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Investigating Territorial Use Rights among Fishermen

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Although social research methods used in both inland and coastal zones are quite similar, certain characteristics of coastal geography and marine resources pose special problems. Perhaps foremost is that it is no simple matter to visit harvesting sites. In contrast to visiting a farm or factory, going on a fishing trip is time-consuming, both in terms of making the arrangements and making the trip itself. Further, because of space limitations, fishermen are frequently opposed to non-productive people on board. Additionally, the mobility of the resource and seasonal variations sometimes result in migratory movements by fishermen, making them difficult to locate. Finally, fishing communities are quite often residentially and/or socially isolated, resulting in a social and spatial distance that creates difficulties with respect to interviewing. Research on sea tenure systems thus has specific logistical problems which makes it more difficult than land tenure research.

This paper makes suggestions concerning techniques that can be used to cope with the effects of these ecological variables in research on sea tenure systems. Although the emphasis is on ecological variables influencing research design, the key variables which guide sea tenure research are defined to provide the framework and rationale for the techniques discussed. This includes operationally defining various aspects of "property" associated with sea tenure systems (*e.g.*, types of ownership, types of use right transfers, types of rights, privileges, and powers associated with tenure, boundary definition and traditional enforcement types).

The various research problems associated with collecting data concerning sea tenure systems are examined. These include consideration of the interrelationship between *emic* and *etic* research procedures, observational difficulties associated with research in the coastal zone, determining the spatial distribution of effort in relationship to defined territories and problems associated with the definition of sampling strata in the coastal zone.

INTRODUCTION

This paper outlines a research procedure for use in investigating territorial use rights among marine fishermen. The first part identifies and defines key variables associated with territorial use rights as a means of providing a framework and rationale for the research techniques discussed. Following sections examine research prob-

lems associated with data collection and techniques that can be used to cope with problems unique to the coastal zone.

RELEVANT DIMENSIONS OF TERRITORIAL USE RIGHTS

Territorial use rights in fisheries (TURF) manifest several important dimensions crucial to a complete description of the phenomena in any given situation.¹⁾ Basic to any type of TURF is a *territory*, usually defined by some sort of a *boundary*. Christy [1982] observes that boundaries in the marine environment are characterized by degrees of *definition* (or diffuseness), varying from clearly demarcated areas (*e.g.*, those associated with fixed gear) to the diffuse boundaries found offshore, in the open sea.

Acheson [1979] notes that the boundaries of lobstering TURFs in Maine manifest differing degrees of *permeability*, which refers to the movement of boundaries, increasing the size of one TURF at the expense of another. *Expandability*, the converse of permeability, where TURFs are adjacent, is another feature of TURF which Acheson [1979] found to vary regionally along the Maine coast. Finally, the extent to which the area within a bounded TURF may be divided (*e.g.*, the right to reallocate use rights within a section of the bounded area, as reported by Johannes [1981] for Palau) is a variable attribute of TURF, which we will refer to as *divisibility*.

A bounded territory is also characterized by varying degrees of *exclusivity*—a concept central to the definition of “use right.” This exclusivity has varying degrees of *scope*: the scope of the use rights includes all or some of the resources and/or applicable technology all or some of the time. It has environmental, technical, and temporal dimensions. For example Acheson’s [1979] discussion of TURF in Maine is related to one resource—the lobster. Richardson [1982] notes that TURFs were species specific among American Indians on the northwest coast of North America, and Klee [1980] reports similar species-specific TURFs in Oceania. With respect to the temporal nature of use rights, an example is provided by Alexander [1977], who writes that TURFs for beach seining in Southern Sri Lanka rotate regularly among users, to provide equal opportunity. The scope of exclusivity can also have an economic basis, an example of which is provided by Johannes [1981], who notes that some districts in Palau allow outsiders to fish for their own needs, but forbid outsiders to fish commercially within their TURF.

Related to exclusivity is the degree of *transferability* of a TURF. Some may be rented or sold (*e.g.*, lobster fishing TURFs around small islands off the coast of Maine [ACHESON 1979]); sometimes the transfer of rights is compensated for by a share of the catch, as on Palau [JOHANNES 1981].

The unit within which rights are vested (*right holding unit*) is also a variable related to TURF. In some cases use rights are individually held, in others they are held by some corporate group (*e.g.*, community, cooperative, kinsmen or nuclear

1) Christy [1982] appears to have been the first to use the acronym TURF.

family, among others) or specific individuals within corporate groups (e.g., chief, kin group elder, and the like).

