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Economic and Technological Implications of Application of Effort Limitations

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I. Elasticity of Effort Put Into Perspective

Under the "total effort" management regime, a rational allocation of effort can be made on the basis of past recorded performance of vessels or classes of vessels, modified, perhaps by other factors, but resulting in a country-by-country apportionment of fishing days by vessel class.

The problem that is posed is that once allocations are established, it would be possible for vessels of a particular fleet or country to increase the effectiveness of its allotted fishing days thus increasing the fishing mortality for the same apparent effort. It has also been suggested that this elasticity of fishing effort could be the result of a number of factors such as time distribution of effort within and among species, changes in vessel and crew combinations, use of the most productive techniques and technology, changes in working conditions, increases in the number of hours per day spent fishing, use of more extensive search methods, better communication, and of support vessels, etc.

Along this line it has been noted during discussions on effort limitation that there is a wide range of performance, as measured in catch per day or catch per trip, even within a group of essentially identical (single class) vessels. Certain vessels consistently appear as "High Liners" while others appear at the lower end of the scale. This situation seems to be primarily a function of the knowledge, skill, and motivation of the individual vessel captain and key members of his crew. This being the situation, it would appear a logical management practice for a fleet operator to send only his most effective, efficient fishing vessel captain, crew, and equipment combinations into an area where an effort limitation management regime is in effect. This then would result in increased fishing mortality over that calculated, based on vessel performance before establishment of the effort regime.

For purpose of illustration we use a hypothetical (but typical) case where the catch profile of a particular class or fleet of vessels is a poisson frequency distribution. This is illustrated in figure 1. In this example the catch/day of 1580 vessels ranges from 1 to 49 tons per day; the average catch is 19.1 tons/day. In this situation removal of 158=(10%) vessels at the low end of the scale would result in loss of only 3.5% of the daily catch. Removal of (30%) of 474 vessels at the low end of the scale results in a loss of 15.05% of daily catch.

The point of the example is that the removal of the vessels at the low end of the curve from a fleet fishing a particular area would not greatly affect the total removal of fish by that fleet, and the increase in average catch/day is much less than a direct proportion to the reduction of vessels. The bulk of the fish is taken by the "high liners" and the large number of vessels near the center section of the curve.

A significant shift of the entire curve to the right, i.e., increase of productivity by all (or the average of all) vessels would be necessary to significantly increase fishing mortality.

Hypothetical Poisson-type Distribution of Catch/Day of 1580-vessel Fleet

$N = 1580$ $\Sigma x_i f_i = 30{,}194$ $\bar{x} = 19.1$ tons/day

30% of vessels, i.e. 474 vessels took 4547 tons = 15.05% of total
10% of vessels, 158 vessels took 1073 tons = 3.5% of total
48% of vessels, 774 vessels took 9058 tons = 30.0% of total

