Carrying Capacity Analysis of Fixed-Territorial Fishing[1]

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Overfishing has seldom been evaluated as an actual or potential problem in anthropological studies of traditional fishing. Rather, there has been a tendency for anthropologists to assume, along with fishery biologists, that over-exploitation of local coastal waters is unlikely where fishing communities are small and isolated and where fish species have a wide distribution and can feed on planktonic larvae. Additional support for this view stems from evidence that in certain maritime traditions there are internal checks on fishing pressure in the form of conservation measures designed to insure the longevity of valuable species (cf. Johannes 1976; Klee 1976). As in other traditional economies where human population density is low, we might expect most fishing communities to exist at levels well below carrying capacity (cf. Harpending 1974: 229-243). This situation may change abruptly, however, when technical innovation occurs or when outside market demands increase, as in the case of the Miskito Indians of Nicaragua (cf. Nietschman 1974).

Rarely does a fieldwork situation provide the opportunity to examine precisely the overfishing question. Necessary multispecies time-series data on catch and effort are hard to obtain even under the most ideal research conditions. Fishery development theory similarly is lacking in means to estimate the expansion potential of traditional fishing as technical advances are introduced. Many studies make passing reference to the biological concept of carrying capacity to interpret change or stability within the production system. The carrying capacity concept itself, however, has come under increasing criticism; it has been erroneously formulated on the basis of exponential rather than logistic models of growth, and threshold definitions are ultimately subjective in that they depend on highly variable ethics concerning the optimal allocation of resources (cf. Johnson 1974; Street 1969).

Here I would like to suggest a somewhat different line of inquiry from that which is normally taken in carrying capacity analysis, especially as applied to fixed territorial coastal fishing. Given the difficulty of measuring population pressure and resource deterioration in many coastal marine settings, an alternative is to inquire how fishermen perceive and talk about the carrying capacity or expansion potential of their system.

Using the example of a small-scale inshore fishing system in Brazil, this paper takes up the problem of how population build-up may be controlled by territorial access limitations. These limits are expressed in the criteria which fishing captains use to decide where to fish each day.

A strictly biological approach to the problem of carrying capacity may well prove to be impractical and unrealistic in most cases of small-scale fishing. Yet I found the concept itself to be meaningful to fishermen. My purpose here is to illustrate how lunar-tide complexities set restrictions on fishing pressure, thus providing the context for the failure of technical innovation.

THE COMMON PROPERTY MYTH IN COASTAL FISHING

Probably the foremost problem in the management of the world's sea fisheries is their susceptibility to "overcapitalization" (Marr 1976: 39). This tendency is usually attributed to the "common property" character of marine resources, to which everyone is presumed to have free access. The yield of any fishery resource is finite, so under conditions of unlimited entry of production units, the total catch will be divided among more and more vessels until individual profits begin to decline. Overcapitalization does not inevitably lead to biological overfishing. However, it will occur if the degree of fishing intensity at which the fishery as a whole becomes unprofitable approximates the level of intensity necessary to prevent a fish stock from reaching maximum weight in a given age class.

The common property theory has proven applicability in industrial-scale, open-ocean fishing. Traditional inshore fishing, however, may present an interesting exception to the common property theory. Recent studies in maritime anthropology have shown that various forms of proprietary rights have evolved in certain small-scale coastal fisheries (Forman 1970, 1966; Nietschmann 1974; Cordell 1974; Johannes 1976; Klee 1972).

Boats must be free to follow fish as they move. Yet fish behavior is not random; most species periodically concentrate to feed or spawn, or migrate in schools. As fishermen learn to capitalize on the patterned behavior of fish, they incorporate this knowledge into "systems of orientation"; essentially calendrical devices which enable them to map out the distribution of sites through which fish pass at predictable intervals. Thus fishermen are presented with opportunities to establish temporary territorial rights which may be converted to long-standing territorial claims.

From the standpoint of resource control and competition, coastal fishing would seem to be transitional, in both a logical and evolutionary sense, between inland and open ocean production settings. In many coastal fisheries the fishing grounds are restricted enough and located close enough to home base to allow fishermen a daily observational check on one another's activities. Tabs are kept on the whereabouts of competitors so that estimates may be made of changes in fish concentration. The fishing grounds may be sufficiently enclosed in river-estuary systems, reefs and lagoons, shoals, banks, etc. so that fishing spots can be treated as unique locations with precise boundary markers for the different methods used (Cordell 1974; Nietschmann 1974; Grossinger 1975).

Realistically, however, one wonders how the fieldworker, often a single investigator, can go about evaluating a complex carrying capacity issue posed by a possible overfishing situation. Time series data on dynamics of fish populations and fishing pressure are usually only obtainable through costly and elaborate biological surveys. Even under conditions where catch and effort data are available and reliable, fishery biologists point out that it is almost impossible to obtain the necessary information on spawning stock/recruitment relationships (Marr 1976: 41).

The primary danger in traditional fishing, however, is not internal human population pressure, but the fact that entrepreneurial agents may introduce over-efficient catching systems before knowledge of expansion potential is available. In fishing communities that have utilized the same stocks for years without depletion, the occurrence of naive modernization may rapidly generate an overfishing situation. Thus we are still critically in need of a method to gauge the expansion potential of local fishing waters where production is geared to low harvest rates but is subject to sudden intensification.

CARRYING CAPACITY IN FIXED-TERRITORIAL FISHING

Ideally, carrying capacity estimates should enable us to evaluate the nutritional adequacy of existing man/marine resource ratios, and by extension, the threat or reality of overcrowding in a given area. In recent years, this mode of analyzing the maximum population level that a given area can support, depending on its potential for food production, has been the focus of much debate in human ecology.[2] Despite valid criticisms of its limited utility as an explanatory device, with certain modifications I have found the concept to be a valuable aid in investigating problems of fishery modernization, providing more refined estimates of population pressure than simple density measures.

Most carrying capacity studies have been concerned with the risk and danger of overpopulation in traditional economies, most often in areas with related landscape deterioration (Allen 1949; Carneiro 1960: 231). Roughly what these studies do is calculate how much food families consume or need to consume, the average yield of land, and the area required to support various levels of population. The production system is then further analyzed to determine the quantity of resources needed to (a) feed the population, and (b) keep the population fully employed at present levels of output, and at current employment levels (supply function of labor), assuming the narrowly defined traditional technology remains constant. Finally, the required levels of resources are compared with available levels to define the limits of overpopulation.

Carrying capacity analysis has been extensively employed to study population pressure in shifting cultivation and other systems of agriculture, but there is only cursory information in the ethnographic and fisheries literature on the overfishing question in a traditional context. As I have indicated, it may be that traditional fishing is not susceptible to overfishing if technology remains constant. On the other hand, in the absence of precise time-series data on fishing pressure, it is always possible to argue that overfishing is a real danger, but that it does not occur because of regulatory social mechanisms. Thus, in an otherwise compelling study of raft fishing in northeastern Brazil, Forman (1970: 65) reasons: ". . . . secrecy regarding particular spots within the grounds serves as a spacing mechanism which minimizes competition and prevents overfishing by according temporary property rights to individual fishermen."