The *legality* of TURFs varies from society-to-society. In some, for example Japan [CHANG 1971; RUDDLE and AKIMICHI n.d.], Newfoundland [ANDERSEN 1979], and Sumatra [COLLIER 1978], use rights in the fishery are a part of codified law. In others, such as among Maine lobstermen [ACHESON 1975], TURFs are extra-legal. *Enforcement* is an important attribute of TURF which is closely related to legality. Some forms of enforcement are supernatural (e.g., taboos against fishing in certain areas, such as in Oceania [KLEE 1980]); some involve fines, and in the past even death, as reported for parts of Oceania [JOHANNES 1978]. In cases where the TURF is extra-legal, enforcement involves interest group-sanctioned destruction of gear or physical violence, as is practised in the lobster TURFs off the coast of Maine [ACHESON 1979].

A socially important aspect of any system of use rights within a fishery involves the concept of *equity*. How equitable is the distribution of use rights? Some societies have addressed the equity question by temporarily rotating use rights among all users [ALEXANDER 1977]; others, such as in Newfoundland [MARTIN 1979], allow all qualified aspirants to have a "fair chance" through the use of a lottery. Some, perhaps less equitably, auction-off use rights, as in Sumatra [COLLIER 1978].

Finally, in my opinion, attempting to include "secrecy" as an aspect of TURF or sea tenure is stretching the concept beyond the realm of credibility. In practically all fisheries with open access (and within communally held TURFs), fishermen attempt to keep knowledge concerning the location of good fishing spots secret from most other fishermen. If this knowledge is shared, it is with kinsmen or friends. The only type of "tenure" involved, then, is that over one's own knowledge; thus, to include secrecy in a consideration of TURF would be pointless.

The framework for researching aspects of TURF thus includes, at least, the following seventeen attributes: a TURF consists of a (1) *territory* which is demarcated by a (2) *boundary* of varying degrees of (3) *definition* or diffuseness, (4) *permeability*, (5) *expandability*, and (6) *exclusivity*. The exclusivity of a TURF usually has a defined (7) *scope* composed of use restrictions which can apply differentially to various included (8) *resources*, (9) *technologies used*, (10) types of *economic* exploitation, and with varying ranges of (11) *temporal* restrictions. The TURF is further defined by its (12) *divisibility*, (13) *transferability*, and classification of (14) *right holding unit*. TURFs have varying degrees of (15) *legality* and violation of their boundaries meet with different types of (16) *enforcement* procedures. Finally, the distribution of TURF can manifest various degrees of (17) *equity*.

VARIABLES AFFECTING TURF

Research aimed at increasing our understanding of the development and change of TURF systems must strive to delimit the system of interrelated variables which have an influence on the various aspects of TURF described above. This is im-

portant because in the social sciences there are large numbers of intercorrelated variables which are spuriously related, *i.e.*, related only because of confounding influences. An important aspect of developing a theory of TURF is the determination of its proper place within a system of interrelated variables; hence, it is essential to ignore the many spuriously intercorrelated variables and concentrate on the smaller number of important causal relationships.²⁾ One way to begin to accomplish this task is to develop a preliminary model, based on previous research as well as on general social science theory. This section will review variables related to TURF and conclude by attempting to place them in a model which depicts their interrelationships and which can be used as a device for developing research designs for investigating TURF.

First, it seems clear that as the number of fishing units exploiting a given fishing ground increases, conflicts in use rights could influence either the development of a TURF system or the alteration of an existing TURF system. Changes in the number of fishing units can result from several factors, including changes in population density, changes in levels of commercialization which may influence non-fishermen to enter the industry, and changes in technology which may lower the price of gear, thus stimulating new entrants. There is no reason why pressure on the resource would necessarily result in either the development of, or changes in, a TURF system. The conflicts generated by this pressure would probably have to be mediated by cultural values, including a norm of conflict avoidance [for an example see MARTIN 1979] and a concept of property rights.

Technological change, by itself, could also influence TURF systems. For example, the introduction of gears, such as large nets that require more space for proper employment, could result in pressure on existing space and generate conflict. Mechanization of vessels can result in increasing areas of exploitation, possibly resulting in conflicts with other fishing communities, the waters of which would be impossible to reach without motors of some sort. The introduction of beach seines could result in beach use conflict, and so on. Anyone with experience in fisheries undergoing change could extend this list, hence it will simply be noted that changes in technology which change use patterns must be accounted for in any examination of TURF.