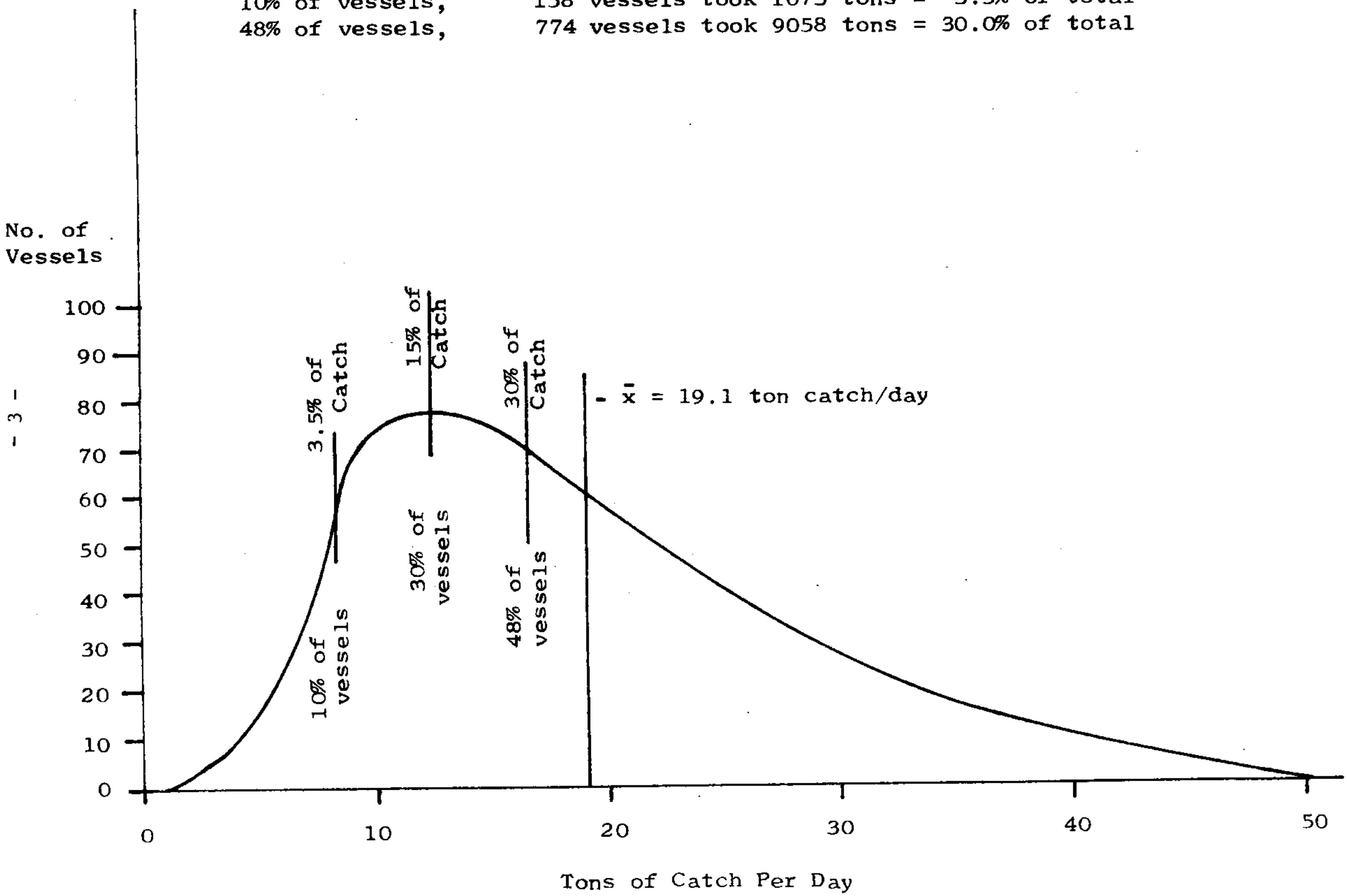

Figure 1

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It is useful to evaluate the question of the degree of elasticity of effort within the context of present-day practices in ICNAF Subareas 5 and 6*. European vessels fishing the North Atlantic do so only after traveling some distance at considerable expense. These expenses of conducting fishing operations and the necessity to return good catches weigh against any tendency for half-hearted or less than energetic fishing operations on the part of any country. Fishing captains and crews are under pressure to maximize catch and productive use of resources available, whether they be manpower, expendables (fuel-food, etc.) or capital equipment. Accordingly it can be assumed that fleets are always attempting to operate at the highest level of long-range efficiency under the various constraints such as personnel management practices, union or other labor agreements, human endurance, machinery capacity, weather, electronic capability, and others.

Because most of the fleets have been fishing for a number of years, they are most likely currently operating near their maximum long-range sustainable efficiency and the possibilities for increasing the catch per standard day fished through efficiency increases is limited and minimal. Barring any significant technological change which should be reported and quantified, the level of effort expended in recent years (with the associated fishing mortality) would probably provide a valid basis for regulating and allocating effort in coming years.

A review of the rate of technological change on vessels during the "life of ICNAF" is useful.

a. Conversion to synthetic net material - nylon (poly amide), dacron (acrylics), kuralon (poly-vinyl alcohol), polyethylenes polypropylene (ulstron courlene) - was first possible in the late 1940s to early 1950s. In mid-1950s (1953-54-55) nylon netting was available and began to be used extensively in small purse seines, gill nets and "stop" seines. Conversion from natural to synthetic fibers proceeded from introduction in the early 50s to essentially complete conversion with attendant increases in efficiency by 1963-65- a period of 13+ years.

b. The first stern ramp factory trawler was the Fairtry (I), a relatively small (280+ foot) transport converted in the UK (Prior to 1954) for extended operation in arctic waters. Based upon successful trials of this vessel the Fairtrys II and III were built in subsequent years.

Also based upon reported operations of the Fairtry I the U. S. S. R. started a program of factory stern trawler construction and development.

