, however, the impact of a trap limit is likely to have very small or no effects on the harvest; nevertheless, it is that very fact which is indicative of over-capitalization and the consequent beneficial reductions in average harvesting costs and increases in fishermen's average net income which can be realized by trap limits. In other words, under most circumstances trap limits are justifiable on economic, but not biological, grounds.

*DeWolfe, Gordon, untitled manuscript in progress, dealing with the effect of trap limits at Miminegash, Prince Edward Island.

The lack of an adequate measure of effort and the uncertainty of our knowledge of lobster population dynamics combine to create a rather hazardous environment for modeling the fishery. For example, recently BELL has constructed a bio-economic model of the fishery in which he uses trap numbers as a measure of fishing effort.* For several reasons in addition to the use of trap numbers as a measure of effort the model is an unconvincing analysis of the fishery, especially of the relationship between current effort and future catch which is so important for management purposes.

One of the most unconvincing aspects of this bio-economical model is the biological side. Using a Schaefer model which assumes density dependent mortality at both the pre- and post-recruit stages of life, Bell further assumes an instantaneous adjustment of the biomass to changes in fishing effort. Though this latter assumption might be appropriate for fast breeding species, it is out of place in a fishery where harvesting is size and/or age specific and where age at maturity is six or seven years. The assumption implies that if fishing mortality of legal size lobsters increases, natural mortality of sub-legal lobsters increases proportionately.

A more appropriate assumption would postulate a six or seven year lag in the adjustment of the biomass, i.e., a lagged adjustment corresponding to average age at harvesting/maturity. The difficulty with taking this approach is that the results are subject to differing interpretations depending upon the population dynamic specified for the lobster, i.e.,

* Frederick Bell, "Technological Externalities and Common Property Resources: An Empirical Study of the U.S. Northern Lobster Fishery," J. of Pol. Economy Vol. 80, No. 1 (January/February 1972) pp. 148-153.

density or non-density dependent. Both a non-density dependent population (curve (c) Fig. II.1) and a Schaefer type population (Fig. II.2.) should show a strong relationship between past (6 or 7 years previous) effective effort and current catch rate. In a pre-recruit density dependent population (curve (a) Fig. II.1) no such relationship should be observable. Using catch six or seven years previous as an appropriate measure of effective effort the following equations were estimated using data from 1950-1969.

$$(1) \frac{Q_t}{E_t} = 49.78 - 0.00000070 Q_{t-6} + 2.01 {}^{\circ}F_{t-6}$$

$$\frac{Q_t}{E_t} \quad (3.33)^* \quad (0.00000067)^* \quad (0.56)^*$$

$$R^2 = 0.63 \quad F = 7.62 \quad D-W = 1.82$$

$$(2) \frac{Q_t}{E_t} = 1.33 - 0.0000016 Q_{t-7} + 1.45 {}^{\circ}F_{t-7}$$

$$\frac{Q_t}{E_t} \quad (3.09)^* \quad (0.0000015)^* \quad (0.57)^*$$

$$R^2 = 0.68 \quad F = 9.54 \quad D-W = 2.13$$

where Q_t equals catch in period t , E_t equals effort (in traps) in period t and ${}^{\circ}F_t$ is average annual sea water temperature (measured at Boothbay). ${}^{\circ}F_t$ is introduced in the equation as a correction for environmental change.

The results of estimating both equations suggests that the strength of the statistical relationship is almost entirely attributable to the effect of sea water temperature. One could not accept the hypothesis that previous catch had a statistically significant impact on current catch rates. These results would appear to be roughly consistent with the idea that the population dynamic of the fishery is characterized by pre-recruit density dependent mortality and non-density dependent mortality in the post-recruit population. However, one should be very cautious about placing much faith in this interpretation primarily because

*Numbers in parentheses indicate standard errors.

the hypothesis which is being tested is essentially very weak.

For example, the hypothesis tested by Bell is nearly identical to that tested above except that Bell does not take into account the pre-recruit part of the lobster life span. Nevertheless, with a pre-recruit density dependent population, a sufficient explanatory model reduces to the relatively simple proposition that with a constant (or nearly so depending on exogenous environmental factors) number of recruited lobsters an increase in the number of traps will lead to a declining average yield per trap. This hypothesized relationship for a pre-recruit density dependent population is identical to the hypothesis tested by Bell even though Bell implicitly assumes a pre- and post-recruit density dependent population.* Therefore, one would have to conclude that since the hypothesis which Bell chose to test his model is very weak (in the sense that it is incapable of discriminating between alternative plausible models with alternative implied optimal policy), his statistical results, though impressive, offer no practical or reliable guide to the fishery management authority. Clearly, more information on population dynamics is required before a confident explanation of current effort/future catch relationships can be established.

Further compounding the difficulty of learning the relationship between current effort and future catch is the statistical problem of

*The equation Bell tested is

$$\frac{Q_t}{E_t} = a - bE_t + c \text{ } ^\circ F_t$$

where Q is catch, E is effort measured in trap numbers, $^\circ F$ is temperature, t denotes time (in years) and a, b and c are constants. See Bell, op. cit. page 151.

attempting to correct for a possibly large number of environmental factors, each acting independently on the size and characteristics of the lobster population. Sea water temperature is generally used by most statistical studies of the fishery as a proxy for the net impact of the various possible environmental changes, or is simply described as by far the most important environmental variable.* The problem with taking this approach is that the various interpretations suggested for the role of temperature appear to be in conflict and, if each suggestion is treated seriously, only serve to further cloud our understanding of the effort/catch relationship. Dow and Bell suggest that temperature affects growth rates and by the use of an unlagged value for temperature imply that this effect is immediate on the exploited population. Flowers and Salla, on the other hand, postulate the greatest effect of temperature is to be found in larval mortality rates. It is also plausible to suggest that temperature exerts a cumulative effect over the entire pre-recruit phase of life. Whatever the correct specification, however, those three explanations share the conviction that the use of the temperature variable merely is a statistical means for accounting for environmental variations.

On the other hand, a fourth suggested interpretation of the role of temperature creates grave doubts about the correctness of treating temperature as a purely environmental variable. Thomas has done work which shows that temperature is related to weather and water conditions

*See Bell, op. cit.; Robert Dow "Some Factors Influencing Maine Lobster Landings," *Commercial Fisheries Rev.* Vol. 23, No. 9, (1961) pp. 1-11; and Flowers and Salla "Temperature Effects on the Inshore Lobster Fishery" *Journal of the Fisheries Research Board of Canada*, Vol. 29, No. 8 (1972) pp. 1221-1225.

and thereby to the number of boat days exerted in the fishery. In other words, by this interpretation temperature merely becomes another means for describing the level of fishing effort in the fishery.*

It is quite possible, of course, that temperature has all these suggested effects on the fishery; however, if it does it is an inappropriate variable for use as a correction for purely environmental factors.

In sum, if we use either Bell's model or similar alternatives incorporating biologically determined lags as a basis for describing the relationship between current effort and future catch, then the best modeling that can probably be done with the data still leaves us with a great deal of quantitative uncertainty with respect to this relationship.

This uncertainty may be underscored by reference to a rather puzzling aspect of the fishery. Most observers of this fishery will agree that the intensity of fishing effort per unit of suitable bottom appears to be much greater in the western part of the State, especially Casco Bay, than it does in the more easterly reaches of the State. One would expect that these differences in intensity of effort would produce statistically discernable differences in catch characteristics. In fact, the length frequency distribution of the catch sampled by the Maine Department of Sea and Shore Fisheries exhibits no such difference.** What does this mean? Several explanations are plausible, but the fact that there are several, each with a different appropriate implied policy, merely emphasizes the uncertainty we have discussed above.

*If this interpretation is correct then the sign estimated by Bell in his model is incorrect because temperature/effort should be negatively related to biomass size.

**This data is presented in Thomas, *op. cit.* page 31; the manipulation of the data leading to this conclusion was performed by Thomas and reported in a personal communication. During preparation of this manuscript Sea and Fisheries became known as the Department of Marine Resources.

For example, (1) this puzzling attribute of the fishery appears to be consistent with a pre-recruit density dependent population dynamic. In other words, it could be argued that in both areas of the State exploitation rates, though very different, have not yet reached the point where egg production has fallen below the point consistent with "collapse". Thus recruitment is relatively constant and similar length frequency distributions for the catch should be expected.

(2) Alternatively, it could be argued that regardless of the appropriate population dynamic seeding is not area specific. That is, since the dispersal of larva by wind and currents during the surface feeding stages is likely to be extensive, it is possible that intensely fished areas like Casco Bay are not self-sufficient in egg production but must rely upon less intensely fished areas for their supply of larva and ultimately recruits into the legal range. This possibility could also lead to similar length frequency distributions.

(3) Still another plausible explanation is that all inshore areas in the State are not self-sufficient in larvae production and must rely on larvae produced off-shore to assure adequate recruitment. Similar length frequency distributions are also consistent with this explanation.

All three of these possible explanations of the puzzle are plausible and each has its advocates and detractors. But, more importantly, each explanation implies very different appropriate policies. For example, if (1) pre-recruit density dependence were to resolve the puzzle, appropriate policy would be to do little or nothing, assuring at a minimum that exploitation rates did not reach a level consistent with "collapse". If (2) Casco Bay alone was deficient in larvae production immediate policy initiatives should be directed at that area; longer range policies should

be directed at preventing a rise in exploitation rates elsewhere. If (3) the entire inshore area was deficient in larvae production, then care and preservation of off-shore stocks and/or attempts to reduce all inshore exploitation rates would be appropriate policy. Unfortunately, at this point in time we do not appear to have the data capable of resolving the puzzle in favor of one of these three - or some other - plausible explanation. In other words, the choice of appropriate policy at this juncture is a very risky undertaking.

From the practical management point of view, uncertainty with respect to current effort/future catch relationships means that estimation of the costs and benefits of management induced changes in the level of fishing effort can only be made in vague, non-quantifiable, terms. That is, (1) the effect on future catch of changes in the level of effort depends upon the population dynamic which characterizes the lobster. We are not certain what the dynamic is and therefore, are not certain about which of several possible policies is appropriate. (2) If the future catch is affected by the level of fishing effort,* lack of an adequate measure of effort means that confident estimates of required changes in the level of effort cannot be made, though it may be possible to stipulate an appropriate direction of change in effort.

From the management point of view, choice of optimal strategies is altered significantly by this state of our knowledge. Instead of being able to impose a known optimum level of effort, the management authority is in a position of having to learn where that optimum is.

*Future catch may not be related to current fishing effort in a pre-recruit density dependent population.

Policy affecting the size of the future harvestable biomass is not limited to manipulation of the level of effort. In the lobster fishery the most prominent alternative policy suggested by biologists is the minimum legal carapace requirement, specifically the current proposal to raise the legal minimum to 3 1/2" by five 1/16" annual increments.

For the purpose of economic analysis, such policy initiatives are most conveniently treated as exogenous constraints. In other words, the economist must accept the biologist's estimate of the impact of the policy on future catch and then determine the net economic impact of the policy.

As we understand the 3 1/2" proposal there are three possible benefits:

- (1) The primary benefit usually cited for the policy is a predicted 18% increase in landed weight once a new equilibrium is reached. This is the short run mesh effect referred to previously.
- (2) A second, and much less certain benefit, is the possibility that the greater number of mature females assured by the policy will lead to greater numbers of future recruits into the harvestable size class. This would seem to imply that the predicted increase in landed weight would be greater than 18% if any increase in the number of recruits was actually realized.
- (3) A third benefit is the use of the policy as a hedge against the possibility of a sudden collapse of the fishery.

For the economist there is one major question posed by the 3 1/2" proposal: What will be the net income effect for the fishery and the men

in the fishery? This question really has two sides: (1) What will be the net revenue effect, and (2) what will be the effect on costs of production?

With respect to revenue effects, consumer reactions to higher unit prices (i.e. for a lobster dinner) will determine whether or not the 3 1/2" proposal will produce a net revenue benefit or loss. Currently the price per pound of lobster in urban wholesale markets varies by size, with premium prices attached to lobsters in the weight range associated with the 3 1/2" plus carapace length. The question that needs to be answered is: how low will the price for lobsters in this weight class fall as a result of the 3 1/2" policy? If the fall in price is more than off-set by the expected increase in landed weight then revenue effects will be positive, otherwise they will be negative. Unfortunately, this question cannot be answered without a detailed market analysis.

