Enforcement of the MFCMA:
An Economist's Perspective

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Introduction

The Federal government spent more than $220 million in FY 1985 to carry out the Magnuson Fishery Conservation and Management Act (MFCMA), and nearly 60 percent of these expenditures were for enforcement of the regulations promulgated under the Act. In late 1985 Federal fisheries enforcement effort was reduced substantially when the U.S. Coast Guard's budget was cut. Sea patrols by the Coast Guard in the Northeast Region, for example, were cut in half as a result.

What are the welfare consequences of this reduction? Can it be justified on economic grounds? Are further reductions in the best interest of the fishing industry, consumers of fish, and taxpayers? Or, is more enforcement justified despite its high cost? A naive observer might expect to find answers to such questions in the Regulatory Impact Analyses (RIA's) required by Executive Order 12291 for regulations under the MFCMA. The RIA's prepared to date, however, do not provide an adequate accounting of the welfare impacts of enforcement and provide little or no information for determining the appropriate level of enforcement. I can only speculate on the reasons for this information gap. The lack of appropriate data likely is a principal reason. But another important reason appears to be the lack of an applied benefit-cost framework tailored to evaluation of the fisheries law enforcement program.

This paper describes a framework for evaluating fisheries law enforcement and uses available data to illustrate its application to evaluation of MFCMA enforce-

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ment. The main body of the paper presents the following sections: 1) An overview of the regulations and enforcement programs under the Act, 2) a basic paradigm for explaining the incidence of violations in a fishery is developed, 3) a model for measuring the effects of regulatory and enforcement policies on compliance and benefits is outlined, 4) the nature and magnitude of enforcement costs are discussed, and 5) some conclusions are drawn in the final section.

Regulations and Enforcement Under the MFCMA

Under the MFCMA, regulations specified in management plans may include:

1) Limitations on the catch of fish based on area, species, size, number, weight, sex, incidental catch, total biomass, or other factors;
2) Designated zones where and when fishing is limited or permitted by specified types of vessels or gear;
3) Prohibitions, or other controls, on specified types and quantities of fishing gear, fishing vessels, or equipment for fishing vessels; and
4) A system of limiting access to a fishery.

Catch limitations are the most prevalent of the above regulations, followed by time-area closures and gear restrictions.

Catch limitations most commonly take the form of an aggregate annual quota for specified species and areas. When the recorded catch for the year equals or exceeds the quota, the fishery is closed. Other common catch limitations include restrictions on incidental catches (i.e., of nontargeted species) on both a trip and aggregate basis. Restrictions on the size

of fish landed are used in a few fisheries.

Time-area closures (i.e., designated zones where and when fishing is prohibited) have been used in most fisheries subject to management plans. It is common to combine this form of regulation with others—e.g., catch limitations and gear restrictions.

Gear restrictions appear to be slightly less common than time-area closures. The regulation usually specifies the type or size of gear allowed in the fishery. In trawl fisheries, for example, the mesh size of the codend must not be less than a specified length when measured a certain way; and only barbless hooks may be used to catch Pacific salmon off the west coast.

Restricting access to a fishery is not common, though some forms of the regulation are found in FMP's for Alaska high-seas salmon; Washington, Oregon, and California commercial and recreational salmon; and Atlantic surf clams and ocean quahogs.

Management plans typically employ multiple regulations. The FMP for the relatively simple northern anchovy fishery uses three types of regulations: Aggregate annual catch quotas, time-area closures, and restrictions on the minimum size of the fish landed. FMP's for more complex fisheries, such as groundfish and salmon, use a greater array of regulations.

Enforcement of the law and regulations under the MFCMA is the joint responsibility of the U.S. Coast Guard (Department of Transportation) and the National Marine Fisheries Service (Department of Commerce). Fisheries law enforcement activities of the Coast Guard traditionally have been limited to surveillance and inspections of offshore fishing operations. NMFS personnel frequently

accompany Coast Guard fishery patrols, making the offshore enforcement activity a joint endeavor. Onshore, or dockside, enforcement of the MFCMA has been the traditional responsibility of NMFS in conjunction with state enforcement agencies.

Offshore enforcement is composed of three principal modes: Observers, sea patrols, and air patrols. The observer program operated by NMFS places an individual on board each foreign vessel to monitor its fishing activities. No observers are placed on domestic fishing vessels. While observers have no authority to take enforcement actions, they fulfill an important role in the enforcement process. Besides monitoring and recording the foreign vessel's activities, they can summon enforcement personnel if a violation is suspected. According to Pallozzi and Springer[1], observers are a good mode for monitoring compliance with nearly all management regulations. Under the current program, the cost of observers is borne fully by the governments of the foreign vessels.