Changes in levels of commercialization is an important variable, frequently antecedent to technological change, which can also have a direct effect on TURF. Of course, such changes can be the result of land-based technological changes (*e.g.*, improved processing and distribution techniques). Changes in levels of commercialization can have a direct effect on TURF when the increased value of a product results in individual harvesting units wanting to increase their production through using more space or more time on a given space—changes in use patterns which can affect existing TURF.

Species composition and distribution are also important influences on TURF. The distribution of desired species obviously influences fishing localities. Thus, if

2) Details concerning this type of theory-building can be found in Asher [1976] and Blalock [1964].

the desired species are concentrated in a relatively small area, increases in numbers of fishermen or effort will more rapidly result in conflict generating pressure on the resource. Species composition and distribution are also mediating variables with respect to the influences of levels of commercialization and technological changes. For example, if a highly localized species becomes commercially valuable, conflicts may result concerning access. These conflicts could influence TURF. In a similar manner, technological changes (*e.g.*, those giving access to highly localized, but previously unobtainable species) could result in increased pressure on a given localized species.

Aspects of the physical environment can have both direct and indirect effects on TURF. For example, an area with numerous reference points (*e.g.*, rocks jutting out of the water, numerous islands and landmarks ashore) facilitates demarcation of TURF. Physical features such as these, however, have an indirect impact on TURF through their influence on the distribution of species. An interesting indirect effect of the physical environment was pointed out by Martin [1979]. He argues that in the North Atlantic the sheer danger of fishing results in a need for solidarity among fishermen which has resulted in a norm of conflict avoidance; thus, in the fishery where he worked, a TURF system was developed to respond to potentially conflict generating pressures in one sector of the fishery [MARTIN 1979]. Storms and shifting currents may also alter aspects of the physical environment in such a way that stable TURF systems are unlikely to develop. For example, storms and shifting currents can change the configuration of beaches and estuaries in such a manner that the distribution of target species will be altered [for a good example, see McGOODWIN 1980].

Aspects of the politico-legal environment have obvious effects on TURF. For example, where TURF is supported by nationally recognized laws the system will be much more stable. The legality of the TURF system also has an effect on the "cost" of both defending and circumventing the system. Where the system is written into law, the state takes over the burden of defending the territory and exacts penalties for violations. In the extra-legal TURF system, the fishermen must assume the costs. In some cases (*e.g.*, a small, poor community versus a larger, wealthy community) this results in costs that exceed benefits, thereby inducing changes in the system.

Alternative employment opportunities can also have an effect on TURF. This variable becomes important when there are increased pressures on available fishing space. In some cases the TURF system will change, as discussed above, in response to the pressure. In other cases some fishermen will leave the fishery for alternative employment, or population pressure will not result in an overwhelming number of new entrants because of alternative employment opportunities. The existence of alternative employment depends, of course, on the occupational structure of the region as well as cultural values associated with the alternatives.

Most of the variables that have been discussed thus far can be viewed as somehow causing or affecting various aspects of TURF. It is also possible to examine the impacts that TURF and/or changes in TURF can have on the system within which it is embedded. First, it is obvious that any system of tenure can have an effect on both

social and economic equity. It is threats to equity (or a desired level of equity) that result in the conflict that TURF can be used to ameliorate. Hence TURF also has an impact on conflict. Depending on the system developed it could either increase or decrease conflict. It has also been argued that TURF can be used to avoid the “tragedy of the commons” because fishermen, having a vested interest in the resource through the TURF system, will be careful to not over-exploit or abuse the resource, thus resulting in resource conservation. Finally, it has been suggested that a TURF system can increase efficiency—it can generate or increase benefits by excluding outsiders, by resulting in a system wherein the fisherman knows where he can fish in advance; thus not wasting time sailing to a given fishing spot only to find it occupied and then further wasting time by sailing on to another, which may also be occupied.