With respect to the effects of the 3 1/2" policy on the costs of production, it is clear that unless the 3 1/2" measure produces long term positive effects on the number of recruits, the impact on costs of production will be minimal or non-existent. This means, that the over-capitalization which characterizes the fishery will not be affected in any way by the 3 1/2" policy. Hence, the policy does not assure the commercial success of the fishery unless it is combined in some way with effort limitations. In effect, management of the fishery does not seem to be faced with the option of choosing either a minimum size policy or a control on effort policy - a combination of both policy approaches may be necessary.

Perhaps the most valuable aspect of the 3 1/2" policy from the point of view of this study, is its possible use as a hedge against

the risk of a sudden and disastrous depletion of the resource. An explanation of this beneficial aspect of the policy is most easily accomplished by reference again to Fig. II. 1. Beverton and Holt suggest that curve (a), which exhibits a strong pre-recruit density dependent effect, is a very common occurrence among marine fish populations and, of course, it is a highly probable occurrence in the lobster population. The predominant characteristic of such a strongly density dependent population is the existence of a sudden decline in recruitment once a certain critical minimum level of egg production is reached. Given the long period of time before declines in recruitment are discernible (i.e. four or five years) and a correspondingly long period before remedial policies will have an impact on the commercial fishery, avoidance of sudden depletion or collapse is a policy objective which ought to have a high priority in the lobster fishery for both biological and economic reasons.*

Viewing the 3 1/2" proposal in this light, however, raises the question of whether that particular measure is appropriate, or in some sense optional, for avoiding the possibility of collapse. The 3 1/2" proposal appears to have been conceived in terms of increases in landed weight and possible increases in recruitment. (point 1 and 2 above). As such it might very well be the case that some other measure, greater or less than 3 1/2", might be more appropriate for hedging against the

*Rough calculations by James Thomas of the Maine Department of Sea and Shore Fisheries indicate that current egg production may be at, or near, the critical point consistent with a sudden decline in recruitment.

possibility of collapse. In practical terms this line of reasoning suggests that if it is felt or estimated that the current 3 3/16" minimum is not sufficient to assure a minimum critical level of egg production, marginal increments in the minimum size should be viewed as acceptable to fisheries policy makers.

IV. Bio-Socio-Economic Heterogeneity

In addition to uncertainty with respect to population dynamics and effort/biomass relationships, those who manage the fishery must also take into account the extreme heterogeneity of biological, social, and economic conditions governing harvesting along the Maine coast. From the point of view of policy making, this heterogeneity is important for both efficiency and equity reasons. As a common property resource the lobster fishery has provided economic opportunity in a rural setting where few alternatives are available. Men engage in the fishery with differing capital resources. Approximately 2500 operate what might be termed standard lobster boats. But there are probably an equal number of men who operate from skiffs and dories, with fewer than 200 traps. Geography also plays a role. Fishermen based on the upper reaches of many deep bays are effectively limited to a four to five month season because of water temperature (which limits the period during which they might trap and also frequently ices their anchorages) and because of the territoriality practiced by men in the fishery (which effectively excludes men "up the bay" from trapping in the more open and deeper water "down the bay"). (See Appendix A.)

Some areas along the coast, because of tradition or favorable location provide easier opportunity for alternative fishery occupations--principally dragging and clamming. In still others, customs accords either a greater or lesser ease of entry into the lobster fishery with the expected results in terms of over-fishing. For example, the Casco Bay area, which is in the most urbanized part of the state is also the area where tradition governing entrance into the fishery seems to

have broken down the most.* As a consequence, the Casco Bay area exhibits the most extreme symptoms of over-fishing. Further to the east, in the more rural Hancock and Washington counties, traditional barriers to entry seem to be more effective and the fishery appears to be in not nearly as much trouble.

Partial evidence of the heterogeneity which characterizes the fishery is contained in Huq's and Acheson's findings. Huq's data are especially revealing in terms of the broad range of characteristics of men in the fishery (i.e., income, trap days, investment, full time/part time, etc.). A random sample we conducted in the summer of 1972 using Huq's questionnaire revealed similar wide variations. (See Appendix A for a comparison of Huq's data with that of the random sample.) Acheson shows the variations in territoriality that take place, and in unpublished work has concluded that such variations are correlated with the extent of over-fishing. Surveys we have undertaken in early 1973 also reveal a broad range of fishing techniques, skills and conditions. The importance of this heterogeneity is that for many practical purposes the fishery must be treated as if it were many fisheries. Management schemes which propose property rights of one sort or another based upon grandfather clauses, equipment limitations, closed seasons, equipment redesigns or any other traditional means for limiting effort are likely to be inadvertently discriminatory and

*In addition to urbanization, closure of Casco Bay during World War II apparently interrupted and considerably weakened any social structure which might have served as a barrier to entry.

inefficient in their impact. Though it is unlikely that any scheme could avoid discrimination and inefficiency altogether, the heterogeneity of situations of the coast means that a significant group of fishermen is likely to raise strong political opposition to almost any management scheme. In most cases of straight-forward management schemes based upon "optimal" or typical methods and conditions of harvesting, much of this opposition is likely to be well founded for any single plan is likely to be less than optimal for many areas along the coast and, quite reasonably, will be perceived as such by certain groups of fishermen.*

*This is not to say that all political opposition to management proposals will be based on discriminatory aspects of proposed schemes. Undoubtedly, proposals for substantial reductions in effective effort will meet with wide-spread political opposition.

V. Implications of Uncertainty

Rational management of the lobster fishery must take into account the interdependent biological, social, and economic aspects of the fishery. But as in any complex, interdependent system, uncertainty with regard to one aspect of the system yields uncertainty with regard to the whole system. Thus, the uncertainty of our knowledge regarding population dynamics, effort/biomass relationships, and the heterogeneity of social and economic conditions governing harvesting, translates the management problem for the fishery into primarily a problem of isolating and dealing with these particular areas of uncertainty. From a practical point of view, this uncertainty requires that management decisions based upon deterministic modeling of the fishery be treated with a great deal of caution and that management procedures which allow a maximum of scope, flexibility, and learning on the part of the management authority be preferred. In effect, any management approach must be capable of securing the long-run adaptation of the fishery to its environment. It would not be wise, at this juncture, to attempt to impose an "equilibrium solution" on the fishery, given our inability to adequately describe that equilibrium.

Evaluation Criteria

The uncertainties described above require that the evaluation of alternative management schemes be geared primarily to their ability to secure the long-run adaptation of the fishery to its environment. On a secondary level evaluation of proposed schemes must be made with respect to their known or expected impact on the biological, economic, and social aspects of the fishery. Though it may be questioned why secondary consideration is given to the biological, social, and economic

impacts, the necessity for this ordering is very clear: Without firm knowledge of population dynamics and effort/biomass relationships, it is impossible to state the long-run benefits and costs of management alternatives.

Primary Evaluation Criteria:

1. Flexibility with respect to biological and economic and social knowledge and conditions:

Since biological data on the fishery are lacking, any management scheme must contain elements which allow for changes in strategy as new or more complete knowledge of the fishery is developed. Similarly, as active management of the fishery proceeds a clearer perception of the social and economic impacts of management will emerge, and any management scheme should contain elements which make it capable of response to a change in these factors.

2. Costs of learning

Management flexibility and adaptability are desirable attributes of fishery policy to the extent that such flexibility is constrained by the potential costs of learning. All other things equal, the lower the costs of learning the more preferred is the policy or strategy.

Secondary Evaluation Criteria:

The lobster fishery is the backbone of the Maine fishery, but it is only one of several economic fisheries. Men and equipment are transferable to other fisheries. As opportunities in the lobster fishery vary so will the level of fishing effort expended within the fishery itself and in other fisheries. Therefore the effect of regulation of the lobster fishery should be weighed in terms of its impact on these other fisheries.

4. Positive impact on the economic return to the harvestable biomass:

As pointed out previously, it is entirely possible that there is little or no relationship between fishing effort and the biomass of the fished population. Under these conditions and given no change in legally harvestable size, effort limitations must be justified entirely on economic grounds. Nevertheless, alterations in legal size limits can affect the size of the harvestable biomass and the economic return to the harvest. Similarly equipment limitations and/or design requirements can affect the costs of harvesting and mortality rates of the fished population.

5. Enforceability:

Costs of enforcement must be considered for each proposal. Additionally there is no history of active management of the fishery and it may be necessary to consciously create the conditions of wide-spread belief in the efficiency of new rules and regulations, thus easing enforcement problems.

6. Ability to deal with widely differentiated harvesting and socio-economic conditions:

Given the wide variation in the situations of individual fishermen and the peculiar characteristics of the fishery in particular areas, a management scheme must be able to allow for widely varying models, conditions and time of harvest if it is to be efficient and equitable.

Particular social and economic criteria appropriate to the evaluation of each plan are:

- a) What particular group or groups of fishermen are likely to be either excluded from the fishery or forced to reduce their expenditure of effective effort?

- b) In the case of excluded persons, can their alternative economic opportunities be assessed: What is the likely magnitude of social and private costs resulting from their exclusion?
 - c) What are the short and long-run benefits to the fishery resulting from exclusion?
 - d) With respect to persons who remain in the fishery, what are the likely impacts of effort reduction? Short term income? Long term?
 - e) With respect to plans for limited entry, what criteria are proposed for allocation of entry positions? How can they be assessed in terms of efficiency and equity?
 - f) With respect to the impact on fishing communities, what is the likely impact of exclusions and short-term effort reduction? Long-term benefits to the fishery?
7. Political possibilities

VI. Methodology

In the early stages of the project, a list of ten alternative management schemes which had been proposed for the fishery or which, in the light of experience in other fisheries, seemed appropriate for the fishery was composed. (See Appendix B) This list was submitted to National Marine Fisheries Service, Gloucester Regional Office and to the Maine Department of Sea and Shore Fisheries. In addition a reworded but similar list composed of only five plans was shown and explained to 48 lobstermen along the coast. On the basis of reaction from these three groups, the list of schemes was reduced to a set of three alternatives. These three alternatives represented what these three groups appeared to consider reasonable or feasible modes of action for the management of the fishery.

At this point the major elements of each of these schemes were combined into a single scheme (see Appendix C) which was then shown and explained to 376 lobstermen. The purpose of this procedure was several fold:

- 1) Much of the earlier socio-economic data collected by Huq and Hasey was inappropriate to certain key provisions in some of the proposed alternatives, e.g. the requirements that x percent of gross income be derived from the fishery in order to qualify for a commercial license.
- 2) We intended to get a "feel" for the climate of acceptability associated with the elements of each of the three proposed alternatives.
- 3) We intended to use the surveying procedure as a means for more fully educating ourselves about the problems of the fishery as perceived by the lobstermen.

4) An unintended, but positive result of the surveying was that the fishermen themselves were educated to a certain extent about the necessity for management and the kinds of alternatives which appeared feasible. This became apparent to us over the course of the year as various forms of proposals we had circulated surfaced in newspaper letters, and hearings and bills of committees of the Maine Legislature.

From our own point of view we learned as a result of this process that the quality and articulation of fisherman response depended crucially upon the manner in which management proposals were presented. Specifically, in our early efforts we tended to present broad outlines, almost theoretical proposals. Fisherman response was generally inarticulate and uncomprehending. As the year went by we became more specific using actual legislative documents. Fisherman response suddenly became articulate and precise. We concluded that either we had become much more adept at communicating with the fisherman or that the fisherman respond much more positively to specific rather than general proposals.