Forman's analysis raises another critical point in regard to carrying capacity which is seldom considered by fishery planners. This concerns the fixed-territorial nature of many inshore fishing grounds. Boats may be equipped with sails, or even motorized, yet fishermen characteristically frequent the same configuration of territories which must be shared and which are ranked according to variables such as ease of accessibility from home port, past production history, and weather conditions. Thus, whether or not a full-fledged system of property rights has developed, inshore fishing is likely to have definite spatial limitations. In this case, the initial restriction on expanding fishing operations may be favorably located waterspace, and secondarily the availability of fish stocks. To enter the fishery under such circumstances, any new production unit would have to contend with the fundamental matter of gaining access to waterspace and the fishing system would be vulnerable to competition along these purely spatial lines.

In light of these considerations, I would like tentatively to propose here that the key to avoiding overcapitalization and to conserving many coastal fisheries lies in recognizing their fixed-territorial nature, and restricting entry accordingly. With gear-upgrading innovations, fisheries may develop so rapidly that for management purposes there is not enough time to acquire the relevant catch and effort data. Furthermore, if the fixed-territorial limits are initially well defined, then an elaborate biological survey, at least for inshore waters, may prove in the long run unnecessary.

Though by no means intended as a substitute for catch and effort data, there are some simple interview techniques which I have used in previous fieldwork which may have a bearing on the carrying capacity issue. I have found that much revealing information can be elicited from the ethnobiology realm by taking a closer look at the identifying characteristics of fishing spots. In the search for some indirect indices of carrying capacity, this procedure assumes that traditional fishermen have a fair impression of the expansion potential of their production system and that the relevant dimensions are reflected in their decisions of where to fish each day. I now proceed to document the pattern of change in Brazilian canoe fishing in which the production expansion capacity of local inshore waters was put to a critical test.

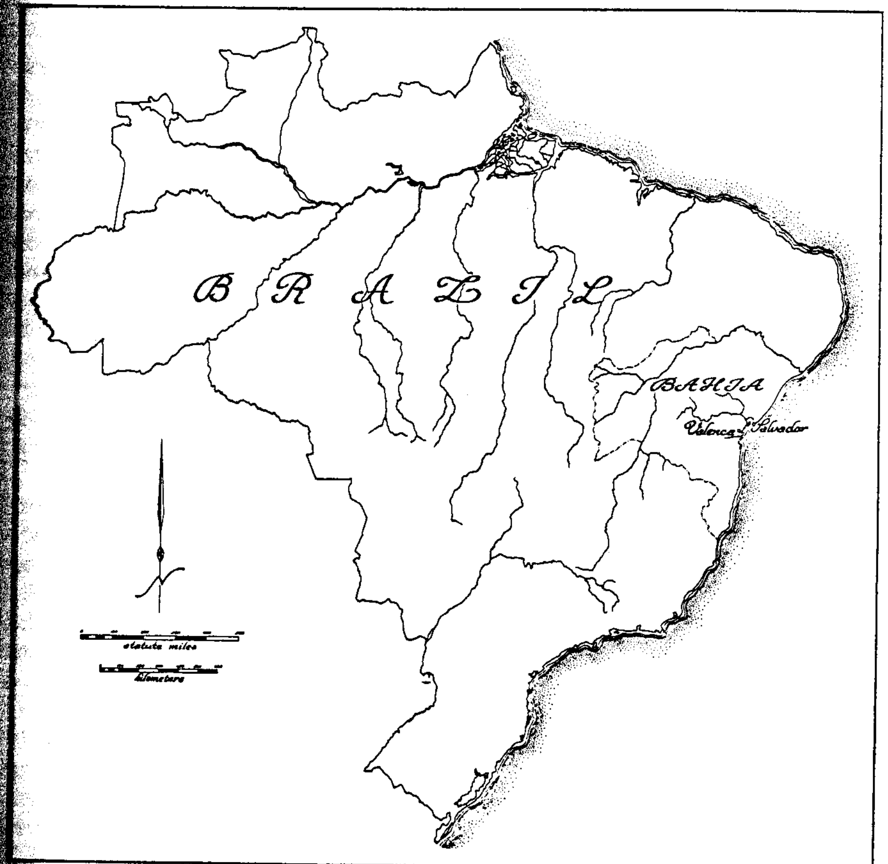
The Developmental Cycle of Canoe Fishing

The fishing-plantation area in question lies in the coastal lowlands of southern Bahia, Brazil (Map 1) and is known locally as the *beirada.* Its inhabitants are *beiradeiros* or "shore dwellers." The *beirada* forms a type of geologically submerging coast, which consists of a narrow plain cut by tidal creeks and rivers. These open onto an extensive system of estuaries flanked by mangrove swamps. Following the river and estuary shoreline, there are small scattered communities of marginal fishermen who now work mainly for a subsistence living. They customarily fish from dugout canoes operated by eight-man crews, though today a wide variety of subsidiary methods, such as traps and trotlines, are utilized. Fishermen also forage for crabs and shellfish in the mangrove swamps. The port of Valenca, located somewhat inland on the Una River about 60 miles down the coast from Salvador, Bahia, is the heart of the canoe-fishing tradition. Valenca has several competitive fishing neighborhoods which I visited in 1970-71.

Most fishing traditions in this part of Brazil retain some interesting adaptive features from earlier periods of essentially noncommercialized, noncompetitive growth (cf. Forman 1970, 1966: 16). Through technical change and outside entrepreneurial activities, however, these traditions are gradually breaking down and many fishermen are being forced into poverty. Throughout my stay in Valenca I was faced with the problem of understanding a group of people whose system of livelihood seemed to have outlived its usefulness and would soon disappear. People continued to fish, though less for the market than for home consumption, and less with larger nets than with secondary techniques which they could operate with a low upkeep as independent producers. Many fishermen were out of work and tended to congregate along the waterfront speculating that the summer fishing season the following year would bring a catfish spawning run up the estuary, in which case all might be well again.

The economic slump in fishing, however, did not appear to be a temporary condition due to a chance off-season in production. Instead, it coincided with recent efforts by fishery planners to upgrade the traditional catching system with

Map 1. Location of Valenca Canoe-Fishing Tradition



nylon nets. Because of its single-minded emphasis on gear efficiency, this innovation was doomed to failure. No one bothered to ask how the traditional fishing system worked in its estuarine environment, how production was organized in local communities, or what impact intensified fishing would have on marine resources. It is no surprise then, that the modernization attempt ultimately proved incompatible with the expansion possibilities of net fishing. The first limitation was purely mechanical, having to do with the fixed-territorial aspect of net fishing. Canoes without motors could seldom venture out beyond the estuaries. Second, the tides along this part of the coast act greatly to restrict fishing in terms of the number of suitable locations for nets each day. I will elaborate on this point in the following section. Let it suffice now to summarize, that over a ten year period too many nylon nets were added, and too few waterspaces were available to accommodate them in the local estuary.

Worse still, in the context of these unrecognized range limitations, was the mistake made in the manner of introducing the new nets. They were originally intended for purchase by traditional fishing captains. Nearly all captains rejected the innovation, not out of any inherent conservatism, but because they could not meet the loan repayment schedules. Consequently, the nylon nets fell into the hands of wealthy middlemen (factory bosses, plantation owners, and local merchants) who could afford to speculate in fishing. Numerous fishermen were already indebted to the entrepreneurs and so were drawn into an easily exploitable pool of cheap labor.

Over the next few years a highly competitive nylon-net fishing enclave grew up in the midst of the traditional community. In the ensuing struggle for control of the fishing grounds, the previous balance between production units and fishing territories was shattered. A tremendous amount of cut-throat competition was generated and much equipment was destroyed in costly disputes over fishing rights. Economic warfare crippled the industry in general and members of the traditional community in particular.