It is also possible to argue that many of the variables discussed as independent and dependent variables have reciprocal effects on one another. For example, if TURF affects conservation it will also have an impact on species composition and distribution. If TURF influences efficiency, it can influence commercialization by providing more product at a lower price. It can also result in increases in available capital among the producers, hence increasing the likelihood of technological changes which require increased investment. The technological changes could be such that they would allow increased numbers of fishermen, thus allowing an increase in population density. If the TURF system is successful it can positively influence

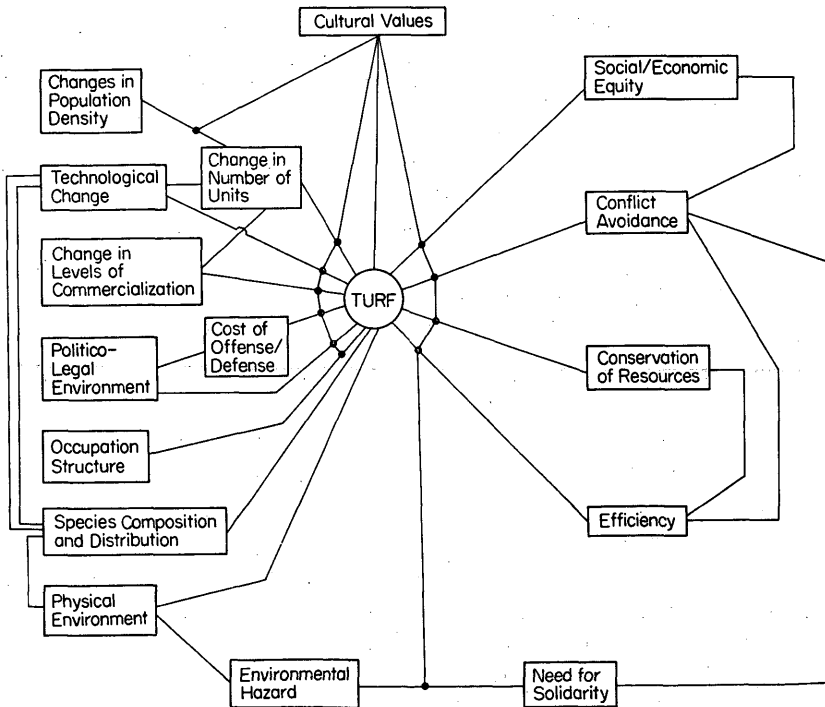


Figure 1. System of Variables Related to TURF

cultural values associated with property; if unsuccessful, it could have a negative influence. Hence, it is possible to see that the variables identified here form an interlocking web of relatedness; changes in any one having ramifications throughout the system (Fig. 1). It thus appears as an approximation of a theory of TURF, a theory that can be used to guide research, to help identify confounding variables so that they can be controlled allowing greater confidence that the relationships uncovered are due to variables in the research design, and not spurious relationships resulting from unidentified and uncontrolled variables.

The remainder of this paper will be concerned with outlining research procedures of use in investigating those attributes of TURF identified so far. Although the use of such a conceptual framework can lead to purely *etic* research methodologies, *emic* techniques are also discussed. The *etic* framework is necessary, however, if we are to arrive at comparable results, thus keeping maritime anthropology at the level of a nomothetic science. Additionally, since some people involved in planning have been suggesting that TURF should be examined in terms of its potential role in the development of marine resource management schemes [e.g., CHRISTY 1982; POLLNAC and LITTLEFIELD 1983], it is increasingly important to be as explicit as possible in designing research methodologies so that results can be effectively used in this important undertaking.

OBTAINING INFORMATION ON THE ATTRIBUTES OF TURF

Units of Observation and Sampling

One of the first methodological tasks is to define the units of observation. It is clear from Acheson's [1979] research that one community is probably not an adequate unit of observation for making generalizations about an entire society. Thus if generalizations about an entire country (or even a limited stretch of coastline within a country—*cf.* Acheson's [1979] research conducted along a *portion* of the coast of the state of Maine), are required, an adequate sample drawn from the total number of fishing "communities" along the coastline is necessary.

This also holds for TURFs with right holding units at the communal and lower levels. When the right holding unit is smaller than the local community level (e.g., at the kin group, producers association, or individual level) and the investigator wishes to generalize to the community or higher level, it will be necessary to gather information from a representative sample of right holding units, especially if there is a need to generalize concerning TURF features which may vary across different use right holding units. These considerations lead to the problem of sampling, which can be extremely difficult in the coastal zone.

Sampling Frame

To draw a sample requires a sampling frame; a list identifying all sampling units belonging to the population to be studied. In other words, if the unit of observation is the community, then the sampling frame will consist of a list of all of the communities along the coastline for which the investigator will make generalizations.