Management Scheme Components

The number of individual management scheme components which have been suggested for the fishery and the possible combinations by which they might be incorporated into management schemes is very large. In the course of this study, we found it necessary to categorize component alternatives according to varying philosophies of fisheries management. There appear to be three broadly distinguishable philosophies in the approach to fisheries management:

Type I: Management approaches designed to eliminate the common property and unlimited entry characteristics of the fishery which are often cited

as the root of the overfishing problem. Suggested management scheme components which fall in this category are:

1. Freeze the number of licenses.
2. Freeze the number of licenses and make available only to "commercial" fishermen.
3. Limited number of transferable (sellable) licenses.
4. Special licenses, with special restrictions: commercial, apprentice, retiree, etc.
5. Decentralized (i.e. local) management "councils" with locality specific licensing.
6. Closed seasons.
7. Trap day or number limitations.
8. Centralized "strong" management authority (regional, Federal, or international).
9. Establish apprentice programs to serve as a partial barrier to entry.
10. Daily curfews to discourage "moonlighters."

Type II: Management approaches which emphasize the use of taxes or subsidies as a corrective to overfishing. Typical scheme components falling in this category are:

1. A special excise tax on lobsters.
2. A tax on traps.
3. A tax on boats.
4. A tax proportional to catch or income.
5. Increased license fees.
6. Subsidies as compensation for lowered fishing effort.

Type III: Management approaches which are primarily a compilation of good (and bad) conservation practices. Scheme components of this type which have been suggested are:

1. Raise the legal minimum carapace size to 3-1/2" (1a. females only).
2. Abolish legal maximum size (2a. males only).
3. Re-designed traps to allow "shorts" to escape.
4. Discontinue "V"-notching.
5. Remove un-buoyed traps from bottom, or require traps with "self-destructing" characteristics.
6. Enhance lobsters' environment with artificial reefs, etc.
7. Bounties on predators.
8. Begin hatcheries or research on hatcheries.
9. Control dragging.
10. Eliminate harmful pollution.
11. Discontinue plugging.
12. Quotas on total catch, or per license.
13. Make license dependent upon the marking and release of 25 mature, but unegged female lobsters.
14. Increased enforcement authority for coastal wardens.

The actual schemes which were chosen for evaluation were derived from two primary sources:

- 1) Theoretical requirements translated into what was felt to be a reasonable management framework by members of the project.
- 2) Legislative proposals which appeared before the 106th Maine Legislature.

In addition to the theoretical criteria mentioned on page 31, we felt that it would also be valuable to assess each scheme in terms of its likely acceptability to men in the fishery.

VII. MANAGEMENT ALTERNATIVES

Management Alternative #1

A. Licensing

1. Create several classes of licenses

- a. Commercial licenses - transferable, limited initially to a number equal to the number of current fulltime lobstermen.
- b. Apprentice license - combined with an apprentice program designed primarily with an eye to reinforcing traditional barriers to entry, e.g. kinship and community ties.
- c. Retirement license - non-transferable, available to men over 60.
- d. Sport and student licenses - limited in number and with trap limits.

2. Use commercial license fees to fund a voluntary license buy-back program, i.e. give management authority the right to use license fee receipts to purchase and retire and thereby reduce the number of commercial licenses.

B. Raise legal minimum carapace length to 3-1/2".

C. Establish a trap limit of 600 for entire coast.

Discussion

The primary attribute of this scheme is that the license buy-back program allows the management authority to alter the level of fishing effort (provided effort is correlated with license numbers) if it sees a need to do so. Given the voluntary nature of license sales, moreover, its authority is essentially limited to carrot and not stick methods. In other words, if the management body sees a need to reduce effort, it is empowered to pursue this goal by offering to purchase outstanding com-

commercial licenses. If there are no or few license holders willing to accept the purchase price offered by the management body, that body must assume that license holders place a higher asset value on the license (and, therefore, the fishery) than does the management authority itself. The authority has no recourse but to raise its offered price until sufficient numbers of license holders respond with an offer to sell. Furthermore, if the management authority can accurately record the price of private license sales, it should be able to note trends which register the expectations of the fishermen themselves.

For the person leaving the fishery, the program has the effect of providing the license seller with an immediate, highly liquid asset which he can use for relocation, retraining, etc. This characteristic tends to make exit from the fishery much more attractive than it is currently. Entry into the fishery, on the other hand, is curtailed to a certain degree by the apprenticeship program. We would suggest that such a program be set up in such a way as to effectively limit entry to persons who have family or community ties with the fishery, i.e. legally establish the current informal barriers to entry. While such a procedure or suggestion would not be viewed as efficient or equitable in a normal industrial or commercial setting, in a fishery limited entry is generally conceded to yield more desirable results for both consumers and producers than a purely competitive, unlimited entry situation. An apprenticeship program, viewed in this light, becomes a convenient and relatively equitable, device for discriminating among potential entrants. The alternative is to discriminate entirely on the basis of the ability to purchase a license.

Additionally, an apprenticeship program may be necessary to a certain extent as a means for training new entrants. Though it is very difficult to document in any quantitative fashion, a readily apparent characteristic of the fishery is the wide variations in the skills of the men, especially skills relating to trap placement and use. (Among other things, we would describe this skill as the ability to place traps in a particular threshold isotherm. Catchability apparently varies to a great extent with water temperatures, and water temperature at any particular place on the bottom is a function of depth, currents, recent weather, etc. Skilled men appear to be able to anticipate or respond quickly to temperature changes and place their traps accordingly. We are not sure whether their skill is generally articulated or is merely the result of long experience. Whatever the case may be, however, the transmission of such knowledge should be encouraged. Younger men as a group do not appear to be as skilled as older men in the fishery and as a consequence tend to pursue a strategy of substituting more and more traps for skill in order to increase their income. This is a perfectly rational strategy from the individual point of view, but under conditions of high exploitation rates it has the potential of forcing a similar response from more skilled fishermen so that an uneconomic escalation of trap numbers may ensue.* This exact sequence of events appears to have taken place in Casco Bay where, generally, the fishermen with the largest numbers of traps tend to be relatively young and tend to be from families outside of the fishery.)

The intention of the 600 trap limit is two-fold: 1) To break the back of the trap escalation which has been occurring in the Casco Bay

*The constitutionality of an apprenticeship approach probably depends on the ability to show the existence of damage to the public interest without the program.

area of the fishery (1200-1800 traps per boat are not uncommon) and 2) to put an upper limit on any future escalations.

An interesting aspect of the interviewing we undertook in the Spring of 1973, is that the fishermen in Casco Bay are perfectly aware of the dilemma they are caught up in. None are willing to cut back unless all cut back because they realize that individual de-escalation will merely result in a decline in individual income. On the other hand, almost all of the fishermen are aware that a cut back by all will result in about the same total catch per man but at greatly reduced costs per man.

Though Casco Bay comprises a relatively small part of the fishery, its problems are important because they appear to be merely a prelude to the problems of the rest of the fishery. We have clear indications from the area immediately to the east of Casco Bay that similar trap escalations are beginning. Still another reason for a trap limit at this time is that large scale trap wars have been threatened in the Casco Bay area. Apparently, many fishermen view wholesale trap cuttings as the only alternative to legal trap limits and limited entry.

The limit of 600 traps suggested here should not be taken as the choice of a number which is in some sense optimal for a boat in the fishery. In fact, the optimal number for a boat with two men appears to be in the neighborhood of 450 to 550 traps depending upon whether trawls are fished or not. Rather 600 appears to be a reasonable number which will not unduly interfere with technical efficiency and which will effectively inhibit uneconomic trap escalations.

One rather important aspect of a trap limit is that in the long-run it is a meaningless policy unless it is combined with some form of

limited entry. A trap limit without limited entry has the potential of leading to (1) the same high trap density (but with fewer traps per boat) as exists currently with no trap limit and virtually unlimited entry, (2) the same or higher costs per unit of output (probably higher because of the need for more boats and other fixed investment), and (3) lower net income for the fishery spread among a greater number of fishermen.

A compelling argument against trap limits relates to enforceability. Conversations with Canadian officials indicate rather high enforcement costs associated with trap limits. Canadian experience also suggests that one effect of a trap limit is to cause fishermen who had previously been fishing fewer traps than the (newly imposed) limit to increase their trap numbers to the limit. If this effect were to occur with a 600 trap limit in Maine there would be a substantial increase in the number of traps in the eastern part of the State where trap numbers are currently well below the proposed limit.

The various rationales for the 3 1/2" limit have been discussed in section III above. It would be appropriate at this point, however, to explain some of the more common objections voiced about the policy.

On the biological side one objection or uncertainty relates to the question of population dynamics. The argument is basically that the 18% estimated gain in landed weight is predicted on the assumption of a non-density dependent population dynamic. If this is not the case, the 3-1/2" limit will have the effect of altering the age distribution of the population and increasing natural mortality rates among sub-legal

lobsters. This will reduce the number of young lobsters coming up the "pipe" which will also reduce the estimated gain in landed weight.

The same argument about the population dynamics could also be applied to the expected increase in future harvests. That is, in a population strongly characterized by density dependent mortality at the pre-recruit stage, an increase in the number of eggs produced could not be expected to result in increased recruitment.

On the economic side there are two aspects of the 3-1/2" minimum which raise doubts: 1) If all states and Canada move to the 3-1/2" minimum, the average retail price of a lobster dinner will rise, all other things equal, causing an off-setting decline in demand and price. Since the current wholesale market price/lb. varies with size and it is not known what the elasticity of demand for larger average sized lobsters is likely to be, the net revenue effect on the fishery cannot be stated.

Another economic fear, or objection, raised by lobstermen is the effect on the catch in the short-run (i.e., the five year period) while the legal minimum is being raised. Rough estimates we have made, assuming a non-density dependent population, indicate that the net effect on landed weight will be negative for the first three years of the program and will then turn sharply upward. For a density-dependent population the negative impact on landed weight will last longer and the upturn will be less marked, if it occurs at all.

Though it is difficult to make a judgment about the 3-1/2" minimum, it would be our guess that the net economic effect of the change would be positive but that the magnitude of the net benefit would be small.

Summary Evaluation

The primary benefit of a buy-back approach to licensing would be the flexibility which it provides to the management authority. The voluntary nature of the buy-back approach constrains the management authority, on the one hand, and assures that those persons leaving the fishery have at least assessed their own opportunities on-shore as greater than their opportunities in the fishery, on the other hand. This characteristic of the program should tend to minimize the social costs of management flexibility and learning.

With respect to the compatibility of the proposal with other inshore fisheries, to the extent that entry in the lobster fishery is closed off potential entrants may move into alternative fisheries. As a matter of practical concern, however, gear and boat constraints are likely to make the pressure on all other inshore fisheries, except clams, insignificant. On the other hand, if management based on this model is successful in stabilizing or improving the state of the lobster fishery in the long run, the potential (and current) pressures on other inshore fisheries exerted by lobstermen is likely to lessen.

With regard to the all important question of political feasibility we would have to conclude that the current prospects are very low. Fisherman reaction to a buy-back approach is generally favorable but only after a lengthy explanation and discussion of the attributes of such a program. General acceptance would only be possible after a long period of education by extension workers and trade journals. Additionally, it should be noted that a proposal of limited entry of any sort will likely have very rough sledding in the legislature at least until the time comes when it is absolutely clear to all that the loss of the commercial fishery is imminent.

Management Alternative #2

This alternative is virtually identical to the first except that it proposes division of the inshore fishery into relatively small management areas corresponding to the territorial boundaries currently enforced by custom and convenience. A license would be valid for only one management area and active management of each area would be the responsibility of the local fishermen.

There are several reasons for suggesting a territorial approach to management of the fishery. The primary reason is to force accountability for the state of the fishery onto the shoulders of the fishermen. It was felt that territoriality along with limited entry and salable licenses would create, in effect, group property rights and, therefore, the incentive to conserve the resource through group management. The suggestion that the territories be relatively small is based on the premise that group management would be more feasible with relatively small numbers of individual fishermen involved in the decision-making process.

Secondly, small territories were suggested because, to a certain extent, this is a reflection of current practices along the coast. It would seem, then, that a program of accountability might be most easily implemented by capitalizing on existing practices. In fact, it should be mentioned that the territoriality which is found in the fishery and the barriers to entry which accompany territoriality (in some places barriers to entry are quite stiff, in others fairly relaxed), seem to have the limited effect of inducing an attitude of accountability on the part of the fishermen. Also contributing to this attitude is the

fact that for most of the men in the fishery alternative economic opportunities are very poor and, therefore, all but a very few men are actively concerned with and take actions to conserve the resource to the extent that it is individually possible.