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*For convenience ICNAF Subarea 5 and Statistical Area 6 are referred to as Subareas 5 and 6

The Pushkin class stern trawlers, were similar to the Fairtry I. Forty-two of these were built in the Federal Republic of Germany during the period 1954-1956. These were followed by the Mayakovskip class in 1958+. Dalmor class in 1959-1962, Kasmos class 1963+. Tropic class 1962-1966 and the Atlantic I II and III group 1966-1968+.

Similar more-or-less parallel development of stern trawlers proceeded in other countries during the 1950s and 1960s. Thus the development and deployment of stern trawlers and factory ships occured over a period of not less than 15 years. The entire process was followed, analyzed and reported in great detail by trade publications, particularly World Fishing and Fishing News International. There was no reason for any country or organization to be "taken unaware" of the developing fishing power represented by development and construction of these new types of trawlers.

c. The tuna "Purse Seine Revolution" started with introduction of the power block and nylon seines in the mid-1950s (54-55). Conversion of bait boats was in rapid progress in 1958 and by 1960 construction of new large tuna purse seiners had begun. The "revolution" and expansion of the American tuna fishery progressed, and again was reported in detail in trade journals and other publications over a period of not less than 8 years.

d. Pelagic trawl experimentation was underway as early as 1952 with successful application and substantial deployment of vessels in the second half of the 1960s.

It would appear to us that "quantum jumps" in fishing technology have not occurred "overnight" or generally in a period shorter than 5 years. Thus it seems reasonable to conclude that unanticipated significant advances will likely not occur undetected without ample opportunity for evaluation. Development of new harvesting systems and new fishing vessels inevitably involve extensive evaluation and practical testing at sea, operations which are observable. In the event that such development results in an apparent increase in CPUE a reassessment of fishing efficiency and recalibration of fishing systems on a periodic basis would detect it with sufficient time for adjustment. Entry of a new class of vessels to a fishery (or into an area) would be contingent upon an objective evaluation of the fishing power represented, prior to such entry. A fishing effort assessment group might be assigned to monitor fishing technology and progressive improvement in vessel efficiency under a total effort management regime.

II. Effect on and of Technological Change

Every nation or company harvesting fish in the Convention Area is interested in maximizing output, i. e. catch, with its capital and labor inputs. Each will seek the best combinations of these inputs in pursuit of its particular objectives. Any technological innovation which will contribute more to the total value of the output than it contributes to the total cost (including social and economic costs) of producing the final output will be adopted.

III. Economic Effects

If we accept the idea that the elasticity factor in effort measurement is limited, then it should be possible to identify this range in elasticity for any given level of fixed effort (f) under any stock or biomass condition Theoretically this range can be shown by the area bounded by the two curves labeled MAXE and MINE in figure 2.

MAXE refers to the most efficient short-term yield function facing a fishing fleet manager at a given point in time on a given resource stock. It is most efficient in that it represents the most efficient combination of production factors (labor and capital) to harvest a given yield at each level of effort, (f). The MINE function is similar except it represents all points of the least efficient combinations for achieving various yields with various quantities of f.

For illustration purposes, let us assume that a given fleet is harvesting P level of yield (see figure 2) using f_5 amount of effort. That fleet could be more efficient and harvest P level of yield with f_4. It could also be less efficient and harvest P with f_6 effort.

Now let us suppose that a limitation equivalent to yield N is established. If this were done by catch quota the tendency, at least initially, would be to keep f_5 amount of effort in the area for at least three reasons: first, in hopes that conditions will improve and that it could be diverted to other species for which no quotas are set or for which quotas will be increased; second, because of a lack in immediate diversion opportunities outside the area; and third, because of potential political and/or management problems associated with tying up vessels. However, this level of effort is even more inefficient than point f_3, the point on the MINE equivalent to yield N and would cause severe problems of adjustment. If the limitation were set by effort quota, it would probably be set at approximately f_2, the efficiency before the limitation.

Two points can be made now about the consequences of suing the effort quota as opposed to the catch quota.