A minimal frame consists of a list, but the more information on the sampling units, the more efficiently can a survey be designed.

Making a list of all fishing communities, fishermen kin group heads, or individual fishermen, depending on the sampling unit, sounds easy. But those who have conducted research in the coastal zone will know that the thin slice of land between the coastal highway (if one exists) and the homes and landing places of marine fishermen is only a thin slice on the map—in reality it is often a morass of swamps, lagoons, deltas and monsoon-soaked mud trails. Not uncommonly it can take a full day to reach what one has been assured is a fishing village, only to find two or three dwellings, that the fishermen have just gone fishing, and that the only people at home are wives and children, with no information concerning the topic of the research!

In addition to the relative isolation of fishing communities in many regions, there also exist fisheries characterized by periodic migration. The movements are sometimes a response to the mobility and/or seasonal cycles of the marine resource, but in other cases they represent a dual agricultural and fishing adaptation in a coastal zone having soil conditions unfavorable to agriculture (*e.g.*, high salinity), that necessitates periodic movements to inland farming sites during the agricultural season.

Researchers in the coastal zone thus find themselves faced with two relatively difficult sampling problems: (1) A large number of relatively small concentrations of fishing families in coves, on the coastal sides of brackish water swamps and lagoons, and sometimes up to several kilometers up the streams and rivers which empty into the sea; and (2) the possibility that the fishing settlements are only occupied seasonally. These problems are of a magnitude that many developing countries find it difficult, if not impossible, to arrive at a reasonable estimate of the total number of small-scale fishermen working in their coastal zone.

No matter what the final sampling unit will be, the landing site (or cluster of landing sites) and associated fishing communities will be the minimum objective of a survey frame if any generalizations are to be valid beyond the local community level. In the hierarchy of sampling units for research involving TURF the landing site is thus the primary sampling unit. Depending on the objectives of the research, however, the more information available on secondary sampling units (*e.g.*, boats), and/or identifiable clusters of boats (*e.g.*, associated with some shoreside social grouping, such as an extended kin group), the more useful will be the sampling frame.

Several approaches can be suggested for developing the sampling frame. First, if little is known about the fishery it may be necessary to try to locate all landing sites by travelling systematically along the entire coastline. Owing to environmental factors mentioned above, as well as the possibility of additional geographic barriers, such as coastal mountain ranges, attempts to conduct the frame survey from land can be time-consuming and error-prone.

Ideally the coast could be surveyed for landing sites from the water by travelling parallel to the shore, close enough to spot landing sites or fishing activity, plotting the activity on topographic maps, and stopping to gather secondary information (*e.g.*, information that may be useful for sample stratification purposes at a later stage;

for example, number of fishing units, fishing type, population estimates, among other topics).

Where information concerning vessel types, crew structures and fishing types is available, a relatively efficient technique for conducting a frame survey is through an aerial reconnaissance. Given the right weather conditions, a light aircraft can quickly cover a relatively large expanse of coastline. The researcher can plot fishing landing sites on a map and photograph the fishery in operation, boats on the beach, and the associated community. The photographs can be associated with plotted landing sites and later analyzed for number of vessels of specific types (to estimate number of fishermen, target species, etc.), fishing areas, and number of dwellings (to estimate population sizes). Not all researchers have the necessary map reading and aerial survey skills, but given the relatively high cost of research time, it may be the most cost effective way to accomplish an accurate frame survey of fishing communities.

Finally, the least accurate, yet a time-consuming technique for conducting a frame survey, would be to go to known landing sites and ask fishermen the locations of nearby sites. These are visited in turn, and the locations of adjacent sites ascertained. This process is continued until the entire region has been covered. The time required to complete this process is quite high, as is the potential for error.

Regardless of the method used, if the fishermen are migratory substantial error could occur unless basic information is obtained about their movements. Hence, prior to conducting a frame survey, the geographic mobility of the fishermen must be determined and surveys conducted when the fishermen are in the coastal zone.

If the goals of the research are more modest, for example, if inferences for only a geographically limited TURF are required, the frame sample will be easier to carry out. For example, if the goal of the research is to investigate the relative equity of a TURF system within a given community (where the right holding unit may be an extended family or kinship group, etc.) or within a cluster of communities, only all right-holding units need be identified and in the process secondary information obtained for use in later stages of the research, for sample stratification purposes. Such information might be obtainable from key informants or written materials. In cases where the settlements are rather large, however, key informant information is frequently quite inaccurate. Sometimes the best procedure is to map the dwellings and systematically sample them. Again, this procedure is quite time-consuming.