Sea patrols by Coast Guard ships and boats is the most comprehensive enforcement mode. Ship and boat patrols can both detect and apprehend violators and can be conducted in all weather where fishing takes place. Large ships can remain on scene in a location far from port for long periods, while smaller boats present a less obvious enforcement presence. Boardings at sea from such patrol ships and boats provides detailed information on catch, gear, processing, and data reporting requirements. Boardings cannot monitor the fishing operations as completely as an on-board observer, who can conduct nearly continuous monitoring, but is still regarded as a very effective technique for monitoring compliance. The principal disadvantage of boardings at sea is their high cost[1].

Air patrols are typically used to search large areas to determine the number, type, and identity of fishing vessels. As provided by the Coast Guard, air patrols range from large, long-distance, fixed wing craft, such as the C130, to helicopters flying short-distance sorties off the decks of cutters. Air patrols can detect limited types of regulatory violations. Violations of time-area closure regulations can be readily detected by air patrol surveillance; however, violations of catch limitations and gear restrictions are usually impossible to detect from the air. Of course, air patrols cannot directly apprehend suspected violators. Dockside personnel or surface vessels must be called in to board the vessel and issue the citation. Air patrols also are often limited by weather conditions. In sum, air patrols are an important complement to other enforcement modes and cannot be expected to achieve enforcement goals alone.

Onshore, or dockside, enforcement modes include monitoring landings, inspecting primary buyers (dealers/processors) and general investigation. Dockside monitoring of a vessel's landings for species, sizes, and quantities is easier and much less costly and, therefore, can be more complete than at sea. Dockside monitoring cannot reliably determine where fish were caught or what gear was actually used. Since most foreign vessels do not normally land their catch in domestic ports, dockside monitoring requires bringing the vessel to port, a time consuming and expensive process. Inspecting primary buyers of fish can be effective for detecting violations of minimum size and prohibited species regulations. Typically there are relatively few primary buyers, making this mode a low-cost means of monitoring landings. Of course, this mode is incapable of detecting violations of gear restrictions, closed areas, and individual trip or vessel quotas. According to the enforcement guidelines (NMFS[2]), investigation includes undercover operations, radio monitoring, data analysis, use of informants, and casual conversation with fishermen and primary buyers. The investigation mode is often used to detect organized and repetitive violations, and can provide information on compliance and effectiveness of an enforcement program.

There are four principal types of enforcement sanctions: Citations, violations, seizures, and permit sanctions. A citation is a written warning involving no penalty, usually issued for a technical infraction or an infraction of minor consequence. A violation is a civil penalty, issued for serious infractions and carries a maximum fine of $25,000 per day of violation. A seizure of a fishing vessel is reserved for gross, flagrant infractions of conservation or criminal laws and carries a maximum penalty of a $100,000 fine and/or 10 years imprisonment plus forfeiture of the vessel, gear, and catch. A permit sanction revokes or suspends an individual's fishing permit. Civil penalty actions resulting from violations are the most common enforcement sanction, followed by citations, seizures, and permit sanctions.

Explaining the Incidence of Violations

A framework for evaluating the costs and benefits of enforcement must be based on a sound paradigm explaining the behavior of individuals subjected to regulatory constraints. The paradigm adopted here is one commonly used in the economics literature on criminal behavior[3]. The paradigm views individuals as rational decision makers who weigh the relative gains and losses of compliance and noncompliance when subjected to regulatory constraint. That is, the decision whether to comply with the regulation is based on which alternative maximizes the individual's welfare.

The decision making environment for individual firms facing MFCMA regulations is portrayed in Figure 1, which is presented in the form of a decision tree where Y represents an affirmative response and N a negative response to the decision question in the associated pentagon. The rounded rectangles contain the economic consequences for the firm of a decision or action taken by the firm or regulatory authorities. The P's in parentheses next to the Y's and N's rep-

[1]Pallozzi, M. M., and S. C. Springer. 1985. Enforcement costs in fisheries management: The alternatives: Paper presented at the Workshop on Fisheries Law Enforcement, Univ. R. I., Oct. 1985.

[2]NMFS. 1982. Guidelines for Regional Fishery Management Councils on enforcement considerations (draft). Unpubl. memo., NMFS, Wash., D.C.

[3]Becker (1968) is widely recognized as the progenitor of this paradigm. An important elaboration of the paradigm was made by Stigler (1970). For a formal adaptation of the paradigm to fisheries law enforcement, see Sutinen and Andersen (1985).

resent the probabilities that the Y or N outcome occurs.

Starting near the top of Figure 1, we see that if a management plan for a fishery (FMP) is implemented, then regulations (R) are issued. If the firm complies with the regulations, its economic consequences are the resulting profits represented by π (comply). If the firm decides not to comply with the regulations and its violation is not detected (with probability $(1-P)$), its resulting profits are represented by π (violation). If the firm's violation is detected and the firm is prosecuted, it faces a penalty and legal fees denoted by PEN and LF, respectively. Therefore, the firm's resulting profits are of the form π (violation) $- LF - PEN$.

As can be seen from Figure 1, several outcomes are possible for the firm. This environment and the decision making paradigm for compliance are now modestly formalized in order to develop a framework for evaluating fisheries law enforcement.