1. The catch quota tends to encourage more inefficiency than existed before the regulation. The effort quota, on the other hand, at least permits maintenance of the same level of efficiency that existed before the

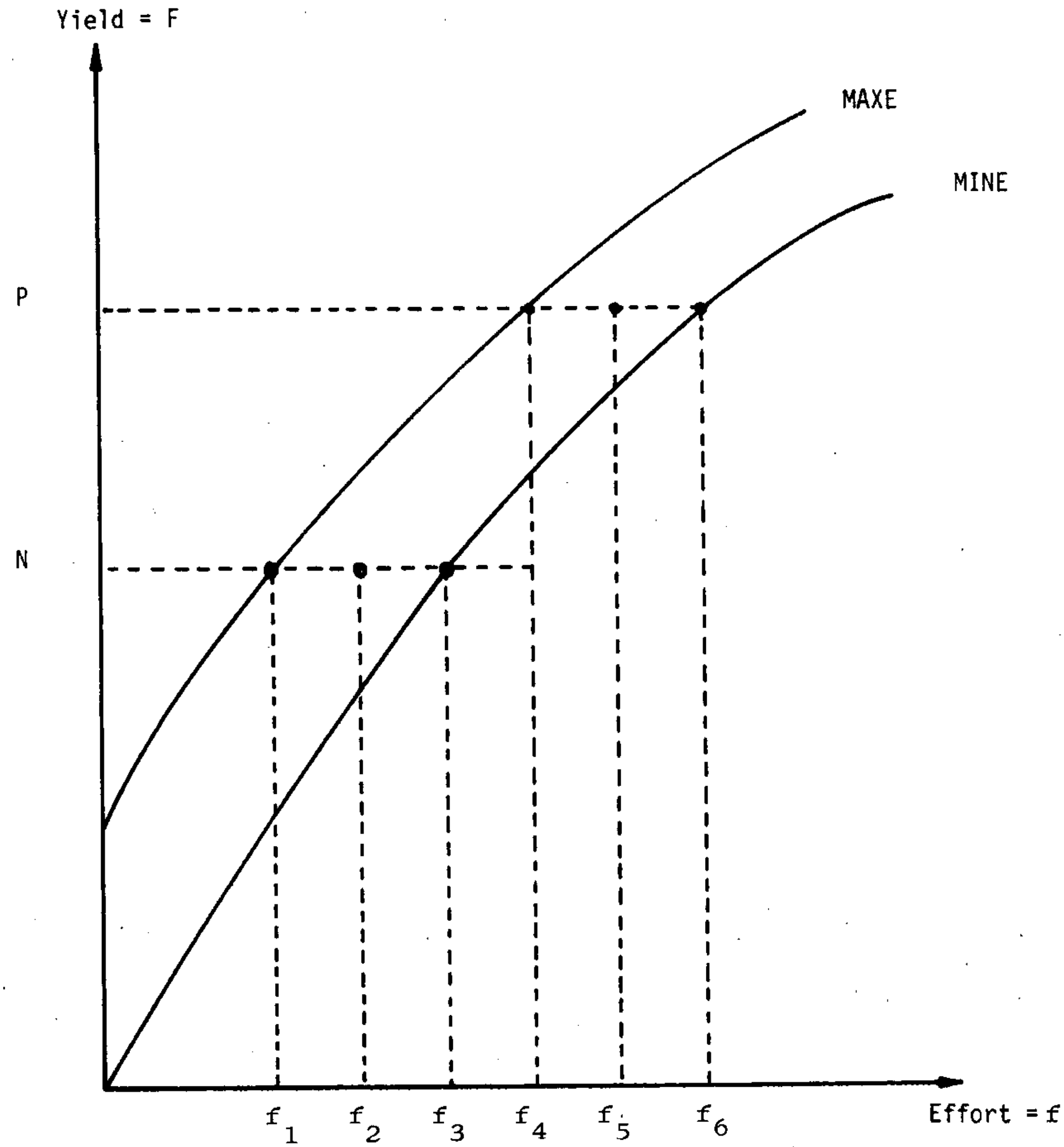

Figure 2

regulation and preserves the option for the manager to become even more efficient (either by further reducing his effort to f_1 or by increasing his catch beyond N to the extent possible within the elasticities of his allotted effort, f_2).

2. The mere presence of redundant effort which would probably exist under the catch quota system, would tend to encourage the fleet manager to seek ways to circumvent his quota restrictions and increase the catch of his fleet (legally or illegally). The effort quota system, on the other hand, would discourage the maintenance of redundant capacity in the area.

There is at least one further important implication of the total effort quota system over the total catch system: the effects on economics and conservation of overestimating the permissible fishing mortality are more serious when the limitation is expressed in terms of catch as opposed to effort quotas.