Pressured by the effects of overfishing, traditional captains were increasingly lured into high risk strategies with their equipment against better financed nylon-net specialists. Since the traditional fishermen did not have sufficient capital to continue fishing on this basis, many captains were forced to dismiss their crews and move their base of operations to the tidal creeks of the mangrove swamp.

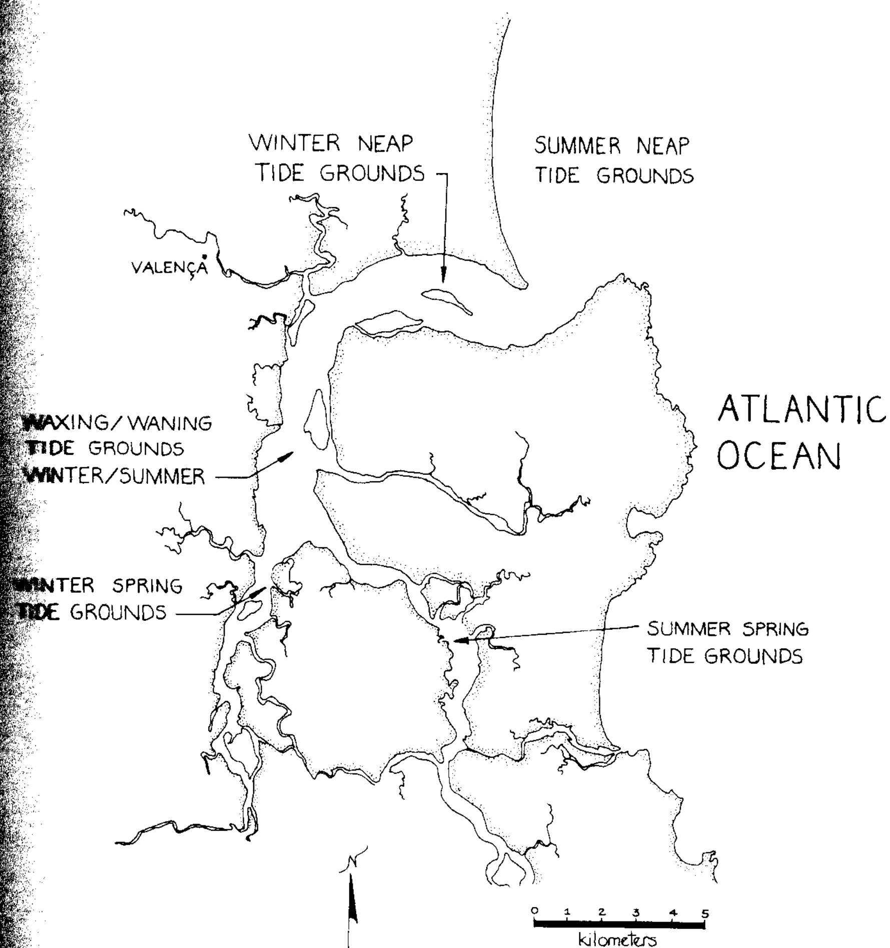
The type of developmental cycle I have briefly documented for the canoe-fishing system might best be described by the term "marginalization." Beginning with a period of essentially nonmarket-oriented expansion, the fishing system then entered a stage of growth characterized by increasing control by entrepreneurs who brought capital and technical advances to part of the community. As this period of speculation ended and catches declined, fishermen reverted to subsistence production, reflected by expansion in utilization of swamp areas and almost exclusively specialized to crab gathering.

In the course of my fieldwork I attempted to reconstruct the major events in this miniature boom-bust cycle, and this brought to light a series of carrying capacity issues concerning adaptive response to modernization. The first of these concerns the traditional system prior to innovation. As a baseline for interpreting change, it seemed necessary to show what, if anything, was "adaptive," that is, what tended to keep the intensity of fishing within tolerable bounds in its traditional culture-environmental setting. What were the mechanisms governing the relationship of production units to available resources which tended to make fishing reliable as a long-term occupation? What sort of production expansion was characteristic of the traditional system and how did innovation in the form it took alter this pattern? In the light of the state of economic stagnation at the time of my research, the system had been unable to withstand innovation, but how could this incompatibility be formally shown in the absence of an elaborate biological survey of fish stocks and production?

LUNAR-TIDE FISHING SPACE

With regard to the *beirada* fishing grounds (Map 2), it is difficult to speak of production potential inherent in local waters, since pelagic fish schools enter the

Map 2. BEIRADA FISHING GROUNDS



estuaries at various points in their migratory cycles. Fishermen's ability to capitalize on these migrations, particularly spawning runs, depends to a great extent on their knowledge of lunar-tide periodicity. Through careful observation of the tide cycle they are able to cue in on the movement of different species on a daily basis. At the same time the variable influence of the tide along the course of the estuary determines the selection and positioning of all their fishing methods on a strictly mechanical basis. To net fish successfully in *beirada* waters one must above all master the art of timing the tides.

Superimposed on the microenvironmental framework of fishing the tides is the most important ecological factor in the estuary. The periodic changes in sea level produced by the tides subdivide the estuary into zones having nearly horizontal boundaries. The tide sweeps strongly in and out of the estuary, invading the seaward end of the floodplain, but has a much less pronounced effect on the foreshores and in the tidal creeks and rivers.

The effect of fortnightly current changes in the zoning of fishing methods adds an element of complexity to the distribution that emerges from depth and substrate influences. The same current may impede the efficiency of one technique, increase the efficiency of another, or preclude the use of a third altogether. Fishing gear set low on shore may be quite safe during a neap tide, but on a spring tide must be moved to higher ground or the currents lower on shore will sweep it away.

The risk of loss or damage and the difficulty of handling heavy gear under incompatible tides is enough to compel fishermen to observe closely the following set of priorities:

1. Gill nets, trotlines, and fish traps which must be anchored and set to drift in the channels work best when currents are weakest at neap tide.
2. Barricade devices and fish corrals work best at any tide but neap tide, since they require considerable current and depth change to snare fish high on shore and in the tidal creeks.
3. Dragged nets and encircling nets do not function well at either spring or neap tide since they require medium velocity currents and these only come at rising and falling phases during the tide cycle.

The limitations on techniques always hold, but never for all areas of the fishing grounds at once. Because of the way the shape of the estuary influences current action, a spring tide in its inner reaches is more like a neap tide in its outer reaches, and vice versa. The result is that fishermen can use most of their techniques on a daily schedule throughout the tide cycle, as long as the choice of fishing spots conforms to the particular current regime on any given day.

Choosing a fishing spot is then largely a matter of proper timing—putting together information on tides, techniques, and fishing areas so there is a good chance of locating a school of fish. Contrary to what one might expect, a fishing spot is not thought of as a purely spatial point. Rather, its existence is always relative to the different phases of the lunar month. By their system of reckoning, names are given to each day in the 28 day lunar cycle which marks the corresponding water level changes (Cordell 1974: 379-391).

It is important now to consider how these timing elements are built into the notion of a fishing spot, or *pesqueiro* (Figure 1). The first point to bear in mind is that *pesqueiros* are the minimal microenvironmental units of fishing, but

depending on their location in the estuary, they are only activated at certain times during the lunar cycle. *Pesqueiros* always fall within more inclusive types of physiographic zones, and are usually referred to as belonging to a specific shoreline (*costeiro*) which is in turn subsumed under one of the major subdivisions of the fishing grounds (*beiradas*). Over 400 fishing spots are known and frequented by Valenca fishermen and each has a name ordinarily taken from a coastal landmark.