To begin, I define A as an ordered n-tuple of activities, $(a_1, a_2, \ldots, a_n)$, by the fishing firm which are subject to regulation. These activities may include the date and location of fishing, the type, size, and quantity of gear used, the total quantity landed of specific species, etc. R is defined as an ordered n-tuple of regulations or regulatory constraints, $(r_1, r_2, \ldots r_n)$, imposed on the activities in A. I denote the firm's compliance with a single regulation, say r_u, by $a_u \leq r_u$, and with all regulations by $A \leq R$. That is, $A \leq R$ holds if $a_i \leq r_i$, for all $i = 1, 2, \ldots n$. Noncompliance with, or a violation of, any one or all of the regulations is denoted by $A > R$. That is, $A > R$ if $a_i > r_i$, for any $i = 1, 2, \ldots n$.

The firm's profits depend on its set of activities A, i.e., $\pi = \pi(A)$. Some or all of the regulatory constraints R are said to be binding on the firm when $\pi(A|A > R) > \pi(A|A \leq R)$. In other words, the regulations are binding when violation can bring the firm greater profits.

With a program to enforce the regulations R, penalties are imposed on those firms convicted of violating the regulations. In practice, the penalties include monetary fines, confiscation of catch, gear, and vessel, suspension and revoca-

tion of fishing permits, and imprisonment.

Of course, not all violators are convicted and penalized under the existing imperfect enforcement and adjudication system. If a firm does not comply with the regulations, it may be detected with probability P_1 or not detected with probability $(1 - P_1)$. The several remaining steps in the prosecution process are portrayed, along with the probabilities of alternative outcomes, in Figure 1. The final consequences for the firm's profits are also given in Figure 1. To simplify the notation I define π (comply) $= \pi(A|A \leq R)$ and π (viol) $= \pi(A|A \geq R)$. LF denotes the legal fees and other costs borne by the firm when dealing with enforcement authorities, where $LF_1 < LF_2 < LF_3 < LF_4 < LF_5 < LF_6$ is assumed. The penalties are as follows:

Full penalty (denoted by PEN_F)—the penalty prescribed by the penalty schedule.

Partial penalty (PEN_P)—an amount less than the full penalty.

Court penalty (PEN_c)—the penalty prescribed by the Administrative Law Court following conviction.

The behavioral paradigm assumes the decision maker for the firm decides whether to comply with the regulations by comparing the profit consequences of complying with the profit consequences of violating the regulations. Let's look at this decision in more detail. Assuming the firm is risk neutral, it makes decisions to maximize expected profits. In general, expected profits are given by the equation $E\{\pi(A)\} = \pi(A) - E\{LF(A)\} - E\{PEN(A)\}$, where the expected legal fees $E\{LF(A)\}$, and expected penalty, $E\{PEN(A)\}$, are positive if $A > R$, and zero otherwise[4]. The decision whether to comply is determined by the rule: Violate/comply as $\pi(A|A \leq R) </> E\{\pi(A|A > R)\}$. Simply stated, if the expected return from

violating a regulation is greater than the certain return of complying, then the firm will commit a violation.

The profit functions above depend on several variables (both endogenous and exogenous) which typically vary over time, such as prices, fish stock abundance and location, species composition, and weather. Such changes in conditions can clearly change the incentive to violate regulations. Hence, a given fishing firm may decide to violate a few regulations only a few times during the year, and another firm, facing different conditions, may decide to violate most regulations most of the time during the year. In addition, some firms behave differently because they hold different perceptions of the probabilities of detection and conviction. The framework here assumes decisions are based solely on the outcome for expected current profits, when, in reality, firms likely consider the stream of expected future profits and perhaps non-economic factors such as social status in the community. Therefore, we cannot expect the simple decision rule—based on comparing profits from complying with profits from violating—to apply strictly in practice. My principal point here is that in any fishery the incidence of violations will vary across the fleet (with some firms committing more violations than others) and over time (as well as across space and other dimensions). Despite these additional considerations, the incidence of violations will be influenced by the probabilities, penalties, and regulations in the same way as predicted by the simple framework developed above. Specifically, higher probabilities and penalties can be expected to increase compliance in a fishery.

The simple theoretical framework developed here is used in the next section to outline an applied model for measuring the effects of regulatory and enforcement policies on compliance in the benefits from a fishery.