This can be demonstrated in figure 3 which charts a manager's short-term yield function in three time periods, T1, T2, and T3. Assume that M, the catch quota, is an overestimate of sustainable yield, and that the taking of M will lead to reductions in the biomass. Assume further that M is harvested with f_1 units of effort in time period 1 (T1). Because of the excessive level of catch, the biomass will deteriorate so that in period 2 the yield function will be shown by T2. To harvest the catch quota, M, in period 2, the manager will have to increase his effort to f_2. If he does, this will result in a further deterioration in the condition of the biomass, leading to an even further increase in effort in time period 3 and so on. This all means that the catch per unit of effort deteriorates, adding to the economic waste being generated by the system. In the face of increasing demand for fish, this situation could easily result in an eventual collapse of the fishery. If, on the other hand, an excess effort quota were set a f_2 in time period 1, instead of a catch quota, then the system would stabilize at some level of yield lower than M, such as K. This would be lower than the substainable yield and catch per unit of effort would deteriorate to some level lower than in period 1 but it would deteriorate no furtner, even in the face of increasing demand.

IV. Impact of the Alternative Schemes for Diversion of Effort

Regardless of the scheme for reducing mortality, the normal result, if effective, should be some reduction in effort (unless the fleet manager decides to become less efficient). This reduction obviously leads to either retiring vessels from the fleet or diverting effort to other areas or stocks. We see no reason why regulations to control mortality in one