Drawing the Sample

Once an adequate frame sample has been established, it is a simple matter, using commonly accepted sampling techniques, to draw the sample. Although it is also ideal to have a sampling frame within the fishing community (if a secondary sampling unit is right-holding units within the community) there are techniques which can be used to identify a sample of right-holding units within communities where the costs of constructing a frame sample would be too great, for example, where the settlement pattern is close and irregular (*e.g.*, a shanty town), composed of both fishermen and non-fishermen, and relatively large, thus making a systematic household survey

difficult, if not impossible, to accomplish. If the sampling unit is at the level of the firm, or could be identified by the firm, a landing survey may be sufficient for purposes of identifying a sample for further interviews.

Several techniques can be used in landings surveys (for details see [CHAKRABORTY and WHEELAND 1979; STEVENSON, POLLNAC and LOGAN 1982]). The easiest for our purposes is to identify landing spots and landing times (fishermen using different gears and/or focussing on different species frequently have different landing times), then visit the landing sites and systematically (e.g., every second, third, fourth, landing, vessel or whatever) to interview incoming fishermen. If there is a series of landing sites, the researcher can select one, systematically interview for a set period of time, then move to another site and repeat the process. Each day the first landing site selected should be different so as to distribute interviews throughout landing times and across landing sites. The sample identified using this technique can then be followed-up for more intensive data gathering concerning the TURF-associated variables of interest.

Data Needs

(i) *The Boundary.* Perhaps the most difficult data to obtain in TURF research is information pertaining to boundary location. With respect to fixed gear, shellfish collecting areas, and beach seine locations, boundaries can be easily demarcated by visiting the site with a right-holding unit representative, and mapping the area. Nevertheless, the further at sea the areas are located, the more difficult the mapping procedure. For example, fish pens are a fixed piece of equipment, but where there are many densely packed in a checker-board pattern, the only practical way to clearly identify the enclosed area associated with a given right-holding unit is to sketch the lay-out and interview right-holding unit representatives, using the sketch as a guide. If a high degree of precision is needed with respect to the area enclosed (e.g., as in studies concerning equity) sophisticated mapping techniques or aerial photography may be necessary.

In other cases, e.g., open ocean TURF, boundary location and definition becomes quite difficult. If the TURFs are specific, identifiable reefs, and if good charts are available, boundary location is simplified. Even if the informant cannot read a map, the investigator should be able to locate the reef using the fisherman as a guide, and then plot its location on the chart. If, however, the TURF is areas of ocean defined by triangulation, depth sounding, loran, or some other technique, it will be necessary in most cases for the investigator to accompany the fishermen to the area and map it using the same techniques as are used by the fishermen to locate the boundaries. With the use of several fishermen associated with each TURF in the sample this technique should provide a wealth of information concerning the diffuseness of the boundary *as defined by the right holding units*. Enclosed areas and boundaries will then have the same level of precision as those which govern the fishermen's behavior. Standard anthropological research techniques (e.g., key informant interview, sample survey) can be used to determine other boundary associated variables, such as permeability, expandability, exclusivity and scope. The researcher need only

frame the appropriate questions, which will probably be society-specific. Information on all of these variables, however, must be collected if the analysis of the TURF system is to have value for comparative studies.

(ii) *Right-Holding Units, Divisibility and Transferability.* The investigation of these three variables associated with TURF can also be accomplished with traditional techniques. In some cases historical records can be used, *e.g.*, as in areas where the TURF has legal status and records similar to deeds are filed with local or higher level authorities. In other cases, key informant and survey techniques will be the sole source of information. As with most matters dealing with fishermen, however, legal records may not reflect reality, especially as the area becomes more remote and the boundaries of the territories more diffuse.

(iii) *Legality and Enforcement.* Legal codes (*e.g.*, written records, where they exist) can be used to determine the legal status of the TURF system. Key informants can also be a source of information. The legal status of the TURF system is a variable which influences data gathering techniques concerning all other variables associated with TURF. For example, Acheson could not have collected the excellent data he presents [ACHESON 1979] with the use of only survey techniques. It was only through intense participant observation that he learned of the TURF system in Maine, and only after winning the confidence of the fishermen was he able to define boundaries and obtain information concerning the extra-legal enforcement techniques used.