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[4]For the system portrayed in Figure 1,

$$E(LF(A)) = P_1 \cdot P_2 \cdot (\sum_{i=1}^{6} w_i l_i) \ ,$$

$$E(PEN(A)) = P_1 \cdot P_2 \cdot P_3 \cdot (\sum_{j=1}^{3} p_j \cdot PEN_j) \ ,$$

where w_i is the conditional probability (given a NOVA has been issued) the ith route to final resolution occurs, l_i is the added legal fees of the last step in route i, p_j is the conditional probability (given a NOVA) the jth penalty is awarded, and PEN_j is the monetary equivalent of the jth penalty.
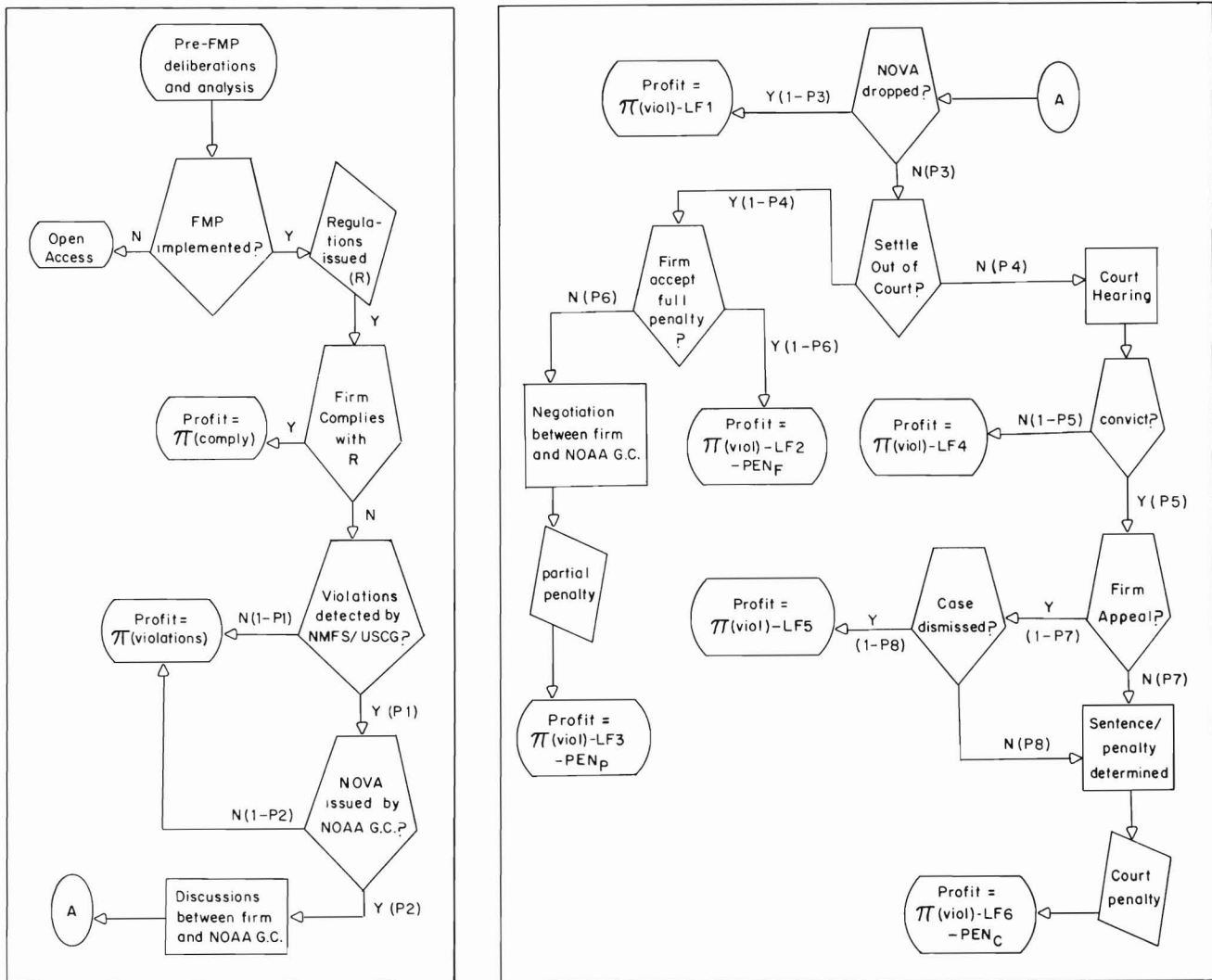
Figure 1.—The decision-making environment for firms facing MFCMA regulations and enforcement actions.

Policy, Compliance and Benefits

The policy variables which affect the violate/comply decision are of three types: 1) the regulations, R; 2) the probabilities of detection, P_1, of prosecution (i.e., successfully issuing a NOVA) given detection, $P_2 \cdot P_3$, and of conviction or settlement; and 3) the penalites, $PEN(A)$. The regulations determine the extent to which activities of firms are constrained. The more constrained, the more likely firms will commit violations, other things constant.

The probabilities affect the magnitude of expected penalties and legal fees—the higher these probabilities, the higher the expected penalties and legal fees, and the less incentive to commit violations. The probability of detection is produced by inputs of sea and air patrols, observers, inspectors, and investigators (provided by the Coast Guard and National Marine Fisheries Service). Assuming efficient deployment, more of these inputs produces higher probabilities of detection. The probability of prosecution, given detection, is produced by the personnel who obtain the evidence and prepare the notices of violation (i.e., the field enforce-

ment agents of NMFS and NOAA attorneys). The greater the quantity and quality of these personnel, the greater is this probability. The probability of conviction or settlement not only is enhanced by the greater quality and quantity of the NOAA attorneys, but is also mitigated by input of the defendant's attorney.