Fishing spots are found continuously along the shores of the estuary, but are actually distributed in discrete clusters. This is because each spot is always defined with reference to the phase of the lunar-tide cycle (neap, spring, waxing, or waning tide) when it may be used.[3] However, since a fishing spot may accommodate a range of techniques, three further factors act to partition it into what are called *lancos*, or water spaces for casting nets: (1) fortnightly current changes, (2) daily tide level changes, and (3) the position of the particular water space relative to the slope of the shore. Thus, a water space may be an area reserved for shooting nets, for setting trotlines, or for construction of a fish

FIGURE 1: Subdivisions of a Fishing Spot

Water Spaces	"Enseada"	"Lancinho"	"Bugaial"	"Tabatinga"
Position Relative to Shore	intertidal	high	mid	low
Depth in Meters	1 - 3	3	3 - 6	6 - 9
Fortnightly Tide Zones	spring	spring neap	neap waxing waning	waxing waning
Daily Tide Zones	high ebb low flood	high ebb low flood	ebb flood	low high
Techniques Used	fish corrals lift nets	beach seine	purse seine gill net	purse seine trot line
Bottom Composition	sand clay	mud	gravel	clay

corral, but because of different zoning and current considerations which apply to each, they do not overlap. *Lancos*, like *pesqueiros*, have distinctive names taken from their boundary markers, such as bottom type (e.g., *bugaial*, a type of gravel; *tabatinga*, a clay), or their position on shore relative to other *lancos*. In any case, the overall effect of timing considerations is to subdivide *pesqueiros* according to an order of technical priorities in which they and the *lancos* they contain are thought of by fishermen as geographical points within the lunar month.

By eliciting the characteristics of several hundred fishing spots, I was able to derive the pattern whereby, at least in theory, fishermen shift the focus of their activity during the tide cycle. This pattern was then compared with the locational data on actual fishing trips, and the correspondence between boat positions and tidally activated fishing zones proved extremely close. Moreover, the fishing pattern as shown by trip frequencies is striking in the way all groups of specialists consistently tend to concentrate in the same general locations from one tide level to the next. At neap tide the concentration is on the *costeiros* at the northern end of the estuary; as the tide begins to rise, people move into the main body of the estuary in from the mouth. At spring tide, activity shifts to the southern *costeiros* and finally, as the tide begins to fall, fishermen move back up the estuary into the main channels. Canoe fishing, in other words, moves in a circuit of logistic areas which are activated periodically by a tide cycle that has differential impact along the course of the estuary.

TERRITORIAL COMPETITION

We have now seen how the fishing grounds are sufficiently enclosed in a river-estuary system, so that fishing spots have come to be treated as unique locations with precise boundary markers for the different methods used. But to find out how fishermen implement their claims, and the implications this has for competition, it is necessary to focus once again on the lunar-tide system.

I have indicated how decisions about where to fish are taken on the basis of timing and zoning considerations contained in this system. Timing and zoning have separate functions, however, when it comes to competition for fishing territories which are at a premium. Taking zoning principles into account first, one can see that they establish a pattern of specialization on the fishing grounds by spatially dissociating fishermen using different methods. This happens because no two classes of nets compete for exactly the same type of micro-environment. The result is a "boat-spacing" effect. On the other hand, timing principles act to confine fishermen using the same nets to a series of logistic areas which must be shared from tide phase to tide phase. Superimposed on the zoning effect, tide-timing gives rise to a concentration of boats and emerges as the conflict-conducive aspect of the fishing pattern. On a strictly mechanical basis, timing principles tend to negate the boat-spacing effect of micro-environmental specialization by reducing the number of alternative fishing spots fishermen using identical nets have to choose from. Relative to the extent of the fishing grounds, the range of spots fishermen actually can work, after preliminary timing and zoning considerations have been applied, is surprisingly small. Restriction on choice options may be illustrated by listing the lunar-tide criteria used to eliminate parts of the fishing grounds which are not viable alternatives

for a particular point in the tide cycle. The process is shown below for a typical fishing captain, who would ordinarily be selecting a fishing spot out of a total of 246 *pesqueiros* (or 1,470 possible *lancos*), on the basis of zoning considerations alone.

Lunar-tide Elements	No. Variants	Total No. Net-casting spaces	Reduced Fishing Spot Choices
1. Lunar Phase	(2) dark tide, moon tide	$\frac{1470}{(2)}$	735
2. Tide Cycle Phase	(4) neap, waxing, spring, waning	$\frac{1470}{(2) \times (4)}$	183
3. Lunar Position	(4) time of moonrise: dawn dusk, noon, midnight	$\frac{1470}{(2) \times (4) \times (4)}$	45
4. Daily Tide Levels	(3) high, flood, ebb	$\frac{1470 \times (2)^*}{(2) \times (4) \times (4) \times (3)}$	43

* There are actually six times during the 24 hour daily tide cycle when it is possible to use encircling nets. This is because high, flood, and ebb tides (the three variants) occur twice daily. Accordingly, all the net casting spaces are activated twice daily.

When timing considerations are introduced (each category contains a number of variants), the total range of fishing spots is eventually reduced to that group appropriate for a specific net at a certain time of day. Thus, moving through the list given above in flow chart fashion, we see that ultimately a fisherman is in theory free to choose from a range of only 43 alternatives from his total known set of 1,470 *lancos*. When the actual choice of where to fish is made, this set of alternatives is further reduced in terms of criteria of weather, production history, etc. It is therefore easy to see how a number of specialists using the same gear might compete for the same fishing spot, and even the same *lanco* on a given day, despite the fact that zoning considerations tend to keep specialists using different methods out of one another's way.

Because nets depend on the right combination of daily and monthly tide conditions to function efficiently, and without risk to equipment in terms of loss or damage, net fishing is subject to territorial competition on a daily, even hourly basis. Only one properly timeable daily fishing opportunity is really thought to exist in most net-fishing locations. Furthermore, opportunities to shoot a net are customarily held on a first-come, first-serve schedule. This puts net fishermen in a competitive position similar to fishermen on the open ocean, with no means short of beating their competitors to the most productive fishing areas, and "not moving for no one," once there (cf. Anderson and Wadel 1972: 612).

Though fishermen must share a so-called "common property" resource, they exercise definite temporary territorial claims to net-casting areas. Serious trouble may occur in net fishing because the stakes are high (catfish landings of several hundred dollars per boat are not uncommon), timing restrictions are acute and there is considerable pressure on available fishing spots. The average ratio of all net captain owners to total available net fishing waterspaces works out to be roughly one-sixth. When other fishing-spot choice criteria are applied after the initial lunar-tide breakdown, the range of choice fishermen need to operate their nets effectively is critically reduced. The opportunity to monopolize waterspace temporarily for net casting is thus in great demand in canoe fishing. Yet temporary ownership rights are difficult to establish and to enforce without disputes. What usually happens to create confusion is the arrival, simultaneously, of several boats in a fishing spot when there is evidence of a large school and only one properly timeable *lanco* in the area. When no one has a clear-cut prior claim, fishermen may draw lots to choose who will be the first to cast his net. Once an order of priorities is established, a tide marker, usually a pole stuck in the bank, is used to dictate the sequence of exploitation rights (not more than one tide-level change is allowed per boat). Sometimes this works, but often a boat will not close its net and draw in the catch in the time specified by the tide sequence. If the next boat in line begins its operations regardless, the two nets may become fouled. Or a boat captain may ignore the normal procedure in drawing lots and insist on casting his net, thereby forcing his competitors to accept a *fait accompli*.