(iv) *Equity.* There are several important, previously discussed variables which must be taken into account when investigating factors involving equity in distribution of marine resources under a TURF system. First is the right-holding entity. Is it the individual, kin group, association, community, or some other level of right holder? If it is the individual, are we going to be concerned with equality in distribution according to right-holding unit, or are we going to account for the number of individuals within the right-holding unit? Second, what will be used as the unit of resource for which we calculate a measure of "equality"? Will it be surface area, or surface areas classified by production (actual or potential)?

In terms of data acquisition the simplest approach would be measure the surface area within each TURF and use this as the variable for calculating a measure of equality within the sample of TURFs. The problem with this approach is that it does not take into account the fact that for true equity, a right-holding unit with twenty members should have twice as much access as one with ten members. A second problem is that in most marine ecosystems the desired resource is unequally distributed. If the desired resource is fish which are found only in a reef environment, a right-holding unit with a 100 km² surface area and a 3 km² reef area would have less of a share than a unit with a 50 km² surface area and a 5 km² reef.

Most would agree that an equality measure calculated across individuals is superior to one calculated across right-holding units, if the units have different total populations. This does not overly complicate the research. It adds only the necessity of determining right-holding unit size and dividing this into the size of the unit

of resource (assuming that there is equality of access within the TURF). The resultant data from each TURF can be used to calculate an equality measure across all individuals in the TURFs sampled. Since the number of TURFs in most instances will be substantially smaller than the number of individuals involved, it does not take much more effort to calculate a measure of equality across TURFs as well. The two equality measures in combination may provide insights that either alone may miss.

Calculating an equality measure according to access to productive area (*e.g.*, such as the reef resource discussed above) creates some rather difficult research problems. As discussed in previous sections, definition of boundaries and calculation of enclosed area is difficult enough without the additional task of surveying reef area or ill-defined fishing spots. One might, however, be able to determine productive reef area (and/or other "fishing spots") with the aid of local informants and charts.

A problem that arises with considerations of productive area, however, concerns relative access. Assuming equal productivity (another difficult assumption), is 5 km² of reef 2 km offshore equal in value to 5 km² of reef 5 km offshore? Will it be necessary to conduct cost and earnings research to arrive at a "true" measure of access? If so, the cost of the additional information will be quite high.

Assuming that the problems of defining the unit of resource and distribution unit (*e.g.*, individuals within TURFs or TURF right-holding units such as communities, etc.) have been solved, calculating relative equity is a simple matter. Perhaps the most graphic technique is to produce a Lorenz curve from the data.³⁾

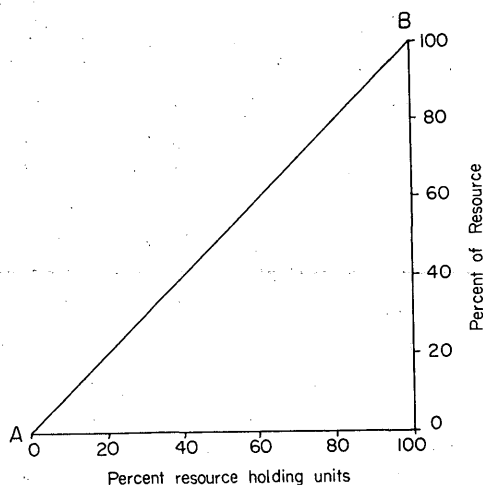


Figure 2. Use of a Lorenz Curve to Demonstrate Total Equity

3) The Lorenz curve is merely a cumulative percentage graph which has percentage of wealth-holding unit (in this case marine resource right-holding units) on the horizontal axis and percent of total "wealth" (resource units) on the vertical axis.