The magnitude of the penalties prescribed directly affects the magnitude of the expected penalty for a given violation. Other things constant, the more severe the penalties are, the more compliance there is with the regulations. The length of the time span from violation to collection of the penalty also is impor-
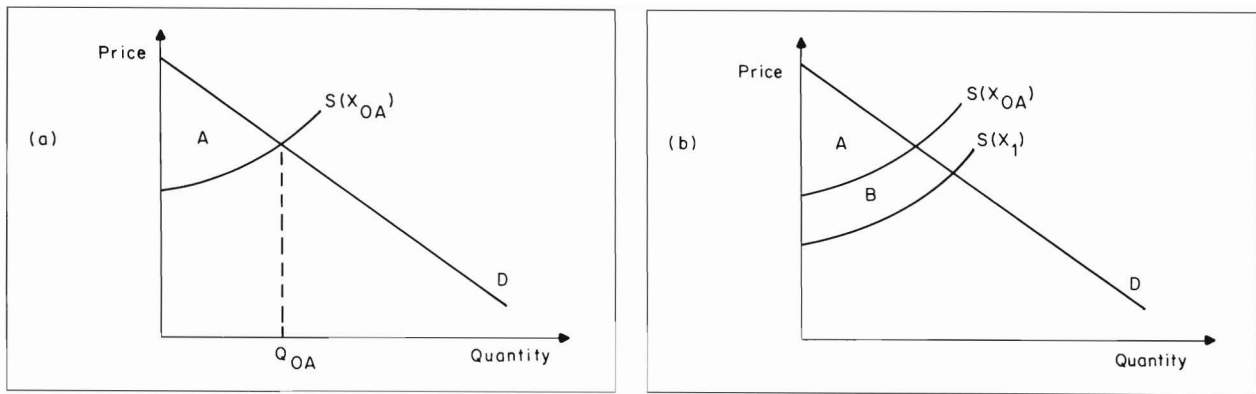
Figure 2.—Benefits from enforcement.

Year	Collections ($\times 10^6$)	Year	Collections ($\times 10^6$)
1977	$7.1	1982	$33.4
1978	8.8	1983	41.3
1979	10.8	1984	42.9
1980	16.7	1985	41.5
1981	24.1		

tant. It is the discounted value of the monetary value of the penalty that influences the decision whether to comply. Therefore, the greater the time span, which has been years in some cases, the smaller the expected value of the penalty and the greater the incentive to violate.

The potential economic benefits to the country from MFCMA regulations and their enforcement consist of four types of benefits: 1) Counsumers' surplus, the benefits from consuming fish; 2) producers' surplus, the benefits from the commercial harvesting, processing, and sale of fish; 3) recreational benefits to anglers; and 4) Federal government revenue, the poundage fees paid by foreign fishing fleets.

We have no estimates of the first three types of benefits—consumers' and producers' surplus and recreational benefits (and I will not derive these estimates, since this is beyond the scope of this paper). The amount of government revenue from foreign fishing fees since 1977 is shown in Table 1.

Even if we had a reliable estimate of total benefits, it would have limited sig-nificance. The estimate, combined with a cost estimate, would tell us whether the nation as a whole is better off, in economic terms, under the Act. While important, the estimate would not neces-sarily suggest areas for policy improve-ments which would yield increased bene-fits. In this section I describe a framework for assessing the current en-forcement system and for identifying areas of beneficial change.

Development of the framework begins with a somewhat heuristic model show-ing how regulatory and enforcement policies are functionally related to the benefits generated from fisheries man-agement. This development is supple-mented with discussions of methods for obtaining empirical estimates of the func-tional relationships which comprise the model. Let me deal only with the case of a fishery in the FCZ exploited solely by domestic commercial fishing vessels. The measure of total benefits in this case is the sum of producers' and consumers' surplus derived from the fishery.

As indicated above, the principal regu-lations implemented under the MFCMA have been total quotas, time-area clo-sures, and gear restrictions. If effectively implemented, each of these measures would ultimately result in a larger stock size on average than would otherwise occur in an unregulated, open-access fishery.

This eventual increase in stock size generates added consumers' and produc-ers' surplus, as shown in Figure 2. Area A in Figure 2 represents the annual flow of benefits under open access, where D is the demand curve, $S(X)$ is the stock-constant supply curve (Sutinen[5]), and X_{OA} and Q_{OA} are the open-access stock size and catch, respectively. Assuming regulation does not radically alter the stock-constant supply curve, a larger stock size, X_1, results in a lower $S(X)$ and added benefits equal to area B in panel (b) of Figure 2.