This strategy, however, seldom goes unchallenged. On fishing spots with several *lancos*, net crews may work simultaneously. As I have indicated, *lanco* boundaries theoretically enable boats to keep a safe distance from one another. Where fish are concerned, however, there are no such limits, and fishermen tend to depart somewhat from predetermined water space as the need arises to secure a satisfactory catch. As a result, the crew working on one *lanco* may be cut out of the waterspace otherwise reserved for it by a crew working on an adjacent *lanco*. Still another possibility is that the best *lanco* on one fishing spot will overlap somewhat with that of another spot located immediately upstream or downstream. In this case, *lanco* boundaries may be correctly observed by the boats involved. What frequently happens, however, is that the crew working upstream takes too much time in hauling its net and in the process interferes with a downstream crew, even though the two begin operating at different tide levels. Such infringements, although they may appear trivial, nevertheless generate much hot debate and occasionally end in serious long-term disputes.

Perception of Crowding in Fishing Strategies

Possible timing conflicts like the above, which are of a purely ecological nature, provide much of the background for competition in canoe fishing. Without forcing the issue at this point, there are at least two things about canoe fishing which imply its vulnerability to population pressure under the impact of nylon nets. The conversion of a segment of the traditional fishing community to more efficient gear took place within the context of the spatial limitations inherent in following the lunar-tide routines which are adaptive to estuary fishing. Under this system, large otherwise potentially fishable areas are ruled out by adverse currents so that a "massing effect" of net specialists is created where spots are available. The number of actual choice alternatives is further reduced because not all spots defined as appropriate by lunar-tide reckoning are thought to offer equal potential for fishing. Instead, they are rank-ordered by considerations such as daily weather, distance from home port, and past history of production.

The second limitation in expanding fishing operations (without somehow simultaneously increasing the range of boats), concerns the fixed-territorial aspect of the fishing grounds. Because canoes as they are presently outfitted are unsuitable for ocean travel, all fishing activity is confined to the local river-estuary system. The lack of ice to preserve the catch and the scarcity of fish-marketing alternatives outside the town of Valenca itself further reinforce transportation limits that set the boundaries of fishing waters. Any addition of production units to the fishery, therefore, has had to be accommodated within a fixed territory.

The modernization trend in canoe fishing did not alter either of the above systemic or range restrictions. It involved only the application of a new and purportedly more efficient catching system. The new gear, however, did not displace traditional methods. It merely increased the total number of production units competing for use of the fishing grounds through the addition of several hundred new nets distributed among some 70 new crews and canoes. It is necessary to ask if the environmental base of fishing was adequate to absorb such a large and relatively sudden increase in fishing units.

As noted earlier, there is little possibility of excessive predation in these waters, since the estuary is periodically replenished by open ocean stocks. Fishing pressure, rather, would appear to be controlled by the number of fishing opportunities which may be appropriately scheduled to coincide with the arrival of fish at different phases in the tide cycle. Therefore, one way to evaluate population pressure on the fishing grounds would be in terms of numbers of production units (canoes rigged for net fishing) as against the numbers of available net-fishing spaces in contention. In this formulation, the notion of a carrying capacity threshold in fishing may be retained. However, it would be expressed simply in terms of the concentration of boats compared to the total configuration of fishing spaces (*lancos*) activated each day by lunar-tide reckoning. If the maximum permissible boat concentration/fishing space ratios were exceeded, then the stage might be set for unavoidable cut-throat competition, though not necessarily with implications of overfishing. To evaluate the impact of nylon nets, we must know whether fishermen still had the margin of choice they needed to make satisfactory decisions of where to fish. Or, had this decision become increasingly hazardous owing to scarcity of preferred water spaces?

To begin to get some idea of the expansion capacity threshold for net fishing in the sense of territorial access possibilities, I first calculated from my data on fishing spots (*pesqueiros*) how many net shooting spaces (*lancos*) were in theory available at the beginning of each of the four phases in the tide cycle (spring, neap, waning, and waxing). These calculations included only water spaces available for the main competitors: crews using a large traditional encircling net and dragged net, and the nylon beach seine and drift net. On the average 980 *lancos* were theoretically open for fishermen using these methods to choose from each day during the tide cycle. This figure can be taken as representing the maximum possible boat load the tidally activated fishing territories could support each day. By the same token, if all such water spaces were occupied whenever they were available by a separate fishing crew, this can be considered the "optimal" distribution of boats from the standpoint of minimizing territorial competition and maximizing access to the fishing grounds.

Having determined *lanco* possibilities, I proceeded to record the total number of actual fishing trips by both traditional and nylon net specialists to compare with the above "boat load" threshold. This was done for each phase of the tide cycle during a summer month (November), and in winter (August). Not all net crews in question made trips at all tide phases surveyed. On the average, 57 were tracked each day at the summer check and 79 in winter.

Figures on trips compared with water spaces available are summarized in Table 1. Before these data can be properly evaluated, it is important to note the basis for several discrepancies in the production unit/fishing space ratios. First, not only were there more boats fishing in winter (taking advantage of spawning runs up the estuary), but also fewer net-fishing areas were available to accommodate them. The winter shortage is due to the elimination of the northern ocean beach, neap-tide fishing grounds (see Map 2), along with portions of the spring-tide fishing grounds at the southern tip of the estuary. Rough water and unfavorable winds make travel to these areas difficult.

Second, there are absolutely fewer fishing spaces at neap and spring tide phases than when the tide is in its intervening waxing and waning stages. Spring tide, moreover, is the least well-supplied phase of all in terms of fishing space. These differences are very likely due to a distance factor. Both spring and neap-tide grounds are more distant than falling and rising phase grounds, which are centered on the main body of the estuary in the north. Farther away from home port, one might expect to find fishing spaces less concentrated than close in. In any case, relative distance must be considered by fishermen in deciding where to fish. Fewer boats worked the more distant neap and spring-tide grounds, at least on the days when trips were recorded, and fishermen generally recognized fewer appropriate water spaces for their nets in these zones. Variations in the number of lunar-tide correspondences thus reflect the total range limitations on nets caused by the variable action of the tides over the estuary.

TABLE 1
Boat Concentration/Fishing Space Ratios

Tide Phase	Spring Outer Southern Grounds	Waning Tide Inner Grounds	Neap Tide Outer Northern Grounds	Waxing Tide Inner Grounds	Averages
SUMMER					
Net Fishing Spaces	945	1270	915	1510	1160
No. Boat Trips	46	66	47	69	57
Boat-Load Fishing Space Ratios	1/21	1/19	1/19	1/22	1/20
WINTER					
Net Fishing Spaces	610	930	655	1065	820
No. Boat Trips	71	82	69	84	79
Boat-Load Fishing Space Ratios	1/9	1/10	1/9	1/12	1/11

At first glance, today's ratios of boats to available water space might indicate that there is still ample room for increasing the number of production units in fishing. Obviously, however, the maximum carrying capacity of fishing, if it is defined as complete utilization of water spaces, is unrealistic. This would allow no flexibility in choosing where to fish, and the tendency of fishing to concentrate in certain areas, of weather to change abruptly, and of boats to shift destination accordingly, makes some margin of flexibility in choosing fishing spots imperative.

I do not intend to attempt to determine an exact boat load figure which would signify the carrying capacity threshold of canoe fishing on the basis of choice margins. The point is, however, when criteria for rank-ordering fishing spot alternatives are introduced, such as weather, distance, and fishermen's desire to monopolize net casting areas, existing choice margins are really not generous (there are 57 sets of 21 nonoverlapping, noncompetitive fishing spot choices for summer net crews in contrast to 79 sets with eleven alternatives each for winter crews).