Thirdly, management of the fishery through small territories has the advantage of providing flexibility with respect to the differing biological and/or socio-economic characteristics of the fishery. Hence, the adaptability of the fishery to its environment would be enhanced.

There are two primary objections to management based upon small territories: (1) Administrative problems involved in the initial definition of territorial boundaries are likely to be insuperable. One of the characteristics of territoriality as it currently exists is that boundaries are in a constant state of flux. Kinship and friendship ties among men from different harbors and territories often give rise to very permeable boundaries. Additionally, men from harbors in which the population of fishermen is growing (usually because entry is less restricted) tend to try to expand their territory at the expense of men from harbors where fisherman population growth is low or negative. Since, trap wars and other extra-legal means of enforcing territorial boundaries are resorted to only under great pressure, the result is often considerable boundary overlapping. Under these circumstances defining legal boundaries could become an administrative, and probably legal, nightmare.

(2) Enforcement problems could possibly be severe and expensive if the coastal wardens were continually forced to survey alleged boundary infringements. On the other hand, there are many extant cases of strict boundary lines which are apparently observed with little friction.

Overall, however, it would have to be concluded that, even though management through the medium of small territories has many positive aspects, administrative problems appear to be excessive. We certainly feel, nevertheless, that serious consideration be given in the future to the gradual evolution of legalized territories, since territoriality does hold the promise of making the fishermen accountable for the quality of the resource.

Management Alternative #3

Over the course of the year several of the ideas developed on the project were incorporated into bills presented to the 106th Maine Legislature. The following management proposal is a bill which was put together by Representative Lawrence Greenlaw of Stonington who has consulted frequently with members of the project. The bill was defeated on its second reading in the House of Representatives.

AN ACT to Conserve, Manage, and Regulate the Lobster Fishery

Preamble. Whereas, the People of the State of Maine are extremely proud of the reputation the State has as the largest lobster producing state; and

Whereas, the lobster has been an intricate part of what has made Maine famous and unique; and

Whereas, the lobster catch is of vital importance to the economy of coastal communities; and

Whereas, the pressures of overfishing have placed the continued existence of the lobster in question; and

Whereas, no proper conservation and management techniques have been introduced to protect these fisheries; and

Whereas, the demand for Maine lobster all over the world is increasing rapidly, thereby creating greater economic pressure to deplete the resource; now, therefore, be

Resolved: that we, the members of the 106th Legislature of the State of Maine find and declare the commercial business of lobster fishing to be of vital economic importance to the State and urge all appropriate actions to be taken forthwith to conserve, manage and regulate the lobster fishing in order to insure its continued existence.

Be it enacted by the People of the State of Maine, as follows:

1. It is unlawful for any person to fish for, take or catch any lobster or crabs in any manner without having a current written license boat currently licensed as provided in this section, notwithstanding that the owner/operator of a currently licensed lobster and crab fishing boat may take a helper(s) without having them licensed. The operator of a boat may haul only traps licensed to that boat. The Commissioner shall be empowered to allow a boat to haul traps not licensed to it when circumstances prohibit the appropriately licensed boat from hauling its traps.

2. Commercial lobster and crab fishing license designation; general scope. The license, designated as a lobster and crab fishing license, entitles the holder to operate a boat and traps to take lobsters and crabs when and where it is otherwise lawful to take them. The applicant shall

specify on his application the registration number of the motorboat from which he shall fish as issued by the Bureau of Watercraft Registration and Safety or documentation number as issued by the United State Government.

3. In order to qualify for a commercial lobster and crab fishing license, the applicant must submit annually to the Commissioner, Sea and Shore Fisheries, with his application written proof that a minimum of 50% of the applicant's earned gross taxable income in the previous calendar year was derived solely from harvesting renewable marine resources. The Commissioner is directed to promulgate a regulation defining written proof. In unusual circumstances when an applicant fails to meet the above criteria, he may petition the Commissioner, Sea and Shore Fisheries, for an exception. When an applicant presents unusual circumstances for not earning 50% of his earned gross taxable income which would lead the Commissioner to believe that failure to renew a commercial lobster and crab fishing license would create an undue and unfair economic hardship upon the applicant, the Commissioner with the advice and consent of the Sea and Shore Advisory Council may issue a commercial lobster and crab fishing license in such a case.

4. It shall be unlawful for the operator of any boat, which is licensed as a commercial lobster and crab fishing boat, to set, have in the water, or fish more than 600 traps at any time, regardless of where the traps are set.

5. Apprentice lobster and crab fishing license designation; general scope. In order to provide controlled entry into the lobster industry and to insure continuation of proper methods of lobstering and conservation, an apprenticeship program is hereby established. This program will be open

to all persons 16 years and older. An apprentice must obtain consent of two commercial licensed master lobstermen who shall agree to oversee, direct, and teach sponsored apprentice for a period totaling 12 months. An apprentice may count toward the total requirement of his apprenticeship tenure a total of 6 months that he has lobstered under a student license. An apprentice may fulfill his apprenticeship by working as a stern man or fishing his own boat with traps. The license designated as an apprentice license entitles the holder to set, have in the water, or fish not more than 200 traps at a time regardless of where they are set. If an apprentice elects to serve as a stern man, this does not allow the boat to fish any additional traps other than those authorized under the appropriate license.

6. The only qualification for a commercial licensed master lobsterman is that he must have lobstered for 10 years before he may sponsor an apprentice. At the end of the apprenticeship, the apprentice shall obtain from the 2 commercial licensed master lobstermen who accepted responsibility for his apprenticeship training, write letters affirming their observation and recommending the apprentice for a commercial license. After June 1, 1975, successful completion of the apprenticeship program will be a prerequisite to application and holding of a commercial lobster and crab fishing license.

7. Student lobster and crab fishing license designation: general scope. Any person who is a full-time registered student at any accredited institution of learning, who meets the residency requirements as established in subsection 4 of this section, may apply to the Commissioner for a lobster and crab fishing license. The license designated as a student license entitles the holder to set, have in the water, or fish not more than 100 traps at a time regardless of where traps are set.

8. Retirement lobster and crab fishing license designation: general scope. Any person who holds a commercial lobster and crab fishing license as established by subsection 2 of this section may apply to the Commissioner for a retirement license. Retirement licenses may be issued to a holder of a commercial lobster and crab fishing license after that person has attained the age of 55 years and who has held a commercial license or its equivalent for a minimum of 10 years. A retirement lobster and crab fishing license entitles the holder to operate a boat engaged in lobster fishing as outlined in subsection 2 of this section except that no person holding a retirement license shall set, have in the water, or fish more than 200 traps at a time.

9. Sport lobster and crab fishing license designation; general scope. Any person who does not qualify for a commercial, apprentice, student, or retirement license, but who meets the residency requirements as established in subsection 4 of this section, may apply to the Commissioner for a lobster and crab fishing license. The license designated as a sport license entitles the holder to set, have in the water, or fish no more than 25 traps.

10. License fees. The fees to license lobster and crab fishing boats in each category will be:

- A. Commercial license - \$25.00
- B. Apprentice license - 25.00
- C. Student license - 15.00
- D. Retirement license 10.00
- E. Sport license 25.00

11. Lobster Conservation Fund. All revenues received from lobster and crab fishing license fees shall be allocated to the Lobster Conservation Fund, which does not lapse. Fees so collected or allocated in any one year may be used in the same or any succeeding year.

A. The Commissioner shall expend 40% of the money in the Lobster Conservation Fund for the purpose of propagation of lobsters and for purchasing seed lobsters from Maine lobster pounds and female lobsters from Maine wholesale dealers and liberating said lobsters in Maine coastal waters.

B. 60% of the Lobster Conservation Fund shall be used by the coastal warden service for additional enforcement of lobster laws.

12. License limitation:

A. The number of commercial lobster and crab fishing licenses shall be limited to a number equal to the applicants who qualify in the first year this legislation becomes effective.

B. The number of apprentice lobster and crab fishing licenses shall be limited to 600.

C. The number of student licenses will be limited to 1500 or the maximum number issued in the first year this legislation becomes law, whichever is lower.

D. There will be no license limitation on retirement lobster and crab fishing licenses.

E. The number of sport licenses will be limited to 1500 or the maximum number issued in the first year this legislation becomes law, whichever is lower.

13. Marking of lobster traps.

It is unlawful for any person to set, raise or haul any pot or trap for any lobster or crab, or to cause the same to be done without having the buoy attached thereto plainly carved or branded with his lobster and crab fishing license number, and unless there is attached to the sill of the trap a metal tag containing the individual's lobster fishing license

number and the current license year of issue (e.g. 1974-1975) plainly embossed thereon. Said lobster trap tags shall be issued by the Commissioner, or his representative, with the individual's lobster fishing license when application for license is made. The number of tags issued will be equal to the number of traps that an applicant is allowed to set, have in the water, or fish under the appropriate license for which he has made application. The Commissioner with the advice and consent of the Sea and Shore Fisheries Advisory Council is empowered to issue additional tags when they determine that an emergency situation exists.

15. Effective Date. This Act shall take effect on July 1, 1974. Licenses will be renewable on July 1 of each succeeding year. The Commissioner is directed to evaluate this legislation from the point of view of implementation and enforcement and to make any appropriate recommendations to a Special Session of the 106th Legislature or to the 107th Legislature.

16. Statement of Fact

The purpose of this bill is reflected in the Title. If enacted this bill will establish a license classification system, a trap limit, a license ceiling, a provision for marking of lobster traps, and provides for an increase in license fees. It also changes the date for renewing licenses from January 1 to July 1.

DISCUSSION

It should be noted that this proposed legislation bears a close resemblance to management alternative number one. There are important differences, however, which are primarily the result of a considerable political process. They are:

- (1) The buy-back and salable license procedures of alternative number one are replaced with a queing and annual qualification procedure

for allocating a fixed number of licenses. That is, a person does not buy a license, rather he has two possible means for obtaining a license: (a) he may go through the apprentice program and be placed on an (implied) list of persons eligible for a license or (b) if he has been engaged in the fishery he may present evidence of having earned more than 50% of his gross income in the previous year which is sufficient evidence for a license.

The primary reason for these changes is a strong feeling among the fishermen (and the legislators) that license allocation on the basis of ability to pay is in some sense inequitable. There may be a realistic fear of an ability to pay criteria since the fairness of that kind of criteria is dependent upon all persons having equal access to capital markets. Even though a commercial license under alternative one would have a considerable asset value, there is some reason to doubt that conservative local banks would behave in such a way as to allow all qualified individuals equal access to capital. As such the queing and annual qualifications procedures described in Greenlaw's bill are a substitute for a market in licenses.

- (2) The lack of a buy-back program effectively denies the management authority the power to alter the level of fishing effort. Therefore, the bill implicitly assumes that the fishing effort consistent with the number of licenses issued under its procedures is, in some way, optimal. Another way of looking at this is that the bill would have the effect of freezing fishing effort at a level, probably just slightly, below the current.

Though alternatives to effort adjustment through a buy-back type scheme are readily available, the committee handling the bill was apparently not willing to assign this power to the Commissioner of Sea and Shore Fisheries.

- (3) The one-time license freeze suggested in alternative number one is replaced in this bill with a similar but annual procedure. That is, every year a fisherman must meet the 50% income qualification for a new license. If he does not then he must give up his license to a person on the waiting list composed of persons who have successfully completed the apprentice program. In effect, the bill provides for no on-going property right in the fishery.

This aspect of the bill may be somewhat, though probably marginally, detrimental to the conserving attitudes of the fishermen, though as noted earlier there are other on-going social and economic factors which do contribute to a conserving attitude.

Administrative problems are also likely to crop up with respect to the annual qualification procedures. One obvious problem is the definition of income, or lack of it, contained in the bill. Another is the administrative or private costs which will be incurred by following the procedure.