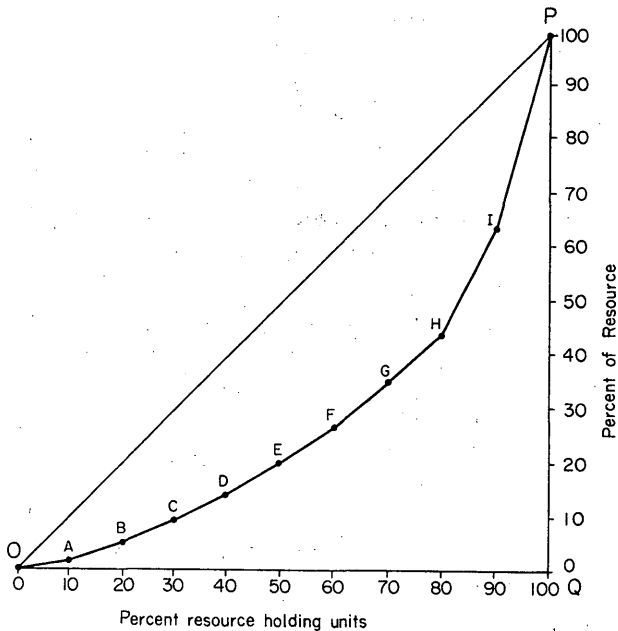


Figure 3. Use of a Lorenz Curve to Demonstrate Unequal Resource Sharing

It is a simple matter to demonstrate that if there is total equity; *e.g.*, one percent of the resource-holding units hold one percent of the resource, two percent hold two percent, etc., the Lorenz curve will be a straight line connecting points A and B in Figure 2.

If, however, the distribution of resource units is unequal across resource sharing units, the Lorenz curve is calculated by arranging the resource sharing units in ascending order from the smallest unit holdings to the largest. We then calculate the percent of total resource held by the first ten percent (or five percent, or whatever is appropriate), the next ten percent, and so on. This is continued until all of the resource and all of the sharing units are accounted for.

For example, if the first 10 percent hold 2 percent of the resource, and the next 10 percent hold 3 percent, these data are plotted as points A and B on Figure 3. It can be seen that 20 percent of the population has 5 percent of the resource. If we continue to increase the holding of each successive 10 percent of the right-holding units by 1 percent, up to 70 percent, we find that 70 percent of the units hold 35 percent of the resource (point G). We then have no increase for the following 10 percent (they hold 8 percent) resulting in point H, where 80 percent of the right-holding units possess 43 percent of the resource. The next to the last 10 percent is relatively wealthy, holding 20 percent of the resource. The final, elite 10 percent holds 37 percent of the resource.

The curve described by the points from O, through A, B, C...I to P graphically

illustrates the degree of equality (or inequality) in the population or sample described. The closer the plotted curve dips toward point Q, the greater the inequality.

The Lorenz curve provides a relatively clear, graphic technique for illustrating degrees of equality. It is, however, possible to express numerically the degree of equality illustrated by a given Lorenz curve. The coefficient (Gini Concentration Ratio) is the ratio of the area between the curve and the straight line connecting points O, P to the area of the entire right triangle defined by points O, P, and Q. The coefficient varies between zero (complete equality) and close to unity (maximum inequality).

Other coefficients which express degrees of equality have also been developed. The simplest to calculate and the most familiar is the coefficient of variation, which is simply the standard deviation divided by the mean. For calculating equity with respect to TURF, one need only identify the amount of resource rights held by each unit, calculate \bar{x} and s , and substitute into the formula:

$$CV = \frac{s}{\bar{x}}$$

Two other important measures are the logarithmic variance (v) and the variance of the logarithms of incomes (v_1) where:

$$v = \frac{1}{n} \sum_{i=1}^n [\log(x_i/\bar{x})]^2$$

and,

$$v_1 = \frac{1}{n} \sum_{i=1}^n [\log(x_i/x^*)]^2$$

In the analysis discussed here, n is the number of right-holding units in our sample; x_i is the amount of the resource held by a given right-holding unit; and x^* is the geometric mean of the distribution. In this case the geometric mean is equal to the mean of the logarithms of the amount of resource held by each unit transformed back to natural numbers. Each of these measures have both advantages and disadvantages, which need not detain us here [*cf.* COWELL 1977]. Suffice it to note that the Lorenz curve and coefficients described here can be of great use in comparing degrees of equality on both an inter- and intra-TURF level.

SUMMARY

Key variables involved in the analysis of various TURF systems have been identified and defined as a means of providing a systematic framework which can guide research concerning TURF and result in findings which will be of comparative value, thus allowing maritime anthropologists to further refine their theories concerning various aspects of man's adaptation to the sea. Research methodologies have been discussed, focussing on aspects of research which pose special problems owing to specific attributes related to maritime adaptations. Aspects of more traditional research techniques were deemphasized, since their methodology is familiar.

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