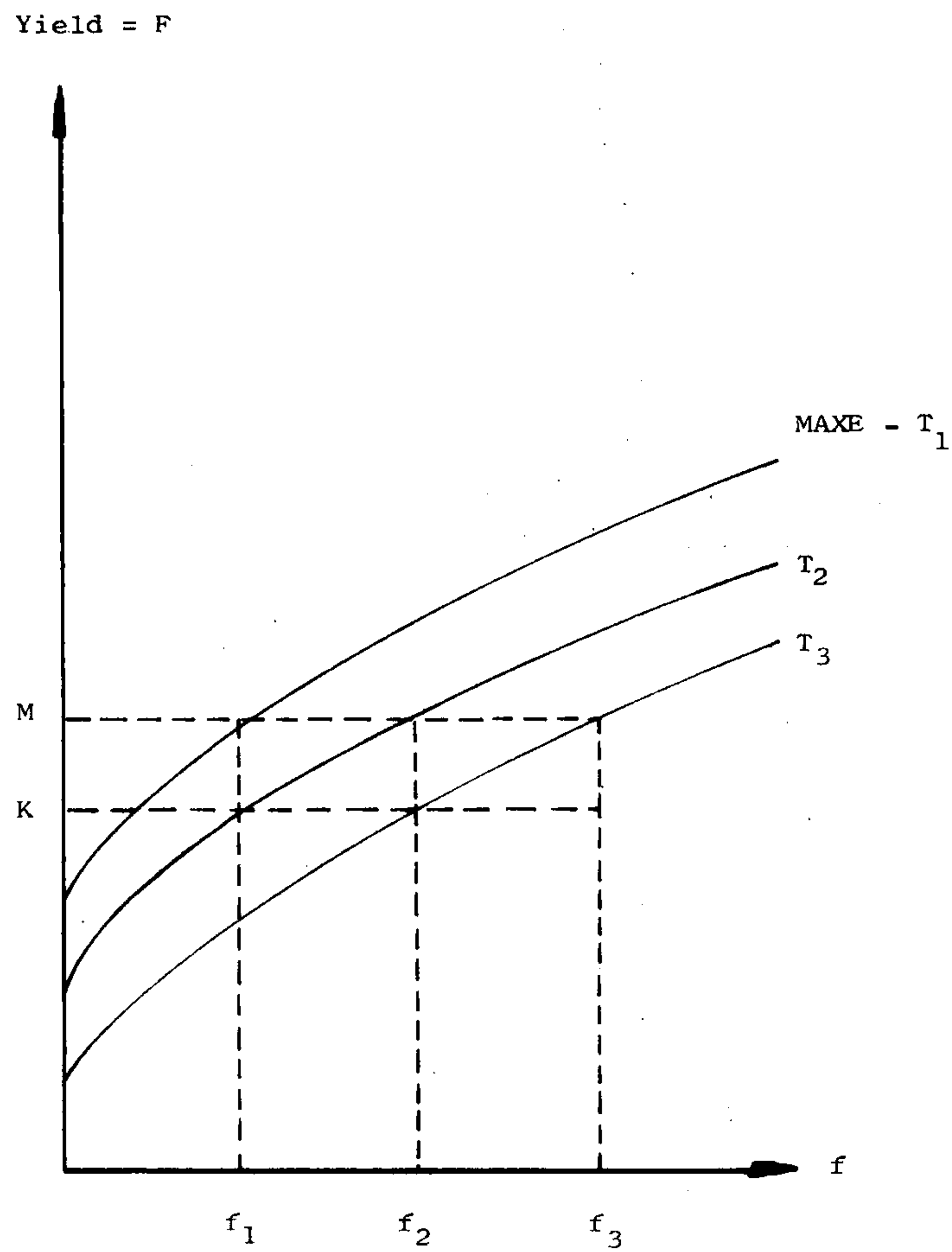

Figure 3

area should not be effected simply because they pose the threat of effort diversion to other areas. All of this simply points to the serious need to rapidly begin to adjust effort to the capability of the resource in all fisheries and areas. We must begin somewhere.

In the face of any kind of limitation, whether in the form of catch or effort quotas, any particular country may find that it has too many vessels because of the limitation. As a result, it will be faced with a decision relative to the deployment of its fleet, maintenance of its fleet, and a whole host of decisions related to maintenance and improvement in fleet and vessel efficiency. But the important point to be made is that these decisions are not unique to a total effort limitation regime.

V. Evaluation of Various Units of Control

1. Days on Grounds

Use of the standard trawler-days on grounds as a control of fishing effort has several distinct advantages:

(a) Vessels can be observed and monitored so that accurate, easily verifiable records can be kept of fishing vessel activities.

(b) Competing vessels of the various competing nations can see for themselves how many vessels are on the ground at a particular time, thus alleviating one factor that might lead to some suspicion.

(c) A vessel or fleet operator has freedom to operate within his own constraints within the allotted time on ground.

One of the primary objections raised in opposition to regulation of fishing effort by means of limiting "days on grounds" was that days on grounds do not equal or necessarily indicate the number of days actually engaged in fishing. This, of course, is based on the fact that some time is lost to weather, in traveling, for gear and machinery repairs, in searching and scouting for fish schools and concentrations, in waiting for fish to move to fishable locations, etc. Also, a vessel captain may elect not to fish for his own reasons (give the crew rest) or to fish only a part of the day; e. g., daylight hours, and some time is required for fleet vessels to offload to motherships and to take on fuel and supplies.

2. Days Fished

"Days on grounds" is not as accurate a measure of effective mortality as in days fished. It is preferable to use the most accurate measure possible to achieve a precise level of F. However, effective control of F also depends on the efficiency of administration and enforcement. This will be increased by using days on grounds rather than a more precise measure of mortality. **A 11**

The goal must be to balance these two factors to optimize achievement of the goal. It is obvious that a number of modifications can be made in a vessel's activity which will affect the efficiency of its operations thus varying the amount of mortality it contributes to the total. However, even in the face of such objections to days on grounds, we feel that the enforcement problem with days fishing regulation is too great for us to ignore and must not reject the concept of days on grounds regulation without a good alternative.

3. Possible Adjustments of Days on Ground v. Days Fishing

It should be possible to identify and enumerate many of the days on grounds lost to certain types of operations. These would include:

1. Loading fish to and resupplying from motherships.
2. Direct travel to and from grounds.
3. The number of days per season for particular size class vessel lost due to severe weather.
4. Time logically allowed for gear repairs and rigging.
5. Trips made to local ports.

It is suggested that an appropriate and quite accurate percentage, by vessel class, of the days-on-grounds can be allotted to the non-fishing type activities such as those noted in 1-5 above. These might be expected to approximate something on the order of 25 percent; all other days; 75 percent, would then be counted as fishing days. Whatever the percentage used, days fished should be directly proportional days on grounds. Support vessels such as motherships, oil transports, tugs, protection vessel, hospital ships, etc. that are demonstrably not capable of fishing would, of course, be allowed on the grounds with no charge against fishing days allotments.

It seems logical and just to presume that all fishing vessels on fishing grounds are there for the purpose of harvesting fish. If there is objection to this premise, it would appear incumbent upon the operating fleet or nation to explain for what purpose a non-fishing, fishing vessel is upon fishing grounds.

To provide additional opportunity for some distant-water fleets to use days on grounds as a variable in their operations, certain areas could be identified as lay-over locations. Vessels could then extend the number of days spent in the area of interest by remaining in these areas. Thus, the enforcement problems inherent in the days fishing measures can be minimized and still allow for time legitimately lost and for time spent not actually fishing for strictly management purposes.