Management Alternative #4

A second bill presented to the 106th Maine Legislature by Senator Paul Huber is reproduced below:

Be it enacted by the People of the State of Maine, as follows:

Sec. 1 R.S., T. 12, §4404, sub-§4-A, additional. Section 4404 of Title 12 of the REvised Statutes, as amended by section 2 of chapter 67 of the public laws of 1967, is further amended by adding a new subsection 4 to read as follows:

Vessel designation. An applicant for a lobster and crab fishing license shall designate on his application the number assigned by the Bureau of Watercraft Registration and Safety to the vessel on board which he intends to exercise the privilege conferred by such license. The commissioner shall enter such number so designated by the applicant on the license when issued. The commissioner shall not issue a lobster and crab fishing license to any applicant, if such applicant has designated in his application the number of a vessel which has already been entered on another license.

Sec. 2. R.S., T. 12 §4404, sub-§5, amended. Subsection 5 of section 4404 of Title 12 of the REvised Statutes is amended to read as follows:

5. License fee. The fee for a lobster and crab fishing license is \$100 which the applicant shall enclose with his application.

Sec. 3. R.S., T. 12 §4404, sub-§6, amended. The first paragraph of subsection 6 of section 4404 of Title 12 of the Revised Statutes is repealed and the following enacted in place thereof:

The license fees for lobster and crab fishing licenses shall be allocated to the Lobster Fund, as heretofore established.

Sec. 4. R.S., T. 12, §4404, sub-§6, ¶ A, amended. Paragraph A of subsection 6 of section 4404 of Title 12 of the Revised Statutes is amended to read as follows:

A. The commissioner may expend any and all of the money in the Lobster Fund from time to time for the purpose of propagation of lobsters, for research, protection and management of the lobster fisheries and for purchasing seed lobsters from Maine lobster pounds and female lobsters from Maine wholesale lobster dealers and liberating said lobsters in Maine coastal waters.

Sec. 5. R.S., T. 12, §4453-A, additional. Title 12 of the Revised Statutes is amended by adding a new section 4453-A to read as follows:

§4453-A. Limitation

On and after January 1, 1974 it shall be unlawful for any person holding a lobster and fishing license to fish more than 600 lobster traps or pots.

Sec. 6. R.S., T. 12, §4453-B, additional. Title 12 of the Revised Statutes is amended by adding a new section 4453-B to read as follows:

§ 4453-B. Marking of lobster traps

It is unlawful for any person to set, raise or haul any pot or trap for any lobster or crab, or to cause the same to be done without having the buoy attached thereto plainly carved or brand-d with his lobster and crab fishing license number, and unless there is attached to the sill of the trap a metal tag containing the individual's lobster fishing license number and the current license year of issue plainly embossed thereon. Said lobster trap tags shall be issued by the commissioner, or his representative, with the individual's lobster fishing license when application for license is made.

Sec. 7. R.S., T. 12, §4467, additional. Title 12 of the Revised Statutes is amended by adding a new section 4467 to read as follows:

§4467. Vessel Limitations

No person shall fish for lobsters and crabs from any vessel other than the vessel whose number, assigned by the Bureau of Watercraft Registration and Safety, appears on his lobster and crab fishing license.

DISCUSSION

One provision of the bill especially bears discussion. This is the proposed increase in the license fee from \$10 to \$100. The intent of this fee increase appears to be to provide a partial barrier to entry into the fishery. In intent it is comparable to the 50% of income from all fisheries criteria proposed in the Greenlaw bill (alternative #3). The differences in the two approaches should be analyzed in terms of their differing social and economic impacts.

Both approaches will, in and of themselves, tend to have a marginal impact on entry.* Each of the approaches, however, will have an impact

*The apprentice program provisions in Greenlaw's bill will probably have a much stronger impact on limiting entry.

on a different group of men in the fishery.

Higher license fees will tend to have the most deleterious impact upon:

- 1) Sportfishermen
- 2) Students
- 3) Clammers and other men who tend to work as stern men or who fish in late summer from dories and skiffs, and
- 4) persons who hold licenses but do not actively participate in the fishery.

License fee increases will not seriously hamper the entry of:

- 5) Full-time lobstermen
- 6) Most part-time lobstermen, and
- 7) Rich sportfishermen.

Of the groups on this list, group 3, is the one which is likely to bear the greatest private burden of license fee increases. This burden may be borne in one of two ways. Either the fee increase will discourage their entry forcing them into their next best alternative or, more likely, the fee increase will merely be accepted as another fixed cost which must be paid in order to make a living. (Obviously as fees rise the possibility of the former rises.) Since most of the men in this group tend to be marginal to the economy as well as the fishery any discouragement of entry which does take place is likely to limit economic opportunities for people with few alternatives. For groups 1, 2, and 4 the effect on entry is likely to be greater, but the social and private

costs are likely to be minimal. Groups 5, 6, and 7 will undoubtedly accept the license fee increase as a fixed cost.

The impact of this approach in terms of decreases in fishing effort is likely to be very minimal. Using data from the Huq sample and the 1972 random sample and assuming, that, at the most, the fee increase would eliminate all persons with 5000 or fewer trap days, we estimate that the decline in harvest would be in the order of 2-3% all other things equal.

The 50% of income alternative (taken by itself) will tend to have the greatest deleterious impact upon:

- 1) part-timers with reasonably good onshore employment
- 2) all sportfishermen
- 3) persons who hold licenses but do not actively participate in the fishery.

The 50% of income criteria will not seriously hamper the entry of:

- 4) full-time lobstermen
- 5) part-time lobstermen employed in other fisheries
- 6) part-time lobstermen with low income employment onshore, and
- 7) students.

The greatest burden of this approach will be borne by men who actively participate in the fishery and who at the same time have good job and income opportunities onshore. In certain areas of the State, especially the urban areas, there appears to be significant numbers of such men, truck drivers, teachers, salesmen, professionals, etc. Data from the Huq sample and the 1972 random sample would lead us to estimate that 25-30% of the men in the sample accounting for 9-12% of total catch

(trap days) would be eliminated by the 50% income requirement. From the point of view of social costs, however, exclusion of this group is likely to cause few problems.

Management Alternative #5

In the fall of 1973 a group of state legislators, fishermen and others with knowledge of the fishery began to work on the formulation of new legislation to be presented to the special session of the 106th Maine Legislature due to convene in January 1974. This effort resulted in a 28 page bill which is summarized below.

DRAFT SUMMARY OF THE PROPOSED
ACT TO CONSERVE, MANAGE AND REGULATE THE LOBSTER FISHERY

- I. The bill proposes to create four kinds of lobster and crab licenses each with different qualifications:
- a. Class A -- a commercial boat license, available to persons with 75% of their gross earned income from marine resources and one-third of that 75% (i.e. 25% of gross earned income) from the lobster fishery specifically. Income qualifications apply to 1973 or to three (3) of the five (5) years immediately before enactment. Age limit of 16.
These qualifications need to be met one time only (Dec. 1974). After that a class A license may be bought and sold, willed, given as a gift, mortgaged, etc.
 - b. Class B -- a commercial boat license available to persons with 30% of their gross earned income from marine resources and one-third of that 30% (i.e. 10% of gross earned income) from the lobster fishery specifically.
These qualifications need to be met one time only (Dec. 1974). A class B license may not be bought or sold or transferred in any way. If the person who holds the license retires from the fishery the license is also retired.
 - c. Class C -- a sport fishing boat license limited to 1500 people each year and available on a first come, first served basis. Only the boat license holder may take lobsters on a class C boat.
 - d. Class D -- a license to take, required for all persons who actually take lobsters. For example, a class A or B license holder will also need a license to take (class D) but his helper or sternman will need only a license to take. A license to take is valid only when used on a licensed boat.
- II. The bill proposes a license freeze:
- a. Class A -- the number of licenses will never exceed approximately the number of persons who qualify in Dec. 1974.
 - b. Class B -- the number of licenses will never exceed the number of persons who qualify in Dec. 1974. Additionally, since class B licenses may not be transferred, the number of class B licenses will gradually be reduced as a result of retirement, etc. After many years there will be no class B licenses outstanding.
 - c. Class C -- the number is limited to 1500.
- III. The bill proposes a trap limit with a trap tagging procedure:
- a. Class A = 600 traps in the water, 300 total tags for each license year and 1000 traps in possession.
 - b. Class B = 200 traps in the water, 300 total tags for each license year and 300 traps in possession.
 - c. Class C = 25 traps in the water, 30 total tags for each license year and 25 traps in possession.

IV. The bill proposes a new license fee schedule:

- a. Class A - \$50.00
- b. Class B - \$25.00
- c. Class C - \$25.00
- d. License to take - \$5.00

V. The bill proposes a "buy-back" program for Class A licenses:

The idea of a buy-back program is this: If, in the future, we find that there are too many fishermen for the fishery, the Commissioner of Marine Resources is authorized to purchase, at the going market price, and hold an appropriate number of Class A licenses. The Commissioner has no power to order a person to give-up his license. The only thing he can do is purchase a license from a person who voluntarily agrees to sell out.

One advantage of this procedure is that when conditions in the fishery are poor many men are (currently) forced out of business with little more than the shirt on their back and a lot of debts. Under the buy-back procedure a man who leaves the fishery gets a kind of nest egg which he can use to get started in a new profession or to pay off his debts. (It should be made clear, that when a man leaves the fishery he does not have to sell his class A license to the commissioner. He may sell or give his license to anyone he chooses.) An incidental benefit of this procedure should be an increased willingness on the part of banks to lend to fishermen.

Money for the Commissioner's buy-back fund comes from license receipts. When the fund reaches \$500,000 all license fees and all interest earned by the buy-back fund goes to the lobster conservation fund.

VI. Other provisions:

- a. The bill provides for replacement trap tags in case of extreme weather and other hardship conditions at the commissioners discretion.
- b. The bill prohibits corporate ownership of a license.
- c. The bill stipulates that no person shall hold more than one boat license (A,B or C).
- d. The bill provides for easy transfer of boat licenses from boat to boat (e.g., when a person buys a new boat).

Discussion

The reader will note that this proposed legislation is very similar to management alternative number one presented above. There are two primary differences, however:

- (1) The addition of the class B, nontransferable license. The purpose of this license is two-fold: (a) it softens the social impact of limited entry by allowing a group of currently active part-timers (i.e. those with 30% of their income from marine resources) continued access to the fishery. (b) It prevents, however, the continued entrance of new part-timers. Thus the effect is to slowly reduce effort through attrition of class B licenses.
- (2) The apprenticeship program of alternative one was eliminated because it was felt that such a program would not stand up to a constitutional challenge.

Appendix A

The Status of Socio-economic Data on
the Maine Inshore Lobster Fishery

Prepared by: Dr. James Acheson
Associate Professor of
Anthropology
University of Maine
Orono, Maine



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
FEDERAL BUILDING
14 ELM STREET
GLOUCESTER, MASSACHUSETTS 01930

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Contract No. N-043-83-72

This Contract, entered into this 7 day of June, 1972
by the United States of America, hereinafter called the Government,
represented by the Contracting Officer executing this contract, and

University of Maine
Orono, Maine 04473

hereinafter called the Contractor, witnesseth that the parties hereto do
agree as follows:

ARTICLE I. STATEMENT OF WORK The Contractor shall furnish the
necessary personnel, facilities, materials for performance of the following
work.

The formulation of a management program for any common property fishery requires preliminary biologic and socio-economic analyses of the fishery and the labor force exploiting the fishery. Over the past two years, the University of Maine has been involved in building a knowledge base on the socio-economic characteristics of the harvesting labor force in the Maine lobster fishery. The purpose of the proposed study is to (1) estimate the bias of their present data and, if deemed desirable, to remove this bias through additional sampling of the population and (2) to identify three or four realistic alternative management schemes and to assess the socio-economic impact each would have on the harvesting labor force and affect communities. It is expected that such analysis will provide meaningful insights into the appropriate approach to follow in rationalizing a final management effort for the American lobster. The above procedures to be used are contained in Professor Heq's Proposal dated May 25, which by reference is incorporated into the terms of contract.

ARTICLE 2. COST The estimated cost to the Government for performance
of this contract is \$26,031.00.

ARTICLE 3. PERIOD OF CONTRACT Work shall be commenced June 15, 1972

and shall be completed not later than June 14, 1973.

ARTICLE 4. OVERHEAD RATE The provisional rate for overhead pursuant to Clause 4 of the General Provisions shall be 40.2 percent.