The effectiveness of enforcement pol-icy affects the extent to which the stock increases in the long run and $S(X)$ shifts down for a given regulation. Obviously, if the expected penalty is zero, the stock-constant supply curve will remain at $S(X_{OA})$. At the other extreme, if the ex-pected penalty is sufficiently high to dis-suade anyone from violating a regula-tion, then the stock-constant supply curve would ultimately shift down to $S(X_T)$, where X_T is the target stock size resulting from complete compliance. (That the shape of $S(X)$ will change as regulations are enforced is ignored here.) Between these two extremes there is a direct relationship between the expected penalty and the long-run flow of benefits. That is, the larger the expected penalty, the fewer the violations, the larger the average stock size, and the greater the long-run flow of benefits from the fish-ery.

Therefore, if we had empirical esti-mates of the following quantitative rela-

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[5]Sutinen, J. G. 1985. Notes on open access ex-ploitation of a simple fishery. Mimeo. rep., unpubl.

tionships, we could compute the change in benefits due to changes in enforcement policy variables:

Dependent variables	Independent variables
1) Probabilities of detection, prosecution, conviction	Enforcement inputs (sea and air patrols, etc.)
2) Violation incidence by regulation	Probabilities and penalties
3) Fish stock size	Violation incidences
4) Benefits	Fish stock size

With these quantitive relationships we can predict the effects of, say, an increase in sea patrols on the probability of detection, the incidence of violations, the stock size, and on benefits. With similar estimates of marginal benefits for all such enforcement policy variables, combined with estimates of marginal costs, we can identify areas where increases and/or decreases in enforcement inputs would be appropriate.

Blewett, et al.[6] pioneered the estimation of relationships 1) and 2). They conducted surveys to obtain fishermen's perceptions of the various probabilities, penalties, and violation rates for selected regulations. Some of their findings are worth noting. In most cases (i.e., violation type and fishery) the probabilities of detection were less than 0.1, and the probabilities of prosecution, given detection, and of conviction, given prosecution, were each about 0.8. These separate conditional probabilities resulted in typical overall probabilities of conviction in the neighborhood of 0.06. With such low probabilities, it is not surprising that they also found the expected illegal gain exceeded the expected penalty in most cases. Their study also includes Ordinary Least Squares estimates of 2) for several cases, estimates which strongly support the basic paradigm described above.

No estimates of 3) and 4) were made by Blewett, et al.[6]. Still, their results proved useful for identifying weaknesses in the enforcement system and for guiding the reallocation of enforcement resources.

No such surveys have yet been completed on fisheries enforcement in the United States. The best available information pertaining to functional relationships 1) - 4) is contained in Frailey and Taylor[7]. Using case data from 1984 and 1985, they estimated the probability of prosecution given detection = 0.9, the probability of assessment (or conviction, in my terminology) = 0.95, the probability of collection given assessment = 0.85 for settled cases and = 0.50 for contested cases. Since reliable estimates of illegal gains and probabilities of detection are not available, they calculated the penalties necessary to deter violations for selected combinations of illegal gains and probabilities of detection. Table 2 presents some of their results. The penalties required for effective deterrence are lower in contested cases since legal fees are assumed to be higher than in settled cases. The most striking result of Frailey and Taylor[7] is that most of the required penalty amounts are many times greater than the $25,000 maximum monetary penalty allowed by the MFCMA. This analysis has prompted the NOAA General Counsel's Office to search for novel ways of increasing the expected penalty violators face. One way now being used with greater frequency is the permit suspension or revocation.

Frailey and Taylor[7] argued that "the permit sanction . . . can have an economic impact greater than the maximum monetary penalty we can assess under the statute." Unfortunately, fishing permits are not widely required in the fisheries regulated under the MFCMA.

The conclusion of this section should be clear. We know what information we need to assess fisheries enforcement policy and its effect on compliance and benefits, and we have methodologies for producing this information. But we do not have this information and we cannot yet say how well the Federal fisheries enforcement system is performing.

Enforcement Costs

In this section I attempt to examine the

Table 2.—Required penalty assessments ($1,000) as calculated by Frailey and Taylor (text footnote 7).

Illegal gain	Probability of detection	
	0.02	0.1
Settled case		
1	166	31
5	833	156
10	1666	312
15	2500	468
Contested case		
1	164	27
5	830	149
10	1664	300
15	2500	452

Table 3.—Federal expenditures on fisheries law enforcement (millions of dollars).[1]

FY	USCG	NMFS	Total
1975	$30.1[2]	$2.1	$32.2
1976	43.0[2]	2.3	45.3
------- MFCMA enacted -------			
1977	99.3	3.3	102.6
1978	87.7	4.1	91.8
1979	72.5	4.2	76.7
1980	52.4	5.2	57.6
1981	83.8	6.4	90.2
1982	86.8	6.8	93.6
1983	108.0	7.2	115.2
1984	105.3	7.6	112.9
1985	129.7	7.6	137.3

[1]Sources: Bell, F.W., and R. Surdi. 1979. An economic benefit-cost analysis of the Fishery Conservation and Management Act of 1976. Econ. Dep., Fla. State Univ., mimeo. rep.; Chapell, W. [Lt.] 1983. Personal commun.; and Peterson (1982), data for 1975-79. The U.S. Coast Guard and National Marine Fisheries Service provided data for 1983-85.
[2]Operating costs only.