Nevertheless, it is possible to judge somewhat more conclusively the adequacy of alternative choice margins to enable net crews to avoid competitive encounters on the fishing grounds. One important consideration here is that competitive pressure over net territories has lessened in the ten year period since the first nylon nets were adopted. Many of these nets are no longer in use, and there has been a corresponding trend in specialization away from traditional net fishing. Present boat loads may thus be viewed as the natural outcome of earlier economic choices made by fishermen to ease competition.

A second consideration in evaluating expansion capabilities concerns the relative distance of fishing spots. As I have suggested, there are numerous reasons this factor may be used as an important ranking criterion in the way fishermen reduce alternative choices. It is often necessary to negotiate difficult tide changes in getting to and from the fishing grounds. Generally, the farther away from home port a spot is, the more difficult it becomes to time the optimal ordered sequences of fishing events—departure on an ebb tide, claiming a *lanco* before competitors arrive, net casting, and getting fish back to market on a flood tide at peak selling hours before they spoil in the sun.

If distance is indeed as critical as I assume in determining where fishermen go, then one would expect the outer limits of the fishing grounds not to be as heavily fished as the inner grounds. Yet, in the trips I recorded there is only a slight difference in boat leads, despite the considerable distance interval (roughly three hours rowing under sail) which separate inner and outer grounds. The outermost fishing areas activated at neap and spring tides are even further away in terms of time. Thus, even the slightly reduced boat loads on the outer neap and spring-tide grounds may be significant in interpreting canoe-fishing expansion potential. In these areas, fishing opportunities are fewer relative to other tidally activated zones. Their correspondingly reduced boat loads may thus represent an adjustment to minimum conditions for preserving the fishing spot choice margins needed for noncompetitive fishing. That is, the maximum number of production units that can be supported effectively by the range of Valenca waters may be limited by the tide phases when fishing spots are minimal, i.e., spring and neap tides to which the outer grounds are attached.

One source of evidence bearing on this possibility lies in the incidence of disputes over fishing rights. In questioning fishermen on this subject, I was able to record where and when disputes had taken place. If we look at the pattern of disputes occurring both before and after innovation with nylon nets, an interesting correlation with tide phase limitations is found. Disputes are itemized in terms of their chronological markers and locations in Table 2.

What these findings indicate is that competition for fishing spots and ensuing disputes occur more often on the least accessible fishing grounds, within the tide phases theoretically offering the fewest available fishing opportunities, relative to the demand for noncompetitive fishing space.

A final estimate of the degree of crowding in canoe fishing may now be made by asking what fishermen themselves consider to be a reasonable margin of choice, and whether this can be exercised. It proved impossible to count preferred locations and compare these data with boat loads to obtain precise measures of crowding since "preferred" sites are never fixed for more than a few hours. When they decide where to fish, captains always have fixed points of reference. They always return to the same considerations in the procedure used to rank-order options. In this fashion, trip destinations are predetermined but fishermen are able to switch to alternate locations as they receive fresh information on the way out to the estuary. Options are selected by anticipating the kinds of fresh information they may have to consider, such as a sudden change of weather.

While conducting some exploratory interviews on this question, I found that fishermen were considering factors other than timing, weather, and distance in ranking their options. Practically above all else, they tried to anticipate the chances of run-ins with competitors, and conversely, where their friends would be fishing—people they might rely upon for favors such as a tow back from the fishing grounds. In their probability calculations, fishermen were most of all concerned with the chances of having a spot to themselves. The question now is how to evaluate the relative weights of the various ranking criteria fishermen

TABLE 2
Location of Disputes

	Waxing and Waning Inner Grounds		Spring and Neap Outer Grounds	
	Summer	Winter	Summer	Winter
1950-1960 (Prior to Nylon Nets)	3	9	4	16
1960-1970	5	12	18	59
1971 (Fieldwork Period)	1	-	-	3

were using. In particular, how strongly did their expectations of competition and crowding affect their choices?

In setting up an interview to elicit these considerations, I assumed that fishing strategies would be planned according to perception of crowding, just as fishermen anticipated other factors to be operating. If the fishing grounds were indeed overcrowded due to "preferred" site scarcity, it seemed reasonable to expect this to show up in the kinds of fishing spot options selected. That is, depending on the value placed on certain of their characteristics, spots would either be rejected as unsuitable or left as options. The point was to determine whether anticipated competitive encounters were sufficient grounds for reducing alternatives, all other things being equal.

The first step in this process was to determine the range of fishing spots a captain had in view before the following day's fishing. My intention was to get fishermen to be explicit about the relative advantages and disadvantages of various spots, without forcing them to simplify among them. Ultimately, this procedure yielded a body of preliminary information concerning the process whereby certain fishing spots are eliminated from the total range being taken into account according to lunar-tide reckoning.

After this initial breakdown, it was possible to sort out the types of considerations which occurred most frequently to narrow down fishing alternatives. Below is a list of these:

1. Distance from home port.
2. Size of fish which could be caught.
3. Variety of fish which could be caught.
4. Whether day or night fishing would be possible.
5. How abruptly the daily tide would rise and fall in a specific location.
6. Whether the weights and tow lines on a fisherman's net were long enough to match the depth range of the *lanco*.
7. How many other net crews might be going for the same *lanco*.
8. Relationship with captains in charge of other net crews that might be encountered—i.e., whether past relations had been co-operative or competitive.
9. Possible wind changes on the way out to the *lanco*.
10. History of the previous catches on the *lanco*.

Having obtained both a realistic range of spots and decision criteria, the next step was to encourage fishermen to narrow their choices, much as they would do naturally in planning a fishing trip. As before, I had them discuss the advantageous and disadvantageous characteristics of the spots they were considering. However, this time they were asked to rank each fishing alternative on all the criteria obtained previously. From these orderings, four factors emerged as almost equally critical in differentiating spots: relative distance, the number of identical net crews which would likely be trying to work the same spot, wind changes that either impede or facilitate navigation, and memories of previous catches.

Having established these principles, a final series of interviews was conducted with five traditional and five nylon-net fishing captains. Each fisherman was asked to name his range of preferred sites for the following day's trip and differentiate each according to the above four criteria. This was done on three consecutive days for a spring-tide and rising-tide phase to cover fishing plans for inner and outer grounds. As fishermen verbalized their choice simplification procedure, their considerations for a criteria preference scale was formed. For traditional fishermen, all other things being equal, perceived competitive possibilities emerged as the foremost criterion for ranking options, followed by distance, production history, and wind changes. While nylon-net fishermen perceived crowding as a factor, it was only third in importance behind distance and memory of previous catches.

Too few fishermen were interviewed on this topic to draw any wide-ranging conclusions about the role of anticipated competition in motivating fishing strategies. If pressure on prime water space were not much of a problem, however, it is doubtful that it would have entered so consistently into captains' plans. The fact that nylon-net fishermen seem to be paying less attention to expected boat concentrations may be due to the fact that they stand less to lose in equipment in a competitive encounter than the traditional captains. Nylon-net captains do not own their equipment, and thus may be more prone to risk-taking.