ARTICLE 5. GENERAL PROVISIONS The attached "General Provisions", Forms are incorporated herein and made a part of this contract. See addition to and amendments thereon as cited in Article 7 and 8 below.

ARTICLE 6. ALTERATIONS The following changes were made in this contract before it was signed by the parties hereto:

ARTICLE 7.

Article 5 is amended to include the following:

- Certification of Equal Employment (See attached Agreement).
- Price Certification (See attached Agreement).
- Certification of Nonsegregated Facilities (See attached Agreement).

ARTICLE 8. AMENDMENT TO GENERAL PROVISIONS

Clause 12 is deleted and the attached Patent and Invention statement is substituted in lieu of.

Clause 19 is amended to read as per attached statement.

ARTICLE 9.

Report will be due quarterly with the final report due 60 days after completion of contract. Mr. Jon Rittgers, of this office, will be responsible for monitoring the contract.

ARTICLE 7.

This contract is negotiated under 41USC252C(5) of the Federal Property Administration Act of 1949 as amended.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written, .

University of Maine

(Contractor)

By

Bruce A. Walker

Vice President for Research & Public Services
(Title)

THE UNITED STATES OF AMERICA

By

Russell D. Lynn

Regional Director
(Title)

There are basically three sets of socio-economic data available on the inshore lobster fishery in Maine. Two of these sets of data were generated with the same data instrument: The first set of data was collected over a two year period (1970-71) by Dr. Abul Huq under contract to MFS. This data set is composed of a sample of 131 lobstermen from four Maine communities -- Beals, Corea, Bath, and Phippsburg. The second set of data was collected in the summer of 1972 using the same questionnaire form devised by Huq. This sample is composed of 82 lobstermen chosen at random from the license files of the Maine Department of Sea and Shore fisheries. The third set of data was collected by Dr. James Acheson over a two year period (1972-73) and represents an in depth sample of 42 full time lobstermen from the central coastal area of the State. We have attempted to assess the reliability of this combined data base by comparing the three sample sets.

I. Demographic data:

The quality of much of Huq's basic information is amazingly good -- especially given the fact that he was carrying out a small pilot study and had no prior knowledge of the industry. Moreover, there is very little literature on the subject so that Huq could scarcely rely on the work of others to guide his efforts. To be sure, we can see areas where Huq's data is suspect, but we are looking at the data having benefited by one year of further intensive research. In a very real sense, Huq's study is a pioneering effort at understanding a very complicated industry, and as such, certain critical aspects of the data show weaknesses under close scrutiny.

Very briefly, Huq's basic demographic data (e.g. age, marital status, children) appears to be representative of the coast as a whole; the same is true of his information on family relationships and occupations of other family members (Table 5, Table 10, Table 11, Table 12, Table 13, Table 14, Table 15, Table 16, and Table 20). For our purposes it is particularly important to note the data Huq has collected on father's occupation (Table 20) and migration (Table 50 and 52) which demonstrate a strong attachment to the industry and to the local community.

The reliability of this aspect of Huq's data is confirmed by virtually identical results obtained from the random sample undertaken in the summer of 1972. It should be pointed out, however, that both these samples are based upon the same questionnaire form and therefore, biases introduced by the questionnaire itself would not be discernable. Nevertheless, both samples are in reasonable agreement with Acheson's data and furthermore, there is little reason to believe that the questionnaire itself would introduce significant biases to this demographic data.

Huq's and the 1970 sample data on boat equipment (Tables 24, 25, and 26) appear to be accurate and consistent. We did not collect much information via intensive interviewing concerning vocational training, experience in other occupations, etc. (e.g. Tables 42, 43, 44, 45, 47, 48, 49), but during the summer of 1972 the random sample of the entire coast picked up some additional information on these subjects. Again, as far as we can see, there are no major inadequacies in the Huq or the 1972 sample data collected concerning these issues.

Investment, variable cost, and income data:

The most apparent problem with the Huq and 1972 random sample data is in the area of income, investment, and variable costs. There are three reasons for being somewhat suspicious of this data: 1) the large statistical variability of both samples, especially with respect to the strength of any relationships between income and/or investment and any measure of effort, 2) the large disparities which exist between the mean value of these variables in the Huq and the 1972 random sample and the mean value of the same variables as obtained by Acheson, and 3) the reasonable grounds for believing that the survey techniques used with Huq's questionnaire would give rise to inaccurate responses to questions on income, investments, and costs.

Our estimate is that mean investment and income are far higher than Huq's data would indicate, and that this is certainly the case where the average full time lobstermen is concerned. Huq, for example, found only one man in his sample who valued his equipped boat at over \$15,000. At today's prices, a new boat rarely costs under \$15,000, and can cost as much as \$30,000 fully equipped. A purchased trap fully equipped with line, toggles, and buoy, etc., costs about \$18 to \$20 and the average full time lobstermen along the coast has in the neighborhood of 400 traps and individual ownership of up to 2200 traps has been reported. Thus, the average lobsterman has at least \$5000.00 invested in lobster gear, and the gear investment of some men has been accurately appraised at over \$22,000. (Acheson) Yet in Table 34, only 5.3% of Huq's sample reported over \$5000.00 invested in fishing gear. In addition, Huq does not make any attempt to assess the value of docks, moorings,

fish houses, maintenance equipment, bait storage equipment, lobster cars, etc. Along the Maine coast where land is currently selling for between \$75.00 and \$150.00 per front foot, a dock alone can easily cost \$10,000. Acheson has computed the assets of three "big" established lobstermen and in all three cases their investment in fishing totalled over \$45,000.00.

In Table 39, Huq reports that only 11% of his sample reported a gross income of over \$14,000, and indicates that the average lobsterman grossed between \$6,000 and \$8,000. The 1972 sample indicates similar figures. Though both samples include large numbers of men who might be classified as part-timers, the upper end of the distribution almost certainly gives a very poor picture of income to be earned by a full time lobsterman. Acheson's data on 28 full time lobstermen in the mid-coast region of Maine shows only 7 men who reported a gross income of under \$14,000 from the lobster fishery; the mean gross income was \$18,700 and cases of men grossing over \$25,000 are not at all rare.* Fully 12 of these men had a taxable income of over \$16,000.

There are several reasons for the discrepancy in figures. First, Huq's sample contained a large number of part time fishermen (especially in the Bath-Phippsburg area) whose income and investment in lobstering is naturally smaller. More important is the fact that questions about

*These income figures were obtained over a two year period from men with whom long standing relationships had developed. These figures were double-checked by using income tax returns and catch records or both. These records were volunteered with the understanding they would be kept strictly confidential. All of these men come from the mid-coast region; all are considered "good" or "top" fishermen. Several come from the "closed" off-shore islands in the Penobscot Bay area.

income are very sensitive for several reasons. There is apparently regular and massive cheating on income taxes along the coast. The I.R.S. has found it worthwhile to set up field offices in several coastal communities and go over the income tax returns of a vast majority of the lobstermen in those communities. Moreover, many men do not want others to know that they are catching lobsters. Anyone can see where you have your traps, but one never tells how much he is getting out of his traps for fear that others will put traps "on top of him" (fish in the same spot). In an effort not to invite unwanted competition, a lobsterman rarely tells anyone (save for perhaps a son) where he is catching lobsters and how much income he is making in the industry. This is a subject where institutionalized lying is expected. Part and parcel of these attempts to keeping fishing success a secret is an act involving old beat up clothes and piteous stories about poverty, trap losses, government harrassment, etc. In addition, we know from rather extensive experience we have had in the past year that neither Huq nor our own 1972 random sample used the best interviewers for the job. The interviewers were young (under 27), inexperienced in the lobster industry, and two were women. In an industry where there is definite age grading, extreme sex segregation, and a tradition of "putting on" outsiders, it is scarce wonder that the interviewers were misled. What is amazing is the fact that much of their information appears to be of reasonably good quality.* Secondly, and equally important, is the fact that Huq's

*In the past year, we have found that the best information came from interviewers who were older men with a lot of experience in lobstering. Such men are able to get the respect of the lobstermen, and less apt to be misled. In fact, we feel so strongly about the quality of work done by one older lobsterman in particular, that in the future we would never hire anyone but an experienced lobsterman to interview other fishermen. This experience was not available to Professor Huq when he chose interviewers for his pilot project.

choice of study sites did not allow him to really see the enormous diversity that exists in the lobster industry. . Despite the fact that Corea and Beals are relatively isolated, while Phippsburg is "in close proximity to sources of alternative job opportunities" (Huq: p 7) the social organization of these communities is very similar as regards to fishing. There are whole sets of communities along the Maine coast organized in quite different ways. These diversities in fishing traditions appear to have a very strong influence on lobster catches and incomes.

The 1972 random sample exhibits somewhat similar problems. For example, one of the areas of the coast which is of special interest because of its problems and the fact that it seems to presage trends for the industry is the Casco Bay area. By the luck of the draw the 1972 sample picked almost no one from this area. Similarly, Huq has no data from this area. Another problem with the 1972 survey is the fact that there are so few observations on each particular area of the coast that it is difficult (impossible) to discern from the data the large variability of fishing income, practices, etc., attributable to location. (See section II of this appendix for a more complete discription of this variability.)

Finally, the income and investment data in the Huq sample and the 1972 random sample give rise to rather weak statistical relationships which, furthermore, are characterized by pronounced heteroscedasticity. Table 1, 2 and 3 summarize the relationships between gross income, trap days per year, and investment in traps and equipment for the various years and towns contained in the Huq and 1972 random sample data. The strange aspect of these results is that

in every case the R^2 and "b" coefficient are statistically significant at the .01 level but the constant term "a" is never significant. Upon examining the data, it is apparent that the frequency distribution of each variable is primarily bi-modal, probably reflecting a split between part-timers on one hand and full-timers on the other. This characteristic of the data explains the high levels of significance accorded the "b's" and R^2 's and also tends to diminish the confidence one can place in the validity of the relationships.

II. Social and Economic Diversity Along the Maine Coast

These problems with the data make us reluctant to place much confidence in their ability to adequately describe the large variation observed in the lobster industry. What follows is an attempt to describe the heterogeneity along the entire coast, which does not appear in Huq's sample or in our own 1972 random sample.

Over the course of the past year, our researches have led us to the conclusion that there is an enormous amount of diversity in the Maine lobster industry. In fact, lobstering communities are organized in such different ways that one could almost make the case that they are involved in different fisheries. For our purposes, it is critical to note that any management scheme enacted is apt to have a very different effect on these different areas.

Before we can discuss differences in coastal communities, three different parameters of lobster fishing must be discussed.

1. In order to go lobster fishing at all in Maine, one must be accepted by the men fishing out of one harbor; and once one has

been admitted to such a "harbor gang" one can only go fishing in the traditional ocean areas of that particular harbor. Violations of territorial rights are usually sanctioned by destruction of the offenders' lobstering gear. While these facts are true all along the Maine coast, in some areas, which I call "open" areas, entry into a harbor gang is relatively easy, so that any long-term resident of the area who does not violate important norms of the industry (e.g. molesting other's gear, etc.) is allowed to fish in the traditional territory of that harbor. In such areas, there is typically a good deal of boundary overlapping. That is, close to the home harbor, the waters are fished by the men of that harbor, but further off shore men from two or more harbors fish together. By way of contrast, entry into the harbor gang of "closed areas" is very difficult, if not impossible. In these areas, boundary lines are known to the yard and are sharply defended so that little or no "overlapping" occurs.

From the point of view of management, two features of this distinction are critical. First, the "closed areas" clearly constitute a case of "limited entry" into the lobstering industry. There are certain islands even in the "open" areas where not everyone is permitted to go lobster fishing. There is not a harbor along the coast where a "summer person" (a non-member of the community originally from out-of-state) with another source of income can begin lobster fishing without meeting substantial resistance. In this regard, it should be noted that Huq does not seem to be aware of the fact that he is dealing with an industry whose traditions make for a case of "limited entry." Instead, he talks as if entry into the lobstering industry

were unlimited and that the only way to achieve a situation of "limited entry" is through some kind of management scheme and legislation. (Huq: p. 1)

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Secondly, there is an enormous difference in both catches and incomes between "open" and "closed" areas. Acheson's sample, for example, shows a mean gross income of \$23,700 for men in "closed" areas and a mean gross income of \$14,900 for men in immediately adjacent, but "open" areas. The higher incomes of men in "closed" areas are not only the result of barriers to entry which reduce the number of lobstermen fishing in those areas, but are due to other factors as well. The lobstermen from Monhegan, for example, have agreed among themselves to fish only from January to June. This means they are fishing at the time of year when prices are relatively very high, and they are not fishing during the "shedding" season when fishing doubtlessly contributes to a high mortality rate in the "short" lobsters caught. Moreover, the men fishing in some other "closed" areas have agreed to a voluntary trap limit, which raises net income by lowering costs of equipment, bait, maintenance, etc.