nature and magnitude of the costs of enforcing regulations under the MFCMA. The Act designates two Federal agencies to carry out enforcement of regulations: The National Marine Fisheries Service and the U.S. Coast Guard. The enforcement duties of these two agencies are primarily devoted to detecting violations of Fishery Management Plans and Preliminary Management Plans, with the Coast Guard conducting most of its surveillance at sea and NMFS acting onshore at dockside. The costs of their enforcement programs will be examined. Table 3 shows expenditures on fisheries law enforcement by the Coast Guard and NMFS since FY 1975. Prior to FY 1977, expenditures were entirely for enforcement of

[6]Blewett, E., W. Furlong, and P. Toews. 1985. Canada's experience in measuring the deterrent effect of fisheries law enforcement. Paper presented at the Workshop on Fisheries Law Enforcement, Univ. R.I., Oct. 1985.

[7]Frailey, M. H., and R. A. Taylor. 1986. Rationalizing sanctions for fisheries violations. Paper presented at the Conference on East Coast Fisheries Law and Policy, Univ. S. Maine, 18 June 1986.

other marine resource-related laws (e.g., the Marine Mammal Protection Act of 1972). The greatest expenditures are by the Coast Guard, reflecting the relatively high cost of air and sea patrols.

Individual states cooperate with NMFS to enforce the MFCMA, and their costs should be recognized. However, no data exist on the cost of states' contribution to the Act's enforcement. NOAA's General Counsel Office and the Administrative Law Court of the Department of Commerce prosecute the cases of violations of the Act. The expenditures of these two offices are small relative to the costs of the NMFS and Coast Guard programs and will not be examined.

In addition to government expenditures on enforcement, a complete discussion must examine the cost to the private sector of enforcement of the Act's regulations. While no data exist, an estimate is made of these costs.

Coast Guard Expenditures

By far the greatest expenditures on Federal fisheries law enforcement are by the Coast Guard, exceeding $100 million annually in recent years. The Coast Guard has several missions or programs. Enforcement of fisheries regulations under the MFCMA is included in the Enforcement of Laws and Treaties (ELT) program. Other programs include Search and Rescue, Drug Enforcement, Commercial Vessel Safety, Aid to Navigation, and Ice Breaking.

Table 4 presents a breakdown of the Coast Guard's expenditures on the ELT program for FY 1985. In addition to the MFCMA, the ELT program is concerned with enforcing the Marine Mammal Protection Act, the Lacey Act, and various fisheries treaties. The Coast Guard estimates that about 90 percent of its ELT program effort is devoted to enforcement of the MFCMA. Table 5 presents these estimates of expenditures for enforcing the MFCMA.

There are three major categories of expenditures by the Coast Guard: Operating Units, Direct Support, and Indirect Support. The expenditures on operating units include fuel, salaries, etc., for the vessels, aircraft, and shore facilities according to the amount of time each unit

devoted to ELT during the year. These expenditures do not include amortized amounts for the acquisition (or replacement) cost of the vessels, aircraft, or other capital items. Direct support expenditures include district staff units, bases which provide repairs and maintenance, health care, and general administrative support. These amounts are provided by the head of each facility, who estimates the percent the facility's effort was directed to ELT matters. Indirect support expenditures include recruit training, public affairs, and alcohol rehabilitation programs. Again, percentage estimates of the extent to which each of these support activities contribute to the ELT program are used to calculate the resultant expenditures.

The estimated expenditures by the Coast Guard on MFCMA enforcement totaled about $117 million for fiscal 1985. Of this total, 61 percent was spent on operating units, 12 percent on direct support, and 27 percent on indirect support. I question whether indirect support expenditures should be a part of this total. Many of the indirect support activities appear to jointly serve all Coast Guard programs and are independent of the size and nature of any one program (e.g., MFCMA enforcement). To the extent this holds, changes in MFCMA enforcement activities do not affect indirect support expenditures. Therefore, these are not additional expenditures due to the

existence of MFCMA enforcement. If this argument is valid, then expenditures total $85 million for fiscal 1985, instead of $117 million.

Just over two-thirds of the expenditures are attributed to enforcing MFCMA regulations on foreign fishing vessels ($80 million including indirect support, $58 million not including indirect support). Most of these expenditures were incurred patrolling the Bering Sea in the Alaska region.

The expenditures on domestic fisheries enforcement ($37 million or $27 million) were for the 25 FMP's in place during the year. A breakdown by region is not available.

Tables 4 and 5 include no expenditures or charges for the acquisition of the ships, boats, and aircraft used in fisheries enforcement. In cases where a craft is purchased and exclusively used for fisheries enforcement, then its capital cost should be amortized over time. In most cases, however, such craft serve several programs which leaves the problem of how to assign the capital cost to individual programs. The Coast Guard has chosen to assign none of these costs to fisheries enforcement. Therefore, the expenditures figures underestimate the costs of fisheries enforcement. The extent of this bias is not known at this time.