SUMMARY

In a small-scale coastal fishing system like the one just described, the carrying capacity issue may appear in several forms, disguised as an economic slump, an increase in competition, or an escalation of disputes arising at sea or on land which are carried over into fishing. The carrying capacity issue came to light in Brazil as I examined how fishing captains plan their trips to different parts of estuary fishing grounds. In any given year, a wide range of catches is possible compared with previous years. Catches may paradoxically increase for a short period and then begin an abrupt decline. When modernization occurs, this catch fluctuation is even more likely, as competition for prime production areas increases. A fishery with customary permanent or temporary territorial rights may revert to the status of common property, a trend which is detrimental to the whole industry. Thus, the first task of carrying capacity analysis is to distinguish actual population-induced welfare reduction from ordinary economizing behavior under conditions of temporary resource scarcity. However, both situations make it necessary to alter the strategy of production. Where population pressure is truly manifest, peoples' conception of the distribution and availability of a resource may change radically. Here I have outlined a way to evaluate the carrying capacity of a fixed-territorial fishery indirectly by focusing on fishermen's perceptual change of resource and territorial availability. Information on this topic is readily accessible through analysis of the daily decision-making procedure used to select fishing spots.

The second goal of this carrying capacity study, where the lack of proper biological surveys forced me to seek alternative measures, is to examine fishermen's own conceptions of the sources of fishing pressure, its tolerable limits, and its consequences. Carrying capacity represents an ideal threshold, but I have found that fishermen in Brazil definitely seem to operate and organize production in terms of what might be called an ethnoecological model of resource use. Even under their own traditional methods, they regard both overfishing and cut-throat competition as a situation which may well develop given the proper incentives. The incentive most to be avoided is any outside factor which will disrupt the flow of authority over fishing territories and their customary means of recruitment of manpower to fishing. Controls on the opportunity structure of fishing are consciously and deliberately exercised by traditional captains who own chunks of lunar-tide fishing space. The knowledge of how to exploit fish stocks and the use of fishing equipment is passed on to only a few apprentices who will become really proficient net-casting specialists. In the Brazilian case, prior to the introduction of nylon nets, competition was directly curbed by fishing property rights which had evolved over generations along with a strict ethic of co-operation in all activities surrounding production. Moreover, the cyclical shift of activity from inner to outer grounds resulting from tide-level changes provided some relief to fish stocks native to the local estuaries which would otherwise be exploited on a continual basis.

With certain modifications along lines I have suggested, the biological concept of carrying capacity may be retained to help visualize the limits to fishery expansion. In the case of canoe fishing in Bahia, traditional fishermen themselves did much toward stabilizing their production system. The critical point here is the time depth of their adaptation. Through an extended period of trial and error, it was possible for fishermen to interpret expansion limits and set the intensity of fishing accordingly. In planning their economic strategies as if there were always a potential overfishing situation, they had established temporary territorial claims which insured that only a gradual expansion of fishing operations took place. Thus, the opportunity structure of traditional fishing, and by extension the population as a whole, was able to grow at a resource harvest rate which was compatible with continuing resource availability within a fixed location. Trouble only came to canoe fishing when the previously adaptive ratio of production units to available water space was disrupted by the unregulated entry of a competitive group of nylon fishing entrepreneurs.

APPENDIX*

Fish Taken in Valenca Waters

Local Name	*Scientific Name*	*English Name*
Agulha		
Agulhão bandeira	*Istiophorous albicans*	Sailfish
Agulhão verdadeira	*Tylosurus marinus*	Billfish
Amoreatim	—	—
Aracanguira	*Alectis ciliaris*	Threadfish
Aramaçã	—	—
Arraia duas bocas	—	Ray
Arraia fita	—	—
Arraia jamanta	*Monfa biuostris*	Devilray
Arraia jereba	—	Ray

Arraia pimenta	—	Ray
Arraia pintada	*Aetobatus narinari*	Ray
Arraia verdadeira	—	Ray
Badejo	*Acanthistus brasilianus*	Sea bass
Bagre amarelo	*Tachysurus luniscutsis*	Catfish
Bagre arituí	—	Catfish
Bagre arituaçú	—	Catfish
Bagre baguri	*Genidens genidens*	Catfish
Bagre bandeira	—	Catfish
Bagre bôca mole	—	Catfish
Bagre	*Tachysurus barbus*	Catfish
Bagre sapo	—	Catfish
Baiacú	*Lachtophrys trigonus*	Common trunkfish
Baiacuara	—	—
Baiacú de espinha	*Cyclichtys spinosus*	Puffer ?
Baiacú-ferreira	—	—
Baiacú-mirim	—	—
Barbeiro	*Acanthurus bahianus*	—
Barbudo	*Polynemus virginicus*	Goatfish ?
Beijuperá	*Rachycentrou canadus*	White grunt
Bicuda	*Sphyraena* sp.	—
Bobó	—	—
Bomhomen	—	—
Botó	—	—
Budião	—	—
Cabeçudo	*Caranx hippos*	Crevalle jack
Cação agulhão	—	Shark
Cação baiacú	—	Shark
Cação bico doce	*Justelus canis*	Smooth dogfish shark
Cação canexa	—	Shark
Cação cauacú	—	Shark
Cação estrella	—	Shark
Cação lixa	*Nebrius cirratum*	Shark
Cação Lustroso	—	Shark
Cação mambimba	—	Shark
Cação panã	—	Shark
Cação sombrero	*Sphyrna tudes*	Hammerhead shark
Cação sucurapoia	—	Shark
Cação-tintureiro	*Galeocerdo cuvier*	Tiger shark

Cação-viola	*Rhinobatus percelens*	Guitar fish
Cambuba	—	—
Camurupim	*Tarpon atlanticus*	Tarpon
Caranha	—	—
Carapeba	*Diapterns rhombeus*	—
Carapau	*Cloroseombrus chrysurus*	—
Carapicum	*Encinostromus californiensis*	—
Canapum	*Promicrops itaiara*	Jewfish
Cascudo	*Plecostomus* sp.	—
Caramura	—	Eel
Chumberga	*Caranx srysos*	Bluerunner
Clariosa	—	—
Curimã	*Mugil cephalus*	Striped mullet
Dentão	*Lufjanus aga*	Snapper
Dourado	*Coryphaena hippurus*	Dolphin fish
Durmioco	—	—
Enchova	*Pomatomus saltutrix*	Bluefish
Galo (verdadeiro)	*Vomer setapinnis*	Moonfish
Gato	—	—
Guaçani	—	—
Guaribebé	—	—
João de ar	—	—
João Duro	—	—
Jabú	—	—
Juruna	*Elops lacerta*	Ten pounder
Linguado	*Paralychthys brasilienis*	Flounder
Maçambí	—	—
Manjuba	*Anchoviella hubbsi*	Anchovy
(vermelha)	—	Anchovy
(lirio)	—	Anchovy
(cara de cachorro)	—	Anchovy
(de roda)	—	Anchovy
Margarida	*Diplecturm formosum*	—
Mariuá	—	—
Merete	*Promiorops ?*	Small jewfish
Mikim	—	—
Mirorô	—	—
Mirorô-mirim	—	—
Mirucaia	—	Thimble-eye mackerel