2. In most parts of the coast of Maine, lobsters are caught by fishing "singles" or "doubles," that is, by putting only one or two traps on a single line. In these areas, the average full-time lobsterman has about 400 traps, which he fishes along with a boat usually under 34 feet. However, in the area between Cape Elizabeth and Boothbay, fishing with trawls (multiple traps on a single line) is the rule. Trawl fishing is especially prevalent in the Casco Bay and Harpswell areas. In these areas, it is not at all uncommon for men to fish up to 2000 traps which they tend with larger boats using a two man crew.

3. Going up the State from west to east, one goes from a very urban, industrialized and rapidly expanding area (e.g. Portland, Portsmouth) to areas which become increasingly rural, less populated and less industrialized as one approaches the Canadian border. Washington County, the eastern most county in the United States, has virtually no industry and by any measure is a pocket of rural poverty. The opportunities for employment differ markedly at different ends of the continuum. For our purposes, it is useful to classify the lobstering communities of Maine into five different types:

A. In the eastern part of the State (Stonington to Lubec) the harbors are basically "open," with a good deal of boundary overlapping. All lobstering in this area is done by fishing "singles" or "doubles" using relatively small boats with one man crews. There are relatively few "part-time fishermen" and those few men tend to fish certain whole seasons of the year, rather than fishing "after," as part-timers do in other parts of the State.

B. The islands of outer Penobscot Bay are all completely "closed," and the boundaries of their traditional territories are sharply delineated. In these large island areas men fish with "singles" and "doubles." For the men who live on these islands year round, alternate employment opportunities are virtually non-existent.

C. In the mid-coast region of the State--between Penobscot Bay and the Kennebec River--lobstering is done by fishing "singles;" the harbor gangs are all "open." Alternate economic opportunities are moderately good.

D. Between the Kennebec River and Cape Elizabeth, the harbor gangs are "open" and territories have extensive overlapping. In this

area, men typically fish trawls, and very large "gangs" of traps.

The opportunities in other industries are very good.

E. Between Kittery, Maine and Cape Elizabeth (the southern most portion) the harbors are reportedly "closed" in that harbor gangs maintain a strict control over fishing practices. Here men fish again with moderate numbers of traps arranged in "singles," "doubles," or "triples." Alternate economic opportunities are excellent.

The critical point is that the three towns Huq chose as study sites all exhibit the "open" harbor syndrome. Moreover, in none of these areas is there trawl fishing. Phippsburg is in the mid-coast region where alternate employment opportunities are much better than Beals and Corea. But they are all very similar with regard to their traditional fishing practices.

Had Huq picked a community with a great deal of trawl fishing, his estimates on boat sizes, amount of lobstering gear, and equipment would certainly have been larger. In all probability, his estimates of Gross Income would have been larger as well. If he had picked a community in one of the "closed" areas, in all probability, his estimates of investment, boat equipment, etc, would be higher, and certainly, his estimates of Gross Income earned in lobstering would be much higher.

In summary, Huq's data can be criticized on the grounds that it gives a very misleading picture of the economics of lobstering along the entire coast. It may, however, tell a great deal about certain aspects of lobstering in the limited areas he did study.

Appendix B

Ten Alternative Management Schemes for
the Inshore Northern Lobster Fishery

October 1972

Our method of devising management schemes for the inshore Northern Lobster Fishery was to first categorize possible scheme components according to the general management approach implied by the component. We distinguish between three different management approaches:

Type I: Management approaches designed to eliminate the common property and unlimited entry characteristics of the fishery which we presume to be the root of the overfishing problem. Management scheme components which fall in this category are:

1. Freeze the number of licenses.
2. Freeze the number of licenses and make available only to "commercial" fishermen.
3. Limited number of transferable (sellable) licenses.
4. Special licenses, with special restrictions: commercial, apprentice, "retiree," etc.
5. Decentralized (i.e. local) management "councils" with locality specific licensing.
6. Closed seasons.
7. Trap day or number limitations.
8. Centralized "strong" management authority (regional, Federal, or international).

Type II: Management approaches which emphasize the use of taxes or subsidies as a corrective to overfishing. Scheme components falling in this category are:

1. A special excise tax on lobsters.
2. A tax on traps.
3. A tax on boats.
4. A tax proportional to catch or income.

5. Increased license fees. 82
6. Subsidies as compensation for lowered fishing effort.

Type III: Management approaches which are primarily a compilation of good conservation practices. Scheme components of this type are:

1. Raise the legal minimum size (1a. females only).
2. Abolish legal maximum size (2a. males only).
3. Re-designed traps to allow "shorts" to escape.
4. Discontinue notching.
5. Remove un-bouyed traps from bottom.
6. Enhance lobsters environment with artificial reefs, etc.
7. Bounties on predators.
8. Begin hatcheries or research on hatcheries.
9. Control dragging.
10. Eliminate harmful pollution.
11. Discontinue plugging.
12. Quotas on total catch.

Alternative Management Schemes

These scheme components (or slight variations of them) were then combined into possible management schemes. The possible number of schemes is very large. Necessarily then the ten schemes which are described below represent only one of many possible sets. Nevertheless we feel these ten schemes represent, not only a wide range of possibilities, but also a reasonably feasible set of general alternatives.

SCHEME # 1

- a. Limit traps to 300 per boat, 400 if there is a regular helper.
- b. Raise license fees to \$200.

Comment: This simple scheme appears to have wide spread support ⁸³ among lobstermen who attended special State Legislative Committee hearings held along the Maine coast in September, 1972 and for this reason it should be considered on any list of alternatives. The scheme appears to appeal to the lobsterman's sense of a man's "fair share" in the common property and at the same time promises to force out of the fishery men who have other jobs. Men with other jobs are also viewed as taking more than their "fair share." Serious questions about the scheme relate to the enforceability of provision (a), its ability to bring to a halt the current state of overfishing and its effects on "marginal" fishermen and men whose "other" jobs are very poor jobs.

SCHEME # 2

- a. Freeze the number of licenses at the current level and allow normal attrition to slowly reduce the amount of fishing effort.
- b. Make licenses initially non-transferable and subject to a minimum use requirement.
- c. Raise license fees to encourage withdrawals from the industry.
- d. When biological information indicates the end of overfishing, match attrition rate with newly created licenses.
- e. As an alternative to d., declare licenses transferable (sellable) when overfishing has ceased.

Comment: The primary purpose of such a scheme would be to slowly cut back fishing effort so as to minimize transitional and dislocation costs. Then once a reasonable approximation to MSY and/or MEY is achieved, to stabilize the fishery at that level by switching to a system with a fixed number of transferable licenses (i.e. licenses which give the holder property rights in the fishery.) If combined with a trap limit or individual quotas the scheme would correspond with lobstermen's ideas of "fair share." Serious questions relate to (a) the timeliness of the

reduction in fishing effort (e.g. could attrition be so slow and technological change or increases in effort among survivors be so fast that no reductions in fishing effort will take place?) and (b) the social effects on "marginal" and part-time fishermen as with Scheme # 1.

SCHEME # 3

- a. Increase the legal minimum size 1/16" every year for eight years.
- b. Repeal the legal maximum size.
- c. Follow procedures in Scheme # 2 at the same time.

Comment: Raising the legal minimum size in combination with Scheme # 2 might be one way to ensure adequate replenishment of the harvestable stock if fishing effort is not expected to decrease. Simultaneous repeal of the maximum size limit is intended to provide alternative fishable stocks to replace those placed off-limits by the increased legal minimum size. Whether or not the stock of currently oversized lobsters is adequate for this purpose is apparently unknown. Hence changes in legal sizes would seem to carry with them high risks of large transitional and dislocation costs.

SCHEME # 4

- a. Create several classes of licenses
 1. Commercial licenses -- transferable, limited in number, initially available only to "certified" full time lobstermen, high fees.
 2. Apprenticeship licenses -- non-transferable, available to men less than 25 years old for a period not exceeding 4 or 5 years. Moderate fees.
 3. Retirement licenses -- non-transferable, available to men over 60 who have been full time lobstermen. Limited period, low fees.

- b. Use commercial license fees to fund a (voluntary) license buy-back program. 85
- c. Combine with legal size changes as before.

Comment: The purpose of the apprenticeship licenses is to ensure a supply of skilled fishermen. Retirement licenses are a means for reducing economic dependency among retirees and also as a means to avoid forced and early retirement among older men with low productivity who may not be able to afford a high commercial license fee. Funding a buy-back program with license fees is appropriate since survivors (license fee payers) benefit from reduced numbers of commercial fishermen.

SCHEME # 5

- a. Divide the inshore fishery into relatively small areas using as criteria (1) "natural" fishing boundaries already established by lobstermen and (2) distinguishing environmental characteristics.
- b. Establish three types of licenses as in Scheme # 4.
- c. License boats with a requirement that the boat be fished by the license holder.
- d. Licenses valid for only one area.
- e. Establish in each area a government (of council or town meeting type) of licensed commercial fishermen. Such governments should be responsible for the management and control of the fishery in their area, subject to certain minimum requirements (e.g. legal minimum size) determined by appropriate State agencies or a regional Federal body established for this purpose.
- f. Raise commercial license fees substantially with large majority of fees going to local councils, remainder to State or regional body.
- g. Regional or State agency to determine the proportion of fees in each area to be set aside for license buy-back (on the basis of indicators of the state of the fishery in each area). This gives regional or State agency power to indirectly raise or lower price of licenses in each area and, therefore, to affect the rate of "voluntary" retirement of licenses.

- h. Regional or State agency to establish quasi-judicial board to mediate disputes between or within local management areas and to establish an "extension service" to promote scientific knowledge and good management practices in each fishing area. 86

Comment: This scheme proposes the greatest departure from current practices. It is an attempt to institutionalize and formalize for each lobsterman his co-operative property rights in the fishery and at the same time to give lobstermen a means to control their "property." Ownership without the possibility of control is generally regarded as meaningless and may not lead to active pursuit of conservationist measures by all men in the fishery. On the other side of the coin, control of property also means the ability to destroy that property. Hence the proposal suggests a State or regional "regulatory" agency which could impose certain minimum requirements on each area in order to preclude "mining" of the fishery. Additionally creation of local management bodies is designed to provide regular and formal channels of communication for the regulatory agency and, especially for the "extension" service. The scheme also proposes the license freeze, high annual fees and transferability suggested in previous schemes. As before the rationale is to provide limited entry, a decline in fishing effort and relocation "allowances" i.e. the selling price of the license) for men leaving the fishery. Finally the scheme is designed to provide management which is flexible and responsive to varying environmental and "fishing" characteristics of each area along the coast. On the other hand, a serious question about the feasibility of the scheme relates broadly to the practicality of decentralized management bodies.

SCHEME # 6

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- a. Impose one or a combination of the following taxes:
 1. A special excise tax on the consumption of lobsters, or
 2. A tax on traps, or
 3. A tax on boats, or
 4. A tax proportional to each man's catch, or
 5. Raise license fees.

Comment: These taxes follow the prescriptions of the classical school of economics. Their rationale is either to raise costs of production or to lower the prices received by lobstermen, which in the long-run will tend to "force" some men out of the fishery, thereby reducing catch and overfishing. The practicality of this plan depends upon the responsiveness of both consumers and lobstermen to changes in the prices which they pay and/or receive for lobsters (i.e., the elasticity of demand and supply). The more responsive (in terms of changed consumption and/or output) both consumers and lobstermen are to changes in price the more practical is the plan. Basic advantages seem to be ease of administration and reliance on the market mechanism. Work on schemes of this sort has been begun by Bell, Fullenbaum and Carlson.