To what extent do the Coast Guard's expenditures represent costs to society? Unfortunately, the answer to this impor-

Table 4.—U.S. Coast Guard expenditures on enforcement of laws and treaties program, FY 1985 (millions of dollars).

Category	Foreign	Domestic	Totals
Operating units			
Vessels	$33.8	$13.3	$47.1
Aircraft	12.8	9.1	21.9
Shore facilities	7.8	2.1	9.9
Subtotal	$54.4	$24.5	$78.9
Direct support			
Administration	$2.0	$0.9	$2.9
Other	8.5	4.2	12.7
Subtotal	$10.5	$5.1	$15.6
Totals	$64.9	$29.6	$94.5
Indirect support	$23.9	$11.3	$35.2
Grand total	$88.8	$40.9	$129.7

Table 5.—Estimated Coast Guard expenditures on enforcement of MFCMA, FY 1985 (millions of dollars).

Category	Foreign	Domestic	Totals
Operating units			
Vessels			
Aircraft			
Shore facilities			
Subtotal	$49.0	$22.0	$71.0
Direct support			
Administration			
Other			
Subtotal	$9.4	$4.6	$14.0
Totals	$58.4	$26.6	$85.0
Indirect support	$21.5	$10.2	$31.7
Grand total	$79.9	$36.8	$116.7

tant question is ambiguous. For these expenditures to represent social costs, the following conditions must hold: 1) Fisheries enforcement is not a joint product of the Coast Guard, and 2) Coast Guard resources are allocated efficiently. A casual examination of the Coast Guard's enforcement operations suggests these conditions do not commonly hold. Therefore, we cannot say whether the above expenditures are roughly equivalent to social costs, or what direction the expenditure data may be biased.

Other Federal Expenditures

The expenditures on fisheries enforcement by other Federal agencies are small in comparison with those of the Coast Guard. The NMFS Enforcement Division spends about $7 million per year on the MFCMA, and the NOAA General Counsel Office and DOC's Administrative Law Court spend about $1.0 million annually.

Private Sector Costs

The regulation of industry has been shown to impose significant costs on the operations of business firms. Weidenbaum (1981) found for every dollar appropriated to operate Federal regulatory agencies there was an additional $20 of costs incurred by business to comply with the regulations. To my knowledge, the costs to the fishing industry of MFCMA regulations have not been estimated, but if the evidence from other regulation is any guide, these costs may be large indeed. The costs of complying with MFCMA regulations may include gear modifications and greater search costs, for example.

If detected of violating a regulation, the fishing firm may hire legal counsel and may have to take time off from fish-

ing and lose income in order to deal with the NOVA against it. All such costs are social costs and should be accounted for in an evaluation of fisheries regulation and enforcement. The costs of fines, however, are merely transfers from the offender to the taxpayers and should not be included in an accounting of social costs.

How large might these defense-related costs be? Recent experience suggests about 300 NOVA's are issued annually to domestic fishermen for violating MFCMA violations. Let me assume that 1) the fees for legal counsel average $2,500 per NOVA, and 2) the income lost due to lost fishing time also averages $2,500. Under these assumptions, the added cost to the private sector of fisheries enforcement currently amounts to $1.5 million annually, or about 5 percent of what the Coast Guard spent on domestic MFCMA enforcement in 1985.

What can we conclude about the social costs of enforcing MFCMA regulations? First, the data are rough and incomplete. Second, the available data suggest these costs are significantly large. And third, the data have limited usefulness. As shown in the previous section, we currently have no measures of compliance, the principal product of enforcement, so we cannot assess the cost-effectiveness of the system. To answer a number of interesting policy issues we would need the functional relationships between the costs of various combinations of enforcement inputs and the probabilities of detection those inputs produce. Such relationships would, among other things, help guide improvements in the cost effectiveness of the enforcement system.

Conclusions

This paper has shown that only a few elements of a comprehensive cost-benefit

analysis of MFCMA enforcement are currently available. The measures of aggregates costs, while not without problems, are relatively complete. Only one of the four types of benefits, foreign fees, is available. The functional relationships needed to support cost-benefit analyses of policy alternatives are not available. These will require additional data collection and extensive analysis and, therefore, are not likely to become available in the immediate future.

The available data do allow a partial cost-benefit analysis of enforcement efforts directed at foreign fishing operations. The Coast Guard's costs for enforcement related to foreign fishing activity totaled $80 million in FY 1985. Foreign fees collected totaled $41.5 million. Unless there are nearly $40 million of additional associated benefits to U.S. producers and consumers from foreign fishing in U.S. waters, these figures suggest the poundage fees for foreign fleets are too low, or there is too much enforcement devoted to foreign operations, or perhaps both. At the least, the formula used to compute foreign fee rates ought to be restructured to recover no less than the true costs of carrying out provisions of the MFCMA that pertain to foreign fishing.

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