Mucutucuçú	—	Eel
Navalha	—	—
Obarana	*Elops sauras*	Ladyfish
Olho de miguel	—	—
Olho de vidro	—	—
Pampo (espinha-mole)	*Trachinotus glaucus*	Pompano
Papa-terra	*Menticirrhus martinisensis*	Kingfish
Piampara	—	—
Piaú	*Leopovinnus* sp.	—
Parú	*Pomacanthus para*	Spadefish
Penima	—	—
Peixe Porco	*Balistes vetula*	Triggerfish
Peixe-pena	—	—
Pegador	—	—
Pescada amarela	*Cynoscion acoupa*	Sea trout
Pescada aratanha	*Bairdiella ronchus*	Ground drum
Pescada branca	*Cynoscion leiarchus*	Sea trout
Pescada camina	—	Sea trout
Pescada de dente	—	Sea trout
Pescada perereca	—	Sea trout
Pescada sete bouchas	—	Sea trout
Pescada savage	—	Barracuda
Pipira de lixa	—	—
Pirira clariosa	—	—
Pira boca	*Lobotes surinameusis*	Tripletail
Premetara	—	—
Rabo Aberto	*Ocynrus chrysurus*	Yellowtail
Redondo	*Peprilus paru*	Harvest fish
Rico manda	—	—
Robalo branco	*Centropomus ensiferus*	Snook
Robalo caramuri	—	Snook
Robalo camurupi	—	Snook
Robalo ripa	—	Snook
Roncador	*Boridia grossidens*	Grunt
Sabão	—	—
Sardinha verdadeira	*Sardinella aurita*	Smooth sardine
Sauara	—	—
Saúna	—	—
Saramonete	—	—
Sardinha mulata	—	Sardine
Sardinha de água clara	—	Sardine
Sororoca	*Scomberomorus*	King

Taínha	*Mugil brasiliensis*	Mullet
Taínha bandeira	—	Mullet
Taínha pratibú	—	Mullet
Tapa	*Eropus crossatus*	—
Tapa redonda	—	—
Tirirí	—	—
Treme-treme	*Narcine brasiliensis*	Red gurnard
Traeira	—	—
Vermelho	*Lutjanus aya*	Lane snapper
Voador	*Exocoetus evolans*	Flying fish
Xangô	—	—
Xaréu	*Caranx* sp.	Jack

* **Note**: The list contains a fair number of locally named species which either have no accepted English equivalents or for which I was unable to obtain a scientific classification. Where correspondences are given, however, they were taken from *Glossario de nomes dos peixes:portugues, ingles, sistematico. Boletim de Estudos de Pesca* 4:11-40.

NOTES

1. I express my appreciation to the American Philosophical Society for a grant-in-aid which made this research possible. Also, I thank Charles Frake and Charles Drucker for their comments on an early draft and Sally Stevenson, who drew the figures.
2. The utility of the usual form of carrying capacity analysis to predict population pressure has been criticized on a number of grounds: (1) diminished welfare can be the result of various processes, not simply population growth (Street 1969:104-107; Bender 1971:40). The a priori assumption of the model is that production functions are fixed or that the populations considered do not optimize under conditions of scarcity; (2) that existing consumption levels accurately represent the nutritional status quo of the population; (3) that no universally applicable carrying capacity measure can be derived since the ethics of land-use vary cross-culturally and through time (Johnson 1974).
3. On Charles Frake's suggestion I have adopted the terms "waxing" and "waning" to refer to the tide changes between spring and neap which coincide with the intervals of lunar passage. For the period between new moon and first quarter, for example, Brazilian fishermen use the term *mare de quebra*. The period between first quarter and full they call *mare de lancamento*. So far, I have been unable to find recognized English nautical equivalents for the Portuguese.

BIBLIOGRAPHY

Allan, W. 1965. The African Husbandsman. New York.

Anderson, R., and C. Wadel (eds.) 1972. North Atlantic Fishermen: Anthropological Essays on Modern Fishing. Newfoundland Social and Economic Papers, No. 5, Institute of Social and Economic Research. Memorial University.

Bender, D. R. 1971. Population and Productivity in Tropical Forest Bush Fallow Agriculture. Culture and Population, A Collection of Current Studies, ed. S. Polgar, pp. 32-45. Carolina Population Center, Monograph No. 9, University of North Carolina.

Carneiro, R. 1956. Slash and Burn Agriculture: A Closer Look at its Implications for Settlement Patterns. Man and Culture, ed. A. Wallace, pp. 229-234. Philadelphia.

Cordell, J. 1974. The Lunar-Tide Fishing Cycle in Northeastern Brazil. Ethnology 13: 379-392.

Forman, S. O. 1966. Jangadeiros: Raft Fishermen of Northeastern Brazil. Unpublished Ph.D. dissertation, Columbia University.

——— 1970. The Raft Fishermen. Bloomington.

Grossinger, R. S. 1975. The Strategy and Ideology of Lobster Fishing on the Back Side of Mt. Desert Island, Hancock County, Maine. Unpublished Ph.D. dissertation, University of Michigan.

Harpending, H. 1974. Genetic Structure of Small Populations. Annual Review of Anthropology 3: 229-243.

Johannes, R. E. 1976. Exploitation and Degradation of Shallow Marine Food Resources in Oceania. The Impact of Urban Centers in the Pacific, ed. R. W. Force and B. Bishop, pp. 47-72. Pacific Science Association. Honolulu.

Johnson, A. 1974. Carrying Capacity in Amazonia: Problem in Theory and Method. Paper presented at the 73rd Annual Meeting of the American Anthropological Association, Mexico City.

Klee, G. 1972. The Cyclic Realities of Man and Nature in a Palauan Village. Unpublished Ph.D. dissertation, University of Oregon.

——— 1976. Traditional Time Reckoning and Resource Utilization. Micronesia 12: 211-246.

Marr, J. C. 1976. Fishery and Resource Management in S.E. Asia. Resources for the Future Program of International Studies in Fishery Arrangements. No. 7, Washington.

Nietschmann, B. O. 1974. When the Turtle Collapses, the World Ends. Natural History 83: 34-43.

Street, J. M. 1969. An Evaluation of the Concept of Carrying Capacity. The Professional Geographer 21: 104-107.

Shifting Marital Alliances Among the Bo

Fu

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There has been considerable debate in the anthropological literature re; the function of patrilateral parallel-cousin marriage. In his summary literature, Khuri (1970: 598-604) divides the functionalist approaches t marriage into three major categories: (1) FBD marriage serves to p property in small descent groups; (2) FBD marriage strengthens and rei political ties within the minimal lineage; and (3) FBD marriage allc agnatic segmentation and structural opposition, which result in a better ; tion to complex environments.

More recent studies have demonstrated inadequacies in these explar For example, Khuri's investigation of two Beirut suburbs revealed tl sistence of FBD marriage "despite the diminishing importance of the family as a property, power, or status group" (Khuri 1970: 606). ! authors including Barth (1973) and Aswad (1971) have suggested that the matter of FBD marriage be reconsidered. According to Barth (1973:13-1 must be recognized that FBD marriage is one of an arsenal of possible mc securing social position. When . . . opposed interests emerge betweei collaterals some of them will seek to align by marriage . . . At the same t is also necessary to establish new alliances, and to renew old ones.' marriage from this perspective is but one option in a series of alliance str that individuals may choose depending on the ecological circumstances.

A similar approach to FBD marriage is taken by Spooner (1973). S; notes that among the Bedouin demographic processes often do not p suitable marriage partners (FBD) and some members of the group mu mates in other categories. In the latter case, however, exogamous marria; not randomly contracted but are established to "maintain reliable relatic with other groups in ecologically strategic places" (Spooner 1973: 31). Spc analysis suggests that while the Bedouin may advocate marriage with the actual marriage patterns shift from endogamy to exogamy, dependi problems faced by individual families.

My own field work among the Pastoral Fulani strongly supports the e(al perspective which interprets all forms of marriage (including FB solutions to specific contextual ecological, economic, and political prol