SCHEME # 7

- a. Terminate all lobster fishing for a period of two years.
- b. Subsidize lobstermen over the two year period in proportion to their reported average catch over the five year period prior to initiation.
- c. At the end of the two year period initiate a management scheme on the lines of Schemes # 1 to # 6.

Comment: This is certainly a drastic approach though there are (inexact) parallels to be found in U. S. farm policy. Apparent problems

concern the effects on alternative fisheries available to the men and 88
equipment currently in lobstering, the probable export of our overfishing
problem to the Canadian provinces, the disruption in marketing channels,
the depressing effect on supporting industries and communities, and the
cost of the subsidy. On the other hand, the scheme would definitely
accomplish an immediate reduction in fishing effort and in all
probability a rather large increase in the stock and poundage of harvest-
able lobsters would occur. A variant of this scheme which might mitigate
some of the above problems might be a "partial shutdown" with each
commercial fishermen allocated a quota equal to, say, 50% of his previous
average annual catch. Subsidies would then be based on the reduction
in each man's estimated catch and/or income.

SCHEME # 8

- a. Retain present industry structure and regulation forms.
- b. Put entire emphasis on legislative passage of some of the
"good conservation" measures as listed on page 2.

No comment at this time.

SCHEME # 9

- a. Integrate the management of the lobster, shrimp, scallop,
and clam industries.

Comment: These four fisheries are closely related in that trans-
ferability of fishing effort between the fisheries is accomplished with
relative ease. For example in recent years bad prospects in the winter
lobster fishery seem to have caused large shifts to scalloping and
shrimping. Such transferability of effort raises the spectre of over-
fishing of, say, shrimp, being caused by "forced" reductions in lobster

fishing effort. The implication is that related fisheries need integrated management. Evaluation of schemes along this line is obviously beyond the resources of this project; nevertheless, we present the idea for your comment.

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SCHEME # 10

a. Do nothing.

Comment: Evaluation of all other schemes must take place in relation to this, the most politically likely of all schemes.

James Wilson, Director
Marine Resources Project
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Orono, Maine 04473

Appendix C

Open-ended questionnaire conducted in
Spring of 1973

The National Marine Fisheries Service is interested in the social and economic impact of proposed lobster fishery management schemes. NMFS has also asked that proposed management schemes be revised in accordance with criticisms and suggestions made by lobstermen and other persons associated with the fishery. The proposal which is attached to this paper is a revised version of an earlier proposal. This revision took place as a result of conversations and interviews with about 50 Maine lobstermen. Now we are interested in your reactions and suggestions. The interviewer who gives you these papers will return to talk with you after you've had a chance to read and think about the proposal.

James Wilson
Department of Economics
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Orono, Maine 04473

James Acheson
Department of Anthropology
University of Maine
Orono, Maine 04473

Management Proposal: February 1, 1973

There are five separate parts to this management scheme, typed in capital letters below:

I. CREATE SEVERAL CLASSES OF LICENSES:

- a. Commercial licenses--These licenses would initially be available only to "certified full time lobstermen". They would be limited in number and the annual license fee would be about \$100.00 to \$150.00.
- b. Apprenticeship licenses--Would be available to residents of Maine for a period not exceeding 4 years. The license fee for an apprenticeship license would be low, but such men would be allowed to fish a very small number of traps, (suggested trap limit 200 traps) and could not sell their license. Holders of the apprenticeship license could serve as stern man or helper for a "commercial" or full-time lobsterman.
- c. Retirement licenses--Available to men over 55 who have been "full-time" lobstermen. Men with retirement licenses could not sell their license, would be allowed to fish only a small number of traps, (about 150), but would pay a low license fee.

Question: Who would be classified as a "full-time" lobsterman when the plan goes into effect?

Answer: We suggest that a full-time lobsterman be defined as either:

- a. a man who earned 60% of his income in three of the five previous years from lobster fishing or b. a man who earned 40% of his income from lobstering and another 30% from other fisheries, i.e., scallop, shrimp, etc.

After the plan had gone into effect, a man could get a "commercial" license only by buying one from another lobster fisherman who was going out of business. Only men who had held an apprenticeship license for two years could buy a "commercial" license from another man.

- II. LICENSE BOATS WITH A REQUIREMENT THAT THE BOAT BE FISHED BY THE LICENSE HOLDER.
- III. USE COMMERCIAL LICENSE FEES TO FUND A VOLUNTARY LICENSE BUY-BACK PROGRAM.

The State would use license fees to establish a fund to buy back licenses. That is, when a man goes out of business as a "commercial" fisherman (e.g. dies, gets better job, gets a retirement license) he could either sell his commercial license to another man who wants to enter the fishery, or sell it to the State. When fishing is bad, the Commissioner of Sea and Shore Fisheries could buy up more licenses of men going out of the industry, and thereby reduce the number of fishermen. This would result in increased catches for those who remain. After the fishery improved, the Commissioner could auction off licenses to the highest bidder if he so chooses.

This program would give the State the power to influence the number of lobstermen, and yet would not prevent men who want to enter the industry from doing so. (If you want to become a lobsterman, you first get an apprentice license, and after two years buy a "commercial" license from a man going out of the industry.)

IV. ESTABLISH A MINIMUM CARAPACE LENGTH OF 3-1/2 INCHES, AND ELIMINATE THE OVERSIZE MEASURE. 94

If we went to a 3-1/2 inches minimum, any lobster about 1-1/4 pounds would be legal. The measure cannot be increased from 3-3/16 inches to 3-1/2 inches in one year without putting a lot of men out of business. Any increase in the measure must be done very gradually-- 1/16 inch each year for 5 years.

There are two arguments in favor of raising the minimum size to 3-1/2 inches. (1) More females will reach maturity and egg before they are harvested, and (2) the majority of lobsters harvested will be one molt older and approximately 50% larger by weight. The smallest lobster that would be harvested would weight about 1-1/4 pounds, and many more would be caught weighting 1-1/2 lbs. to 1-3/4 lbs.--a range bringing a much higher price per pound.

V. ESTABLISH TRAP LIMITS IN THREE ZONES.

- A. Between Kittery and Cape Elizabeth--maximum of 300 traps.
- B. Between Cape Elizabeth and Cape Newagen--maximum of 600 traps.
- C. Between Cape Newagen and Eastport--maximum of 300 traps.

A trap limit is a good idea, but trap limits alone will not solve the problem. When the Canadians imposed a trap limit they discovered the total catch did not decrease. The Canadian fishermen kept their best traps, and fished them harder. However, trap losses and total trap costs declined greatly which resulted in decreased costs to the fisherman and greater net income.

Explanation:

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The following statement contains additional ideas on all five parts of the proposed lobster fisheries management scheme. It contains a lot of ideas. To understand it completely you must read it carefully and mull it over.

The purpose of changing licensing methods in several gold. In the first place it is designed to bring about a rather quick reduction in fishing effort by eliminating many part-time men who would not fit it whorthwhile to pay a license fee or who would not qualify for a license. Though it would be very difficult to predict how many men would be in this situation a rough estimate of the reduction in trap days brought about by this licensing policy would be in the order of 5 to 18 percent. This would have the effect of reducing the impact of raising the legal minimum. In other words, raising the legal minimum size will reduce catch in the first few years; however imposing the new license requirements will simultaneously reduce the number of men fishing. In addition to the part-timers who will leave the fishery as a result of the new licensing requirements, some men who qualify for the commercial license will choose to sell their licenses to the buy-back program. For the men remaining in the fishery this will also soften the blow of raising the legal minimum size. The license buy-back program also had the effect of providing full-timers who choose to leave the fishery with a relocation allowance or nest egg of sorts. This may be especially important to men near retirement or to men in areas where over-fishing has been the greatest.

Additionally, the purpose of apprenticeship licenses is to insure a supply of skilled fishermen. Retirement licenses are a means for reducing

economic dependency among retirees and also a means to avoid forced and early retirement among older men with low productivity who may not be able to afford high commercial license fees. Funding a buy-back program with license fees is appropriate since survivors (license fee payers) benefit from reduced number of commercial fishermen.

An important point to note about the license buy-back program is that it is voluntary and to a certain extent self-regulating. What we mean by self-regulating is this: Right now there is disagreement about whether there is over-fishing or just a temporary downturn. If over-fishing is the case, in fact, many men will begin to feel the economic pinch. Some men will choose to sell their licenses as a result. This will reduce the number of men fishing and total fishing effort. In other words, lobstermen themselves will make the decision--through their own actions--about over-fishing. If we have only a temporary downturn few men will choose to sell their licenses and there will be little reduction in fishing effort.

As far as the 3-1/2 inches minimum size in concerned, since approximately 60% of the current harvest falls below the proposed 3-1/2 inches minimum size, implementation of this regulation should be approached with great caution. Probably the most reasonable suggestion is to raise the legal minimum by 1/16 inch each year for five years. If this is done the economic impact of raising the legal minimum size will be minimized in two ways: (1) The reduction in the harvest each year will be in the vicinity of 12 to 14 percent (in numbers) rather than 60 percent. (2) Many of the lobsters not harvested (i.e. that 12 to 14 percent) will molt, grow in weight by approximately 50 percent and be harvested in the following year. This process will continue for five years. Making very rough

calculations of the interaction of these two effects we estimate that in 97 the first three years of the program the harvest by weight would fall 10 to 15 percent below the normal which would be expected for that year.* By the fourth year harvest by weight would be about normal and in the fifth year would be approximately 30 percent above the normal which would be expected for that year.

*What we mean by "the normal which would be expected for that year" is this: Each year the number of lobsters which reach the current legal minimum size (3-3/16") varies according to the environmental conditions which governed their growth. We cannot predict these variations. Hence the estimates made here do not take into account the yearly fluctuations in the number of lobsters reaching the 3-3/16" size.

QUESTIONNAIRE FOR PROPOSAL OF FEBRUARY 1, 1973

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Background (optional)

1. Name:
2. Harbor
3. Age
4. Years in fishery
5. Engages in other fisheries
 - a. scallop _____
 - b. shrimp _____
 - c. clam _____
 - d. other _____
6. % income from other fisheries _____.
7. Other employment _____ . % income _____.

Reactions:

1. RE: 3-1/2" by 1/16" increments

Favorable

- a. Would increase landed weight _____.
- b. Would increase egged females _____.
- c. Last increase didn't hurt _____.
- d. 1-1/4 to 1-1/2 lb. lobsters get premium prices _____.
- e. Other

Unfavorable

- f. Would reduce catch too much
long run _____ short run _____ both _____
- g. Would price lobsters out of the market _____.
- h. Other

General impression

- i. Does or does not comprehend 3-1/2" argument _____.

2. RE: Eliminate maximum size limit

Favorable

- a. Would allow development of offshore fishery in Maine _____.
- b. Too few anyway _____.
- c. Other

Unfavorable

- d. Would destroy seed stock _____.
- e. Other

3. RE: Licensing proposals

Favorable

- a. Buy back is fair way to bring down number of licenses _____.
- b. Criteria for commercial licenses seem fair _____.
- c. Likes apprentice approach _____.
- d. Likes retirement alternative _____.

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e. Other comments

Unfavorable

- f. Commercial license requirements too discriminatory _____
against who, why _____.
- g. Commercial license requirements too lax _____, why _____.
- h. Doesn't like sellable licenses _____
why _____.
- i. Doesn't like recreational license _____
why _____.
- j. Doesn't like apprentice approach _____
why _____.
- k. License fees too high _____.
- l. License fees too low _____.
- m. Other comments

n. Suggested changes: _____

o. General comments: (e.g. understands buy-back etc.)

4. RE: Trap limits

Favorable

- a. Would reduce costs _____.
- b. Would reduce overfishing _____.
- c. Would be fairer _____.
- d. Other

Unfavorable

- e. Unfair _____, why _____.
- f. Would reduce net income _____, gross income _____.
- g. Wouldn't stop over-fishing _____.
- h. Unenforcable _____.
- i. Would cause hard feelings, spying, etc. _____.
- j. Suggested changes:

